Exploring Grade 10 Learners' Engagement with the Kahoot Game in Physical Sciences: Action Research Study in Umgungundlovu District

By

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Abstract

Digital educational games can enhance learners' engagement in learning different concepts. This action research study, therefore, endeavoured to enhance learners' engagement when learning Physical Sciences via a digital Kahoot game-based learning tool. The qualitative study was carried out with one grade 10 Physical Sciences class, consisting of ten female participants who all opted to participate in this study. Five action research cycles were followed to respond to the research questions. The first action research cycle was conducted by a pre- and post-intervention questionnaire that was administered to recognise any shift in learners' engagement. Learners were then asked to complete diary entries concerning their emotional, behavioural, and cognitive engagement after each of the three Kahoot games played. A teacher log was used to allow reflection concerning the implementation of the intervention. The learners and the researcher spent more time on reflection in the 2nd- 4th action research cycles to implement changes for improving engagement. Learner interviews were conducted finally, with five participants to gain further insight into their engagement. Based on the evidence obtained from the data collection tools, the participants in the study found learning Physical Sciences prior to the game interesting because of watching videos and conducting practical investigations. They viewed Kahoot to be more interesting, exciting, and fun. Learners were not cognitively engaged with learning Physical Sciences via the Kahoot game because it has a cognitively undemanding nature. The outcome was not exactly what was anticipated. That is, I had concealed strong suspicions that the Kahoot game would increase all three dimensions of engagement positively. However, the findings indicated that learning Physical Sciences via the Kahoot game increases two out of three learner engagement dimensions. The findings that emerge from this study will inform the way games and used to promote the teaching and learning of Physical Sciences.

Keywords: Learner engagement Game-based learning; Action Research; Kahoot

Declaration

I, Nontokozo Mbokazi, 213507545 declare that:

• The research reported in this dissertation is my original work, except where otherwise indicated.

• This dissertation has not been submitted in any form for any degree or diploma to any tertiary institution.

• This dissertation does not contain other persons' writing, data, pictures, graphs, or other information, unless specifically acknowledged as being sourced from other researchers.

• This dissertation does not contain texts, graphics or tables copied and pasted from the internet, unless specifically acknowledged, and the source is detailed in the dissertation and the references section.

Signature: _____ Date: July 2022

Nontokozo Mbokazi

This dissertation was supervised by Dr. Doras Sibanda at the University of KwaZulu -Natal, Edgewood Campus.

Signature: _____ Date: July 2022

Dr. D. Sibanda

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Dedication

To my late grandmother, Veronica Sizakele Mbokazi.

Thank you for always believing in me.

List of abbreviations/acronyms

CAPS	Curriculum and Assessment Policy Statement
COVID – 19	Coronavirus
DBE	Department of Basic Education
Edu-Tech	Technology in Education
FET	Further Education and Training
GBL	Game-Based Learning
IA	Interaction Age
ICT	Information Communications and Technology
KZN	KwaZulu-Natal
NS	Natural Sciences
NSC	National Senior Certificates
POE	Predict Observe and Explain
PS	Physical Sciences
SA	South Africa
SRS	Student Response Systems
UAE	United Arab Emirates
USA	United States of America
3IR	Third Industrial Revolution

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Chapter 1 - Introduction

This chapter endeavours to provide a preamble and context to the more focused research problem statement and the objectives of the study. Firstly, it introduces the study with an opening section; it describes the background of the study, followed by the statement of the research problem, the research purpose, aims, objectives and research questions. Thereafter, it accentuates the motivation/rationale for conducting the study, the significance of the study, the context of the study, the limitations of the study and finally, the structural outline of the study along with a conclusion of the chapter.

1.1 Opening section

According to Dhurumraj (2013), Physical Sciences (PS) as a subject in the Further Education and Training (FET) phase is considered one of the challenging subjects because of the overall decline in performance indicated by the National Senior Certificate (NSC) PS results in KwaZulu-Natal (KZN). There are inconsistent interpretations and an overall shortage of research regarding how best to engage learners in a subject, such as PS, where content knowledge seems to be abstract and massive to comprehend. Learner engagement research has established that learners' motivational, emotional, and cognitive engagement levels are essential contributors to increased success in teaching and learning a subject. Therefore, this study explores learners' engagement when learning PS. In this regard, the learner engagement concept is when the learner is actively involved in their learning in three dimensions: emotionally, behaviourally, and cognitively.

The research intends to explore learners' engagement in PS with and without the intervention of a Kahoot game-based learning (GBL) approach. Kahoot is an online student response system

(SRS) formed to manage quizzes, support discussions and store survey data. It encourages learners to approach lessons as fun games rather than as boring or mandatory processes. The GBL learning approach is explored in this study for learning PS in the 21st century and in the third industrial revolution (3IR) for its relevance to our learners who are digital natives.

1.2 Background of the study

Learners have faced several challenges when learning PS. Mji and Makgato (2006) argue that one of these challenges causing a decline in the pass rate is learners' lack of motivation and engagement in learning PS. Adding to the challenges, learning at schools in South Africa (SA) and most of the world was disrupted due to the lockdown dictated by the Coronavirus (COVID-19) pandemic (Mhlanga & Moloi, 2020). To mitigate the extent of academic disruptions caused by the pandemic, many learning institutions in developed countries responded by moving to digital learning platforms to continue learning. According to Mhlanga and Moloi (2020), the occurrence of COVID-19 surfaced as a wake-up call for the education field in SA.

COVID-19 has also performed as a motivating factor for digital transformation in the education sector. Although the Department of Basic Education (DBE) has been executing online technology, the implementation has been sluggish. Songer and Ruiz-Primo (2012) claim that research about technology in education (Edu-Tech) is on the rise, and there is a necessity for research about the benefits of using technology for evaluation in science education. Among the applications that are at the leading edge of innovation and hold promise for educational purposes, digital games are an emergent form of modern learning (Brill & Park, 2008). Moreover, they argue that in this Interaction Age (IA), technologies will contribute to learner

engagement. Amalgamating these arguments resulted in this study exploring a digital GBL tool to enhance learner engagement in PS.

My area of interest in this matter is to enhance NSC PS results in my school, resultantly, KZN results. The plan is to increase learners' engagement holistically (emotional, motivational, and cognitive) in PS using the Kahoot games. Schunk et al. (2012) argue that it is now necessary to change our focus to affective constructs and learner motivation since studies in science education are fixated largely on cognition. One of the best tools, which latches the three engagement domains, is the Kahoot GBL platform. GBL is a method of using games, amusement, and engaging approaches in educational contexts. Kahoot is an effective GBL tool to introduce new concepts or assess the extent of the content already mastered by learners. This study conducts qualitative action research to explore learners' holistic engagement in a lesson with and without the Kahoot game. Debatably, Caponetto et al. (2014) argue that research on educational games has been explored in less than 3% of research in the South African school context and this study explores Kahoot in a South African rural area context as a tool that can reduce the existing challenges elaborated in this study.

1.3 Statement of the problem

Conditions dictated by the pandemic have amplified existing challenges, such as disengaged and demotivated learners in PS (Pountney, 2022). Likewise, Asa'd and Gunn (2018) had a challenge on how to motivate learners to practise Physics. There have also been a few empirical studies and very slight consensus on what elements critically affect learners' engagement in a gamified milieu (Byun & Loh, 2015). The focus on learner engagement in Kahoot games, specifically the affective constructs, motivation and cognitive engagement when learning PS, is explored in this study. North et al. (2021) contend that there is now a need to produce

innovative and striking learning tools, learning approaches, and learning content that support the procurement of proficiencies. North et al. (2021) maintain that the changing demands of the new generations, 'Generation Y', call for structural change. There is evidence indicating that while most learners in SA are disengaged from learning, they readily play games on their cell phones. Bruff (2009) calls for deliberately incorporating cell phones with suitable applications into lessons to promote active learning, in preference to other games that do not support knowledge development. However, the use of cell phones has, from the start of the technology, been banned in most schools. Nevertheless, Anderson et al. (2007) reason that, under proper guidance, cell phones can be particularly useful for school purposes. A digital game with the potential to engage learners and increase their motivation in PS is explored in this study. Potvin and Hasni (2014) advance that creating positive attitudes, motivation and concentration in school activities and scientific subject matters is not a futile issue. Besides, Mudaly et al. (2015) see it as vital to develop curricular tasks that can support critical and creative interaction with new technologies.

1.4 Purpose of the study

The study is determined to explore Grade 10 learners' engagement with the Kahoot game in learning Physical Sciences.

1.5 Research aim

Arguably, there is minimal research regarding learner engagement in PS through GBL approaches. Thus, this study aims to explore the use of a digital GBL tool as a strategy to increase learner engagement to learn PS. However, this study is not intending to find the effectiveness of Kahoot as a game. The provision of functional data about the content of games

and game task formulation to mention a few are also best excluded from this study. GBL literature recommends that both player engagement and learning be considered relevant to assessment (Bellotti et al., 2013). In this study, the focus is on both the player/learner and their engagement when using Kahoot.

1.6 Research objectives

The objectives of the study are:

1. To understand the Grade 10 learners' interest in learning Physical Sciences before playing the Kahoot game.
2. To understand the Grade 10 learners' engagement when learning Physical Sciences after the intervention of playing the Kahoot game.
3. To understand why Grade 10 learners engage with the Kahoot game in the learning of Physical Sciences in the manner they do.

1.7 Research questions

The research questions that were addressed by the study are:

1. What makes the Grade 10 learners interested in learning Physical Sciences without using the Kahoot game?

2. How will the Grade 10 learners engage with Physical Sciences via the instruction of the Kahoot game?

3. Why do the Grade 10 learners engage with the Kahoot game in the learning of Physical Sciences in the manner they do?

1.8 Motivation/Rationale to conduct the study

My interest in this study was prompted by the global changes caused by the pandemic, which highlighted the need for introducing innovative technology into CAPS to support learning. I observed that when I was teaching science in the United Arab Emirates (UAE), a first world country, for the 2020 academic year, learning continued online, and learners were engaged through games. In particular, the Kahoot digital game maximised learners' participation and interest in the subject. I believe that exploring current digital pedagogical instruments would be an important approach to cultivating motivation among my learners in SA too for the 2021 academic year. This is in line with one of the aims of the DBE (2011) intended to provide quality teaching and learning that is equivalent in breadth and depth to that of other countries.

1.9 Significance of the study

This study is important because it will contribute to the literature on Kahoot games and contribute to the body of knowledge and skills for learning PS. Both teachers and learners will benefit from this study, which will explore a digital instrument for schools. The practical implications of the findings of this study may be important for teaching and learning practices. Educators will be able to understand learners' needs to be in a better position to increase learners' engagement. There is potential for learners' engagement in learning PS to increase when learning via the game. The study will contribute to the knowledge of how learners are engaged in a Kahoot game. It will support the researcher in education to utilise more updated and effective educational tools to enhance learners' engagement and their academic success rates in PS.

1.10 Context of the study

The study will be conducted in a public school in uMgungundlovu District in KZN in the rural area of Mid-Illovo. This is a small school that caters for approximately 150–200 learners, mainly from historically underprivileged communities. This school is among the first in the area to offer PS as a subject in 2021. Thus, the participants of this study are the first grade 10 PS class in the school.

1.11 Limitations and Delimitations of the study

Kahoot is an online game that can be played individually or in teams. This GBL tool has the potential to engage learners' affective, motivational, cognitive, and social aspects. However, due to COVID-19, social distancing regulations and time constraints the total of four engagement domains of the game were not explored. Specifically, the social constructs were excluded, when the game was played in a class by ten grade 10 PS learners individually and not in teams or groups.

The research was conducted in one PS class of all female learners. Although the school enrolment consists of both male and female learners, the research was guided by the participants of the grade 10 PS class who were of the same gender. The boys did not enrol in this first PS class of 2021. Therefore, the results cannot be generalised due to gender bias and the small sample explored in this study.

1.12 Structural outline

This study comprises five chapters. The chapters are organised as follows:

In Chapter One, the background of the study and the research problem have been presented. The research objectives and questions have been acknowledged, and the significance of the study is argued. The limitations of the study have also been deliberated.

In Chapter Two, the existing literature will be reviewed to identify the key strategies to increase learner engagement within the technology-intensive era, such as the GBL platforms. Thereafter, the conceptual framework of learner engagement in GBL environments will be presented and explained as the lens to conduct this study.

In Chapter Three, the research methodology and methods will be explained. The use of an interpretive research paradigm, qualitative research design and action research methodology will be justified. The sampling and research methods used will be discussed, including the ethical issues.

In Chapter Four, the characteristics of the participants and the data collected from each of the data generation tools used in this study are provided. Thematic analysis and inductive reasoning for the key findings will be discussed. A visualisation of the responses to each research question will be presented in tables and figures.

In Chapter Five, a summary of the research objectives, questions and key findings will be presented.

1.13 Summary

A brief synopsis of the motivation/rationale for the study has been described in this chapter. The chapter has provided the introduction in the opening section, the background of the study, the statement of the problem, research aims, research objectives, research questions and the significance of the study. The chapter ends by presenting a map of the study in the structural outline. The next chapter will present the literature review and the conceptual framework.

Chapter 2
Literature Review and the Conceptual Framework

2.1 Introduction

The following contemporary literature was reviewed regarding learner engagement, learner disengagement, the influence of learner engagement on academic success, GBL and Kahoot. The literature reviewed papers from 2012 to 2021. This chapter proceeds with an explanation of the conceptual framework that was used to make sense of the data collected in this study. A summary and a critique of the existing literature are presented later. Finally, a conclusion of the chapter is offered.

2.2 What is learner engagement?

Fredricks et al. (2019) state that the roots of interest in learner engagement were driven by the desire to improve learning. Similarly, in this study, learner engagement is the cornerstone for the improvement in the teaching and learning of PS. According to a study by Groccia (2018) on what is learner engagement, different authors have defined learner engagement as one-dimensional before 2012. However, after 2012, various authors modified the term learner engagement to be multi-dimensional. Groccia (2018) maintains that the concept of engagement has existed in literature for more than seventy years, with the meaning of the term evolving. This study conveys the history of the learner engagement concept, starting with Ralph Tyler, the pioneer of learner engagement to Fredrick, Reschly and Christenson, the advocates of learner engagement interventions for disengaged learners in the classroom environment.

According to Groccia (2018), the term *learner engagement* was popularised in the 1930s by an American psychologist, Ralph Tyler. He was one of the first authors to concentrate on learner engagement and defined it as the effects of time on a task or the effects of time on learning. Later, by 1970, Robert Pace modified Tyler's definition by stating that learner engagement is the quality of the effort put out by the learner. For instance, it is about more energy and time invested in educationally purposeful tasks such as studying, interacting with peers and teachers regarding essential matters, applying what was learnt to real life and tasks and so forth. Thereafter, by 1984, Alexander Astin extended Tyler and Pace's definitions of learner engagement. He converged learner engagement with his theory of Involvement in Learning. As it stands, Tyler, Pace and Astin portray learner engagement to be an action done by the learners to show that they are involved in learning. Similarly, Martin and Bolliger (2018) reason that there is a close relationship between interaction and engagement, such that they are used interchangeably.

The evidence of learner engagement was first categorised into seven practices: time on task, active learning, elevated expectations, respect for various learning styles, immediate feedback, and collaboration (Groccia, 2018). According to Groccia (2018), there were more than 1,000 academic papers located in literature during 2010 that were devoted to the concept of learner engagement. Groccia (2018) maintains that the evidence of learner engagement that emerged in 2010 was similar practices to the first seven practices: learner involvement, interest in learning, learner establishments and learner connection with the class and with each other. An additional aspect related to learner engagement to behavioural involvement and is a process experienced on a continuum synergistic between motivation and active learning (Groccia, 2018).

Nevertheless, Groccia (2018) maintains that though these definitions could improve learning, they only show an understanding of learner engagement as a one-dimensional perspective at the time. Groccia (2018) contends that most of the classifications of the term learner engagement already depicted in this review associate learner engagement with involvement in learning activities. Hence, the history of the term learner engagement from the 1930s is focused on learners' behaviour, which is a one-dimensional form of learner engagement (Groccia, 2018).

Alternatively, Groccia and Hunter (2012) provide an amendment term for the concept of learner engagement by describing it as multi-dimensional. Groccia and Hunter (2012) share that learner engagement extends beyond learning behaviours. In their study to support student learning and success, Groccia and Hunter (2012) define learner engagement as a process in behavioural, affective and cognitive domains. For example, a learner with some degree of participation or effort and persistence in the learning process has behavioural engagement, whilst a learner with a level of interest in the experience that results in improved motivation and enjoyment, thus establishing a level of commitment has affective engagement. Then, cognitive engagement involves learners who display a degree of mental activity, processing thought experiences and establishing linkages to experiences**.**

According to Groccia (2018), there was confusion with the term *learner engagement* in 2014, as it was problematic to know what people meant by it. This ambiguity makes the implementation of educational policy to support learner engagement difficult. For instance, Sabourin and Lester (2014) advance that learner engagement is evident in a learner if they show positive emotions, joy, and excitement. In that period, learner engagement was complicated as it was looked at as either a positive effect or motivated learners or cognitively engaged learners

in isolation. Finally, Groccia (2018) completed her historical analysis of the constructs of learner engagement with a definition she retrieved in 2016 from an online resource, Glossary of Education Reform, which defined learner engagement as the degree of attention, curiosity, interest, optimism, and passion that learners show when they are learning, leading to the level of motivation they must learn and their progress in their education.

In addition to the above, a diverse group of economists, sociologists, anthropologists and both developmental and educational psychologists began to discuss the concept of learner engagement as a potential unifying theme across their disciplines. According to Eccles (2016), he was put in charge of a group that discussed and agreed on metaphors related to the concept of engagement so that they could figure out what it is and how to study it most effectively. One metaphor of learner engagement that stood out for Eccles was learner engagement being what happens when "the rubber meets the road." This metaphor summarised the three dimensions of learner engagement. Other metaphors include the car's wheels as the psychological dimension and the road as the activity in which the individual is engaged. Therefore, the wheels enact motivation in an individual when on the road. Put simply, Eccles concluded that learner engagement can be generally defined as doing, feeling, and thinking.

This study uses the concept of learner engagement as a collective by Fredricks et al. (2019); learner engagement is multidimensional. It connects learners' behaviour (participation, learning time), emotion (feelings, affect) and cognition (solving problems, thought process). The behavioural elements are accompanied by a positive emotional tone of positive emotions expressed, including enthusiasm, optimism, curiosity, and interest during learning. Likewise, Groccia (2018) concludes that learner engagement is learner involvement in a subset of 'educationally purposive activities', leading to positive outcomes of learner success and

development, including satisfaction, persistence, academic achievement, and social engagement.

As the definitions above attest, learner engagement has taken many forms. Thus, in the efforts to define learner engagement for this study, the researcher took Fredrick's work by defining learner engagement as a holistic and multidimensional concept involving not only the learners' behaviour with the learning activity but their cognition and affective aspects as well. In this regard, the researcher defines learner engagement as a fused concept that means a level of interest, passion, joy, motivation, optimism, confidence and understanding demonstrated by learners when learning.

2.3 What is learner disengagement and negative engagement?

According to Groccia (2018), there are two opposing sides further complicating the concept of learner engagement. She states that while learners engage positively in one or more of the three dimensions, on the other side, learners might be negatively engaged in the other dimensions. Similarly, Chipchase et al. (2017) agree that whilst a learner is engaged in one unit of study, they may be concurrently disengaged in another. According to Chipchase et al. (2017), the constructs of learner engagement were complex, which implies that disengagement and negative engagement are complicated as well.

Disengagement cannot be simply understood as the absence of engagement aspects or the neutral to the negative pole of an engagement continuum. However, disengagement and negative engagement can be explained with evidence. Trowler and Schreiber (2020) state that the constructs of learner engagement could be positive, neutral, or negative on a continuum. An example of positive engagement in the behavioural/motivational construct is attendance

and participation, while a negative behavioural engagement may involve boycotting or disrupting classes.

Sabourin and Lester (2014) state that negative emotions, such as frustration, boredom, and anger, lead to decreased motivation, effort, and desire to be off task. Particularly, bored learners are likely to engage in harmful behaviours. Moreover, in their analysis of learner disengagement assessment in GBL, Soland and Kuhfeld (2019) report that a learner's response is considered disengaged if it were given too quickly. The assumption is that the examinee could not have fully comprehended the item's content. Therefore, such a learner is categorised as having a negative cognitive engagement. Furthermore, Chen et al. (2021) claim that exhaustion, environmental disruptions, boredom, mind wandering, distraction by an extraneous goal, impulsively responding and "gaming" the learning environment are likely to get learners disengaged. Thus, numerous factors can lead to disengagement or "off-track" behaviours, and these can be voluntary or involuntary. The time-course of completing a task is also an important consideration. For example, learners might begin a learning session with some level of interest and enthusiasm, but boredom or fatigue may creep in as the session progresses, as the novelty of the system fades or when they have difficulty comprehending the material as it becomes progressively more complex (Chen, 2021).

Trowler and Schreiber (2020) propose to simplify the term *learner disengagement* to be described as learner *non-engagement*, which has been adopted in this study as opposed to disengagement. Non-engagement occupies the neutral part of the learner engagement continuum between positive and negative engagement poles. Examples of non-engagement were said to be absenteeism, boredom, late or rushed or absent assignments. Moreover, Trowler and Schreiber (2020) describe learner non-engagement as withdrawal or apathy. The negative

pole, termed *negative engagement*, was proposed to be evidenced behaviourally: boycotting, picketing, disruption of learning activities, emotionally: the rejection of learning and cognitively: redefining the parameters of assignments, rapid guessing, and 'gaming' the system. Therefore, the literature reviewed synthesises that learner disengagement indicates the neutral part between learner positive engagement and negative engagement. It is noteworthy that the literature warns against using the terms *disengagement* and *negative engagement* interchangeably, as they are two separate concepts. However, non-engagement and disengagement can be used alternatively.

2.4 The relationship between learner engagement and academic success

According to Pedler et al. (2020), learner engagement sits at the heart of the teaching and learning process. They claim that learner engagement is important because it joins the three dimensions to improve learning, increase academic achievement more holistically and prepare learners to be lifelong learners. However, Lei et al. (2018) argue that the correlation between learner engagement and academic achievement is inconsistent. They published a meta-analysis of literature from 2003 to 2015 on the relationship between learner engagement and academic achievement of which, according to Lei et al. (2018), the extensive empirical research on this correlation shows multiple perspectives linked to the learners' behaviour, emotions, and cognition. Lei et al. (2018) outline that there was a significant and relatively strong correlation between learner engagement and academic achievement in 2010 and 2015. However, only a positive correlation between the learners' behaviour and feelings was discovered in 2015, whereas a positive correlation between academic achievement and the learners' cognitive engagement was noted in 2014. According to Lei et al. (2018), some researchers accentuated that in comparison to learners' engagement emotionally, behaviourally, and cognitively, it is

behavioural engagement that takes centre stage, as it is proven more obvious to show a positive correlation for academic achievement. Nevertheless, the conclusion from the findings of these studies states that the different dimensions of learner engagement have divergent relations with academic achievement.

In contrast, Lei et al. (2018) claim that other researchers found no significant correlation between learner engagement and academic achievement. A study in the United States of America (USA) showed that learners' engagement did not predict grade point average among African Americans; there was no significant correlation between learners' active emotional engagement and their Mathematics and English achievement scores. Lei et al. (2018) maintain that other researchers found that the correlation between cognitive engagement and academic achievement was weak. In conclusion, Lei et al. (2018) emphasise that the relationship between learner engagement and academic success remains ambiguous.

2.5 The significance of Game-based learning

Chandra and Watters (2012) claim that there is an extensive interest to involve Information Communication and Technology (ICT) in science classrooms. However, more evidence is needed on how ICT impacts the learning practice and the outcomes at the classroom level. One strategy that information technology software developers have taken has been to increase learner engagement through gamification (Mills, 2017). According to Oliver (2017), games are a universal part of the human experience; they are played everywhere on Earth, and they are present in all cultures. Serrano (2019) contends that GBL is not a new concept in education. Nonetheless, Wang and Tahir (2020) claim that there is a popular worldwide trend in education of using mobile online GBL tools, such as Socrative, Quizizz, Clickers and Kahoot, as

supportive educational tools to enhance learner engagement. Henceforth, Serrano (2019) highlights that there is increased usage of GBL by educators as more schools move to technology-based initiatives and increase the availability of digital devices and online resources. In the same way, researchers support that educational gamification is a technology-based method for increasing learner engagement and motivation for learning by playing educational games (Simões et al., 2013).

A study by North et al. (2021) coincides with Wang and Tahir (2020) in that GBL is increasingly recognised as beneficial for learner engagement and it is one of the predominant factors contributing to an increased motivational engagement in the process of playing a game. North et al. (2021) illuminate that learning content in a playful way increases the motivation of learners and promotes their learning process. Similarly, Ismail and Mohammad (2017) claim that GBL is important for improving learners' motivation and learner engagement, with learning through immediate effective feedback. Likewise, King and South (2017) advocate for Edu-Tech because it offers fresh and stimulating opportunities for learners and teachers. Furthermore, North et al. (2021) stress that GBL is important because it is increasingly recognised as beneficial for engagement.

In GBL, the role of the teacher helps to contextualise gameplay (All et al. (2014). However, this guidance could lead to problems with internal validity. There should be some rules about the role of the instructor during the intervention of a GBL tool to increase learner engagement. Hence, consideration for the positionality of the researcher is required. For instance, in their methodological review of measuring effectiveness in digital GBL. All et al. (2014) found that six experts agreed that the game component should be kept as isolated as possible, considering that other elements added to the intervention could influence learning, thus, confounding

results. Nevertheless, some elements that might be indispensable for practical reasons could be allowed. The introduction or training sessions should not contain substantive information on the learning content covered in the game and should only cover such elements as getting acquainted with the game elements and controls. Otherwise, participants with lower computer skills or less game experience will use up more cognitive capacity in trying to understand the environment, instead of the game or the idea behind the game. Hence, several experts also stated that the necessity to provide procedural help might be avoided by providing a training session before the intervention (All et al., 2014).

Another significance of games in education is that they are a popular form of entertainment, which can keep individuals motivated and engaged for hours at a time (Su, 2010). Digital GBL consists of two important elements: fun/entertainment and an educational component (Bellotti et al., 2013). Prensky (2001) introduced digital natives in 2001 and re-defined GBL to be the usage of game entertaining power to serve an educational purpose for the new generation of learners. According to Prensky (2001), "the new generation of learners is no longer the people our educational system was designed to teach" (p. 8). Similarly, Nussbaum and de Sousa Beserra (2014) express that digital GBL is the consequence of a balance between learning and gaming elements. Therefore, Juveng (2018) points out that this willingness to invest considerable hours in playing games has been studied by researchers, instructional designers, and game designers alike, with the goal of understanding and highlighting the elements that have positive or negative effects on the players.

Games have been recognised as potential teaching and learning tools due to their ability to integrate curriculum content with elements that nurture intrinsic motivation and learner engagement and facilitate different approaches to learning. Siegle (2015) endorses the use of

educational games as pedagogic learning tools to scaffold learners' development, thereby positively affecting cognition, motivation, emotions, and social identities. In addition, researchers agree that playing digital games can improve learners' engagement with learning and provide effective immediate feedback (Ismail et al., 2019). However, not all researchers agree with the use of GBL as a strategy to enhance learner engagement.

Bogost (2015) and Todd (2017) are some of the pivotal authors against GBL. Bogost (2015) considers the whole gamification context as 'nonsense' and calls it ‘exploitation ware’. Similarly, Todd (2017) states that GBL is ‘malarkey’, a term designed to obscure, mislead, or impress. Bogost (2015) maintains that he sees it as a rising popular trend that is pretentious, and focused on ideas and promise, but once it becomes established, it is worthless and becomes less important with repetition. Bogost’s (2015) argument directs that after several encounters with the game, there would be a negative engagement or disengagement. However, Todd (2017) highlights to those in support of GBL that if it is done properly, it can increase learner engagement. Chen et al. (2021) state that GBL is important because it can increase learner engagement. However, they highlight that the opposite can also happen. The learners can also experience disengagement and negative engagement in games just as they do in learning environments without gamification. Furthermore, Ismail and Mohammad (2017) claim that in their research about the effectiveness of Kahoot, female learners expressed less appreciation of digital GBL.

North et al. (2021) argue that further research is needed to explore the multi-faceted tenets of GBL. Likewise, in their study of gamification and education, Caponetto et al. (2014) recommend more research on educational games to contribute to gamification research

conducted in SA. There is a likelihood of digital games becoming an educational trend as they make them valuable applications in education (Chu & Hung, 2015).

2.6 Impact of Kahoot game on learner engagement

Gamification of instructional activities, such as using the Kahoot game, is a useful approach, as it has been shown to promote effective learning environments by increasing problem-solving, critical thinking and competence in the classroom (Whitton & Maclure, 2017). Amongst other popular educational games, Kahoot is a free online game learning platform that has gained wider acceptance and now has more than 30 million users worldwide (Plump & LaRosa, 2017). Kahoot was developed by Jamie Brooker and Johan Brand in 2015.

The Kahoot game helps to administer quizzes, facilitate discussions, and collect survey data integrated with gamification principles, such as sound and a scoreboard with a point system. Kahoot is both enjoyable and educational, engaging learners using quizzes relevant to their learning (Diana et al., 2021). Using Kahoot in the classroom means learners tend to be more motivated towards their learning; there is enhanced teacher-learner engagement, and learners have more constructive discussions with peers and their teachers (Plump & LaRosa, 2017). Uçar and Kumtepe (2017) maintain that Kahoot is still relevant for both online education and face-to-face learning contexts to promote learner engagement. Moreover, Martín-Sómer et al. (2021) concur that the use of Kahoot is still relevant in the trying times of the lockdown period caused by the COVID-19 pandemic to keep learners motivated.

In a study on improving problem solving skills in introductory Physics classes, Asa'd and Gunn (2018) specify that the best strategy necessary for engaging learners to learn PS was to introduce Kahoot. They introduced the Kahoot game and found that learners liked this game.

The learners responded that Kahoot motivated them to practise more problems and come to class better prepared (Asa'd & Gunn, 2018). On the other hand, Hakim et al. (2019) state that there were some challenges found with learners playing Kahoot. Hakim et al. (2019) reported that one such issue was the unreliability of the internet connection, as the 32 learners in their study of Kahoot for thematic learning maintain that they were attracted to the Kahoot game features. However, they were displeased by the lack of accessibility. Plump and LaRosa (2017) also argue that the Kahoot game has some shortcomings, such as the limit on the number of characters you can use in questions and responses; it requires a strong network connection, stable Wi-Fi and learners need their smartphones and an affinity for digital games.

Benhadj et al. (2019) state that previous studies recommend that future work needs to be more qualitative, with data in the form of words, text, or behavioural patterns, with appropriate analysis. Benhadj et al. (2019) recommend for future studies to focus on using the Kahoot game among a small number of learners, in a different subject, and it should assess learners' experience. They argue that such data will allow deeper insight into why learners have developed such a great liking for Kahoot and why it has sustained their interest. Such a study would surely allow for the 'voice' of the participants to be heard by means of interpreting potential observations and focus group interviews (Benhadj et al., 2019). In line with Benhadj et al.'s (2019) recommendation, this study is focused on exploring a small group of learners' engagement in learning PS via Kahoot.

The literature emphasises that Kahoot is a highly successful educational technology that could change how psychological theories of engagement and motivation are used in the classroom (Serrano, 2019; Ismail & Mohammad, 2017; Diana et al., 2021; Plump & LaRosa, 2017). Correspondingly, Plass et al. (2020) concur that Kahoot and games, in general, are a complex

genre, which creates learning environments that cannot be understood from only one perspective of learning. They maintain that the uniqueness of GBL cannot be defined only at an epistemological level, since game designers use behaviourist, cognitivist, and constructivist elements (Plass et al., 2020). Much effort is required in the design and implementation of the learning experience to be fully engaged, since it is not trivial to achieve a positive effect (Domínguez et al., 2013). Although much research has been conducted on GBL and its potential to engage learners, there have been very few studies focused on the actual engagement of learners in an interactive context of GBL (Byun & Loh, 2015). In this line of research, the present study introduces GBL to explore the learning engagement of the research participants.

2.7 Conceptual framework

According to Varpio et al. (2020), the terms, theory, theoretical framework, and conceptual framework, share common meanings across different research approaches. However, how they are applied differently between an objective and subjective researcher. This study considers Varpio et al. s' (2020) understanding of the conceptual framework by describing it as the state of known knowledge from the literature and as a justification for why the study should be conducted. Therefore, this study adopted the conceptual framework represented to increase learner engagement. The conceptual framework represented in this study shows a visual or graphical relationship between learner engagement aspects in GBL. Digital games engage learners in affective, behavioural, cognitive and sociocultural domains in ways that few other learning environments can. Therefore, this study uses a conceptual framework to explore the gaps in one's understanding of learner engagement in GBL.

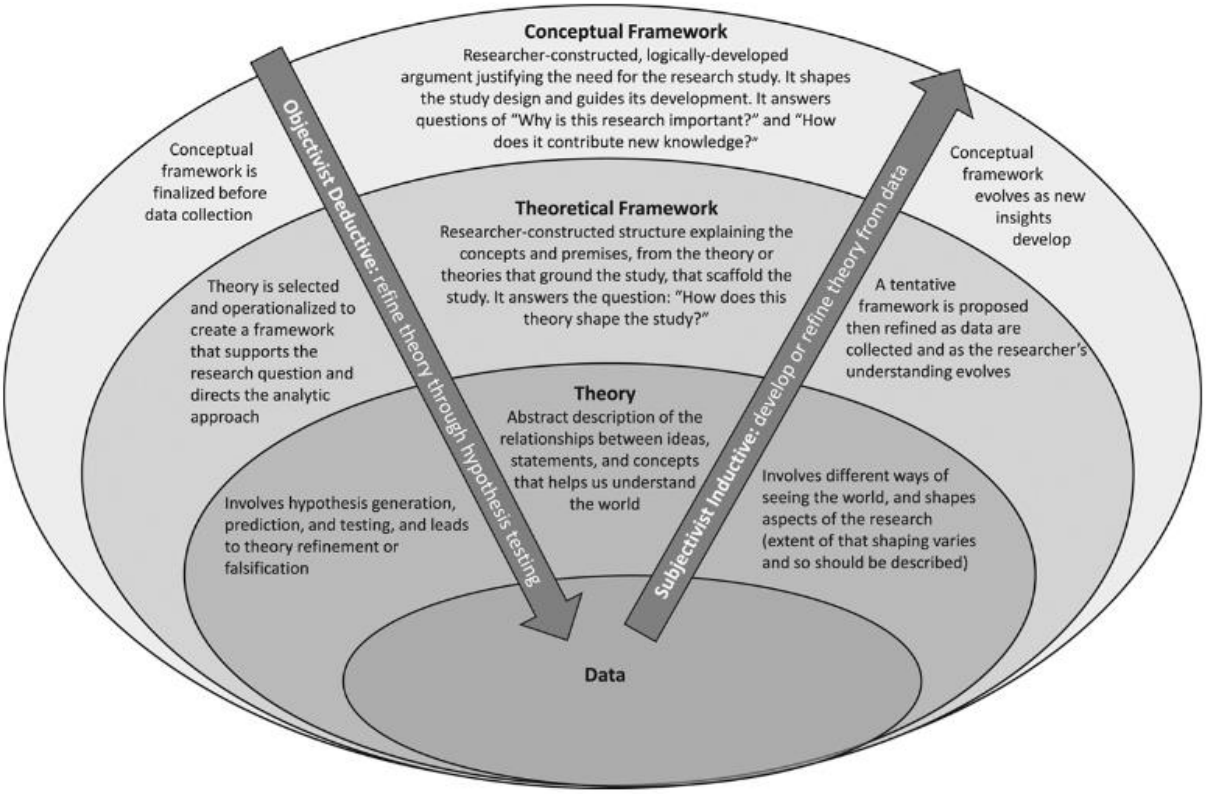


Figure 2. 1 Comparison between theory, theoretical and conceptual framework

The visual depiction of the similarities and differences between *theory*, *theoretical framework*, and *conceptual framework* across objectivist deductive and subjectivist inductive approaches to research (Adapted from Varpio et al. 2020) is shown in Figure 2.1. Plass et al. (2020) explain that their conceptual framework of learner engagement in GBL was drawn from the work of Fredricks et al. (2004) shown in Figure 2.2, by usefully identifying three dimensions of learner engagement, which can be understood individually and are intertwined. Particularly, this study adopts the fused model of Plass et al. (2015) shown in Figure 2.3 as the conceptual model for this study to explore learners' engagement in a Kahoot GBL environment as the lens to guide this study.

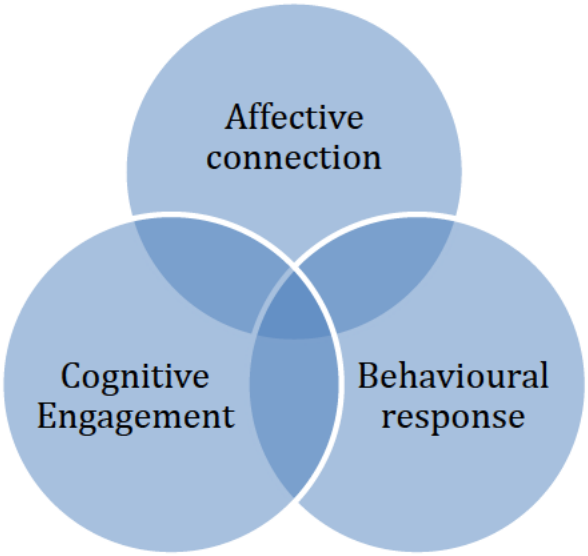


Figure 2. 2: Model of the three dimensions of learner engagement

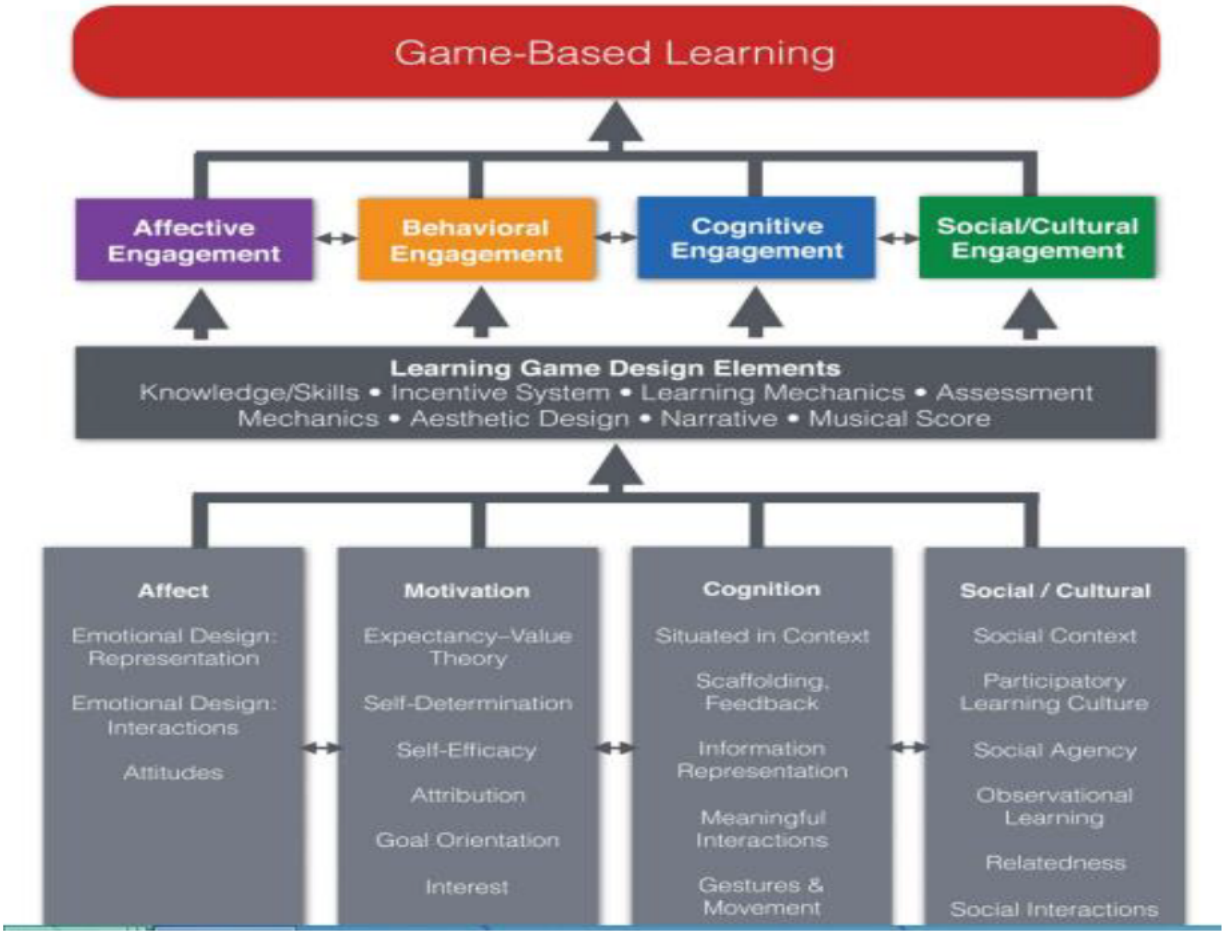


Figure 2. 3: *Integrated design framework of Game-based and playing learning by Plass et al. (2015)*

2.7.1 Affective/Emotional Engagement

The affective engagement dimension acknowledges the importance of players' experienced emotions, attitudes and beliefs, and that learners' emotional states can strongly impact on how they learn. According to Sabourin and Lester (2014), one can measure the affective engagement of a learner by considering the moods, emotional interactions, and feelings about the game. However, the results of an affective engagement are bound to differ. There can be a positive affective engagement whereby there is a state of flow, curiosity, excitement, concentration, motivation, and persistence (Plass et al., 2020). Eccles (2016) emphasises that learners' emotionally engaged state would have affective reactions such as interest, enjoyment or experience of a sense of belonging. On the other hand, there can be a negative effect whereby there is a state of boredom, frustration, anger, demotivation, reduced effort, and a desire to avoid the task (Plass et al., 2020). Fredricks et al. (2004) include other affective reactions that can be found in emotional engagement, which are boredom, happiness, sadness, and anxiety. In addition to the positive and negative poles of affective engagement, there may exist a state of learner affective disengagement.

According to Eccles (2016), each of the three dimensions of learner engagement can have both a 'positive' and a 'negative' pole, each of which represents a form of engagement, separated by a bay of non-engagement, disengagement, withdrawal, or apathy. The terms 'positive' and 'negative' engagements are used not to denote value judgment, but to reflect the attitude implied in much of the literature that learners whose engagement complies with the expectations and norms that seem to be productive will get approval. Yet, conducting those challenges, confronting or rejecting the expectations leads to disruption, delay or obstruction, thus being seen to be counterproductive.

2.7.2 Behavioural/Motivational engagement

Motivational engagement is also called behavioural engagement because, historically, explanations of the role of motivation in learning came initially in 1996, through Graham and Weiner, from a behaviourist tradition. To gauge this aspect, one needs to note the learners' learning goals, the outcomes of learning and the challenges they encounter and the learners' attitude and behaviour in the face of competition, points, stars, badges or trophies (Plass et al., 2020). The aspects of intrinsic and extrinsic motivation are reflected in their persistence and enjoyment when engaged with the game. When playing an educational game, the engagement dimensions can overlap, such as when a player's interactions with the game motivate them and foster cognitive processing of the game content, this improves learner engagement in the behavioural and cognitive dimensions (Plass et al. (2020). According to Eccles (2016), learners who are behaviourally engaged would typically comply with behavioural norms, such as attendance and involvement or participation, and would demonstrate the absence of disruptive or negative behaviour. Positive behavioural engagement includes effort, persistence, attention, asking questions, participation, following rules and the absence of disruptive behaviours.

2.7.3 Cognitive engagement

Plass et al. (2015) maintain that psychologists have long acknowledged the importance of play in cognitive development, such as in 1962, when Piaget described play as being integral to and evolving with children's stages of cognitive development. To assess the cognitive engagement aspect, one must detect learners' decision making, information processing, moral reasoning, and monitoring and evaluation of their learning, and their plans for future behaviours to increase their learning. In the gaming context, Mayer (2014) shares that this involves discerning how learners first select what is presented in the game, how they organise this information as

visual and verbal representations in working memory, and how they then integrate these representations and with prior knowledge. Eccles (2016) upholds that positive cognitive engagement is evident in learners who would be invested in their learning, seek to go beyond the requirements and would relish the challenge and are hard workers, self-regulated, and put effort into mastering new knowledge and skills and in learning strategies. In terms of this tri-dimensional understanding, Eccles (2016) concludes that learner engagement might be able to relate areas of research about backgrounds and consequences of how learners feel, act and think. Henceforth, learners' engagement might start by liking or participating; eventually, it can result in commitment or investment, thus may be a key to diminishing learner disengagement, therefore, enhancing learning.

2.8 Developments of the game-based learning conceptual framework

Good games should, as Plass et al. (2015) recommend, aim to be within a player's zone of proximal development; a notion which comes from Vygotsky in 1978. Playing a game with an adult or more capable peer is a social interaction that enables a child to succeed at a level just beyond his or her current ability. When designing learning experiences that focus on the social and cultural aspects of learning, the goal should relate to learners participating in groups, and using collective knowledge to meet goals. Hence, this is the fourth dimension of learner engagement in GBL. Nevertheless, due to circumstances of compliance with COVID-19 social distancing rules, the social/cultural learner engagement dimension may be problematic to measure at this stage, hence this dimension of the conceptual framework will not be included in this project. Besides, Eccles (2016) contends that we should consider the items assessing social engagement as a fourth dimension on the same plane as these three. He thought otherwise, as it seemed to him that the distinction between social- and solo-levels of

engagement represents two different orthogonal planes. In other words, he assumed that engagement at the social level can also be endorsed in behavioural, cognitive, and affective engagement, creating at least a three (3) by two (2) conceptual space.

Conceptual frameworks linking learner engagement illustrate a multidimensional conception of learner engagement and propose ways that learners can be engaged during their academic experience. This study will explore learner engagement in the main three dimensions of cognitive, affective, and behavioural levels. Other dimensions stated in the conceptual framework by Groccia and Hunter (2012) such as engagement with the school environment, teachers and family are not considered in this study.

More recently, a conceptual framework relating to learner engagement and the teacher's role was also proposed by Pedler et al. (2020). They maintain that the model was proposed based on Fredricks et al.'s (2004) work on school engagement, since they called for tri-dimensional learner engagement. Pedler et al. (2020) incorporated the three dimensions discussed, with an explicit focus on the teacher's role in enhancing learner engagement. Correspondingly, the conceptual framework chosen in this study incorporates the three dimensions discussed with an explicit focus on the Kahoot game in enhancing learner engagement. Therefore, the developments of the learner engagement conceptual frameworks maintain the tri-dimensional considerations of learner engagement and differ according to the research topic at hand.

2.9 Critique and Summary of the literature reviewed

Groccia (2018) claims that a sound body of literature views learner engagement as learner involvement, while Martin and Bolliger (2018) report that learner engagement and learner interaction are used interchangeably. The reviewed literature first outlined a historical background of the constructs of learner engagement based on Groccia (2018) about what is

learner engagement. Two perspectives of the term *learner engagement* were shown, one before 2012, where authors saw learner engagement as a single dimension of behaviour, and the other after 2012, which was a rising trend of viewing learner engagement as a three-dimension of emotions, behaviour, and cognition. The researcher concluded by defining learner engagement as a holistic, multidimensional concept involving not only the learners' behaviour with the learning activity but their cognition and affective aspects as well. To distinguish learner engagement, the state of learner disengagement and negative engagement was also reviewed. A conclusion reached was to also define learner disengagement as a multidimensional non-engagement state, which falls in-between the negative and positive continuum of engagement. Moreover, studies proposed the use of GBL to enhance learner engagement. Ismail and Mohammad (2017) share that there is a link in GBL influencing learner engagement in learning. In contrast, Bogost (2015) disagrees with the latter and perceives GBL as pretentious and unworthy of attention.

Finally, studies based on learners' experiences with the Kahoot game were reviewed. Most of these studies share similar strengths and weaknesses. For instance, Wang and Tahir (2020) and Plump and LaRosa (2017) share similar strengths in that Kahoot is a free online game learning platform that has gained wide acceptance globally, with the potential to increase learner engagement. Nevertheless, findings from Hakim et al. (2019) and Asa'd and Gunn (2018) show similar weaknesses that their learners found attractive attributes and disadvantages to playing Kahoot. The key disadvantages are unreliable internet connection and network instability. Although studies have found different outcomes depending on the samples used, there is consensus that GBL has an important role in learner engagement and that future work should be more qualitative and more research on learner engagement and GBL is required. Table 2.1

provides a summary of the reviewed literature and Table 2.2 presents a summary of learner engagement in a GBL conceptual framework.

Table 2. 1: Summary of the literature reviewed

Aspect	**References**
Increased usage of games for learning. Development of the trend of the Kahoot game. Relevant approaches during COVID-19.	Wang & Tahir (2020), Ismail & Mohammad (2017), Plump & LaRosa (2017), Uçar & Kumtepe (2017), Oliver (2017), Serrano (2019), King & South (2017)
Shortcomings of using games in education. Unworthiness of games for learning.	Bogost (2015) Todd (2017)
The importance of game-based learning. The benefits of using the Kahoot game. Results of learning with Kahoot game.	Juveng (2018), Siegle (2015), Ismail et al. (2019), Vasalou, Khaled, Holmes & Gooch (2017), Asa'd & Gunn (2018), Diana et al. (2021), Plump & LaRosa (2017)
Challenges found when the Kahoot game was used in education. Limitations of using Kahoot in the classroom.	Hakim, Rahayu & Affida (2019), Plump & LaRosa (2017)
Recommendations from literature for future studies. Suggestions for a qualitative study. The gap in literature.	Benhadj, Messaoudi & Nfissi (2019) Caponetto et al. (2014)

The minimal research done on games in South Africa.	
Learners' engagement with Kahoot game in Physical Sciences. Learners' views and experiences of learning with games.	Current study

Table 2. 2: Summary of engagement in the GBL conceptual framework

Engagement Dimension	Description
Affective/Emotional Engagement	● Players' experienced emotions, attitudes, interests, and beliefs. Learners' emotional states can strongly impact how they learn. (Constructive elements).
Motivational/Behaviour Engagement	● Players' actions, involvement, intrinsic and extrinsic motivation. (Behaviourist elements)
Cognitive Engagement	● Player identifying what is presented, organising this information as visual and verbal representations in working memory and how they then integrate these representations with prior knowledge. (Cognitive elements)

2.10 Conclusion

This chapter presented the literature review and the conceptual framework. The literature reviewed learner engagement and disengagement definitions and studies about GBL and

Kahoot game were analysed. The descriptions of the affective, behavioural, and cognitive engagement in GBL conceptual framework were offered. The next chapter outlines the research methodology and methods.

Chapter 3

Research Methods and Methodology

3.1 Introduction

The previous chapter reviewed the literature regarding learner engagement, disengagement, GBL and Kahoot game. This chapter will describe the research methods and methodology that were used to answer the research questions, along with an explanation of the suitability and rationale for the choice of the research methods and methodology of this study. The goal of this study was to learn more about how learner engagement could be improved via a Kahoot educational game to promote holistic engagement most effectively with learning PS. The chapter begins by explaining the interpretive research paradigm framing this study and the qualitative action research design embedded in this study. It is followed by a thorough description of the plan of action research methodology, along with the game context of this study. Thereafter, a description of the selection of participants and the research methods chosen is provided, followed by a description of the data analysis procedures, and ethical considerations and concludes with the anticipated limitations of the study.

3.2 Research paradigm

According to Creswell (2009), a research paradigm is a worldview. A paradigm in research is the intended philosophical perception taken by a researcher on how to view the world; it guides decision making and the actions taken to carry out the research. According to Williamson and

Johanson (2017), a research paradigm helps the researcher to conduct the study effectively. A research paradigm determines for a researcher the kinds of questions to be asked, what can be observed, how data should be collected and how findings should be interpreted (Bertram & Christiansen, 2014). This study adopted the interpretive research paradigm because it focuses on the way people interpret and understand their daily experiences (Mohajan, 2018). The interpretive researcher sought to gain an understanding of learners' engagement as they learn PS through playing the Kahoot games. Furthermore, the interpretive paradigm was chosen for this study because of its association with qualitative studies that are described as contextual, involved, and emergent (Cohen et al., 2018).

3.3 Research Design

The research design is described by Kumar (2018) as a proposed study plan, which has been thought through and can be communicated to others. It involves the methods used for collecting data from participants, selection of participants, data analysis and communication of the findings. Likewise, Augustyn (2014) defines a research design as a plan of how the research is going to be conducted, who or what is involved and where and when the study will take place. This study favoured a qualitative research design. A qualitative research design is a broad umbrella term in research that aims to describe and explain the meaning of peoples' experiences and social contexts without using statistical procedures (Fossey et al., 2002). According to Cohen et al. (2018), a research design involves not only the elements of the study plan but also the justification for their use and the degree of trust that can be placed in the reliability of each element. A qualitative research design is embedded in this study because it gives rich descriptions that allow exploration and understanding of the meaning people assign to a social or human problem (Thanh & Thanh, 2015).

Moreover, the qualitative research chosen for this study allowed the researcher to gather in-depth data on learners' engagement when learning PS with and without the Kahoot game. Creswell and Poth (2016) state that the qualitative design is different from the quantitative research design because the qualitative data is formed by general, emerging questions to permit the participant to generate responses, and it gathers word (text) or image (picture) data and collects information from a small number of individuals. The study found this research design to be suitable to explore learners' attitudes, interests, behaviour, feelings and experiences. Furthermore, the qualitative researcher has a goal to explore detailed descriptions of internal experiences that the learners have and how they form meaning (Gentles et al., 2015).

The qualitative research design and the action research methodology adopted in this study were used to address the following research questions:

1. What makes the Grade 10 learners interested in learning Physical Sciences without using the Kahoot game?
2. How will the Grade 10 learners engage with Physical Sciences via the instruction of the Kahoot game?
3. Why do the Grade 10 learners engage with the Kahoot game in the learning of Physical Sciences in the manner they do?

3.4 Research Methodology

According to Lambert (2019), the research methodology is the philosophy or general principle which guides the research. Excellent teachers improve their effectiveness by asking the right questions, formally gathering evidence, reflecting on the responses, deciding upon a specific

course of action and drawing robust conclusions through an action research methodology (Burton et al., 2014). Action research is widely regarded as a powerful qualitative research methodology to improve the educative process (Mills & Birks, 2014). According to Mertens (2015), practitioner action research is designed to promote teachers' professionalism by drawing on their informed judgement to enable them to act more wisely. Therefore, this study was informed by the practitioner's action research methodology since the researcher/teacher/practitioner wished to improve her teaching skills by drawing on informed judgements about learners' engagement when learning PS via a game. Moreover, the action research methodology was preferable to this study because, according to Cain (2011), action research moves beyond positivist, interpretive and critical research paradigms, to become self-reflexive, collaborative, political and suitable for distribution. The researcher focused on the collection, analysis, interpretation and subsequent use of evidence gathered in the classroom to better understand how her learners learn, hence how she can improve their engagement. Historically, the term action research has been long associated with the work of Kurt Lewin, who viewed this research methodology as cyclical, dynamic and collaborative (Mills, 2014). A typical action research procedure/cycle followed in this study is shown in Figure 3.1.

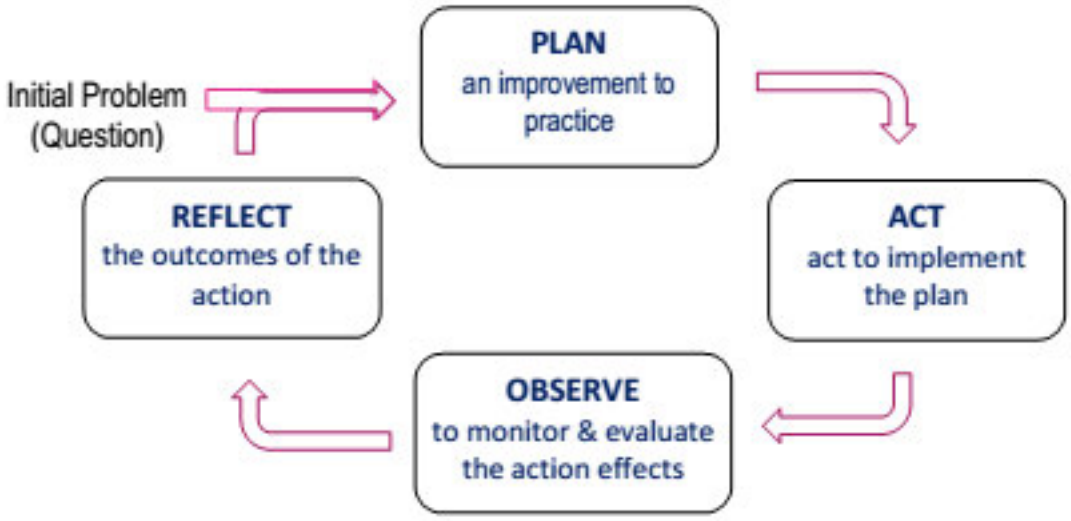


Figure 3. 1: Action research cycle

For the conduction of practitioner action research in this study, firstly, the researcher identified the initial problem as the first step in the action research cycle. The problem observed in class and stated in the literature is learners' engagement playing a huge role in the decline of the success rate of the NSC PS results in KZN. The researcher took the first step to identify what makes learners interested and bored in the Physical Sciences classroom by providing a pre-intervention questionnaire for learners to respond with their views. The next step in the action research cycle was for the researcher to devise a plan of action to improve the teaching and learning practice in the Physical Sciences classroom for learners to be more engaged. The plan was assumed to potentially have learners' affective, behavioural, and cognitive engagement improved by preparing and playing Kahoot games. The next step in the action research cycle was for the researcher to act to implement the plan by allowing learners to play the first Kahoot games in class based on chemical naming. Afterwards, the researcher observed and collected data through reflection journals, teacher log, post-intervention questionnaires and interviews. The last step in the action research cycle was for the researcher to reflect by interpreting and analysing the findings, which were the outcomes of the action of playing the Kahoot game. After the reflection, a new action research cycle began. This study repeated the same action research cycle (shown in Figure 3.1) five times after the reflection on the consequences of the action that took place as summarised in Table 3.1. The data collected on learners' perceptions and interpretations informed professional practice for the researcher in teaching PS within her classroom.

Table 3. 1: Action Research Multiple Cycle Table

1ST CYCLE	**2ND -4TH CYCLE**	**5TH CYCLE**
Step 1: Ask a question Research Question 1	***Step 1: Ask a question*** Research Question 2	***Step 1: Ask a question*** Research Question 3
Step 2: Plan action Learners will do Exercise 1 on naming compounds and watch the experiment video related to compounds.	***Step 2: Plan action*** Learners will play three online Kahoot games quizzing them on: 1st game, week 1 - Chemical naming **(2ND cycle)** *(Kahoot game played with background music off and questions read aloud)* 2nd game, week 2 - States of matter (**3RD cycle)** *(More time provided and space for justifying the answer)* 3rd game, week 3 - Electric circuits (**4TH cycle)** *Kahoot game played with background music off and questions read aloud, more time provided for calculations)*	***Step 2: Plan action*** Selection of learners whose affective/behavioural/cognitive engagement did not show obvious shifts before and after the Kahoot game for an interview.

Step 3: Implement action Learners wrote Exercise 1 on naming compounds and watched the experiment video related to compounds.	***Step 3: Implement action*** Learners played the three online Kahoot games in three consecutive weeks.	***Step 3: Implement action*** Selected learners whose affective/behavioural/cognitive engagement did not show obvious shifts before and after the Kahoot game were interviewed.
Step 4: Collect data Learners responded to the pre-intervention questionnaire provided.	***Step 4: Collect data*** Learners responded to the reflection journals after each Kahoot game. Practitioner reflected on learners' attitudes, behaviours, and responses during the Kahoot game. Learners responded to the post-intervention questionnaire provided in week 4, after the intervention of playing Kahoot games.	***Step 4: Collect data*** Learners responded to the interview questions provided.

Step 5: Reflect and analyse Read learners' responses to the pre-intervention questionnaire and identified key findings.	***Step 5: Reflect and analyse*** Read learners' responses to the reflection journals and post-intervention questionnaire to identify key outcomes.	***Step 5: Reflect and analyse*** Listened and transcribed learners' responses to the interview and identified key findings.

3.5 Detailed Plan for the intervention

The study was conducted in five multiple cycles (as shown in Table 3.1) over five weeks because Rosenzweig et al. (2022) note that action research involves a recursive process of investigation and analysis motivated by the desire to improve practice and is focused on the development and study of an intervention. Lambert (2019) states that action research begins with a process of communication and agreement between people who want to change something together. In this regard, the first cycle involves the researcher stating the first research question, then, planning to gather the information through the pre-intervention questionnaires. Thereafter, learners were to respond to a worksheet and watch a video on naming chemical compounds lesson taught in term 1. Learners watched the experiment video for 7 minutes and responded to the Exercise 1 worksheet (see Appendix 8) for 20 minutes on the first day of the first week. Lastly, the learners responded to the pre-intervention questionnaire 10 minutes after the activity. The learners submitted the pre-intervention questionnaires and the researcher analysed learners' responses to understand and change learners' interests and engagement in PS. After reflecting, the 2nd cycle of action research emerged.

After gathering evidence about learners' engagement before the intervention, the researcher planned and implemented the main intervention of the Kahoot game, which was lied in the 2nd – 4th cycles. The Kahoot game consisted of sets of multiple-choice questions, which check learners' understanding of the material. The questions used were a combination of questions pre-set by the online Kahoot game and the teachers' questions to emphasise content in CAPS. To implement the action for learners to play the Kahoot game, the following steps were taken:

Step 1: Teacher displayed a pre-set online Kahoot game pin on the screen for learners to login. https://create.Kahoot.it/

Step 2: Learners went to https://Kahoot.it/join and entered the game pin displayed on the screen into their mobile to login in to the Kahoot game set by the teacher.

Step 3: Once the learners entered the game pin, they were directed to type in their nicknames for the Kahoot game.

Step 4: Once all ten learners' nicknames appeared on the screen to show they successfully logged in to the Kahoot game, the teacher pressed the start button for the game to commence. The question, options and stopwatch were displayed on the screen, while the shapes corresponding to the options were displayed on the learners' cell phones.

Step 5: The learners chose one answer by clicking on the corresponding shape. When the time allotted collapsed, the correct option in shape and colour form was displayed on the screen, along with the scoreboard shortly after to show learners' points for the question. This was repeated until the last Kahoot question, where the top three learners who collected the highest points had their names displayed next and got trophies. This was the end of the Kahoot game with learners. The next step for the Kahoot creator/teacher was a statistical bar graph, indicating learners' progress from the first to the last question. By default, the software kept track of learners' responses and provided up-to-date reports on their performance on tasks.

The five steps taken to implement the intervention were repeated for the 2nd to 4th action research cycle. The researcher and the learners moved through stages of planning, acting, observing, and reflecting. This process happened in five cycles before everyone could be happy that the changes had been implemented in the best possible way. The 2nd- 4th cycle was conducted to answer research question two, where communication between the researcher and the learners to implement changes to acquire the best engagement out of the Kahoot games took place as follows:

In the 2nd cycle, the intervention of playing the game on a typical countdown timer shown on the screen was set to 30 seconds by the practitioner to keep learners on-task, and under pressure to promote a competitive spirit. The researcher prepared a Kahoot game based on the topic of naming chemical compounds, which was taught in the 1st term of the PS CAPS in 2021. The learners played the Kahoot game for the first time. This first game was played on the first day of the second week for 15 minutes. After the first intervention of playing the Kahoot game to increase learner engagement, the learners responded in their diary entries about their first Kahoot game at home and submitted the diary the next day. The researcher also filled in the teacher log about interesting observations when learners interacted with the game. Later, the researcher evaluated learners' responses, of which, outcomes led to the development of a 3rd action research cycle.

The 3rd action research cycle was established based on the learners' communication that the Kahoot background music should be switched off so that they could be focused and concentrate on the questions. The learners also asked for the questions to be read aloud instead of playing music to promote their understanding, for some of them who could not read faster and for those who could not see on the screen clearly. The researcher prepared the 2nd Kahoot game based

on the topic of states of matter, which was taught in the 1st term of the PS CAPS in 2021. This second game was played on the first day of the third week for 15 minutes. After the second improved intervention of playing the Kahoot game to increase learner engagement, the researcher filled in the teacher log and the learners responded in their diary entries about their second Kahoot game at home and submitted the diary the next day. The learners then asked for the countdown timer on the screen to be increased to at least 60 seconds to provide them with more time to engage with the questions. The researcher agreed and asked learners to use this time to show their working to promote understanding of the topic and their cognitive engagement. The outcomes of this cycle led to the 4th action research cycle.

In the 4th cycle, the learners played the Kahoot game without music and the teacher read the question out loud when it appeared on the screen. The improved intervention also involved a longer countdown timer on the screen was increased to 60 seconds to provide them with more time to think about the question and show their working. The researcher prepared the third Kahoot game based on the topic of Electric circuits, which was taught in the 2nd term of the PS CAPS in 2021. This last Kahoot game for this research was played on the first day of the fourth week for 15 minutes. The learners were asked to first fill in the post-intervention questionnaire immediately after the game for 10 minutes. The researcher filled in her teacher log and the learners filled the diary entries regarding their engagement with the Kahoot game when learning PS at home and submitted them the next day. The researcher analysed learners' diary entries, teacher log and post-intervention questionnaires. Thereafter, the 5th cycle of action research was developed based on the outcomes of the findings of the previous cycle.

The post-intervention questionnaire provided in the 4th action research cycle indicated changes in learners' engagement when learning PS via the Kahoot game. However, the researcher

identified learners whose engagement was not explicit as to whether it improved or not. The researcher then planned the 5th action research study and prepared an interview schedule for the selected learners. The researcher interviewed the learners to respond to research question three of this study. The interview was conducted on the first day of the fifth week for 10 minutes. After the analysis of the results of the data collected in this cycle, the formation of the 6th cycle of action research was prompted by the minimal increase of engagement in the cognitive aspect. A new cycle to further improve learners' cognitive engagement was necessary, however, due to the time constraints of this research, the action research cycle was discontinued after the 5th cycle.

This study uses a 'multi-cycle' research model (Table 3.1) whereby the research and the intervention almost constantly inform each other. The research activity continuously informs and shapes the intervention towards the pre-determined goal to improve learner engagement in learning PS through Kahoot games. Burton et al. (2014) argue that in a multiple cycle model, the researcher works with a particular outcome in mind, using the analysis of the evidence being gathered to inform and flex the intervention towards achieving the goal. This study assumed an outcome for the group of learners to have positive and higher affective, behavioural, and cognitive engagement. Therefore, each of the five cycles was designed to get progressively closer to the desired outcome by making changes to the intervention informed by findings. The focus of these five multiple action research cycles was on the outcome of the intervention of playing the Kahoot games to achieve enhanced learner engagement. Nevertheless, it was difficult to visually present the multiple cycles, where the research activity and intervention are entwined. Moreover, the pioneers of action research noted that it is cyclic and tends to continue endlessly until the goal is achieved. However, due to the scope and time of this research, the multiple cycles ended with the 5th cycle.

Table 3. 2: Summary of Pre- and Post-Intervention activities

Topic	**Pre-Intervention**	**Post Intervention**
Chemical names and formulae	Exercise 1 (Appendix 8) Pen and Paper, Video	Kahoot game (Appendix 9) Projector and cell phones
States of Matter	Reflect on Practical/Experiment Term 1	Kahoot game (Appendix 10)
Electric circuits	Reflect on Introductory pen, paper and drawing classwork Term 2	Kahoot game (Appendix 11)

This study was conducted in term three of the 2021 academic year. The three topics chosen for AR cycle 2-4 Kahoot gameplays were: Chemical naming, states of matter and Electric circuits. The chemical naming topic was already taught at the beginning of Term one as part of the grade 10 PS CAPS teaching plan for the revision of the grade 9 Natural Sciences (NS) topic about naming compounds and periodic table elements. The states of matter topic during Term one was a practical demonstration of a heating curve and cooling curve, where learners filled a lab report by Predict Observe Explain (POE) method. This formal assessment was collected and recorded for the Term one report. In Term two Electric circuits topic was introduced in a pen and paper classwork where the learners drew the circuits. In Term three, for this research, the learners played the Kahoot game based on these three topics in the 2021 academic year.

3.6 Sampling and recruitment of participants

The notion of sampling in a study is described by Mertens (2015) as the decisions that a researcher makes regarding from whom the data will be collected, who is to be included, how

they are included and what is done to conceal or reveal identities in research. This study employed convenience sampling. The researcher conveniently sampled a grade 10 PS class of ten female learners in a school in the rural area of uMgungundlovu district. Convenience sampling means that the participants are chosen because they are readily available (Patton, 2002). The participants were convenient to me as a researcher since I worked at the school, and I taught them PS. No transport was required to reach the participants. Hence, it was cost effective to sample the learners already enrolled in my class. However, due to the small sample of this study, the findings cannot be generalised nor replicated. Nevertheless, the smaller sample was suitable for this study since Lambert (2019) maintains that action research tends to take place with a small group of dedicated people who are open to new ideas.

All learners were female. However, the gender composition of this PS class is not implying that this is an all-girls secondary school. The current enrolment of the school comprised 67% male and 33% female learners. However, no male learners chose to partake in the PS class introduced to the school as a new subject in 2021. All ten female learners were African, and the race of the school was also 100% African. The learners were all from poor socio-economic backgrounds, and their ages ranged from 15 to 17. All ten learners were invited to participate in this study. There was no inclusion or exclusion for the recruitment of the participants in this study based on gender, age, ability, or ethnicity.

The study was conducted in the third term because, at the end of term two, the researcher sent permission letters to the parents/guardians of all potential participants in the study (see Appendix 7a). The researcher also discussed the nature and purpose of this study on the last day of term two and requested learners' participation. Grade 10 PS learners indicated that they sometimes found the PS class boring, especially the Chemistry component. It was at this point

that I explained to the grade 10 PS learners the importance of undertaking this research to determine how to improve grade 10 PS learners' engagement in lessons and that more research needed to be done around the teaching and learning of PS topics in a gamified way in secondary schools in South Africa.

Following parental consent, potential subjects were asked to read and sign an assent form (Appendix 7b), and the researcher verbally read the script to the potential subjects. After reading the document to the learners, I answered the questions they asked at that time. Learners were able to decide on participating in the study during the two weeks holidays before term three commenced. I explicitly reminded learners that choosing not to participate would, in no way, affect other aspects of their participation in the subject, including their final marks. Learners were also told that they could choose to participate in this study without participating in the interviews. All learners in the PS class chose to participate fully in this study. The following research methods were used by the qualitative researcher to collect data in a series of interrelated activities as shown in Figure 3.2. After locating the ten participants and gaining access through gatekeepers, data were collected from the convenient sample where it was recorded, analysed and stored.

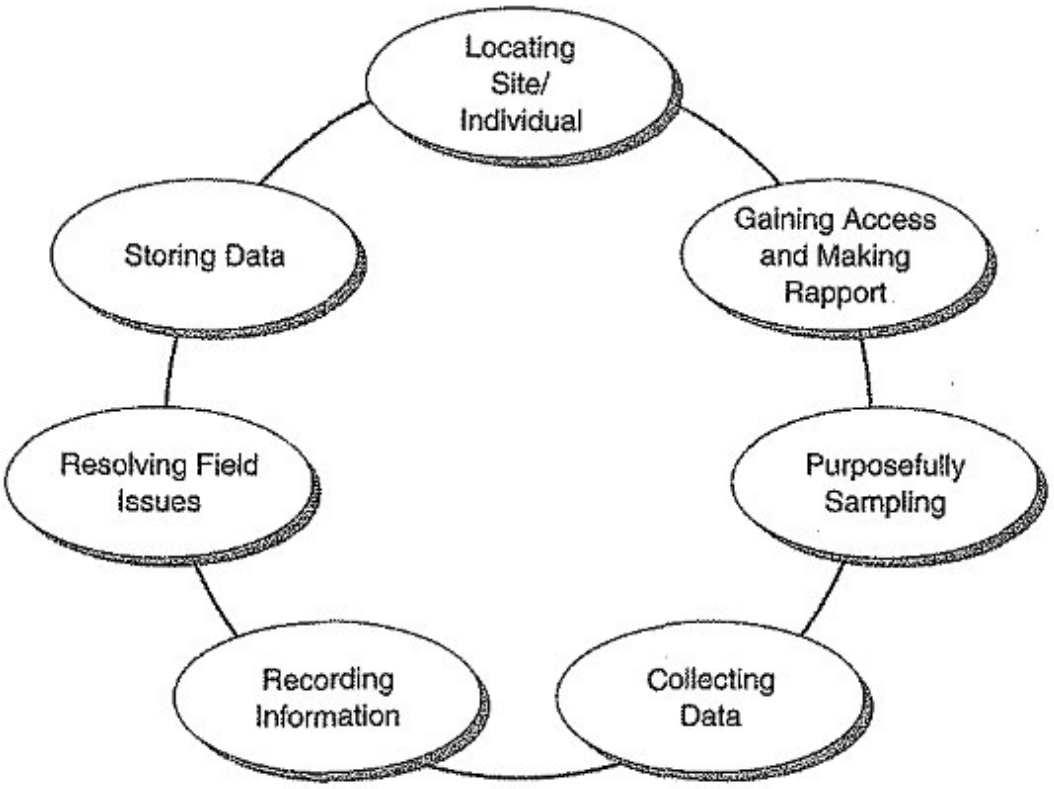


Figure 3. 2: Data collection activity cycle (Adapted from Cresswell, 2012)

3.7 Research methods

Research methods are the tools used to gather data (Lambert, 2019). The data gathering tools were chosen in accordance with the qualitative approach. Creswell (2013) asserts that, for meaningful data in qualitative research, "researchers need to gather information by actually talking directly to people and seeing them behave and act within their context" (p.185). Four research methods for data collection were used in this study: pre- and post-questionnaires, diary entries along with the teacher log and the interview. The pre-questionnaire was used at the beginning of this study, the diary entry, teacher log and post-intervention questionnaire were used in the fourth week of this study whilst an interview was conducted towards the end of this study.

3.7.1 Questionnaire

Closed ended questions, open-ended questions, or a combination of both closed and open-ended questions are the three basic types of questionnaires (Lambert, 2019). This study adopted a combination of both closed and open-ended questions, also known as semi-structured questions. According to Lambert (2019), many researchers tend to use a combination of closed and open-ended questions because it is possible to find out both the quantity and the quality of the data collected. Likewise, this study utilises a combination/semi-structured questionnaire. The pre- and post-intervention questionnaires were administered before and after the intervention, respectively. The semi-structured questionnaires began with a list of closed ended questions, where the learners had to tick a box scale to rank their engagement when learning PS before and after the game. The questionnaires then finished with a section of open-ended questions for more detailed responses about learners' interests in PS lessons. Nevertheless, the 7- Likert scale of closed ended questions is not intended for statistical purposes. However, it was used as a baseline test to determine if there was any shift in learner engagement from before and after the intervention.

Firstly, Part A of the questionnaire addresses learner demographics (Appendix 1A). Part B is the pre-and post-intervention questionnaire, which addresses learners' attitudes, interests, motivation and cognition in learning PS before and after the game (Appendix 1B). Out of the ten participants, the teacher observed that before the intervention, eight learners were very inactive and quiet during PS lessons. They were very passive and seldom spoke during lessons. Then, the pre-intervention questionnaire was developed to gather information about what makes or keeps learners interested in learning PS without a game. Accordingly, the questionnaire attempts to also get the learners to open up about what disengages them from learning PS before the game. The post-intervention questionnaire was then used at the end of

the three Kahoot games played to determine if there was any shift in the learners' engagement in learning PS via the game.

3.7.2 Diary entry

There are many choices of research methods available in qualitative research. However, Hyers (2018) reasons that the diary entry method is distinctive for its capability to capture phenomena of interest regularly. A diary entry research instrument (see Appendix 2A) was deemed appropriate for this study. At the end of each of the three Kahoot games played, learners were asked to populate a diary entry at home, which was submitted to the researcher the next day. The researcher asked the learners to go home with the diaries so that she could read the participants' responses without interfering with the learners to maintain objectivity. The diary entries were used to monitor learners' continuous engagement in learning PS via the Kahoot game. Diary entries were suitable for this study because they are one of the recommended tools in action research, which allows participants to freely record their experiences, perceptions, and emotions (Cypress, 2018).

3.7.3 Teacher Log

Glennie et al. (2017) state that studies of instructional practices in classrooms have traditionally relied on two methods: classroom observations and surveys. A new and improved tool for classroom observation in action research is a teacher log. Glennie et al. (2017) applaud the use of a teacher log because it provides a concurrent method for collecting data on classroom practices by giving teachers a tool to document and reflect on specific lessons and the impact they may have had on their learners. In this study, the teacher log (see Appendix 2B) was used in 2nd to 4th action research cycle at the end of each of the three Kahoot games. The teacher

filled in the teacher log, which had prompts about the learners' behaviours and learner facial expressions and actions during the Kahoot game played. The observations were linked to the conceptual framework of game-based learning by Plass et al. (2015) discussed in Chapter two of this study. The researcher looked out for positive body language, consistent focus, learner confidence and excitement to fill in the teacher log. A 7-point Likert scale, with 1 being very engaging to 7 being very high positive learner engagement, was used to measure the level of learner engagement demonstrated in the classroom when playing the Kahoot games.

Gathering data through enhanced classroom observations in a teacher log is considered highly suitable in gamified environments to understand learner engagement (Hsieh, 2015). The teacher log was used in this study because it is useful in action research to improve the practitioners' awareness of the impact of the intervention. Glennie et al. (2017) maintain that teachers can use the log data to reflect on practice, determine areas of strength and challenge and set goals for personal improvement. Although the qualitative researcher used a teacher log to observe learner engagement, the researcher attempted not to be subjective when making the observations by limiting interactions to avoid any influences over the data collection processes.

3.7.4 Interview

In social research, there are many types of interviews. Lambert (2019) states that the most common are unstructured, semi-structured and structured interviews. This study adopted a semi-structured interview (Appendix 3) because Lambert (2019) argues that it is perhaps the most common type of interview structure used in qualitative social research. The interview aimed to gather details about the extent to which the participants were engaged with the use of the Kahoot game to learn PS. Moreover, the researcher also wanted the interview to remain flexible so that other important information could still arise (Lambert, 2019). According to Cresswell (2012), general interviews are suitable so that the views of the participants are

unrestricted. During interviews, it is important to have some means for structuring the interview and taking careful notes. As already mentioned, audiotaping of interviews provides a detailed record of the interview. As a backup, one needs to take notes during the interview and be prepared to answer questions.

The semi-structured interview is suitable because it is a good data collecting tool in the interpretive paradigm. In this study, the interview was used to give respondents and the researcher a chance to clarify what could not be done by the questionnaires, diary entries and teacher log. The interview was audiotaped in the 5th action research cycle to gain in-depth data from five participants. Audiotaping of interviews took place to provide accurate data. All subjects' names were replaced with pseudonyms in the reporting of any data from this study. The collection of data took five weeks. Table 3.3 indicates a summary of the research methods used in this study.

Table 3. 3: Summary of the research methods and their justification

Data Sources	**Data collection method**	**Purpose and Justification for the method**
Learners	Pre-Intervention semi-structured questionnaire	● Closed ended questions as a baseline test. ● Open ended questions to justify responses. ● Questionnaire to identify learner cognitive, emotional, and behavioural engagement prior to the Kahoot game.
Learners	Reflection journal	● Diagrams – Emojis, scale and thought bubble to visualise learner feelings, motivation and problem solving. ● Descriptions - Justify the responses.

Researcher	Teacher log	● Prompts – To observe actions, and gestures to gather information on learner emotional, behavioural, and cognitive engagement.
Learners	Semi structured interview	● To justify responses to questionnaire, reflection journal and teacher log.
Learners	Post Intervention semi structured questionnaire	● Closed ended questions as a post test. ● Open ended questions to justify responses. ● Questionnaire to identify any shift in learner cognitive, emotional, and behavioural engagement after the Kahoot game.

3.8 Data analysis

Cresswell (2012) states that analysing data is a process of sensibly obtaining data, organising the data, coding, deriving themes and recognising patterns coming up from the data collected. However, Cresswell (2012) argues that analysing text data presents a challenging task for qualitative researchers as they also decide on how to represent the data in table and narrative forms. The qualitative researcher analysed the data following the data analysis and representation spiral in Figure 3.3.

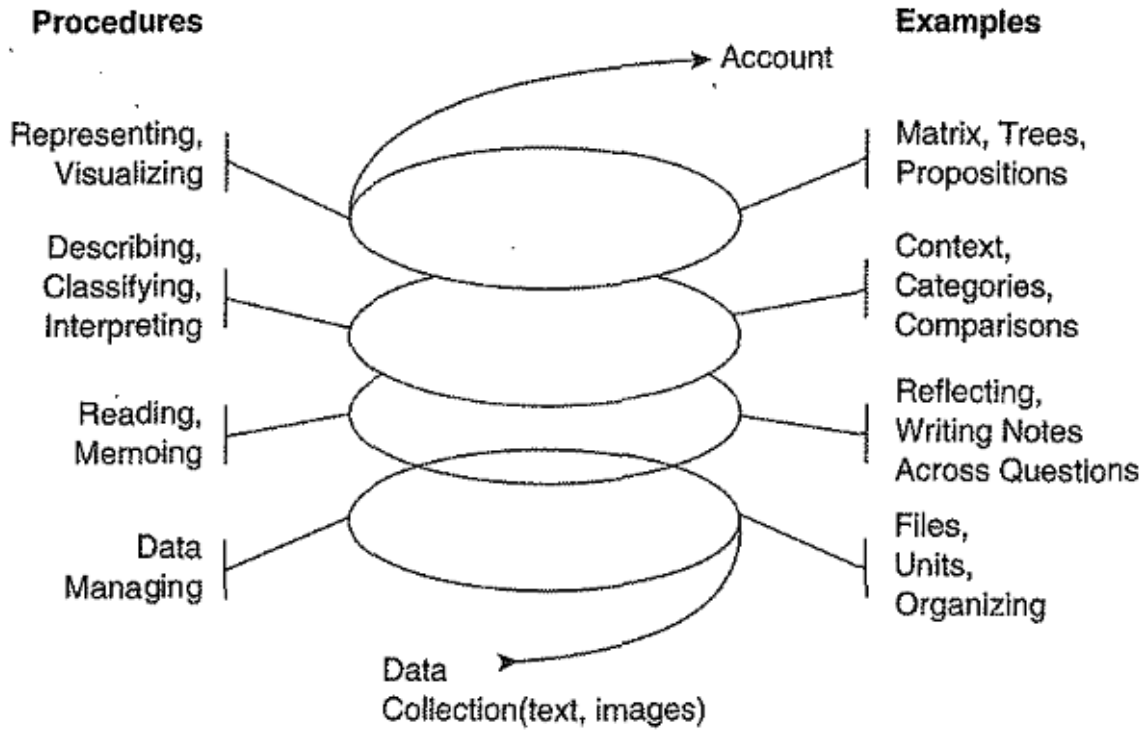


Figure 3. 3: Data analysis and representation (Adapted from Cresswell, 2012)

Firstly, data were collected in text and then managed or organised into codes by reading the texts several times to develop a deeper understanding of the information supplied by the participants. The learners' responses to the questionnaires, diary entries and interviews were read meticulously, along with the teacher log to reflect and support findings. Thereafter, data were interpreted and categorised into pre-determined themes and compared to other findings of similar studies in the literature. The analysed data were then visualised into tables. There is no single, accepted approach to analysing qualitative data, however, Creswell (2012) advances that an analysis of qualitative data requires an understanding of how to make sense of the text to form answers to the research questions.

According to Braun and Clarke (2006), the thematic analysis offers "a more accessible form of analysis, particularly for those early in a qualitative research career" (p. 81). Judging by the

researcher's level of expertise in the qualitative research design, the thematic analysis of data was preferable. The procedure involved open coding where the interviews were read and re-read for familiarisation and initial codes were identified based on explicit, surface-level semantics in the data, rather than implicit responses and preconceptions (Braun & Clarke, 2006). Through axial coding, codes were recombined, and connections were formed between ideas. Then, I used thematic mapping to restructure specific codes into broader themes. Finally, borrowing from Braun and Clarke's (2006) selective coding procedure, the resulting themes were refined and organised into a code.

Creswell (2012) maintains that the steps commonly used in analysing qualitative data are not always taken in sequence, but they represent preparing and organising the data for analysis. Fielden et al. (2011) indicate that thematic analysis allows the researcher to explore the individual experiences of participants and the meanings they attribute to them.

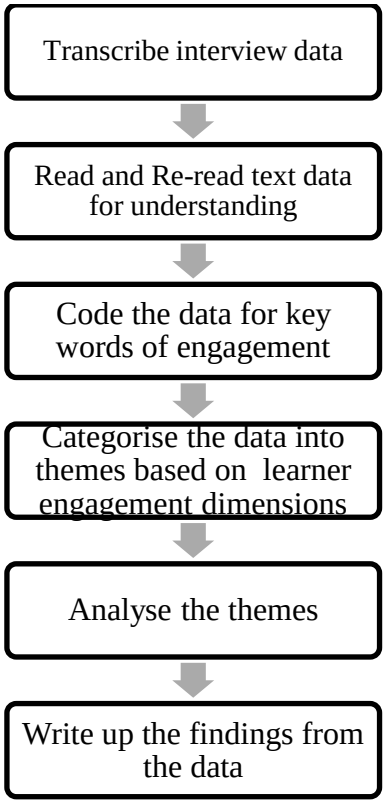


Figure 3. 4: Direction of data analysis process followed in this study

Accordingly, thematic analysis was deemed appropriate because this study sought to uncover the participants' engagement when learning PS through the Kahoot games. Data were analysed using an inductive approach. A grouping and re-grouping of codes under broader themes were done to reduce the vast amount of data that can be generated to a manageable level, from which the data can be distilled further. The coding process entailed three distinct stages:

(i) an initial coding was conducted, which involved the labelling of data using pre-existing or pre-determined codes borrowed from the literature and the conceptual framework discussed in the previous chapters

(ii) a refined or focused coding was conducted whereby main categories and sub-categories were created by means of combining, dividing and eliminating codes by looking out at the entire data for overarching themes, commonalities and divergences to synthesising the data. This third stage ensured validity for the researcher's interpretation of the data by involving a comparison of data using different perspectives.

The qualitative data collected by its very nature is more open to ambiguity, thus identification of emergent key themes will be collated and interpreted. The linguistic and visual nature of what can be construed from the qualitative data requires the researcher to be crucial in the selection and interpretation of evidence for the success and validity of the research. All potential for bias was acknowledged at an early stage and literature was used to justify the coding and data organisation.

According to Cohen et al. (2018) people attempt to comprehend the world around them by using three types of reasoning: deductive reasoning, inductive reasoning, and the combined inductive-deductive approach, which combine Aristotelian deduction with Baconian induction.

This study adopted inductive reasoning. Cohen et al. (2018) argue that one must be mindful that the researcher's background interest, knowledge and biography precede the research. Although initial hypotheses may not be foregrounded in qualitative research, nevertheless, the initial establishment of the research presupposes a particular area of interest, that is, the research and data for focus are not theory-free. Knowledge is not theory-free, yet there is a recognition that all research commences with some prior knowledge or theory that gives rise to the research. I adopted an inductive approach to content analysis to test whether clear themes relating to classroom dynamics, engagement, motivation, and learning appeared in the data (Patton, 2002). The researcher read the data collected from the following research methods, marked parts of the text by hand using colour to create coding and divided it into parts**.**

Varpio et al. (2020) describe inductive research as involving going from specific data relating to a particular phenomenon to a general or abstract conceptualisation of the phenomenon. It is a bottom-up approach (i.e., working from data up to abstract conceptualisations). Subjectivist inductive research does not begin with a hypothesis. Instead, this research began with a desire to understand or explain a particular phenomenon. The researcher collected data of and/or about this phenomenon and sought patterns across the data to generate an understanding of the phenomenon. Paradigms that often use the subjectivist inductive approach include constructionism/interpretivism.

3.8.1 Questionnaire analysis

To analyse the data of the questionnaire, the researcher first familiarised herself with the data by re-reading the responses and noting the ideas initially shown. Thereafter, general codes were

generated by finding interesting and similar features. Each code was then organised into themes, which were reviewed and refined.

3.8.2 Diary entry and Teacher log analysis

The researcher immersed herself in the data by first reading and re-reading the written data. This process of repeated reading results in data immersion ensured the researcher's closeness with the data (Braun & Clarke, 2006). Line by line, each of the ten diary entries was coded and supported by the teacher log. A Microsoft Excel spreadsheet and Nvivo were created in which various codes for each transcript were listed for each participant. However, the texts ended up analysed by hand. Nevertheless, the codes were highlighted to group similar codes. These groupings were developed into themes.

3.8.3 Interview analysis

After having conducted an interview, Lambert (2019) states that it is useful to complete a summary form, which contains details about the interview. The summary form can be attached to the transcript and used to help with the analysis. The responses were recorded and transcribed verbatim. The researcher listened and re-listened to the audio-recording before transcribing it. This served as a reminder so that no points would be omitted from the responses made during the interview. The transcriptions were read and re-read thoroughly until the researcher became immersed in the data. Following transcription, codes are created as the meanings are extracted from the original words of the participants to form sub-themes and then major themes. The codes were organised into groups according to similarity, then sub-themes and major themes were formulated that described the phenomenon of interest, motivation, and cognitive engagement (Lindseth & Norberg, 2004).

In this research, the intelligent verbatim method of transcription was adopted (McMullin, 2021). It was intended to capture the meanings and perceptions created and shared during the intervention, thereby accurately reflecting the substance of the action. By allowing for fillers and repetitions to be edited, it creates a reader-friendly transcript, which ensures the reader is not distracted from the content of the action. A summary of the research methods and methodology is shown in Table 3.4.

Table 3. 4: Summary of the research methods and methodology chapter

Research Paradigm, Research Design and Research Methodology	Research methods/data collection tools	Sampling	Data analysis
• Interpretive • Action research • Qualitative	• Questionnaire • Diary entry • Teacher log • Interview	● Convenience sampling ● Ten female Grade 10 Physical Sciences learners	Thematic analysis ● Reading ● Coding ● Categorize into themes

3.10 Trustworthiness

According to Guba and Lincoln (1994), trustworthiness involves credibility, dependability, conformability, and transferability. A multi-modal data collection approach enhances trustworthiness in qualitative research because it increases the quality and value of the data collected and its analysis in a qualitative study. Each criterion for trustworthiness is discussed below. Referred to as democratic validity/trustworthiness, Anderson et al. (2007) believe that

action research is seen as "an opportunity to make the voices of those who work closest to the classroom heard" (p.7), including both practitioner and learner.

Positionality of the researcher could negatively affect the trustworthiness of the study if the researcher is oblivious to their position and influence. Thus, in full acknowledgement, as the only PS teacher in the school, I am in a position of a pilot as this could lead to the creation or demise of opportunities for more PS learners and teachers/classes. Furthermore, it was also possible that learners felt pressured by the results of the game and data generation tools, such as from the journal entries. This situation was dealt with by reminding learners several times, in written and oral form, that their marks would not be affected in any way by their choices to participate or not to participate, in this study, and that they had the choice to opt-out of the study without it affecting their marks or status in the classroom.

3.9 Credibility

Cohen et al. (2018) assert that credibility could be ensured by using triangulation in a qualitative study, which infers generating data from multiple sources. Using diverse sources and cross checking between and verifying these sources of information ensures trustworthiness in qualitative research. In this study, data collection tools dealt with the same concept, but questions were asked in different ways to ensure that the participants gave the best reflection of their experiences, without trying to impress the researcher. Triangulation was used to cross-validate data from participants.

For a study to be credible, the findings must be congruent with the reality and phenomena being studied (Merriam, 1998). To accomplish this, the researcher encouraged the participants to be

open and truthful in their questionnaire responses by assuring them of their anonymity and creating a safe space (Curry & Nunez-Smith, 2015). Secondly, participant confirmation was done, in which the researcher went back to the participants to check whether the findings were consistent with their experiences (Curry & Nunez-Smith, 2015). Lastly, a reflective commentary was used as an important aspect of the data analysis process. This meant that the researcher engaged in critical reflection throughout the study, and continually reflected on and evaluated the project as it developed.

3.10 Dependability

Trustworthiness is reinforced if the research instruments are dependable and consistent (Maree, 2007). A detailed description of the research process was shared in the methodology chapter, including details of data gathering tools used to record the data (Silverman & Marvasti, 2008). Data generated by the instruments and the thematic analyses are to be saved for at least five years by both the researcher and the researcher's supervisor, thereby providing other researchers with the opportunity to make use of the data collected or to replicate the study.

3.11 Conformability

Conformability refers to the objectivity of the study procedures and the findings thereof (Guba & Lincoln, 1994). In this study, the researcher ensured conformability by transcribing verbatim all audios and videos recorded during data collection observation sessions. The findings generated entailed rich descriptions to give readers a sense of "being there", in that they would be able to follow the path the researcher took and trace how she arrived at her interpretations (Holloway & Wheeler, 2002).

3.12 Ethical considerations

The axiology of the study required that I conducted the research in a socially just, respectful, and peaceful manner and that I would avoid or minimise risk or harm, whether its physical, psychological, legal, social or economic. This conduct is founded on the understanding that all humans have the dignity that must be respected, and they have a fundamental human right to make choices, which researchers must respect. Thus, during the planning and implementation of this study, due consideration was given to ethical issues in using learners as a source of the data. All ethical procedures were followed. These included obtaining ethical clearance from the university and the DBE, as well as obtaining signed consent letters from the parents of the learners and the learners themselves. This was done to confirm their awareness of the study and negotiate access with authorities, participants and parents, guardians, caregivers, and supervisors. A promise was made to uphold confidentiality to protect the information, identity, and data. I ensured the participants' rights to withdraw from the study at any point.

3.13 Anticipated Problems or Limitations

Declaring the limitation of a study raises the dependability of the study, as stated by Rule and John (2011). A limitation of this study was its nature and small size of the sample available (ten learners), which was further limited to only female learners, with no males present in this classroom. The intention of using technology in my study also created problems. The school is in a deeply rural area; it is under-resourced. There is no Wi-Fi, and the mobile network connection is unstable. The socio-economic background of many of the learners is poor, so not all of them own smartphones or are familiar with them. While they can share them with their peers for school purposes, some learners might not participate fully. This serves as a weakness of the study since a generalisation of the findings cannot be made of the learning

practices of all learners. Nevertheless, the researcher is not intending to generalise but to elicit findings about these learners' experiences.

Although there are numerous benefits of action research for educators, there are several challenges associated with this research methodology. According to Hine and Lavery (2014), action research is time consuming for educators in addition to the demands of their teaching, which may threaten the rigour of data collection. Moreover, Hine and Lavery (2014) maintain that the validity of collected and analysed data may be questionably biased because action research is carried out by individuals who are interested parties. Furthermore, the interviews had a disadvantage to the research because the presence of the researcher may affect how the interviewee responds.

3.14 Conclusion

This chapter has tried to justify the choice of the appropriate methodology used to address the research questions. This research was embedded in the interpretivist paradigm to explore learners' engagement with learning via a Kahoot game. The research design chosen in this study was the qualitative approach because it consisted of descriptions and not quantity. The action research methodology was employed by using questionnaires, diary entries, teacher log and interviews as the data collection tools. Triangulation was maintained and described for trustworthiness in this study. All human subjects were treated with respect, and this was described in the ethical considerations. Lastly, the anticipated problems and limitations were outlined. The next chapter presents the data collected and an analysis of the findings.

Chapter 4:

Data Presentation and Analysis

4.1 Introduction

The previous chapter described the research methodology and how the data collection tools were utilised. This chapter presents a post-data collection phase, by presenting the data collected and analysis of the results. Firstly, learners' responses to the pre-intervention questionnaire are presented to respond to research question one of this study. Thereafter, learners' responses to the diary entries are analysed along with the teacher log to respond to research question two of this study. Furthermore, the post-intervention responses were analysed to compare if there were any similarities, differences, or any shift in the learners' engagement when learning PS with and without the Kahoot game to also respond to the central research question two. Lastly, the interview transcripts data were analysed to clarify responses from the questionnaires and diary entries to respond to research question three of this study. In summary, a discussion of the key findings is presented at the end of this chapter, along with a conclusion of the chapter.

The purpose of this study is to explore grade 10 learners' engagement when learning PS topics via the instruction of a Kahoot online game. The following research questions guided the researcher's analysis process:

1. What makes the Grade 10 learners interested in learning Physical Sciences without using the Kahoot game?
2. How will the Grade 10 learners engage with Physical Sciences via the instruction of the Kahoot game?
3. Why do the Grade 10 learners engage with the Kahoot game in the learning of Physical Sciences in the manner they do?

4.2 Characteristics of the participants

The characteristics of the participants are explained first to indicate the population of the study.

Table 4. 1: Learners' demographic information

Characteristic	Category	Names of learners (number of learners)
Age	15	Za and Bongiwe (2)
	16	Sno, Njebs, Ayo, Nomsa, Phume and Tha (6)
	17	Phumzile and Bule (2)
Guardian	Parent	Njebs, Za, Ayo, Phume, Tha and Bule (6)
	Grand Parent	Phumzile and Sno (2)
	Other	Bongiwe and Nomsa (2)
Last Term Mark in Physical Sciences	0-29%	0
	30-69%	Njebs, Za, Ayo, Nomsa, Phume, Sno and Bongiwe (7)
	70-100%	Bule, Tha and Phumzile (3)
Own a mobile phone	YES	Njebs, Za, Ayo, Nomsa, Phume, Bule and Phumzile (7)
	NO	Bongiwe, Sno and Tha (3)
Have played an educational game for any subject before	YES	Tha, Sno, Phumzile, Za, Ayo, and Nomsa (6)
	NO	Bongiwe, Phume, Njebs and Bule (4)

The demographic information of the participants is provided in Table 4.1. Pseudonyms were used to ensure anonymity and confidentiality. The results show that two learners were the youngest (15) in class, with two others being the oldest (17), while the majority was 16. All participants had never played a Kahoot game. Six out of ten learners have formerly played Sudoku for Mathematics or Word puzzles in English. Learners' responses were grouped accordingly to pre-determined categories shown in Table 4.2 to code the form of engagement displayed by the learner at each stage of the action research cycle.

Table 4. 2: Pre-determined categories of learner engagement in GBL (*Plass et al., 2015)*

Predetermined categories of learner engagement	Description of the category
Affective engagement (Learner feeling/emotion)	Negative - affective engagement: *Anger, fear, sad, frustrated*
	Non-affective engagement: *Bored, not interested, dispassionate, disaffected*
	Positive - affective engagement: *Enjoy, Entertain, satisfied, happy, interested, fun*
Motivation (Intrinsic and extrinsic factors)	Negative - motivational engagement: *Disruptive/dangerous behaviour, discouraged*
	Non-motivational engagement: *off-task, not participating, inactive/sleep/*

	Positive motivational engagement: *active participation, self-efficacy, goals, win, or loss encourages, eager to play/do a task again/feedback/doing correction*
Cognitive engagement (Learner knowledge)	Negative-cognitive engagement: *Rapid Guessing, cheating/copying*
	Non-cognitive engagement: *Not thinking/analysing, passive, avoiding challenges*
	Positive-cognitive engagement: *Reviewing Prior knowledge, communicating content or writing the problem and solving, concentration*

Five action research cycles were developed to respond to the three research questions. In essence, this study explored the descriptions of the learners' engagement experiences before and after the Kahoot game. The first action research cycle was to respond to research question one. The second, third and fourth action research cycles were to respond to the central research question two of the intervention. Lastly, the fifth action research cycle was to respond to research question three.

4.3. The first cycle of action research: Data collected from the pre-intervention questionnaire responding to research question 1

4.3.1 Learners' affective engagement without the Kahoot game

In the initial phase, learners were asked to complete an activity on naming chemicals and watch a video of a flame test experiment concerning the topic.

Exercise 1. Provide the name or formula for each ion:

_____	Chloride ion	Li^+	_____
_____	Bromide ion	Na^+	_____
F^-	_____	K^+	_____
S^{2-}	_____	Mg^{2+}	_____
O^{2-}	_____	Ca^{2+}	_____
N^{3-}	_____	Al^{3+}	_____
P^{3-}	_____	_____	Barium ion
I^-	_____	_____	Boron ion

Exercise 2. Complete the table of neutral ionic compounds with the formulas and names for each cation -anion pair

	Cl^-	I^-	S^{2-}	O^{2-}	Br^-	N^{3-}
Na^+						
K^+						
Mg^{2+}						
Al^{3+}						

Figure 4. 1: Excerpt of the naming chemicals class activity before the intervention

Figure 4. 2: Flame test experiment of ionic compounds and metals for the Naming of compounds lesson

All the learners were asked to complete the activity in Figure 4.1 and watched a video of an experiment presented in Figure 4.2. Learners were asked to mark, present, and do the corrections on the chalkboard.

At the end of the activity, learners were asked to reflect on this lesson of instruction without the Kahoot game. The learners were also advised to share any other valuable information about their engagement experiences in learning PS in prior lessons. Learners' responses for each of the three dimensions of affective (feeling), behavioural (motivational) and thought processes (cognitive) in their pre-intervention questionnaire are presented as follows:

Table 4. 3: Learners' responses to their feelings in the pre-intervention questionnaire

Name of learner	Non-Affective engagement	Negative Affective engagement	Positive Affective engagement
Phume		X	
Phumzile			X
Njebs			X
Bule	X		
Tha			X
Sno		X	
Nomsa			X
Ayo		X	
Bongiwe	X		
Za			X
TOTAL	2	3	5

The affective/emotional domain was analysed first, and the learners' responses are shown in Table 4.3. The table shows learners' state of affective engagement in the current study before the intervention of the Kahoot game in PS class. The responses from the pre-intervention questionnaire showed that five out of ten learners demonstrated positive affective engagement. These learners used keywords such as "enjoying", "helpful", "supportive" and "interesting" in their responses. They stressed that they are interested to learn PS because they get to watch videos or do experiments. They stated that PS is nice because it has clear and straightforward classwork. The following quotes illustrate the learners' views, signifying they had a positive affective engagement. The last two excerpts show Nomsa and Njebs' responses, respectively.

Physical Sciences is useful and interesting because we get to do investigations sometimes. (Pre-Intervention questionnaire – Tha)

I like Chemistry when we get to make Practicals, doing presentations every Friday, and having nice and clear classwork is helpful to make me understand the topic more. (Pre-Intervention questionnaire - Phumzile)

Tha and Phumzile shared similar views of feeling happy and interested in PS before the intervention. They indicated that the experiments are supportive and useful and make them interested in the subject. Phumzile highlighted that lucidity in a task makes it nice. The other three out of ten learners demonstrated a negative affective engagement when learning PS without the instruction of the game. They used words such as "scared", and "nervous" in their responses. The following quotes indicate what they said:

I do not enjoy Physics when we write the tests every Monday; even the test we wrote today, I got so scared before we wrote it. (Pre-intervention questionnaire – Phume)

I don't like the class presentations that we do on Fridays. They make me nervous because I am shy. I also get terrified by the loud experiments. Sometimes it is much better to watch the videos. (Pre-intervention questionnaire – Ayo)

From the two quotes, Phume and Ayo displayed anxiety towards learning PS before the game. This was grouped as a negative affective engagement to learning according to the predetermined codes presented at the beginning of this chapter. Two out of ten learners, Bule and Bongiwe, displayed non-affective engagement in learning PS before the intervention. Keywords such as "boring" and not "interested" were in their responses about their feelings. The following quotes illustrate what they said.

I only enjoy watching videos; everything else is boring, especially the classwork and Friday presentations. I just lose my mind when they start to talk. (Pre-Intervention questionnaire Bongiwe)

I was not interested in responding to this activity because it was too long. (Pre-Intervention questionnaire – Bule)

The learners' feelings before playing the game varied, with two learners displaying non-affective engagement, three learners showing negative affective engagement and five out of ten learners demonstrating positive affective engagement.

4.3.2 Learners' motivation/behaviour engagement without the Kahoot game

Table 4. 4: Learners' responses to their motivation in the pre-intervention questionnaire

Name of learner	Non-Motivational engagement	Negative Motivational engagement	Positive Motivational engagement
Phume		X	
Phumzile	X		
Njebs			X
Bule		X	
Tha			X
Sno	X		
Nomsa	X		
Ayo	X		
Bongiwe	X		
Za	X		
TOTAL	6	2	2

The results in Table 4.4 show that six out of ten learners demonstrated a non-motivational engagement in learning PS without a game. Keywords such as "not motivated", "not participating", "difficult", "don't like theory" and "sleep" were found in their responses. The following quotes illustrate learners' views:

It would have been better if we experiment live, and not on video because Science is about experiments, so sometimes, I am motivated to learn, and occasionally I am not motivated to learn. (Pre-intervention questionnaire - Phumzile)

When I don't understand the other questions because they are too difficult, I sleep to take a break before my mind overheats, I end up not motivated to study. (Pre-intervention questionnaire – Nomsa)

My motivation depends on the topic. If it is Physics, I am excited and participate because we do calculations, but when it is chemistry, I hate theory, so I don't participate. I wait till it is over. (Pre-intervention questionnaire - Bongiwe)

The learners' responses show that two out of ten learners displayed a positive motivational engagement in learning PS without playing the game. The other two learners, Bule and Phume demonstrated a negative motivational engagement. However, it is interesting to note that the same group of learners, Tha and Njebs, demonstrated positive affective and motivational engagement in learning PS before the game. They used keywords, "motivated", "practice" and "wish", in their responses. The following quotes are an illustration of their views:

I am motivated to learn Science because I wish to become a doctor. (Pre-intervention questionnaire - Tha)

I am motivated to practise past exam papers because I wish to pass Physical Sciences with flying colours. (Pre-intervention questionnaire - Njebs)

In the quote, Phume had demonstrated a negative affective engagement and then displayed a negative motivational engagement in learning PS before the intervention. Bule had a non-affective engagement along with a negative motivational engagement. Keywords such as "making bombs", and "copying" were included in their responses as shown in the following quotes:

I'm not motivated to learn when the experiments are done in class by mam. We don't get to go outside and make bombs or play around with stuff that explodes and shines bright. (Pre-Intervention questionnaire – Phume)

I'm not motivated to use books, paper, and pen. If we use cell phones, it can be much better than using books because cell phones give answers faster than me, even faster than books. I'm not motivated to even read the whole chapter anymore, but just type in the questions and copy the answers. (Pre-Intervention questionnaire - Bule)

Learners' cognitive engagement before playing the Kahoot game was also explored in the pre-intervention questionnaire to understand their holistic engagement with makes them interested in learning PS without the game.

4.3.3 Learners' cognitive engagement without the Kahoot game

Table 4. 5: Learners' responses to their cognition in the pre-intervention questionnaire

Name of learner	Non-Cognitive engagement	Negative Cognitive engagement	Positive Cognitive engagement
Phume		X	
Phumzile			X
Njebs			X
Bule		X	
Tha			X
Sno	X		
Nomsa			X
Ayo			X
Bongiwe	X		
Za	X		
TOTAL	3	2	5

Learners' responses to their thought processing (cognitive engagement) are shown in Table 4.5. Five out of ten learners demonstrated a positive cognitive engagement towards learning PS before the game. Keywords, "imagine", "drawing", "rewrite", "solve", "challenging", and "understanding", were found in their responses. The following quotes illustrate learners' views:

When I see a challenging question, I first draw a picture of molecules if we are not given a diagram. I do this so that I can see it properly from my understanding. (Pre-intervention questionnaire - Tha)

Chemistry can be quite challenging, so I first have to imagine the problem in my head when we do not have the apparatus to experiment or if there is no video. (Pre-intervention questionnaire - Phumzile)

I need to first rewrite the elements and ions so that I can analyse and see what to check and what needs to be balanced so that I can complete the chemical formulae needed to solve the problem. (Pre-intervention questionnaire - Njebs)

On the other hand, three out of ten learners demonstrated non-cognitive engagement towards learning PS before an intervention. Keywords such as "corrections", "forget", "waiting for the teacher", and "do not think" were found in the learners' responses. The following quotes illustrate what the learners said:

I don't think about what the lesson will be about before learning about it. I wait for the teacher to explain everything first. (Pre-intervention questionnaire - Za)

I forget very quickly, and it makes it worse when the bell rings before we finish corrections. (Pre-intervention questionnaire - Sno)

Bule and Phume were the only two out of ten learners who demonstrated negative cognitive engagement. It is evident that Phume consistently demonstrated negative engagement in all three dimensions. Keywords such as "cracking my head", "overloaded", and "teamwork by sharing answers" were found in the following quotes, which illustrate their responses.

Using a cellphone with the internet is easier instead of cracking my head. We use a calculator instead of mental calculations, so why can't I use google to find answers? (Pre-intervention questionnaire- Bule)

My brain gets overloaded when an activity is too long. It is better to do teamwork by sharing answers and dividing the work, maybe the first part is done by others and the other part too. (Pre-intervention questionnaire- Phume)

The learners' thought processes before playing the game varied, with three learners displaying non-cognitive engagement, two learners demonstrating a negative cognitive engagement and a majority of five out of ten learners demonstrating positive cognitive engagement.

Overall, the learners' responses for all three dimensions showed a positive affective engagement, a positive cognitive engagement and a non-motivational engagement when learning PS without the instruction of the Kahoot game in the first cycle of the research. The second to fourth action research cycle consists of three Kahoot games played as the intervention to increase learners' engagement in PS.

4.4 The second to the fourth cycle of action research: Data collected from the diary entry, post-intervention questionnaire and a teacher log responding to research question 2

The learners were introduced to a lesson on how to play the Kahoot game. All ten participants played the first Kahoot game based on naming chemicals. The questions on the game were projected on the screen and learners responded using their cell phones. A screenshot is presented in Figures 4.3 and 4.4 showing the screenshot of the learners' cell phones.

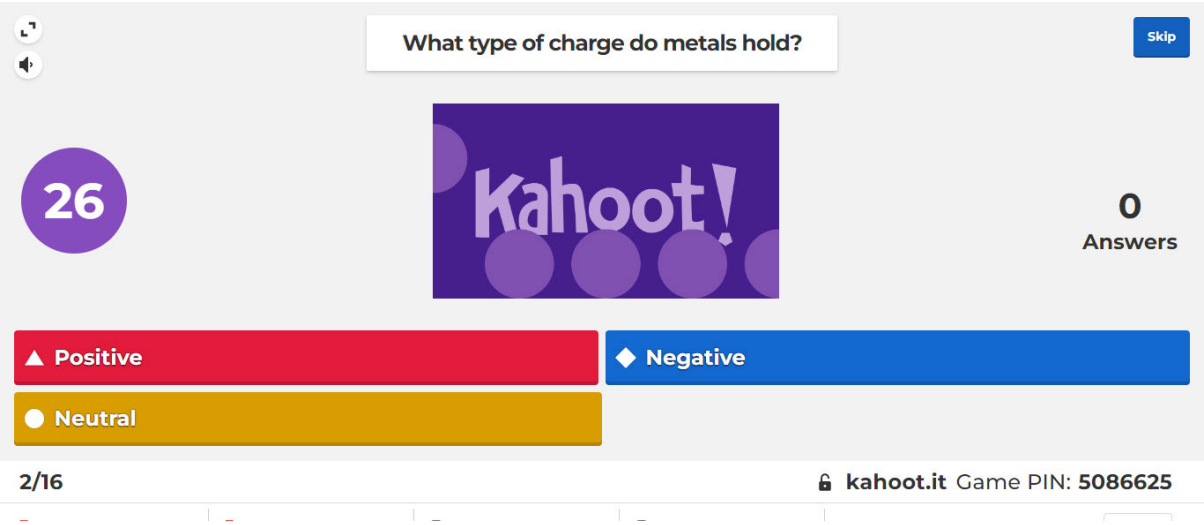


Figure 4. 3: Kahoot game displayed on the projector for chemical naming

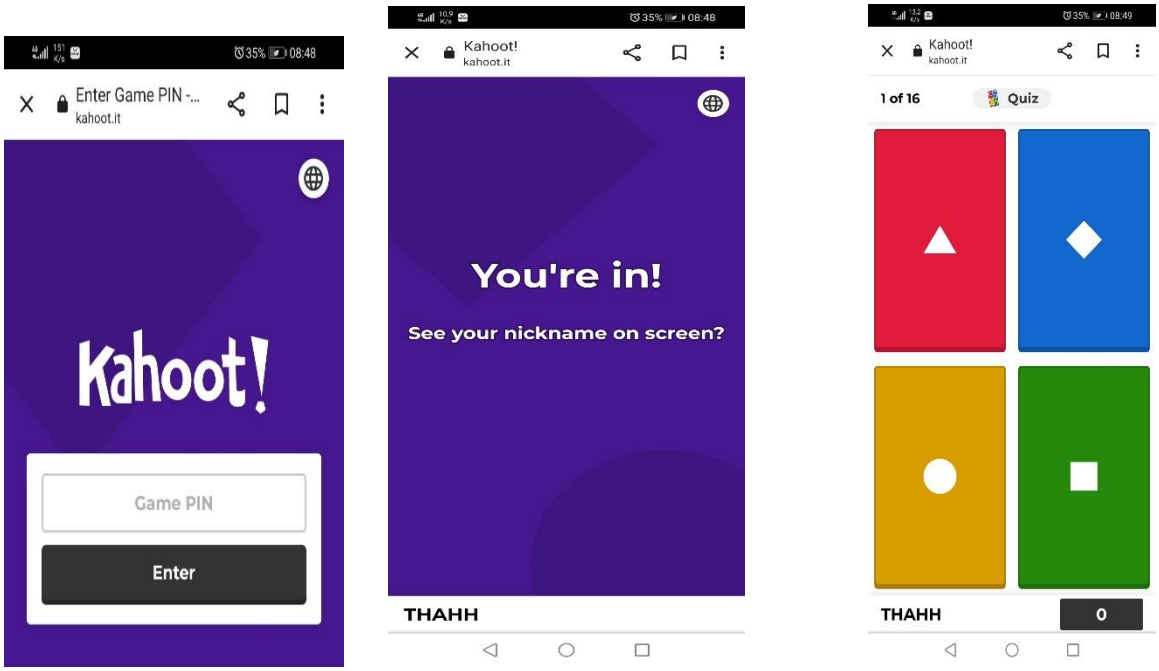


Figure 4. 4: Learners' mobile view of the Kahoot game played

Figures 4.3 and 4.4 show the excerpt of the Kahoot game played as projected on the screen and learners' cell phones, respectively. After the game, learners were requested to write their reflections in a journal.

In the 2nd cycle, the learners wanted the background music off because it was a distraction. Thus, the 3rd action research cycle involves an intervention of learners playing the Kahoot game with the music and the chimes of the game switched off. The learners suggested the teacher to read the question out loud in the placement of the music.

The reflection journal prompted learners to express their feelings using emojis to gather information about how they emotionally engaged with learning PS via Kahoot. They also had to shade in a motivation metre to obtain their motivation level after playing the game. Lastly, they had to present proof of how they worked out the problem or at least indicate how they went about finding the solution to acquire how they cognitively engaged with PS via Kahoot.

4.4.1 Learners' feelings about the Kahoot game

Table 4. 6: Learners' feelings as they played the Kahoot game

Name of Learner	Emoji / Feeling excited 🙂 serious 🤔 sad ☹️ bored 😴		
	Before (setup)	During	After (game over)
Tha	🙂	🙂	🙂
Bongiwe	🙂	🙂	🙂
Sno	🙂	🙂	🙂
Phume	🙂	🙂	🙂
Nomsa	☹️	🤔	☹️

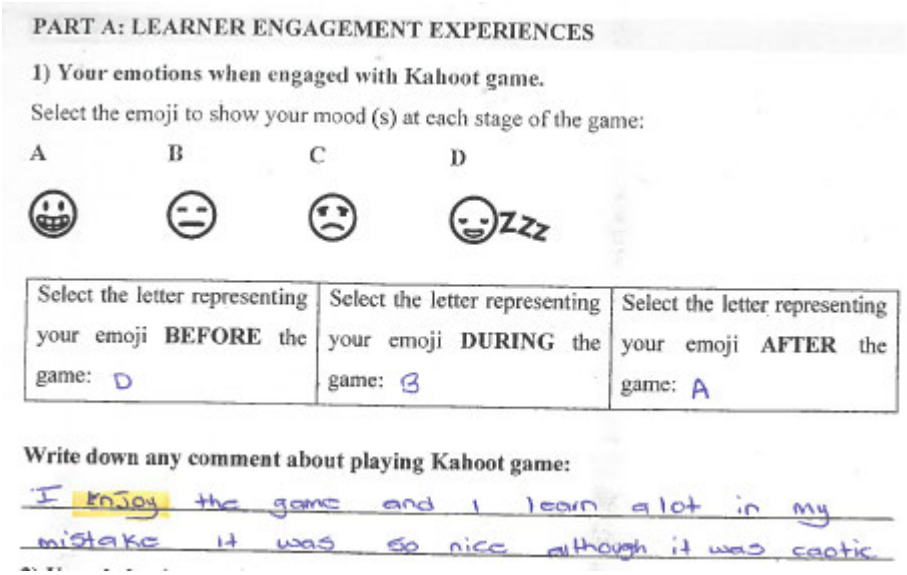
Za			
Njebs			
Ayo			
Bule			
Phumzile			

The results in Table 4.6 show learners' feelings towards learning PS via playing the Kahoot game. A majority of eight out of ten learners expressed a mood of "excited" at the end of the Kahoot game. Keywords found in learners' responses were "enjoy", "happy", "nice", "more fun", "more interesting", "curious", and "excited". The feeling of enjoyment, as expressed by most learners, indicates positive affective (emotional) engagement. The following quotes reflect how learners learnt PS via the instruction of the Kahoot game.

I was very happy because it was more fun to learn this way and it will help me remember some things. (Diary entry - Bongiwe)

Playing this game was very nice, exciting, and funny too because there were some things that I learnt during the game which I didn't know before. (Diary entry - Sno)

I became enthusiastic when I was playing this game because it was exciting, and I could quickly see the correct answer when the options came up. I love this game. (Diary entry - Tha)



PART A: LEARNER ENGAGEMENT EXPERIENCES

1) Your emotions when engaged with Kahoot game.

Select the emoji to show your mood (s) at each stage of the game:

A B C D

Select the letter representing your emoji **BEFORE** the game: D	Select the letter representing your emoji **DURING** the game: B	Select the letter representing your emoji **AFTER** the game: A

Write down any comment about playing Kahoot game:

I enjoy the game and I learn a lot in my mistake it was so nice although it was caotic

Figure 4. 5: Phume's response to how she felt about learning via Kahoot

However, Bule and Nomsa were the only other two learners who displayed negative affective engagement. Keywords such as "upset", "frustrated", "embarrassed" and "sad" were found in the learners' responses. The following excerpts were drawn from the learners' diaries:

I was annoyed because others screamed, yes, when they got it right and shouted, eish, when they got it wrong. I was just quiet, just seriously focused the whole time. I don't think my classmates took the game seriously. They were too hyper and chaotic which made me upset and lost focus. I ended up with low scores which made me very sad. (Diary entry - Nomsa)

I was sad and embarrassed because I was not in the top 3. I didn't win much. Even though no one could see that I was not a winner because of my nickname, I knew that some of them could see that I was not happy, meaning I lost. It ruined my reputation because usually I am always at the top. (Diary entry – Bule)

Learner engagement in terms of facial expressions was also confirmed from the teacher log. It is interesting to note that none of the learners demonstrated non-affective engagement after playing the game. There was no evidence indicating that learners were bored at the end of playing a Kahoot game. However, Bule, Ayo and Njebs indicated that they were bored at the setup stage where everyone had to login first before the game could commence. Therefore, learning PS via Kahoot resulted in no learners displaying a non–affective engagement. A majority of eight out of ten learners displayed a positive affective engagement whilst a minority of two out of ten learners displayed a negative affective engagement.

4.4.2 Learners' motivation with the Kahoot game

Table 4. 7: Learners' motivation level after playing the game

Name of Learner	Motivation level		
	High	Moderate	None
Tha	X		
Bongiwe	X		
Sno	X		
Phume	X		
Nomsa	X		
Za	X		
Njebs	X		
Ayo	X		
Bule	X		
Phumzile	X		

The results in Table 4.7 show that the learners' level of motivation was high after playing the game. The results show that all ten learners were highly motivated to learn PS after playing the Kahoot games. It is noteworthy that all ten learners displayed positive motivational/behavioural engagement. The following quote illustrates the majority of learners with a positive motivational engagement driven by "learning", understanding", "self-confidence", and "more practice".

I was sad about losing in the Kahoot game at the end, but at the same time, I was motivated to study more and practise more so that I could play it again next time easily. (Diary entry – Nomsa)

The game boosted my self-esteem because it marked me correctly and gave me larger points to show that I understand the topic. (Diary entry – Phumzile)

I was motivated to keep seeing my name at the top of the scoreboard. It made me feel good about myself. That is why I will keep studying and practicing so I remain at the top. (Diary entry – Tha)

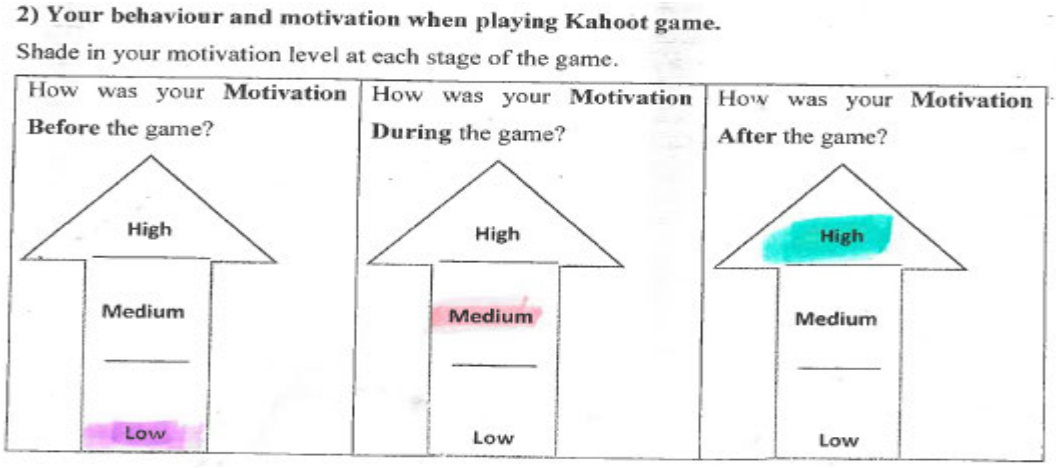


Figure 4. 6: Njebs' response about her motivation when learning PS via Kahoot

I could be faster and listen to the questions more attentively. (Diary entry – Phume)

Za, Bongiwe, Sno and Bule were the second group of learners with a high, positive motivational engagement. However, they were focused on "beating the time" and "winning" as they mentioned in their journals. Findings suggest that they also displayed a positive motivational engagement, however, this was inspired by the motivation to win and not for learning with understanding.

Za was one of the learners with a positive motivational engagement that was not directed towards learning goals yet directed to competing. The following excerpt illustrates her response:

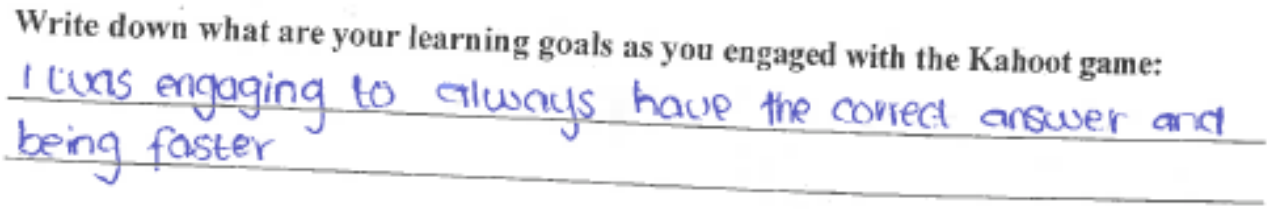


Figure 4. 7: Za's response about her motivation when learning PS via Kahoot

Similarly, Bongiwe was focused on the time and motivated to play the next game as expressed below:

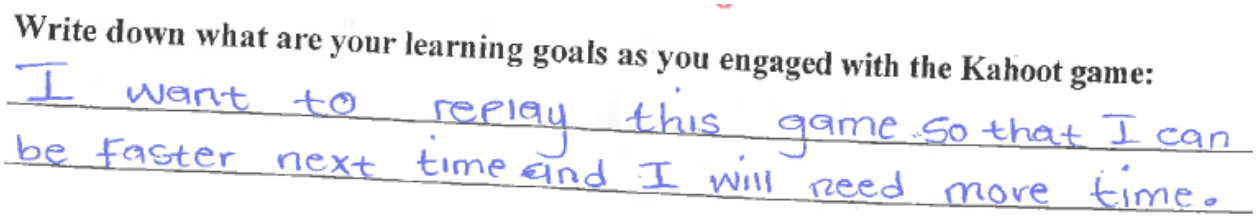


Figure 4. 8: Bongiwe's response about her motivation when learning PS via Kahoot

Although Sno was also motivated by being faster, an interesting finding about the competitive nature of the game was identified. The following excerpt illustrates what she said:

I was jealous to see other peoples' names on the top of the scoreboard and mine was in the middle. This made me motivated to try and beat the time so that I can score higher points and become number one. (Diary entry – Sno)

None of the learners displayed a negative nor a non-behavioural/motivational engagement. There was no evidence of any dangerous or disruptive behaviour displayed by the learners. None of the learners expressed a low or medium motivation at the end of the game. Six out of ten learners had a positive motivational engagement driven by learning goals, such as learning for understanding. Whilst four out of ten learners had a positive motivation engagement driven by the desire to win the competitive game of Kahoot.

Learner engagement in terms of body language was drawn from the teacher log. The participants demonstrated significant positive body language during the second – fourth action research cycles.

4.4.3 Learners' thought processes when using the Kahoot game

In trying to understand the learners' cognitive processes, the learners were presented with 30 seconds before moving to the next question in the Kahoot game to show their work on paper, since the Kahoot game only made them choose the option.

Table 4. 8: Learners' cognitive engagement when learning with a game

Name of Learner	Evidence of learner cognitive/thought processes				
	Non – engagement			Negative	Positive
	Wrong answer and no workout	Wrong answer and wrong workout	Correct answer and no workout	Correct answer and wrong workout	Correct answer and Correct workout
Tha			X		
Bongiwe				X	
Sno					X
Phume	X				
Nomsa		X			
Za					X
Njebs			X		
Ayo	X				
Bule				X	
Phumzile			X		

From Table 4.8, it is evident that some learners completed their work, whilst others did not. It also indicates whether the answer and the workout were correct or wrong. The analysis of learners' responses in the reflection journals shows that only two learners, Za and Sno, displayed a positive cognitive engagement as they presented both a correct answer and a correct workout. The positive engagement was also evident in their reflection journals, with the keywords such as "recognise", "analyse", "knowledge", "organising", and "remember" originating from their responses to cognitive questions. The following excerpt demonstrates what they said:

It is easy and quick to recognise if you are wrong or right because the game gives the corrections at the same time, then I think about why my answer was wrong and analyse my mistake. (Diary entry – Sno)

I'm so proud to see that my memory and knowledge are very good because I remember a lot of what I learnt. I was also more focused so that I could organise the information in my head. (Diary entry – Za)

From the quotes, Bule and Bongiwe demonstrated a negative cognitive engagement as they consistently chose incorrect options because they were too fast. They were not paying attention to the questions. It was also found that they were able to select the correct options only because it was guesswork. This was also proved by their working out, which was incorrect considering that the answer was correct. The following excerpt from the reflection journal illustrates the learners' responses, which were gauged to be negative engagement:

I study harder now but I skip difficult questions because, firstly, I can guess the answer. After all, the game will not ask me to show my working and, I will get more points on the easier questions which I studied. (Diary entry – Bule)

Six out of ten learners demonstrated non-cognitive engagement in learning PS via the instruction of the Kahoot game. The keywords, "limited", "autopilot", "not for marks", and "no energy to analyse", were prevalent in their responses. Although three of the six learners, Tha, Njebs and Phumzile, had correct answers, they did not show any workout. Keywords such as "game did not require" a workout, "disturbing the energy" and "too easy" were found in their responses as evidence of non-engagement. The following excerpt displays the learners' responses who had a non-cognitive engagement:

I'm used to trying to solve the problem and discuss it and keep trying till the answer makes sense. I am just on autopilot when answering this game because it already has the options for the answer to work towards. I feel like my mind is being limited; it would have been different to think about it if the answer was not there, I think. (Diary entry – Phumzile)

This is just a game; it is not that serious and it ain't for marks. So, I don't have the energy to analyse, write or work out. (Diary entry – Njebs)

I was lazy to do the work out because the options were already there, and I found it more obvious to recognise the right answer. (Diary entry – Tha)

Therefore, learners' cognitive engagement when learning PS via the instruction of Kahoot varied. An unexpected outcome of a majority of six out of ten learners displayed a non–

cognitive engagement after interacting with Kahoot. Two learners demonstrated a negative cognitive engagement, whilst the two other learners displayed a positive cognitive engagement.

What learners said in their diary entries was also confirmed in the teacher log. Learners were observed scratching their heads and yawning, then considered eliminating the background music and reading the questions out loud, increasing allocated time, and allowing pen and paper for them to work out their thoughts. The fourth action research cycle was prompted by the obvious lack of increased learner engagement within the cognitive domain. Furthermore, I reflected on my teaching method and recognised the need to enhance my teaching of PS with technology and gamified tools since they are easy, fast, and useful for gathering learner progress.

Three lessons assessed via the Kahoot games were: Chemical naming, States of matter and Electric circuits in respective weekly Kahoot game sessions. Each time, the learners responded to the diary entries. However, after the 3rd Kahoot game, all ten learners were asked to respond to the post-intervention questionnaire. The results show comparisons between learning PS without the game and learning through the instruction of the Kahoot games. Learners' responses are presented for each of the three dimensions.

4.4.4 Learner's affective engagement before and after interacting with Kahoot

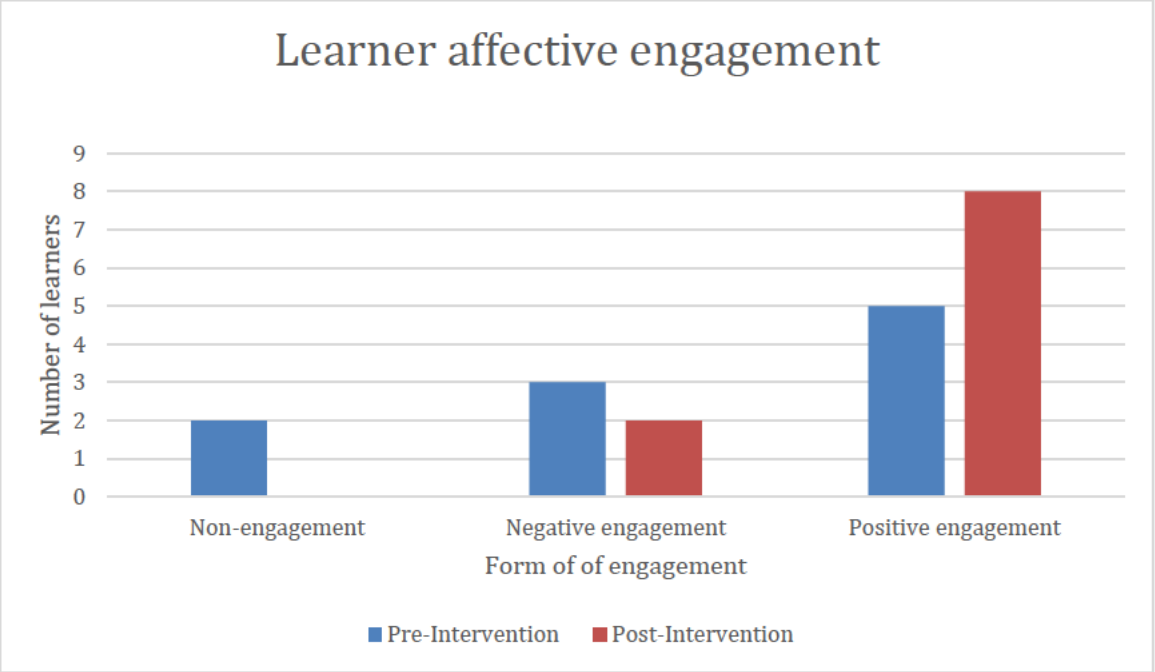


Figure 4. 9: Bar graph of learners' affective engagement before versus after the game

The results in Figure 4.9 indicate that before the intervention, two learners had a non–affective engagement, yet after interacting with the Kahoot game, no learner experienced a non-affective engagement when learning PS. However, before the intervention of the gameplay, three learners displayed a negative engagement, as they experienced feelings of fear and were nervous. After interacting with the Kahoot game, two learners displayed a negative affective engagement. Nevertheless, there was a significant increase in positive affective engagement for learners learning PS with the instruction of Kahoot as before the intervention. Five learners displayed a positive affective engagement, yet after the Kahoot game, eight out of ten learners demonstrated a positive affective engagement.

Sno, Ayo and Bongiwe's feeling of affective engagement improved to a positive affective engagement after playing the game. The keywords, "fun", "happiness", "excited", "relaxed", "calm", "confident", "enthusiastic", and "passionate" were common in their responses to the

post-intervention questionnaire after the game as opposed to the keywords in their responses before the game of "fear of assessments" in the pre-intervention questionnaire. The following excerpt illustrates their views:

I am passionate about learning Physical Sciences with the game because it makes me calmer. (Post-intervention questionnaire – Ayo)

I am more confident because I am really relaxed and not scared. (Post-intervention questionnaire – Sno)

Furthermore, Bongiwe was one of the three learners with improved affective engagement. Before playing the game, she had a non-affective engagement as was indicated in the pre-intervention questionnaire. She had stated that she disliked learning Chemistry, and after playing the Kahoot game, this was her response:
I think I've developed an interest to go and do research on theory too and not just the calculations. (Post-intervention questionnaire – Bongiwe)

Therefore, Bongiwe had a shift from non–affective engagement to a positive affective engagement after interacting with the Kahoot game. None of the learners demonstrated a non-affective engagement after interacting with the game. There was no evidence of the keywords of boredom or a lack of interest in the learners' responses. However, Bule and Nomsa were the only two learners who displayed a negative affective engagement after playing the game. Bule had a shift from a non-affective engagement to a negative affective engagement after interacting with the Kahoot game. Similarly, Nomsa had a positive affective engagement before playing the game. Thereafter, she displayed a negative affective engagement after the

game. These were unanticipated outcomes that a Kahoot game could have a negative affective engagement. Keywords such as "embarrassed", "not like", "losing", "annoying" and "childish" were evident in their responses. The following excerpt illustrates what they said about their feelings after the game:

I didn't like the game. I felt embarrassed when I was losing, and my classmates were surprised that I was not in the top 3 though we used nicknames. (Post-intervention questionnaire – Bule)

The game was so annoying and childish. Maybe it can be played for LO, not science. (Post-intervention questionnaire - Nomsa)

Overall, the learners' feelings before and after playing the Kahoot game were interesting, as there was a shift from two learners with non–affective engagement to none of the learners displaying a non-affective engagement. The other three learners had a negative affective engagement before the game, which changed to two learners developing a negative affective engagement after the game. Lastly, five learners displayed positive affective engagement before the game, which shifted to an improved majority of eight out of ten learners demonstrating positive affective engagement.

4.4.5 Learners' motivational engagement before and after interacting with Kahoot

Before the game, only two learners, Tha and Njebs, displayed a positive behavioural/motivational engagement towards learning PS, whilst a majority of six learners displayed a non-motivational engagement and lastly, two learners displayed a negative motivational engagement. However, after playing the game, all the other eight learners then expressed that they were highly motivated to learn PS via the Kahoot game. Thus, a total of all ten learners displayed a positive behavioural/motivational engagement in learning PS in the post-intervention questionnaire after the interaction of the game. Tha was one of the learners

who spoke about confidence boost and learning in small chunks in the post-intervention questionnaire as follows:

Playing this game was a boost to my confidence and just reassured me that I was on the right track with my studies. This game helped me make sure that I do not study only for the big exams only but study in bits every day. (Post-intervention questionnaire – Tha)

The learners' positive motivation varied. After the last Kahoot game, one group of learners viewed the game as a competition, and they focused on the actual learning as the other group did. The rest of the learners were focused on the competitive nature, winning and time of the gameplay. The following quote illustrates one of the learners' responses:
I'm motivated to learn Physical Science because we are in a healthy competition, and I feel the pressure to win by studying more in the evening and asking about what I did not get right. (Post-intervention questionnaire – Za)

None of the learners displayed a negative or non-motivational engagement. This was evident because all the learners played the game, and none of them skipped the game session or gave excuses. Furthermore, none of the learners disrupted the game session. Learners' motivation/behavioural engagement after the game was impressive.

The learners' motivation before and after playing the Kahoot game was impressive because there was a shift in six learners with non-motivational engagement to zero out of ten learners displaying a non-motivational engagement. Moreover, two learners had a negative motivational engagement before the game, which changed to no learner developing a negative motivational engagement after the game. Lastly, two learners displayed positive motivational

engagement before the game, which shifted to an improved majority of ten out of ten learners demonstrating positive motivational engagement.

4.4.6 Learners' cognitive engagement before and after interacting with Kahoot

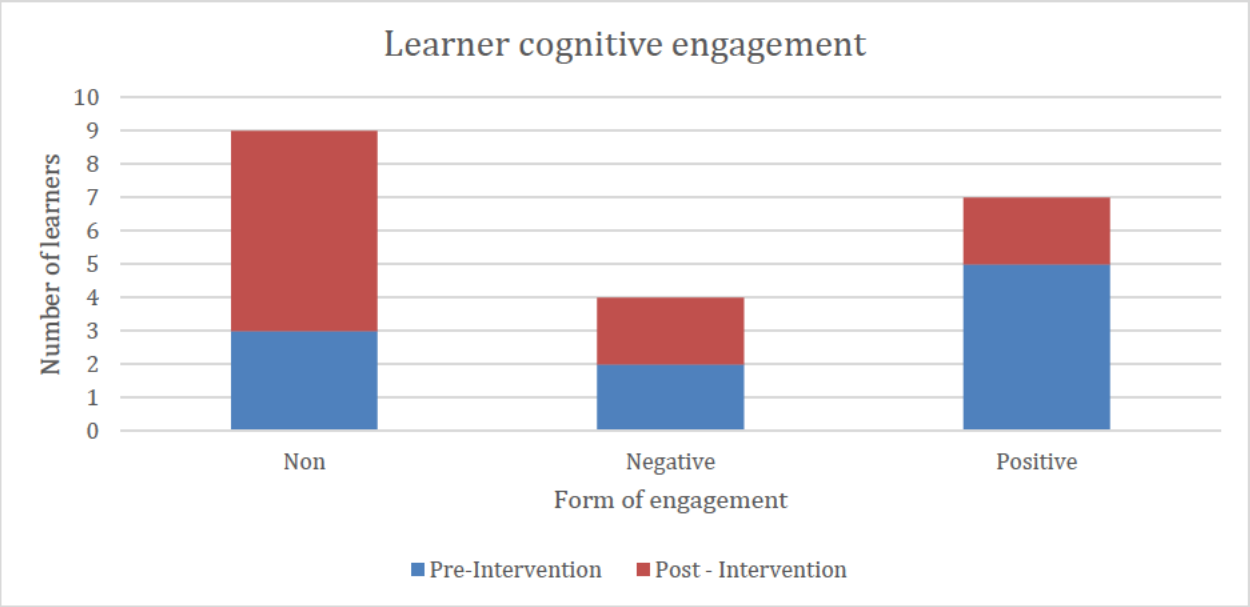


Figure 4. 10: Bar graph of learners' cognitive engagement before versus after the game

Figure 4.10 shows learners' pre- and post-intervention questionnaire results. Before the instruction of Kahoot, five out of ten learners displayed a positive cognitive engagement, whilst at the pre-intervention, there was a massive drop to only two out of ten learners with a positive cognitive engagement after the game. Interestingly, there was a significant shift to a non-cognitive engagement for a majority of six learners after receiving instruction via Kahoot. Before the instruction of Kahoot, there were only three learners with a non–cognitive engagement.

There was evidence of late submission of responses inserted to the game because the learners were idling, looking around and not working out during the 30 seconds provided. They were not concentrating on working out to find the solution to the problem. However, it was

interesting to find that Phumzile and Tha who had a positive cognitive engagement in the pre-intervention to be among the learners with a non-cognitive engagement after the Kahoot game. The following excerpts illustrate their responses to the post-intervention questionnaire:

I did not learn anything new, and the options limited me because you may end up not appreciating your intelligence in finding the answer but instead you are guided to work towards an answer. (Post-intervention questionnaire - Phumzile)

I just wanted the game to end already. There was nothing much to analyse because the options were there, making the task too easy. (Post-intervention questionnaire - Tha)

Furthermore, Bule and Bongiwe were the only two learners with a negative cognitive engagement at the end of the Kahoot game. A new code of feeling like "a loser", "an idiot", "dumb" and "lowest" emerged from their responses.

Sometimes I was not getting any answers correct. It made me feel like I was the dumbest and an idiot. Sometimes I was lucky as I was guessing the correct answers. (Post-intervention questionnaire – Bongiwe)

The learners' cognitive engagement before and after playing the Kahoot game varied unexpectedly. There was a decline from a majority of five out of ten learners displaying a positive cognitive engagement before the game to only two out of ten learners demonstrating positive cognitive engagement. Three learners displayed a non–cognitive engagement before the game, which shifted to a majority of six out of ten learners demonstrating a non-cognitive engagement.

4.5 The fifth cycle of action research: Data collected from the interview session responding to research question 3

The learners who portrayed no explicit changes in each of the three dimensions/domains before and after the Kahoot game were selected for the interview. The interview was aimed at responding to the third research question. The learners were interviewed to understand why they engaged with the Kahoot game in the manner that they did and to get clarity on whether their engagement increased, decreased, or remained the same. Five learners, Bule, Za, Phumzile, Njebs and Tha were interviewed. The interview questions and the learners' responses are presented according to each of the three dimensions.

4.5.1 Affective engagement interview responses

The first four learners interviewed individually for their consistent positive affective engagement before and after the game were Phumzile, Njebs, Tha and Za. The learners were interviewed about their feelings when learning PS with and without the game. The interview questions focused on seeking clarification of the learners' responses presented in their pre-intervention questionnaires, post-intervention questionnaires and reflection journals. In the interview, learners were asked to explain the following:

Researcher: ***Is there anything you like about Kahoot that makes it different from normal teaching and learning?***

Tha: *I liked that Kahoot gave me so much pressure to think faster and I was so enthusiastic because I didn't want to lose; I wanted to win. I didn't like that we had the options to choose because others didn't know the answer but ended up just choosing something*

Za and Njebs shared a similar view that they liked Kahoot because of the adrenaline it brings to come up with the right answer as compared to the norm. They displayed improved positive affective engagement. The following excerpt displays their responses to the interview:

Njebs: *As each question popped on the screen, I could not even stay on my chair because I was so excited that I knew the answer and wanted to log in as soon as possible so that I could score the highest points. The game gave me a good, exciting rush*

Za: *I liked the game because we are all given the same amount of time to answer, and it is easier to see who is the best. It was a good competition.*

In the quote, Phumzile felt that there was nothing special about learning PS via the Kahoot game, hence her positive affective engagement remained the same. It neither improved nor negatively declined because of the game.

Phumzile*: There wasn't really anything special about this game. It seemed to me like multiple choice questions but had fun with the music and technology, it was good to use technology in class; maybe that is what was special.*

Researcher*: Would you prefer to learn Physical Sciences with or without Kahoot?*

Tha, Zah and Njebs agreed to rather receive PS instruction via Kahoot. Keywords such as "faster", "easier", "and cool" were found in their responses.

Za: *I prefer to learn via Kahoot because it makes learning funnier and more relaxed and it is easy to test what I know about the topic and what I still need to learn.*

Njebs*: I would prefer to learn via Kahoot. … I think because it is cool to use our phones in class for schoolwork like they do in other schools …"*

Tha*: I prefer to learn via Kahoot because it is easy for the teacher to tell who the best learner and the slow learner is and for all of us to see the corrections at the same time because sometimes (laughs) we don't get our scripts back.*

Phumzile*: No, thanks! I still prefer to learn the way we are learning. Kahoot can be played at most once a month because it will be a waste of time to finish the curriculum. It wastes time when it is being set up and the network here is the worst.*

Researcher: Would you like to play the game again and for other subjects?

All four learners agreed to play the game again and for other subjects. However, Phumzile emphasised limiting the gameplay to the minimal number of times possible.

Njebs: *Yes, I wish we can play the game again for all the subjects because we are all different and have different ways of learning. Some of us can learn more when playing a game*

Phumzile*: I don't mind; we can play the game again but only once a month*

Researcher: ***Which features do you like in Kahoot? (Music, graphics, points, competition, leaderboards, anonymity, etc.)***

From the quotes, it is evident that all four learners share the same views. Learners' excitement, interests and confidence were boosted by the competitive nature of the game.

Phumzile*: I liked that it was a competition, and I was winning because I understood the topic. The leader board at the end, showing the top 3, was the best part because it showed that I am still the top dog on paper and technology. The game gave me so much confidence*

Tha*: I like the leaderboard because it keeps showing that I'm at the top. Even if we used the nicknames (laughs), I know that they know, and we all know that I was in the top three "akugeji" (there is no doubt about it)*

Njebs*: The competition and the pressure were so nice because we were all fighting to be number one*

Za*: I liked the music and the stopwatch making us think quickly, but every time I just wanted to see my name on the leaderboard, it was so fun, I will keep trying till my fake name is there too*

Learners' positive engagement before and after playing shifted, with three learners displaying a higher positive engagement after interacting with the game whilst one learner, Phumzile, demonstrated an unchanged positive cognitive engagement with and without the instruction of the Kahoot game.

4.5.2 Motivational engagement interview responses

There were only two learners, Njebs and Tha, who had consistently positive behavioural engagement. In the interview, the learners were asked to respond to questions about their level of motivation when learning PS before and after the game. The quotes from their responses

indicate that the game improved their positive motivational engagement as they were more motivated after the game.

Researcher: How would you describe your experiences of using Kahoot during Physical Sciences class?

Njebs*: Winning or losing did not make me stop playing the game. I wanted to play again and keep winning. What motivated me, even more, was that we can get so much done in a short space of time. I think I really appreciate the Kahoot game more for that because technology makes things faster.*

As Njebs described her motivation to be based on winning or losing, in contrast, Tha based her motivation on learning for understanding.

Tha*: I found the game to be useful when it motivated us to go learn about what we forgot, and it made us remember what we knew, making us understand it even more.*

Researcher: Were you more motivated to learn Physical Sciences after playing the game?

Njebs*: Yes! Definitely, it motivated me to always go home and studied more because I really wish to be in the top three.*

Tha*: Yes, I can say I was motivated because I was proud of myself. I study all the time "vele" (anyway) so I was not losing, but for the other tricky questions that the other learners got wrong, I was motivated to explain to my friends how the question was trying to catch us but it didn't catch me. I wanted to help them because that's how I learn by teaching others.*

Tha and Njebs shared similar views of being motivated by the game to learn Physical Sciences. The two learners demonstrated a higher positive motivational engagement after the game.

4.5.3 Cognitive engagement interview responses

Only one learner, Bule, was found to display consistently a negative cognitive engagement from all sources of data generation tools. Clarity was pursued through the interview to determine whether Bule's negative cognitive engagement increased, decreased, or remained the same after the Kahoot game. Bule's responses to the interview show that she further developed a negative cognitive engagement after playing the game as there was evidence of her 'gaming the system' through guessing, memorising the answers to similar questions as in the past papers:

Researcher: What do you think helps/supports and disturbs/hinders your concentration on the activity?

Bule*: I'm a person who doesn't like to spend a very long time sitting down studying. I prefer using technology because it is faster than books. Also, I can't focus on the activity during normal class time and during the game because I'm used to sitting next to my friend. She helps me a lot, but this time, she was too far away though I could see what she chose. She did not get a chance to help me this time.*

Researcher: How was your thinking process when learning Physical Sciences through the game?

Bule*: It was irritating to finally be using technology in class but not in the way I thought. For example, google helps me with everything, but the game was too fast. I couldn't research the*

questions. I didn't know, so I had to click on any answer as fast as possible and luckily, it was the correct options.

Nine out of ten learners' cognitive engagement varied before and after the game. Only one learner, Bule, demonstrated that she had a consistent negative cognitive engagement without the game and maintained negative cognitive engagement after playing the game.

4.6 Discussion of Key Findings

The three research questions are concerned with the learners' engagement before and after playing the Kahoot game to learn PS. The discussion and analysis of the findings employ an inductive approach and a thematic analysis of the questionnaires, reflection journals, teacher log, and interviews to respond to the key research questions. The key findings of this study were grouped into the three dimensions of engagement for each of the three research questions, with the central research question 2 entailing the intervention discussed in more detail.

4.6.1 Findings before learning PS without the Kahoot game

The key findings responding to research question 1 under the three engagement domains were listed as follows: Practical work and watching videos make learners interested in learning PS prior to the game. Future career goals make learners motivated to learn PS before the intervention. Representing information and analysing the questions cognitively engages the learners before playing the game.

Five out of ten learners are interested in learning PS without using the Kahoot game. This finding suggests that five out of ten learners demonstrated positive emotional engagement in learning PS prior to the game. Watching videos, doing experiments/practical/investigations, presentations, and lucid classwork makes learners interested in learning PS without the instruction of the Kahoot game. On the other hand, the other five out of ten learners were found to not be interested in learning PS before the game. The learners did not enjoy PS, rather, they felt anxious, bored and, nervous about the PS tests and when they must present.

Six out of ten learners displayed non-motivational engagement in learning PS without the game. The learners are unmotivated to learn or participate prior to the game, nor are they motivated to use books, pen, and paper. On the other hand, two out of ten learners, Phumzile and Tha displayed a positive motivational engagement without the game. Wishing to pass and fulfil a career made the learners motivated to learn PS without the instruction of the Kahoot game.

Five out of ten learners displayed a positive cognitive engagement when learning PS without the instruction of Kahoot. Drawing images, imagining, rewriting, and analysing the question made learners cognitively engaged with learning PS before the game. On the other hand, the other five out of ten learners demonstrated that they are not curious about PS lessons, and they are forgetful, and seek simpler ways when the task at hand is thought-provoking.

4.6.2 Findings after learning PS via the Kahoot game

The main findings responding to research question 2 and 3 under the affective domain were listed as follows: Assessment of PS via Kahoot game is calming/relaxing. Learning PS via

Kahoot is more interesting/more fun and more exciting. The Kahoot game made some learners feel sad and ashamed.

Three learners, Phume, Ayo and Sno experienced emotions of fear and anxiety towards PS assessments before the intervention of playing the Kahoot game. Learners indicated that they felt nervous when faced with PS assessments. Nevertheless, in the reflection journals, teacher log, and post-intervention questionnaires, interesting findings emerged. It was found that Kahoot makes the assessment of PS more relaxing and calming. In addition to this finding, Licorish et al. (2018) argue that more relaxed learning may also result in the absence of Kahoot, although the Kahoot game is likely to provide an atmosphere that would lead to potentially more relaxed and more attentive learners.

On the other hand, before the game, Bule and Bongiwe were the only two learners who found PS boring. They argued that what makes the subject uninteresting is the long activity and a lack of technology inclusion in the lesson. After interacting with the Kahoot game, none of the learners displayed a non–affective engagement. This means none of the learners found the learning of PS via the Kahoot game boring. This finding was in contrast with Machajewski (2017) who found that some of the learners' reviews in his study of gamification application indicated that Kahoot is fun, and they enjoyed it. However, Machajewski (2017) shared that not all reviews indicated experiences of fun as some learners experienced that Kahoot was "boring as hell" (p. 79). Instead of experiencing boredom, learners in this research study found learning PS via the Kahoot game to be more interesting, more fun and more exciting. Similarly, Diana et al. (2021) state that Kahoot is both educational and enjoyable. Similar findings were reported by Bicen and Kocakoyun (2018) who concluded that timely questions in Kahoot

activities increase learner excitement. Therefore, this study found that using the Kahoot game to learn PS improves learners' positive affective engagement.

Even though none of the learners experienced a feeling of boredom after learning PS via the Kahoot game, there were two learners, Bule and Nomsa, who displayed unexpected negative affective engagement after interacting with the game. The learners stated that they felt sad and embarrassed after playing the Kahoot game. This was a new and surprising finding that learning PS via Kahoot makes some learners feel humiliated. Formánková (2019) claims that a game should not humiliate its participants. On the other hand, Nebel et al. (2020) found different results in their study on video games by reporting that participants had a lowered feeling of shame, increased responsiveness, and increased behavioural engagement after playing a video game.

The main findings responding to research question 2 under the motivational domain were listed as follows: Learning PS via Kahoot boosted some learners' confidence. Kahoot motivated learners to study more and practice more. The Kahoot game increased some learners' motivation because of its competitive nature.

Findings about learner motivational/behavioural engagement after interacting with the Kahoot game indicate that positive motivational engagement improved for ten out of ten learners. Some of the learners indicated that they became more motivated to study and practise more to gain understanding. Knowing that there would be a Kahoot in class also motivated learners to prepare and review the topics to do well in the Kahoot game. Asa'd and Gunn (2018) concur with these findings as they also found that learners are motivated to practise more problems and come to class better prepared after playing Kahoot. It was found that learning PS via

Kahoot boosted some learners' self-confidence as they received immediate feedback and got higher on the scoreboard. Similarly, Dellos (2015) notes that playing games is beneficial to rise confidence, especially for shy learners with low self–confidence. Moreover, Dellos (2015) states that as the learners succeed in the game, their success increases self–confidence, thus giving them a sense of achievement. It was also found that learning PS via Kahoot makes some learners more motivated to win by scoring the largest number of points by inserting the correct answer as quickly as possible. The learners got absorbed in the competitive nature of the game by trying to be at the top of the leader board at all costs.

Formánková (2019) shares that an educational game should neither increase enmity nor envy because the point of incorporating a game in educational proceedings is for learners to learn something. Therefore, the findings indicate that some of the learners became motivated because they incorporated envy to be number one and not on learning something. Therefore, findings indicate that the learners' positive engagement stemmed from two sides/groups. One group was motivated to learn for understanding whilst the other group was motivated by the competition. Competition was viewed as a strong motivator. Learners expressed that they were motivated to reach the top of the scoreboard and be the best in the class. Having the desire to win encouraged many learners to prepare for the next Kahoot game. Despite the positive experiences associated with the competitive nature of learning via Kahoot, the findings indicate that a group of participants had focused more on the competition and having fun rather than learning. These effects of enhanced attention and competition are consistent with Wang et al. 's (2016) findings. On the contrary, Bawa (2019) finds one unexpected result for despite the game-show aspect of Kahoot and its focus on competition between learners, participants did not identify the game as a competitive experience. Nevertheless, the findings conclude that learners' motivation to learn PS increased after playing the Kahoot game. These findings are

in line with Wang et al.'s (2016) study, which concluded that Kahoot advocates a new style of learning that promotes motivation and facilitates engagement.

The main findings responding to research question 2 under the cognitive domain were listed as follows: Kahoot has a cognitively undemanding nature. The Kahoot game limits some learners' cognitive engagement. Learning PS via Kahoot improves learner memory and mental organisation of knowledge.

Findings indicating that learning PS via Kahoot had undesirable forms of cognitive engagement emerged from the data. Learning PS via Kahoot adversely moved most learners to non-cognitive engagement and negative cognitive engagement. The learners expressed that they were not getting mentally challenged to solve PS problems when learning via the Kahoot game. Learners thought that they were being robbed of the chance to solve the problem and find the answer without being given options. They saw the game as a shortcut, limiting their thought processes. Moreover, they did not think playing a game was serious work or for formal marks. They thought it was 'what it was' - a game - just for fun.

Furthermore, in their desire to compete, some learners rushed to answer questions, not taking time to understand the questions or the answers. Thus, they thought the quiz format of the Kahoot game has a cognitively undemanding nature, as they could guess the correct answer. The findings also show that Kahoot was putting too much pressure on learners in a short space of time to think and this caused them to make more errors than usual. These findings are like those of Çekiç and Bakla (2021) who found that the learning tools, which offer basic types of close ended questions such as multiple-choice questions, true or false and fill in the gaps, are cognitively less demanding and necessitate fewer learner engagements. Interestingly, the

findings show that there was a decline in cognitive engagement after interacting with the Kahoot game.

Although the findings indicate that most of the learners did not display a positive cognitive engagement, the learners agreed that playing the Kahoot game helped them recap what they learnt and discover what they did not know, which they needed to focus on. Participants felt strongly that Kahoot could be a useful tool for revision. However, they maintained that they did not acquire any new knowledge. Therefore, this result indicates that learning PS via Kahoot assists learners in quickly identifying what they understand and need to put more effort. The finding also implies that the learners can mentally organise what they know and exercise their brains to store the information in their long-term memory. Similarly, Bawa (2019) found that learning via Kahoot helped some learners retain information better; it refreshed and reinforced what they learnt and put the knowledge in their long-term memory.

Learning PS via Kahoot improved both learners' affective engagement and motivational/behavioural engagement. However, learning PS via Kahoot did not have a significant positive impact on learners' cognitive engagement.

4.7 Conclusion

This chapter has presented the data collected along with an inductive analysis of the learners' responses to interpret the data and discuss the key findings. Responses to the pre-intervention questionnaire, diary entries, teacher log, post-intervention questionnaire and interviews were presented respectively into predetermined categories of positive, negative, or non-engagement of the three dimensions. Additionally, learners' responses were also categorised into emerging

themes. It was noteworthy that there was a significant shift to positive motivational/behavioural engagement. Thus, learning with the Kahoot game increases learner motivational engagement. Likewise, learning with Kahoot was found to have improved learner affective/emotional engagement since learning without Kahoot made some learners afraid of assessments. Henceforth, learning PS with Kahoot makes learners feel more relaxed and calmer when assessed. On the contrary, learning PS via a Kahoot game did not significantly enhance learners' cognitive engagement as Kahoot has a cognitively undemanding nature. The next chapter outlines the conclusion of this study.

Chapter 5

Conclusion

5.1 Introduction

This study aimed to explore grade 10 learners' responses to learning PS via the Kahoot game in a rural South African school. Learner engagement was assumed to be important for the success of learners in the subject. Assumptions about learners' engagement after using the game were developed through a variety of selected data sources. The results of this research were intended to respond to the three research questions to explore the use of a digital GBL tool as a strategy to increase learners' emotional, behavioural, and cognitive engagement when learning PS. The outline of this concluding chapter is as follows: A review of the research questions informing this study, a summary discussing the key findings from the data collected through the pre- and post - questionnaire, diary entry, teacher log and interviews. Thereafter, implications, contributions, limitations of the study and recommendations for future studies are presented subsequently, followed by the conclusion of the study.

5.2 Summary of key findings and implications

The main findings of this research described that learning PS with the instruction of a Kahoot game positively increases only two domains, emotional and motivational engagement, yet there is a minimal impact on the positive cognitive domains. Data were collected from the diary entries, a teacher log and post-intervention questionnaires to address the second research question. This research question explores how the act of playing the Kahoot game impacted the holistic engagement of learners in all three domains. This study shows that using the Kahoot game in the PS class improved the learners' affective/emotional engagement and behavioural/motivational engagement.

Findings showed that some learners are interested in learning PS without the Kahoot game because they preferred the traditional ways of learning the subject through practical investigations, experiments, and demonstrations. They indicated that the experiments are useful, and make them interested in the subject, highlighting that lucidity in a task makes it nice. On the other hand, an emerging view from the pre-intervention questionnaires is that some learners are not interested in learning PS without the game because writing tests and doing presentations are intimidating and cause anxiety. Some learners indicated that they become nervous and scared when faced with a PS test or a class presentation.

Learners fell short of a significant positive motivational engagement before playing the Kahoot game. Nevertheless, a few learners who displayed a positive motivational engagement in learning PS without Kahoot such as Phumzile and Tha were driven by intrinsic motivation towards their future goals.

From the learners' descriptions, it was established how the learners engaged with the Kahoot game in each of the three engagement domains outlined in the conceptual framework. Most of the learners indicated excitement emojis, which is a positive affective engagement because the game consisted of exciting elements for learning. The findings also revealed that employing the use of the Kahoot game to learn PS allowed learners a space to support their emotional engagement dimension, which leads to a potentially more relaxed atmosphere and more attentive learners (Licorish et al., 2018).

Furthermore, the findings showed that after the learners played the Kahoot game, some learners were motivated to learn in bits every day and not only once off for the formative assessments. Their behaviour to organise information into smaller chunks showed that learning PS using the

Kahoot game increases the learners' confidence in the subject. This finding indicated that most of the learners displayed a positive behavioural engagement dimension in learning PS via the Kahoot game. There was minimal cognitive engagement enhanced by playing the Kahoot game during the learning of PS.

Most learners found the learning of PS via the Kahoot game to be cognitively undemanding. The learners' motivation was the most improved dimension when using the Kahoot game to learn.

Data were generated from the interview to address the third research question, which sought clarity on why the learners engaged with the Kahoot game in the manner they did. From the learners' responses in the interview, it was established that there were several reasons the learners' emotional and behavioural engagements increased and why they had a minimal increase in cognitive engagement. The findings show that learners were motivated to engage with the Kahoot game because they were able to receive immediate feedback and the scoreboard had a feature that tracked their progress whilst playing the Kahoot game. Learners also viewed the Kahoot game as having interesting elements that were different from normal teaching and learning resources and processes. It also emerged that learners viewed the Kahoot game as a tool that should not only be used in PS but also in many other subjects to raise interest. Furthermore, the findings indicated that the learners had minimal cognitive engagement because they thought PS was abstract, and their mental capacity should be challenged. Learners also cognitively engaged with the Kahoot game in the manner they did because of the questioning nature of the game. Findings suggested that the Kahoot game is an online quiz, designed as a basic multiple-choice question. This led some learners to have a

negative cognitive engagement with learning PS. Some learners chose to not think or analyse the answer and rapidly guess for the correct answer.

The findings of the study were:

- Learners' affective engagement increased because they deem it important that passion to learn is important to motivate one to study.
- Learners' cognitive engagement was the least improved domain because Kahoot was unchallenging for the learners to discover the solution but made them choose an answer.
- Learners engaged with the Kahoot game in this manner because the use of a game relates to playfulness and not seriousness.
- Playing Kahoot increased negative learner cognitive engagement, as they guessed rapidly.
- Learning via Kahoot was more interesting compared to traditional chalk and talk.
- Learners felt that Kahoot captured their focus and interest in PS. They stated that they became more focused on their homework to do well in Kahoot. The learners felt that Kahoot helped them to maintain their interest in the subject.
- The level of anonymity afforded by Kahoot made some learners who performed poorly save face, since they stated that they felt humiliated when they did not score any points.
- The outcomes of the study show that Kahoot motivated learners to be positively engaged. Kahoot motivated competition in the classroom, where learners were driven to see their nicknames at the top of the leader board.

Table 5. 1: Summary of key findings about learner engagement after playing the game

Learner engagement domain	Key finding
Affective engagement	✓ Assessment of Physical Sciences via Kahoot game is calming/relaxing and interesting/exciting ✓ The Kahoot game created a negative affective engagement in some learners, making them feel sad and humiliated.
Motivational engagement	✓ The Kahoot game boosts learners' confidence and increases learner motivation through its competitive nature.
Cognitive engagement	✓ Kahoot game limits learners' cognitive engagement; Kahoot has a cognitively undemanding nature. ✓ Learning Physical Sciences through the Kahoot game improves the retention of knowledge and mental organisation of knowledge

Although there is a key finding that the use of the Kahoot game did not show significant improvement in the cognitive engagement of the participants, this study may have taken a key step towards investigating new ways, forms or tools for acquiring skills and abilities that support learning processes.

5.3 Recommendations, implications, limitations, and contributions

The following sections cover recommendations, implications, limitations, and contributions.

Recommendations

The following recommendations guide future research endeavours in the areas of learner engagement. Learners were motivated to learn PS through the Kahoot game: thus, I recommend to the DBE that:

- Gadgets that allow learners to learn PS through gamification should be included in the curriculum. Future research should develop more engaging GBL opportunities, to teach curriculum content, which can increase learner engagement.
- One GBL tool was used in this present research, future studies should explore the impact of other digital gamification tools such as Quizzes and ClassDojo to mention a few.
- Future research needs to measure the impact of GBL on cognitive gains by utilising a test because the study revealed that the learners' cognitive engagement after playing the Kahoot game did not have any significant improvement.
- Further investigations on cognitive measures and the design of the game features to consider how the learners reach their choices in the quiz.

Implications

In terms of research implications, there are strong indications that the GBL intervention of the Kahoot game was successful in delivering higher affective and motivational engagement, as opposed to traditional teaching, and learning without a game. In terms of practitioners'

implications, instructors should look to GBL interventions as tools that can potentially increase engagement to a point where performance is positively impacted in the cognitive domains.

However, a quick diagnosis and awareness for both the teacher and learner were observed from the immediate feedback and Kahoot summary chart for each learner highlighting spots of focus for the next lesson. Thus, Kahoot has not only served the purpose of improving learners learning goals and enjoyment to learn PS, but it has also served to simplify the life of the teacher and learner by catering to a more individualised teaching approach in PS. Nevertheless, the learners found this game useful for theory questions instead and calculation questions and wished to play it for English, Life Sciences, Geography, Business Studies, Life Orientation and Mathematics. Others stated they did not wish to play the game for other subjects such as Accounting. The data analysis of the pre- and post-intervention questionnaires, diary entries, a teacher log and interviews indicated more focus and direction on the next cycle for potentially fruitful cognitive engagement to occur.

Limitations

The study was limited by the COVID -19 social distance rules such that the social engagement domain illustrated in the conceptual framework used in this study was not included in the engagement dimensions explored in this study. Learners' social constructs such as group work, peer work or playing games in teams were excluded to adhere to the rules protecting learners from the pandemic. Moreover, the participants in this study were only ten females, no male was present. Therefore, the results cannot be generalised due to gender bias and the small sample explored in this study as well. The practitioner was unable to fully engage the learners positively in all three dimensions. The time constraints did not allow for the researcher to continue the action research cycles further.

Contributions

This study has provided a research perspective that can be a starting point to more creatively addressing GBL in the South African school's context. This study has provided knowledge of factors that enhance learner engagement during the teaching and learning of PS.

5.4 Conclusion

This study has provided a digital transformation solution in a modern-day school, which should be incorporated into future studies because it can enhance concentration and eliminate digital illiteracy, particularly in rural South African schools. The analysis showed that GBL impacted learners' learning outcomes in two of the three dimensions. This was supported by the qualitative data gathered from the learners. Data collected through the various data generating tools namely, pre-, and post-intervention questionnaires, diary entries, a teacher log, and interviews offered evidence supporting the assumption that learning PS via the Kahoot game is more exciting and calming. The chapter outlined a summary of the key findings responding to the three research questions informing this research. Recommendations, implications, limitations, and contributions of the study are also discussed. The qualitative action research concurs with the literature that learning PS via the Kahoot game is recommended to increase learner affective and motivational engagement, with little or no impact on the cognitive domains.

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Appendices

Appendix 1A	Learner demographic information
Appendix 1B	Pre-test and/ Post-test
Appendix 2A	Diary entry
Appendix 2B	Teacher log
Appendix 3	Interview Schedule
Appendix 4	Ethical clearance certificate
Appendix 5	Turn it in report
Appendix 6	Letter to gatekeepers
Appendix 7	Child/ assent consent forms
Appendix 8	Language Editing Certificate

Appendix 1A - Learner demographic information

Topic: Exploring Grade 10 Learners' Engagement with Kahoot Game in Physical Sciences: Action Research Study at UMgungundlovu District.

Dear Research Participant

Thank you for agreeing to participate in this research study. Your responses to the questions below will be used to help the researcher better understand learners' attitudes, beliefs and goals about Kahoot game. Responses will be anonymous. There are no wrong and right answers, rather your input is valuable to the researcher to gain knowledge on *what would make grade 10 learners interested in learning Physical Sciences using Kahoot game-based learning tool.*

PART A: DEMOGRAPHIC INFORMATION

1.1 Name of learner: .....

1.2 Age: .....

Please make a cross (X) on the appropriate answer.

1.3 Guardian: Parent Grandparent other

1.5 Last term mark in Physical Sciences: .....

1.6 Do you own a smart phone? Yes No

1.7 If No, does anyone close to you own a phone? Yes No

1.8 Have you played a game for learning before? Yes No

If Yes, which game and for which subject? .....

.....

1.9 Have you played a game for learning Physical Sciences? Yes No

If Yes, what is the name of the game? .....

.....

Appendix 1B – Pre- test/ Post-test

PART B: PRE – INTERVENTION QUESTIONNAIRE AND POST- INTERVENTION QUESTIONNAIRE

Consider your learning of Physical Sciences and please answer the following questions.

Where level 1 indicates the Almost Never and 7 indicates Almost Always.

Question	1	2	3	4	5	6	7
1. Before you learn about a topic in Physical Sciences, do you think about what it will be about?							
2. While you learn about the topic, do you imagine the scenario in your head to understand the lesson?							
3. After the lesson, do you think about how well you understood the topic?							
4. How motivated are you to learn Physical Sciences?							
5. How confident are you with your knowledge of Physical Sciences Topics?							
6. How much do you enjoy playing educational games?							
7. How much do you learn from activities in Physical Sciences lessons?							

8.1 List what activities help to make you interested in learning Physical sciences

Interested:

_____

_____

_____

8.2 List what activities makes you get bored of learning Physical Sciences.

Bored:

_____

_____

_____

THANK YOU FOR YOUR PARTICIPATION

Appendix 2A – Diary entry

Topic: Exploring Grade 10 Learners' Engagement with Kahoot Game in Physical Sciences: Action Research Study at UMgungundlovu District.

Thank you for participating in the second phase of this research. You are required to keep the journal where you are going to record the experiences of playing the Kahoot game. You will capture your experiences by filling in the table that is presented below.

PART A: LEARNER ENGAGEMENT EXPERIENCES

1) Your emotions when engaged with Kahoot game.

Select the emoji to show your mood (s) at each stage of the game:

A **B** **C** **D**

Select the letter representing your emoji **BEFORE** the game:	Select the letter representing your emoji **DURING** the game:	Select the letter representing your emoji **AFTER** the game:

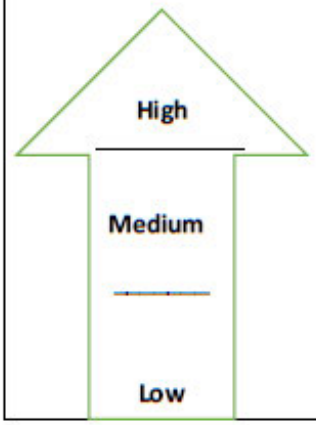
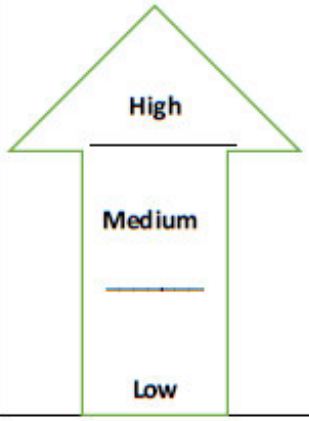
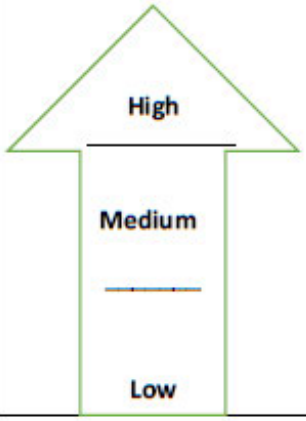
Write down any comment about playing Kahoot game:

_____

_____

2) Your behaviour and motivation when playing Kahoot game.

Shade in your motivation level at each stage of the game.

How was your **Motivation Before** the game?	How was your **Motivation During** the game?	How was your **Motivation After** the game?
		

Write down what are your learning goals as you engaged with the Kahoot game:

_____

_____

3) Your Understanding of The topic and ways of thinking

List the concepts you understand during different stages of the game about the current topic.

What did you **Know Before** the game?	What did you **Know During** the game?	What did you **Know After** the game?

Explain how does playing Kahoot game make you process your knowledge:

_____

_____

4) Think about your overall experience with Kahoot. Discuss in as much details as possible about what made you like or dislike using Kahoot game in Physical Sciences.

_____

_____

_____

_____

_____

_____

5) Do you wish to play Kahoot for other subjects? Why?

_____

_____

THANK YOU FOR YOUR PARTICIPATION

Appendix 2B – Teacher log

Time	Action	Learners' facial expressions	Learners' behaviour/ actions	Learners' responses on the Kahoot game and workouts
08:50 am	**Before the Kahoot game starts. During the setup of equipment and introduction of the lesson.**			
09:00 am	**Beginning of the Kahoot game. During the first 5 min.**			
09:10 am	**In the middle of the Kahoot game. After approximately 7 questions.**			
09:20 am	**At the end of the game. During results outcomes and discussion of the lesson.**			
09:30 am	**After the Kahoot game. During the conclusion and summary of the lesson.**			

Learners' reactions as they engage with Kahoot	**Mark a Yes or No (Provide alternate reaction if it a 'No')**
The learners are enjoying	
The learners are focused/attentive	
The learners are wrapped up in the game	

Action	**Reflection/Summary**
Before setting up for learners to play the Kahoot game.	What are the learners' reactions? Are they interested in learning? Do they look excited or bored? _____ _____ _____ _____
During the Kahoot game play	What are learners' reactions, their actions and facial expressions showing that they are cognitively engaged/emotionally engaged/motivated? _____ _____ _____
At the end of the Kahoot game session	How are the learners' attitudes? How do they feel? What are they doing? _____ _____ _____

Appendix 3 - Interview Schedule

This is the last phase of the research with Interview guiding questions.

1. How would you describe your experience using *Kahoot* during PS class?
2. Why do you think using *Kahoot* is useful for learning PS?
3. Is there anything you like or dislike about *Kahoot?* Explain.
4. What do you like best about *Kahoot* for learning PS? What makes *Kahoot* fun?
5. How did playing *Kahoot* affect your learning and knowledge?
6. If you could change one thing about *Kahoot* what would it be and why?

The interview questions will be further developed after the analysis of the questionnaire.

E.g

7. In the questionnaire you wrote how do you feel when you play *Kahoot*? (Excited, engaged, bored, nervous, enthusiastic, etc.)
8. What features do you like in *Kahoot*? (Music, graphics, points, competition, leader boards, anonymity, etc.)

Appendix 4 - Ethical clearance certificate

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

28 October 2021

Nontokozo Mbokazi (213507545)
School Of Education
Edgewood Campus

Dear N Mbokazi,

Protocol reference number: HSSREC/00003473/2021
Project title: Exploring Grade 10 Learners' Engagement with Kahoot Game in Physical Sciences: Action Research Study in Umgungundlovu District
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 06 October 2021 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL.**

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

This approval is valid until 28 October 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

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

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

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Appendix 5 - Turn it in report

MED by N Mbokazi

ORIGINALITY REPORT

8%	7%	2%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	media.proquest.com Internet Source	1%
2	researchspace.ukzn.ac.za Internet Source	1%
3	link.springer.com Internet Source	1%
4	Amna Khan, Farzana Hayat Ahmad, Muhammad Muddassir Malik. "Use of digital game based learning and gamification in secondary school science: The effect on student engagement, learning and gender difference", Education and Information Technologies, 2017 Publication	<1%
5	hdl.handle.net Internet Source	<1%
6	mafiadoc.com Internet Source	<1%
7	Submitted to University of KwaZulu-Natal Student Paper	<1%

Appendix 6 - Letter to gatekeepers

School of Education,

College of Humanities,

University of KwaZulu-Natal,

Edgewood Campus

Dear: Principal

RE: Request for permission to conduct research at your school.

My name is Nontokozo Mbokazi, I am a Master of Science Education student at the University of KwaZulu-Natal Edgewood campus. I am currently engaged in a research project entitled, "*Exploring Grade 10 learners' Engagement with Kahoot game in Learning Physical Sciences"*.

The research aims to explore Learners' engagement experiences of using Kahoot game. The study will understand what makes Learners interested in learning Physical Sciences through a Kahoot game.

I hereby request to conduct my research with Grade 10 Physical Sciences learners at the school. I would like to collect data from the learners using multiple methods of data collection (Questionnaire, Reflection journal and interviews). The Learner is expected to spend at least 60-180 minutes to reflecting on their experience/s for a period of 3 days.

This study is purely for academic purposes and there will be no financial gain involved. You are assured that the findings of this research will not be used for any other purpose other than the Master's thesis. In this regard, no harm will be caused on the learners participating in this project. This study will ensure that anonymity of both school and the learners is ensured by using pseudonyms to protect your school and learners.

The decision to participate in this study is entirely voluntary and you may withdraw your permission for the research without any negative consequences. If you have any further questions about the study, at any time feel free to contact me. Should you have any other concerns about your rights as research participant, you may contact my supervisor Dr. Doras Sibanda, contact details: sibandad@ukzn.ac.za 0724910131.

Thank You

Yours faithfully

Nontokozo Mbokazi

Student number: 213507545 Email: 213507545@stu.ukzn.ac.za / missnmbokazi@gmail.com

……

Acknowledgement by the principal

I_____,the Principal of _____ grant/ not grant permission to Nontokozo Mbokazi to conduct her research in my school

Appendix 7 - Child/ assent consent forms

School of Education,

College of Humanities,

University of KwaZulu-Natal,

Edgewood Campus

Dear Participant

My name is Nontokozo Mbokazi. I am a Master of Education candidate studying at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in Exploring Grade 10 Learners' engagement experiences with Kahoot game in Physical Sciences. To gather the information, I am interested in asking you some questions.

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person but reported only as a population member opinion.
- The observation may last for about 30 minutes.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to be observed, please indicate (by ticking as applicable) whether or not you are willing to allow the researcher to record by the following equipment:

Equipment	Willing	Not willing
Audio equipment		
Photographic equipment		

I can be contacted at:

Email: missnmbokazi@gmail.com

or 213507545@stu.ukzn.ac.za

Cell: 0727101169

My supervisor is Dr Doras Sibanda who is located at the School of Education, Edgewood campus, University of KwaZulu-Natal (UKZN).

email: Sibandad@ukzn.ac.za

Phone number: 0724910131

You may also contact the Research Office through:

HSSREC Research Office

Email: HSSREC@ukzn.ac.za

Thank you for your contribution to this research.

DECLARATION

I…… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF PARTICIPANT DATE

…… ……

SIGNATURE OF PARENT (If participant is a minor) DATE

…… ……..

Appendix 8 - Language Editing Certificate

Registered with the South African Translators' Institutes (SATI)
Reference number 1000363

SACE REGISTERED

16 July 2022

TITLE: Exploring Grade 10 Learners' Engagement with the Kahoot Game in Physical Sciences: Action Research Study in Umgungundlovu District

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

Yours faithfully

Dr. K. Zano

Ph.D. in English
kufazano@gmail.com/kufazano@yahoo.com
+27631434276