Learning to integrate the affordances of interactive smartboards when teaching population ecology to grade 11 Life Sciences: A self-study.

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Abstract

Interactive smartboards (ISBs) offered a range of functionalities that held promise for enhancing teaching and learning. However, effectively integrating these affordances could be challenging for educators. This self-study investigated how a teacher, acting as both researcher and participant, could integrate the pedagogical affordances of interactive smartboards (ISBs) while teaching population ecology to grade 11 Life Sciences learners. While Grade 11 learners are at a critical juncture in their development, poised to become active citizens, the relevance and complexity of population ecology can present significant challenges. This study explored how ISBs might be used to bridge this gap, transforming abstract concepts into tangible and engaging learning experiences. Despite the potential benefits of ISBs, their effective integration into teaching population ecology at the grade 11 level might pose challenges. This included determining how best to utilise ISBs to enhance understanding of complex ecological concepts such as population dynamics and community interactions. The study employed a multi-method approach, including documentation of lesson planning, reflective journal entries, audio recordings of critical friend discussions, and video recordings of lessons. To ensure credibility, collaboration with critical friends and peer review with other researchers were utilized. Analysis, informed by Puentedura's (2014) SAMR model, revealed the crucial role of thorough lesson planning and teacher knowledge across four domains: understanding the learning context, learner needs, subject matter expertise, and pedagogical skills. Additionally, collaboration with colleagues emerged as vital for identifying and leveraging ISB potential. The research underscored the value of self-study for educators to independently develop skills for integrating ISBs. It highlighted the importance of a positive attitude towards educational technology and the power of self-reflection in bridging the gap between theory and practice. This study specifically demonstrated the value of self-study in exploring and integrating the pedagogical affordances of ISBs, achieving a "redefinition" level of integration using the SAMR model.

Keywords

Self-study, learning, ICT integration, interactive smartboards, affordances, critical friends, SAMR model.

Declaration

I **<u>MAGWAZA SINOTHILE</u>** (student number 1147517), affirm that this research study is entirely my own work. This work has not been previously submitted for any academic qualification at any institution. All instances where I have incorporated the ideas or words of others are fully referenced, and a complete list of sources is provided. I acknowledge that the University of the Witwatersrand holds the right to pursue disciplinary actions if there is evidence suggesting plagiarism or a lack of proper citation within this work.

Magwaza SLS

University of the Witwatersrand, March 2024

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Abbreviations

ATP- Annual Teaching Plan

BSc- Bachelor of Science

CAPS -Curriculum Assessment Policy Statement

DBE- Department of Basic Education

DoE- Department of Education

GDE- Gauteng Department of Education

ICT- Information Communication Technology

ISB- Interactive Smart Board

IWBs- Interactive Whiteboards

L.S -Life Sciences

PCK- Pedagogical Content Knowledge

PK-Pedagogical knowledge

PGCE- Post Graduate Certificate in Education

PPT- PowerPoint presentation

L&T-Learning and teaching

SAMR- Substitution, Augmentation, Modification, Redefinition

SMK- Subject matter knowledge

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- Last but not least, “And now we thank you, Our God, and praise your glorious name." -1 Chronicles 29:13.

Dedication

I dedicate this research report to my parents, Hlengiwe and Mbhekeni Magwaza. To my family, whose love and encouragement kept me motivated throughout this journey. To the highest God, Ebenezer!

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1.0 Introduction

In this chapter, I seek to offer a concise exploration of both my personal and professional motivations, given the self-study nature of this research. Additionally, in this chapter I outlined the specific aims, objectives, and research questions that will guide the study, providing a clear roadmap for the study's direction and focus. Through this overview, I seek to establish a foundation for the subsequent chapters, laying out the context and purpose that underpin this self-study endeavor.

1.1. My journey to teaching

I am an educator at a secondary school situated in Gauteng, South Africa, and I have a first-hand experience of the usefulness of integrating Information and Communication Technologies (ICT) in the classroom. I joined this school 5 years ago (2019), straight from university after completing my Postgraduate Certificate in Education (PGCE). As such, I was a novice teacher who had a largely theoretical conception of what teaching was about and to be specific what my role was as a teacher. Before completing the PGCE, I was studying for a BSc degree in Biochemistry and Physiology at the same university. When I was appointed in 2019, I was hired to teach grades 8 and 9 Life Orientation, Technology, and Natural Sciences. I believe I was hired based on having adequate results for these subjects. Furthermore, I had confidence that I would be able to teach learners with ease because of the good marks on my academic transcript. When I started teaching at this school, I did not go through any orientation, instead I was taken straight to class on the day of the interview. I had a conception of teaching as a smooth sailing profession in which I only had to do better than my previous school teachers in order to do my job well. Indeed, this line of reason seemed justified to me because I was not previously satisfied by how I was taught in my schooling years.

My first week of teaching demonstrated the complexities of the teaching profession, contrary to my prior conception of teaching as a smooth sailing endeavor. Left to navigate unfamiliarity on my own, I relied more on the learners for assistance than the teachers. While I met my Head of Department, the rest of the staff remained unknown faces. The lack of familiarity with context during briefings created confusion. For instance, I would be instructed to contact Mr. Tshabalala (pseudonym) for learning materials, however, I had no idea who he was as I had never met him. Consequently, I resorted to writing down names and asking the learners for information about these staff members and their whereabouts. This reliance on the learners became a recurring theme during those initial weeks, extending to basic tasks like finding the stockroom to retrieve textbooks that only arrived in mid-February. Limited resources and the frustration of relying on a dusty chalkboard for notes and classwork activities led me to seek online solutions. Searching for annual teaching plans and suitable textbooks, I began to piece together my own approach, especially relevant with my subject combination of Life Orientation, Natural Sciences, and Technology. Thankfully, a few weeks later, the textbooks arrived, allowing me to shift from chalkboard notes to written materials.

By the end of March, in the second month of my first year, I realised that I was unintentionally replicating my own learning experience, solely relying on the textbook as a resource. This led me to discuss my concerns with my Head of Department (HoD). Fortunately, she informed me about the availability of a projector. Embracing this new tool, I began creating presentations and implementing diverse ICT-based teaching strategies. In Life Orientation, for instance, I used video clips and documentaries to introduce topics like bullying. Similarly, in Natural Sciences, I incorporated simulations and visual representations to explain abstract concepts like the solar system and the water cycle. This shift from solely lecturing to facilitating interactive learning fostered collaboration among learners, increased their engagement, and ultimately reduced my own frustration.

1.1.1. A turning point in my understanding of teaching

Having seen the effectiveness of using a projector in my classroom pedagogy, my biggest desire was to change the way my teachers had taught me as I was often dissatisfied with their delivery of the content. Although I do not remember much of the teaching and learning logistics from my school years, but I do remember that textbooks were the only mode of reference, particularly in my high school years. I remember how we were not allowed to ask a question from a teacher because *'that's just how things should be*'. When I got to university, I started seeing multiple resources being used for teaching and learning. These included the use of presentation software such as Microsoft PowerPoint and google slides displayed using overheard projectors. I was inspired by the use of a learning management system which was called e-Sakai back in 2015. These platforms and software made me realise that my teachers could have used them to enhance my learning but, maybe due to financial difficulties, the school could not afford to purchase them. I made it a mission to integrate these ICT tools if I was ever going to become a teacher at a school that was well resourced. Thus, after I completed the Bachelor of Science (BSc) degree, I then enrolled for a PGCE in attempt to realise my passion for an ICT-informed teaching profession. After completing my PGCE in 2018, I further strengthened my understanding of the conceptualisation and use of ICT tools in classroom through completing a Bachelor of Education Honours.

1.1.2. My professional experience of ICT in the classroom: A motivation for the study

In 2021, the Gauteng Department of Education (GDE) implemented smart classrooms equipped with Interactive Smartboards (ISBs) in selected schools, including mine. According to SMART Technologies Inc. (2006), an ISB is defined as a "touch-sensitive board connected to a computer and a digital projector" (p. 5). These classrooms, as described by Mugani (2020), are characterised by the presence of electronic devices like laptops, smart televisions, tablets, and smartboards. Despite lacking prior knowledge of ISB operation, I enthusiastically accepted a laboratory class equipped with one. The lack of training and support from the GDE motivated me to actively learn the functionality of the technology, and potentially share this knowledge with others.

During my first week teaching in this class, I resorted to the familiar whiteboard and marker, hesitant to utilise the ISB. Perhaps a fear of struggling and appearing 'incompetent' in front of the learners played a role. However, this initial apprehension did not hold me back for long. After school hours, I embarked on a self-directed learning journey. I mastered the smartboard's basic functions such as: turning it on and off, operating the IQ interactive software for writing, erasing, highlighting, deleting, and integrating a presentation software like Microsoft PowerPoint. As the weeks progressed, I confidently incorporated these basic functionalities of the ISB into my lessons, often receiving helpful assistance from learners familiar with the technology.

In 2022, a GDE representative began offering in-house training on the use of ISB at our school. While these weekly Thursday sessions aimed to cater to a broad range of skill levels, they proved to be less beneficial for me because the training commenced with fundamental tasks like email composition. During these trainings, I found myself yearning for a deeper dive into the ISB's full potential, particularly in integrating its capabilities into my teaching practice. This lack of advanced training led me to continue my self-directed learning, ultimately revealing the ISB's versatility. Embracing this resource, I began incorporating it into my daily lesson delivery. However, recognising the vast potential yet to be explored, I developed a research interest of how to effectively integrate the ISB's affordances to enhance teaching and learning, specifically in the Life Sciences (L.S) topic of population ecology. This interest stems from the gap between my initial unfamiliarity with the ISB and its clear potential to enrich instruction in this complex subject. Fueled by a desire for professional development and pedagogical innovation, I embarked on this exploration to unlock the smartboard's transformative power as a tool for active learning when teaching the topic population ecology.

The axiological assumption of this study revolved around the belief that integrating interactive smartboard affordances into teaching practices could enhance the learning experience in the specific context of population ecology. Axiology concerns itself with the study of values and judgments, particularly in terms of what was deemed valuable, worthwhile, or desirable. My belief was that the integration of interactive smartboard technology was beneficial for teaching population ecology, hence this self-study. This belief motivated this study which focused on me exploring how such integration could be learned and applied effectively in educational settings. Ontologically, this study assumed that technology, specifically the interactive smartboard, had a significant influence on teaching practices and learning outcomes in population ecology. This perspective suggested that the affordances and constraints of the technology shaped and determined how teaching and learning of population ecology occurred. I adopted a constructivist epistemological framework, positing that knowledge was actively constructed by individuals through their engagements with the environment, which included technological tools such as interactive smartboards. Central to this perspective was the recognition of the significance of personal experiences and interpretations in the process of learning. In this self-study, the aim was to acquire proficiency in integrating the affordances offered by ISBs. Through reflective analysis of various pedagogical approaches associated with these affordances, I sought to develop effective strategies for teaching population ecology.

1.2. Background and context of the study

Different ICT tools can help learners achieve the learning outcomes that are outlined in the Curriculum Assessment Policy Statement (CAPS) (DoE, 2004). CAPS is a national curriculum framework for South Africa, and it specifies the skills and knowledge that learners should acquire at each grade. These skills are essential for the success of learners in the South African education system (DoE, 2004). To accomplish this goal, traditional chalkboard classrooms have been replaced by smart classrooms in some selected township schools located in Gauteng. Smart classrooms are classrooms that are characterised by electronic smart devices such as laptops, smart televisions, tablets, and smartboards (Mugani, 2020). In such Gauteng schools, each learner and teacher has also been provided with a tablet or a laptop. The provision of these devices was to assist the teacher and learner with additional forms of ICT tools which will enable them to easily access knowledge thereby reducing the barriers to teaching and learning (Mugani, 2020). This is taking into consideration that these smart classrooms aim to achieve the goal of effective teaching and learning by providing educators with the tools to set clear learning goals, craft engaging materials, and choose the most effective teaching methods. A central point of effective teaching, according to Maxwell et al., (2011), is that a teacher must place the learner as the central focal point in thinking about teaching. In accordance with this, the focus of this study is to learn to integrate the affordances of the ISB (one of the ICTs that were installed in schools) when teaching population ecology to grade 11 L.S. learners.

1.3 Defining Interactive Smart Board

An ISB can be defined as a "touch-sensitive board connected to a computer and a digital projector" (SMART Technologies Inc., 2006, p. 5). ISBs use digital projectors to display computer images on touch-sensitive screens (Mihai, 2020) as displayed by Figure 1 below.

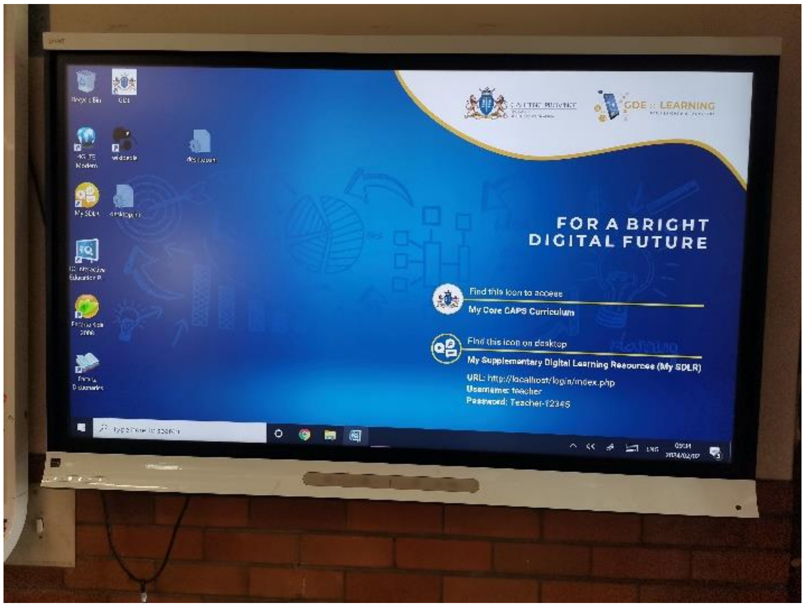


Figure 1: Interactive Smart Board (ISB) in the classroom setting

It has been argued that the use of ICT tools such as the ISB has made a significant contribution to learning and comprehension of Life Science topics (Nath, 2019; Turgut & Aslan, 2021). This is taking into consideration some of the functionalities of smartboards such as the display of images or videos that allows learners to interact with content in engaging and meaningful ways. Also, ISBs can be used to facilitate learner discussions with their peers inside the classroom and in other countries (Nath, 2019).

Interactive smart board affordances and integration

The term affordance refers to the powers and potentials of a technology (Moll et al., 2022). The affordances of ISBs include, among others, a touch screen, digital ink, multimedia, internet connectivity, and lesson capture. The concept of integration was explained by Lloyd (2005), as the degree to which an ICT tool vanishes into the background of the classroom and becomes an integral part of the learning environment. This definition means that the affordances are seamlessly used and are seen as a natural component of the learning environment. Technology is no longer seen as separate but rather blended into the overall education setting. Vanishing into the background means the interactive smartboard is not the focus but rather the transformation of content knowledge that the teacher accomplishes through the ICT tool. With this study, I therefore, sought to use the methodology of self-study to investigate how the affordances of ISBs as an ICT tool can be integrated in the teaching and learning of a topic-population ecology to grade 11 L.S. in a public school in Johannesburg.

1.4. Rationale and the significance of the study

Despite the recognised benefits of the use of ISBs in education, a gap persists between teachers' awareness of these tools and their ability to effectively integrate them into teaching practices (Al-Faki et al., 2014; Bakkadam et al., 2012; Mtshali, 2021). This is particularly true for complex topics like population ecology which is a topic that is rich in abstract concepts thus posing as a challenge to learners ' understanding. This self-study addresses this gap by investigating how an individual teacher, myself in this case, can learn to integrate ISB affordances while teaching population ecology to Grade 11 L.S. learners. The study holds significance on two levels. First, by exploring various ISB affordances and their application in population ecology lessons, I aim to enhance my own pedagogical skills and knowledge. Secondly, this self-study serves as a valuable tool for professional development, allowing me to unlock the full potential of ISBs in my classroom and potentially inspire other teachers to do the same in their own teaching practices.

Furthermore, by documenting my experiences and the insights gleaned from this self-study, I aim to contribute a unique study to the field of educational technology integration. As Berry et al., (2014) suggest, making learning public through self-study informs and advances the teacher education community. This can inform future research and provide practical guidance for educators seeking to effectively use ISBs in teaching population ecology. Ultimately, this self-study extends beyond my personal growth as an educator. By sharing my findings, potentially leading workshops, or even publishing the results, I hope to encourage colleagues to embrace ISBs and explore their transformative potential in teaching L.S. This will ultimately benefit both educators and learners by fostering more engaging and effective learning experiences. As a grade 11 L.S. teacher using a smart classroom with an ISB compared to the traditional chalkboard, this study was aroused by the curiosity to find out what other ways can the affordances provided by ISBs be used when teaching and learning.

1.5. Research problem

Interactive smartboards (ISBs) have become increasingly common in South African classrooms, yet their potential remains largely untapped, especially in subjects like population ecology. This disconnect between technology availability and effective pedagogical integration is a significant challenge. Despite the Department of Education's efforts to equip township schools with smart classrooms, research suggests that these technologies are not always fully utilised (Mugani, 2020; Abdullahi, 2014). A study by Mtshali (2021) revealed that teachers acknowledged underutilising interactive whiteboards (IWBs) and ISBs due to technical issues, connectivity problems, and insufficient training.

Similarly, Al-Faki et al., (2014) identified several factors hindering ISB integration in learning, these included teachers' limited computer skills, misalignment between school goals and decision-makers' understanding, inadequate ongoing technical support, and techno-savvy learners who may pose challenges for less competent teachers. Herawati et al., (2023) further emphasise the challenges of unstable or nonexistent internet connections and the time investment required for lesson preparation using ISBs. In this study, I therefore used the self-study methodology to learn the affordances of ISB and how to integrate them when teaching population ecology to grade 11 learners.

My experience teaching population ecology underscored the subject's complexity, characterised by numerous abstract concepts that often hinder comprehension and visualisation. Survivorship curves exemplify this challenge. Recognising the potential of ISBs to address these difficulties, this self-study aimed to explore effective integration strategies. While ISBs offer promising avenues for visualising complex ecological relationships, simulating population dynamics, and presenting interactive data, their full potential remains untapped due to inadequate teacher training and support. Moreover, Grade 11 learners are at a pivotal stage in their development, poised to become active citizens and agents of change. Population ecology provides a crucial foundation for understanding environmental issues and taking informed action. By effectively integrating ISBs into the curriculum, teachers can empower learners to analyse population trends, identify environmental challenges, and develop potential solutions. This aligns with the subject's potential to foster critical thinking, problem-solving, and a sense of civic responsibility. Bridging the gap between technology and pedagogy requires a concerted effort to equip teachers with the necessary skills and knowledge to integrate ISBs effectively into their teaching. Additionally, curriculum developers and policymakers must support this initiative by providing relevant resources, professional development opportunities, and clear guidelines for technology integration.

1.6. Research objective

This self-study aimed to investigate how I could integrate the affordances of the ISBs in my teaching and learning of population ecology for Grade 11 L.S. learners. Thus, the main objectives of this study were:

- To explore the affordances of the interactive smartboard that I could integrate when teaching the topic of population ecology to grade 11 learners.
- To explore how I could integrate the identified affordances of interactive smartboards into my teaching of population ecology in grade 11 Life Sciences.
- To investigate the challenges (if any) of integrating the affordances of interactive smartboards in my teaching of population ecology.

1.7. Research questions

To address the above outlined aims of the study, the following research questions guided this self-study:

<u>Main research question</u>

How can I integrate the affordances of ISBs in my teaching of population ecology to Grade 11 Life Sciences learners?

<u>Sub-research questions</u>

1. What affordances of the interactive smartboard can I integrate in the teaching of population ecology to grade 11 learners?

2. How do I integrate the identified affordances of interactive smartboards when teaching the topic of population ecology in grade 11 Life Sciences.?

3. What are the challenges (if any) of integrating the affordances of interactive smartboards in their teaching of population ecology?

1.8 Outline of the report

This report is comprised of 5 chapters as explained below:

Chapter 1 comprised of a contextual discussion of my personal and professional motivations, and outlined the rationale, significance, aims, objectives, and research questions guiding the investigation. In this chapter I have presented my desire to do this self-study and specifically focus on the integration of the affordances of ISBs. I also argued that schools received ISBs, however, teachers received inadequate training which had led to less integration of the ISBs when teaching.

Chapter 2 began by laying the groundwork with a review of relevant literature and the theoretical frameworks. Additionally, I defined key concepts such as integration and affordances, and provided an outline of population ecology as outlined in the CAPS document. Finally, the chapter discussed a review of literature on teaching population ecology, followed by an exploration of PCK, pedagogical reasoning and actions, and the SAMR model as the theoretical frameworks underpinning this study.

Chapter 3 outlined the research methodology used to gather, organise, and analyse data collected in the study.

In **Chapter 4**, The chapter detailed the documentation of planning efforts to integrate ISB affordances and reflections on the planning process.

In **Chapter 5,** I explored the practical application of the ISB functionalities beyond lesson planning. This chapter analyzes the integration strategies employed in my lessons through the lens of the SAMR model.

In **Chapter 6**, I provided a focused response to the initial research questions that guided the research. Here, I critically examined my experiences with the SAMR model as a tool for analyzing ISB integration and the self-study methodology employed throughout the research. Furthermore, in this chapter I explore into the broader significance of the findings, acknowledges any inherent limitations of the study, and proposing actionable recommendations for future research and practice. The final section of the chapter provides a comprehensive summary of the research journey, reiterating the key takeaways and potential contributions to the field.

1.8 Summary

In this chapter I have laid the groundwork for this self-study by exploring my personal and professional motivations for investigating the integration of ISBs in teaching population ecology to Grade 11 L.S. learners. I also outlined the rationale and significance of this study, highlighting the need to address the gap between teacher awareness of ISBs and their effective integration into teaching practices. Furthermore, I established the specific aims, objectives, and research questions that will guide this investigation. These research questions aim to guide the exploration of how I, as a teacher, can learn to effectively integrate the affordances of ISBs while addressing the challenges of teaching this complex subject. In the next chapter, I will review relevant literature and explore the chosen theoretical framework for this study.

Chapter 2: Literature review and the theoretical framework

2.1. Introduction

In this chapter I review selected literature which is relevant to my study. The focus of the study was learning to integrate the affordances of the ISBs when teaching population ecology to grade 11 L.S learners. This led to me reviewing literature related to teaching, and the specific use of ICT in teaching. To effectively carry out my study, it was important to understand the following areas: defining ISBs as an ICT teaching tool, the concept of integration, the meaning of the term affordances, review of literature on teaching population ecology and teaching population ecology using the pedagogical content knowledge (PCK). All the ideas listed above form part of my literature review which is discussed in this chapter.

2.2 In depth exploration of ISBs as an ICT teaching tool

There are similar conceptions to what an ISB is (SMART Technologies Inc., 2006; Mun et al., 2016, Bokhari et al., 2011). ISBs, also known as electronic whiteboards, interactive whiteboards, or e-boards, are large, touch-sensitive displays connected to a computer and projector (SMART Technologies Inc., 2006). They offer teachers a significant advantage in the classroom, functioning as modern ICT tools for enhanced learning. Compared to traditional chalkboards or projectors, ISBs provide greater interactivity and control as previously mentioned in Chapter 1. Users, primarily teachers in this context, benefit from the ability to access and interact with various software and digital resources saved on the connected computer. Similar to a chalkboard, ISBs allow users to write, draw, and erase directly on the board (Friedland, 2006). Additionally, they offer affordances like highlighting, annotation, and manipulation of digital content, fostering a more engaging and interactive learning experience for learners (Mugani, 2020). Ultimately, ISBs have revolutionised the classroom by introducing a new technological element that enhances lesson planning, delivery, and learner engagement.

Smartboards have software installed in them with different affordances that enhance teaching and learning, and they have similar affordances to personal computers (Mugani, 2020). These technological affordances are described by Şen and Ağir (2014) as follows:

a) Touch function: the surface of the smartboard screen requires to be touched for it to start working. A user can touch the screen to select their required options.

b) Writing and drawing function: smartboards can be used to write and draw like traditional chalkboards.

c) Annotating function: Documents and presentations can be annotated using smartboards.

d) Deleting function: this feature helps to delete or erase written text or images. Erasing can be done by using a finger or stylus.

e) Save, open, and print function: files can be opened, saved, and printed from an interactive smartboard.

f) Presentation function: Presentations can be created and delivered with a smartboard.

g) Text conversion function- Work written with handwriting can be transformed into computer-written text.

h) Recording and playback function- a user can record any information on the smartboard and be replayed when needed.

i) Storage and discovering function: once drawings or text have been done, they can be stored and re-opened when necessary.

j) Colors, highlighters, and shading function: users can use this function to highlight differences and similarities between concepts and colors that can be used in drawings.

k) Online platforms: users can use this function to conduct an online classroom discussion or use online platforms such as Google for more information.

All these functions are present in smartboards to make information sources easily accessible.

2.3 Conceptions of ICT integration

Lloyd (2005) argues that definitions of integration are too narrow, specifically ICT integration. Lloyd further argues that researchers do not capture the complexity of the process adequately, therefore proposes a new definition based on the notion of 'seamlessness'. Based on this definition, integration of ICT is "the degree to which ICT vanishes into the background of the classroom"

(Lloyd, 2005, p. 5), and becomes an integral part of the learning environment. In this study, the ICT tool is the ISB. As indicated earlier in the introduction to this study, this definition means that the teacher seamlessly utilises the affordances in their teaching making them natural components of the learning environment. The definition implies that technology should be integrated such that it is no longer seen as separate but rather blended into the overall education setting. Vanishing into the background means the ISB is not the focus, but the transformation tool of content knowledge taught.

According to Fluck (2003), integration is concerned with how ICT is incorporated into learning. The inclusion of the terms ‘seamless’ and ‘natural’ implies that the use of the ICT tool must not disrupt the flow of the learning process. Playing a video during the lesson does not necessarily mean content knowledge and the affordance of the ISB have been integrated. Rather, a teacher has to effectively combine pedagogical affordances with the technological affordances of ISB (explained in the below subsection). This is the conception of ICT integration which is adopted for this study because it goes beyond a marginal use of ISBs in the classroom to a functional use in which ISBs become part of the classroom environment. A teacher can use the ISB's annotation tools to draw on or add text to diagrams or visuals within a video. This can help clarify complex concepts, emphasise specific elements, or link the video content to other learning materials. In essence, the teacher is not just showing a video; they are actively using the ISB's affordances to make the video content more interesting and easier for learners to understand.

2.4 Defining the term affordances

In this study, the term affordances are used interchangeably with capabilities and/or functionalities of the interactive smartboards. *Affordance* is a term coined by Gibson in 1977, which he describes as “what it offers the animal, what it provides or furnishes, either good or ill” (as cited in Moll et al., 2022, p. 57). In other words, affordances are powers and potentials in a technology that exists whether a teacher recognises them or not (Moll et al., 2022). A study by Moll et al., (2022) differentiates between two types of affordances, namely pedagogical affordances, and technological affordances. Pedagogical affordances refer to possibilities for learning that are offered by a particular teaching strategy, technology, or environment (Moll et al., 2022) while technological affordance refers to the possibilities for learning and engagement offered by a particular technological tool (Moll et al., 2022). In population ecology, understanding the interconnectedness of various factors within an ecosystem is crucial. This aligns with the pedagogical affordance of fostering systems thinking. Many ISBs offer interactive simulations that model population dynamics. This technological affordance directly supports the pedagogical goal of developing systems thinking. Learners can manipulate variables like predator-prey ratios, resource availability, and environmental conditions within the simulation. By observing the resulting changes in population sizes and ecosystem health, they can gain a deeper understanding of how these factors are interrelated.

2.5 The use of interactive smartboards in South Africa

In the ever-evolving landscape of educational technology, ISBs are rapidly transforming classrooms across the globe. South Africa is no exception, with this technology offering a unique blend of ICT benefits within the context of its diverse educational landscape. This section explores the current utilisation of Interactive Smartboards (ISBs) in South African classrooms, examining both the opportunities and challenges associated with their implementation. According to Mihai (2020), teachers employ ISBs to deliver lessons, illustrate concepts, and engage learners through interactive activities. Similarly, Makgato and Mji (2018) emphasize that ISBs enable educators to present multimedia content, conduct virtual experiments, and facilitate collaborative learning experiences that cater to diverse learning styles. The integration of ISBs in South African educational settings aims to overcome traditional teaching limitations by fostering active participation and critical thinking among learners. By enabling real-time interaction with digital content, ISBs enhance learner engagement and promote comprehension of complex concepts, a sentiment echoed by both Gumbo (2019) and Mihai (2020).

Karadag et al., (2017) found that the usage of ISBs positively impacts in-class communication, enhances learning enjoyment, and promotes attentiveness among learners, thereby facilitating classroom management for teachers. According to Karadag et al. (2017), educators believe that science education, being abstract, benefits significantly from ISBs as they aid in visualising concepts, thereby stimulating student curiosity. In contrast, Mhlongo et al., (2023) highlight several challenges associated with the implementation of technologies like ISBs in South African classrooms, including inadequate infrastructure, insufficient teacher training, limited technical support, and disparities in technology access among schools. These factors contribute to the digital divide, which impedes equal opportunities for learners to benefit from technological tools.

ISBs have the potential to revolutionise education in South Africa. By providing a dynamic and engaging learning environment, ISBs can overcome traditional teaching limitations and enhance student learning outcomes. However, challenges such as inadequate infrastructure, teacher training, and unequal access to technology must be addressed to fully realise the potential of ISBs in South African schools. Ultimately, the successful integration of ISBs requires a comprehensive approach that includes infrastructure development, teacher training, and equitable distribution of technology resources.

2.6 The complexities of the digital divide

Access to education is a pivotal factor in determining individual and national success. The digital divide, as defined by Mhlongo et al., (2023), underscores the disparity in technology access between different groups. This chasm has exacerbated inequalities among learners. Those without computers or internet struggle with online assignments and activities, while limited connectivity restricts access to educational resources. Furthermore, socioeconomic status influences technology ownership, with learners from low-income backgrounds often disadvantaged.

South Africa, a country marked by its historical apartheid policies, continues to grapple with deep-rooted socio-economic disparities. The digital divide in South Africa is multifaceted, influenced by factors such as income inequality, geographical location, education levels, and infrastructure availability (Steyn, 2020). Access to digital technologies and the internet is unevenly distributed, disproportionately affecting rural and marginalized communities. Chisango et al., (2021) emphasise the acute digital divide in three underprivileged Gauteng schools. These institutions grappled with a critical shortage of ICT infrastructure, hindering their ability to implement online learning, especially during the COVID-19 pandemic. This technological disparity widened existing educational inequalities. The abrupt transition to online learning exacerbated these challenges, as schools lacking infrastructure were unable to provide remote education. Consequently, learners in these schools experienced a significant disadvantage compared to their peers with adequate technological resources.

Mothibi (2019) highlights the stark digital divide between urban and rural South Africa, with the latter experiencing significant limitations in infrastructure. This disparity was exacerbated during the COVID-19 pandemic, as rural learners faced substantial challenges in accessing online education. While urban learners often enjoyed uninterrupted connectivity, their rural counterparts contended with limited or nonexistent infrastructure. Low-income households, regardless of location, encountered additional barriers to digital inclusion, as outlined by Steyn (2020). The acquisition of devices, data costs, and the requisite digital literacy skills formed a complex interplay of factors hindering access. Diko (2021) emphasizes the correlation between educational attainment and digital literacy, arguing that disparities in these areas perpetuate socioeconomic inequality. Despite policy initiatives aimed at bridging the digital gap, Mothibi (2019) underscores the persistent challenges in implementation and bureaucratic hurdles that have impeded progress.

From observation, the integration of ISBs in classrooms has been primarily restricted to replacing traditional projectors, indicating a superficial adoption of technology. Teachers frequently overlook the potential of ISBs for interactive and learner-centered approaches. The underutilisation of ISBs can be attributed to the challenges educators face in integrating ICT tools, as highlighted by Karadag et al., (2017) and Mhlongo et al., (2023). The complexities of the digital divide in South Africa underscore the need for multifaceted strategies that address infrastructural, socio-economic, and educational barriers. Sustainable solutions require collaborative efforts between government, private sector, and civil society stakeholders to ensure equitable access to digital technologies and opportunities for all South Africans. Although the use of ICT tools has addressed some of these disparities in schools, however there is still a huge gap that needs to be addressed in under-resourced schools and communities.

2.7 The current learner achievement in Life Sciences in South Africa

The global integration of ICT tools has significantly transformed education; however, its specific impact within South Africa's Life Sciences remains underexplored. There is a notable lack of studies investigating learner achievement in this field with the integration of ICT tools, particularly Interactive Smart Boards (ISBs). In South Africa, ICT adoption in education has led to significant advancements, enhancing teaching methodologies, fostering learner engagement, and improving overall outcomes in Science, Technology, Engineering, and Mathematics (STEM) education. For instance, Sitsha's (2023) research emphasizes that integrating Indigenous Knowledge Systems (IKS) into Life Sciences education through ICTs enhances cultural relevance within the curriculum. ICT tools facilitate the documentation, preservation, and dissemination of indigenous knowledge, making it more accessible to both learners and educators. This underscores ICT's potential to enhance understanding and application of IKS in classroom settings.

The recent report by the DBE on learner achievement in South African Life Sciences reveal a complex landscape influenced by various factors such as educational resources, teacher capacity, and socio-economic disparities (DBE, 2023). Performance in Life Sciences, as evidenced by national examinations like the National Senior Certificate (NSC), varies significantly across provinces and schools. Generally, provinces with better-resourced schools tend to exhibit higher pass rates and superior outcomes (DBE, 2023). Despite improvements in pass rates, challenges persist in rural and under-resourced schools due to infrastructure limitations and inadequate teacher support (Ramohai, 2021). In 2020, the pass rate was recorded at 71.0%, which saw a slight increase to 71.5% in 2021. This rate remained steady in 2022 at 71.5%, before experiencing a notable rise in 2023 to 75.6%. These figures reflect incremental improvements and fluctuations in performance over the past few years, indicating both stability and significant progress in learner outcomes in the subject of Life Sciences. These figures though do not represent an increment due to the use of ICT tools.

Socio-economic factors, including poverty levels and access to supportive learning environments, continue to influence learner achievement in Life Sciences (Ramohai, 2021). Learners from disadvantaged backgrounds often encounter additional barriers affecting their academic performance. Moreover, teaching quality in Life Sciences significantly impacts learner outcomes. Schools with well-trained educators, sufficient teaching resources, and opportunities for professional development tend to yield better results (DBE, 2023). Despite the South African government's initiatives to enhance learner achievement through reforms and resource provisions, disparities persist among schools in teaching quality and learning outcomes (DBE, 2023). Addressing these disparities requires sustained improvements in educational infrastructure, robust support for educators, and equitable access to quality education across provinces and communities (Ramohai, 2021). Furthermore, integrating technology and innovative teaching methodologies holds promise for enhancing learning outcomes in Life Sciences, underscoring the need for continued research and strategic interventions in this critical area of education. While ICT tools have shown potential in enhancing STEM education in South Africa, including the incorporation of Indigenous Knowledge Systems into Life Sciences, their specific impact on learner achievement in this subject remains understudied. Despite overall improvements in Life Sciences pass rates, significant disparities persist due to socio-economic factors and resource inequalities. To optimise the benefits of ICT tools and bridge the achievement gap, further research is needed to understand their effectiveness in Life Sciences classrooms, coupled with targeted interventions to address underlying challenges in education.

2.8 An outline of population ecology content as per the Grade 11 L.S. CAPS document

According to Dempster (2012), "population ecology is a study of the factors that affect species abundance and involves the recognition and mode of action of those environmental factors that cause variations in population size as well as those that determine the magnitude of these fluctuations (p.1). This topic was chosen in this study because it is under-researched, yet it is considered too complex, and abstract in nature (Knapp et al., 2010). In grade 11, learners are taught about what is population ecology, the factors that influence population size, and the different interactions in the environment as well as the human population. Population size is influenced by “immigration, emigration, mortality, natality, fluctuations, and limiting factors” (DBE,2011, pg. 49). Two growth curves, logistic and geometric with the phases are emphasised. The following interactions in the environment are described as part of the curriculum: predation, competition, specialisation, parasitism, mutualism, and commensalism (DBE, 2011, p. 49). Lastly, under the human population, the reasons for exponential growth are considered. Learners often find this chapter uninteresting as some teachers only use textbook information to teach learners (Cooke et al., 2021) whereas it requires learners to be actively involved and work collaboratively to better comprehend population ecology concepts.

2.9 A review of the literature on teaching population ecology

Understanding science, including ecological processes is crucial for building scientific literacy in citizens and empowering them to make informed decisions about the world around them (Shymansky et al., 1992). This includes grasping the quantitative aspects of population ecology, such as interpreting graphs, measuring populations, and determining carrying capacity (Trenckmann, et al., 2021). However, math anxiety can hinder learner engagement with population ecology concepts (Urry et al., 2014). Learners often struggle to connect these quantitative tasks with the broader ecological concepts and their real-world applications. For example, they may fail to understand the limits to population growth even with abundant resources. This highlights the need for teaching approaches that not only develop quantitative skills but also help learners connect them to overarching ecological principles and track their understanding as they learn.

One of the prevalent misconceptions is that the subject solely focuses on studying insects and basic environmental observations, making it seem irrelevant to learners' lives (Magro et al., 2002). This perception can render population ecology unappealing and hinder learner engagement. Furthermore, Irish et al., (2018) suggests a disconnect between the way science, including ecology, is taught and its real-world applications. When instruction emphasises abstract concepts and theories without connecting them to everyday life, learners may struggle to see the subject's relevance. Consequently, they become disinterested and less likely to invest in learning the material. As a result, the learning population ecology for many L.S learners then becomes a collection of facts to memorise rather than a tool for understanding and interacting with the environment.

Additionally, traditional teaching methods that rely heavily on memorisation can contribute to a lack of learner engagement with population ecology (Magro et al., 2002). In contrast, studies like that conducted by Trenckmann et al. (2021) highlight the effectiveness of active learning approaches. Their research found that clicker-based lessons, encouraging learner participation through prediction, data analysis, and evidence evaluation, can improve learning outcomes in population ecology (Trenckmann et al., 2021). Building on these insights, this study investigates the integration of ISB affordances in teaching population ecology. Since, ISBs offer various affordances, such as simulations and visualisations, which have the potential to enhance learner comprehension and engagement with the subject matter compared to traditional methods as explained earlier. By incorporating interactive elements and real-world applications, ISBs can potentially bridge the disconnect between abstract concepts and their practical relevance.

2.10 Underpinning Theoretical frameworks: Pedagogical Content Knowledge, Pedagogical Reasoning and Actions, and the SAMR model

This study was structured around three frameworks that played a pivotal role in shaping both the planning and actual teaching of the eight lessons conducted in this study. These frameworks, Pedagogical Content Knowledge (PCK), Pedagogical Reasoning and Actions, and the SAMR model, collectively guided the planning and eventually the teaching processes. PCK served as a tool for understanding essential knowledge domains crucial for effectively teaching population ecology. Simultaneously, pedagogical reasoning provided ongoing insights into content selection and the formulation of teaching strategies. Also, given that in this study the perspective of integration was adopted in terms of 'seamlessness', as proposed by [insert reference] earlier in this chapter. Consequently, the SAMR model was employed to systematically document the precise ways in which I integrated the affordances of ISB when teaching the topic of population ecology. This is because this model facilitated a comprehensive understanding of the varying levels of technology integration, from substitution to redefinition, thus contributing to a nuanced analysis of the teaching practices employed. These three complementary frameworks are further explained in greater detail below.

2.10.1 Planning to teach population ecology: A PCK framework

To ensure effective teaching of this topic, I utilised Pedagogical Content Knowledge (PCK) by Shulman (1986). PCK emphasises the importance of transforming content knowledge into a form that is comprehensible and engaging for learners. This aligns with the concept of integrating technology like ISBs, as it can facilitate a more effective transformation of complex population ecological concepts. Below is a description of the PCK framework.

2.10.1.1 Pedagogical Content Knowledge

Shulman (1987) defined PCK as the general knowledge and skills that a teacher needs to effectively teach any content area. Gudmundsdotti & Shulman (1987) suggested that PCK describes how a teacher's understanding of subject matter is transformed to make it 'teachable'. This process of transformation is influenced by four knowledge domains, hence the framework's suitability in guiding my planning for the lessons presented in this study. These are knowledge of the subject matter, general pedagogical knowledge, knowledge of learners, and knowledge of context. Below follows a description of each knowledge domain as defined by Shulman.

Subject matter knowledge (SMK)- This knowledge domain is defined as "the teacher's raw untransformed subject matter" (Rollnick et al., 2008, p. 1384). This is a deep understanding of a particular topic, including its key concepts, theories and methodologies. As a teacher, I need to have knowledge of subject matter as this is the knowledge I need to impart on my learners. For instance, reading through the CAPS document one gains an understanding of the content knowledge that needs to teach.

Pedagogical knowledge (PK)- this is the knowledge domain that teachers have of how to teach in a way that will lead to learners fully understanding what the teacher is meant to teach (Rollnick et al., 2008). It includes creating an effective learning environment and knowing which teaching strategy will work for your learners. For instance, the use of simulations, group works, discussions, analogies, PowerPoint presentations, videos, illustrations, games, quizzes, and diagrammatic presentations. These are all meant to enhance understanding of content knowledge.

Knowledge of learners- this knowledge domain encompasses knowledge of how learners receive information, their prior knowledge, their learning styles, misconceptions, what they find difficult to learn and their interests (Rollnick et al., 2008). This knowledge can be used to plan differentiated learning strategies in order to identify knowledge gaps and stimulate learners critical thinking. With this knowledge, a teacher can also create a safe and inclusive space in their classroom, where diverse perspectives and backgrounds are recognised and valued.

Knowledge of context- this knowledge refers to the teacher's understanding of various factors that influence the teaching and learning environment (Rollnick et al., 2008). This domain includes the knowledge of school and classroom dynamics and community and cultural characteristics such as understanding the classroom management strategies, the interaction amongst learners and the classroom routines, sensitivity to the socio-economic and cultural background of learners and their families.

Figure 2 below is a Venn diagrams that shows relationship between some of the knowledge domains explored above.

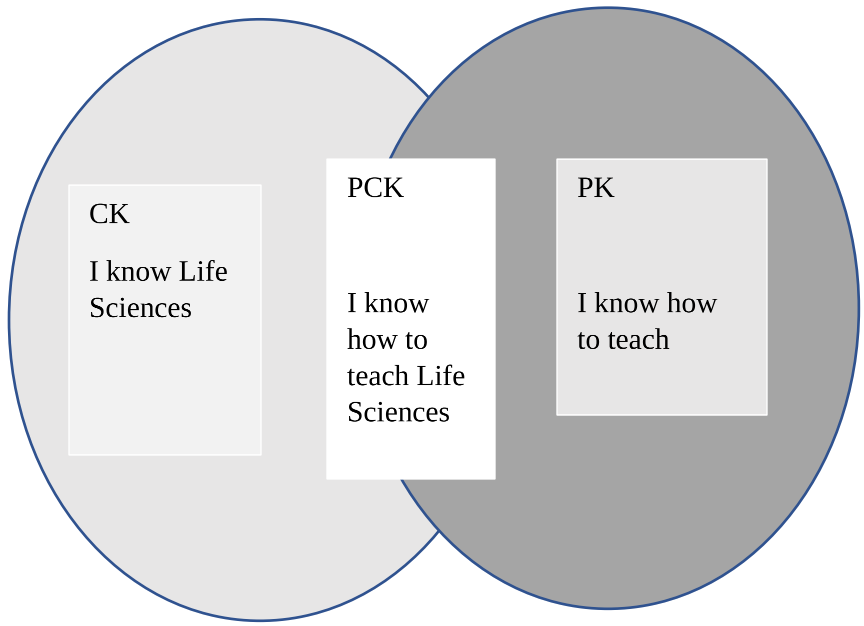


Figure 2: A Venn diagram showing pedagogical content knowledge.

This Venn diagram illustrates the overlapping nature of the previously discussed knowledge domains. It visually depicts how both content knowledge and pedagogical knowledge are essential components of pedagogical content knowledge.

2.10.2 Pedagogical reasoning and action

In planning for my teaching, I drew upon the concept of pedagogical reasoning introduced by Shulman (1987). This concept describes the process by which educators leverage their professional knowledge to inform decisions about curriculum selection and teaching strategies (Loughran et al., 2016). I used the model of pedagogical reasoning and action presented by Loo (2007). This six-stage framework provided a valuable structure for navigating the complexities of effective teaching. As shown in Figure 3 below, the stages involve: comprehension, transformation, instruction, evaluation, reflection, and new comprehension (Loughran et al., 2016). It is important to note that while these stages may not be explicitly referenced during lesson planning, they are nonetheless evident in the implementation of pedagogical actions.

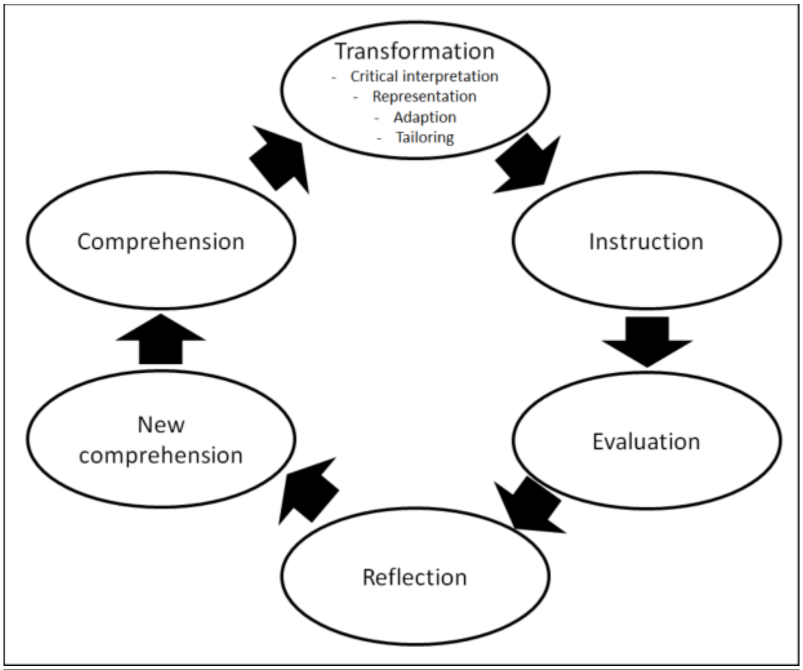


Figure 3: Shulman's model of pedagogical reasoning and action

Below is a description of the stages of pedagogical reasoning and action with a description of how they informed my study.

1. *Comprehension*

During the first stage of the framework, comprehension, I explored the learning goals, curriculum constraints, and my learners' prior knowledge as outlined by Loo (2007). Specifically, when teaching population ecology, I assessed my learners' prior understanding of the topic, and examined their potential interest in environmental issues such as ecosystems and food chains through quizzes and discussions. This comprehensive understanding of various factors served as the foundation for planning and delivering impactful learning experiences. For each lesson, I clearly defined the learning goals and objectives for the topic population ecology, focusing on concepts like carrying capacity, population growth, ecological relationships and many other (see Appendix 1). I then reviewed the CAPS document to ensure my lessons aligned with the prescribed learning objectives. This stage helped me identify areas where prior knowledge was strong and areas where clarification was needed.

2. *Transformation*

The second stage of the framework, as described by Loughran et al. (2016), involves transformation. This stage is crucial as it requires educators to transform complex content into engaging instructional strategies and activities that resonate with learners (Nyamupangedengu, 2015). In my teaching of population ecology, this involved transforming abstract concepts into activities that would capture learners' interest and promote understanding. For instance, I integrate the ISB's simulation affordance to visualise the impact of predation on prey population. This interactive approach aimed to make the concept more relatable and engaging for learners compared to traditional static presentations.

Nyamupangedengu (2015) further breaks down the transformation stage into four sub-stages:

a) **Critical Interpretation:** A deep analysis of the content to understand its essence and identify key learning objectives. I analysed the contents of the CAPS document in relation to the grade 11 L.S. topic of population ecology and focused on key learning objectives.
b) **Representation:** Selecting appropriate representations, such as visuals, simulations, or analogies, to effectively convey the transformed content. Instead of relying solely on textbook explanations, I used an ISB application that allowed learners to manipulate a virtual environment, simulating the effects of population growth on resource availability and carrying capacity.

c) **Selection and Adaptation:** Choosing existing instructional materials or adapting them to align with the transformed content and learning goals. I designed a short interactive quiz on the ISB using Kahoot and added a diagram learners needed to interpret. The quiz questions challenged learners to interpret the information presented and apply their understanding of population growth concepts.

d) **Tailoring:** Tailoring the transformed content and chosen representations to the specific needs, interests, and learning styles of my learners. I found an existing virtual biology laboratory activity that I allowed learners to manipulate to make learning more meaningful and relatable.

3. *Instruction*

The crux of the pedagogical reasoning and action model lies in the instruction stage (Loo, 2007). This stage is where the meticulously planned lessons come to life in the classroom. My instruction involved guiding learners through simulations, facilitating discussions, and encouraging critical thinking. I implemented the planned lesson using the ISB and other relevant instructional materials. This involved clear explanations, interactive activities, and opportunities for learners to engage with the content in a meaningful way. I presented a lesson on population growth using the ISB affordances, incorporating interactive graphs that learners could manipulate to see the effects of different factors like birth and death rates.

4. *Evaluation:*

Rigorous evaluation follows, employing diverse methods to assess learners understanding and gauge the efficacy of the chosen path (Loughran et al., 2016). After using various forms of assessment strategies such as short quizzes, I evaluated the effectiveness of the ISB affordance integration by observing learner engagement, participation in activities, and their responses to questions related to the concepts presented. I noted these observations in the journal entries.

5. *Reflection*

In the reflection stage, I engaged in deep introspection, analysing my entire teaching journey of population ecology. This stage involved unearthing valuable insights and identifying areas where my teaching could be refined for future iterations (Loughran et al., 2016). I specifically reflected on the integration of the affordances of the ISBs, the effectiveness of collaboration with critical friends and the knowledge domains as described by Shulman (1986) and Mavhunga et al., (2013). I also reflected on whether the integration of the ISB affordances sparked engagement among learners. I reflected during the planning of my lessons and after discussions with critical friends to continuously refine my teaching practices and enhance the learning experience of the integration of affordances of the ISBs. These reflections were noted on my journal as journal entries.

6. *New Comprehension*

Finally, having applied the pedagogical reasoning and action framework, I arrived at a new level of comprehension (Loo, 2007). This involved incorporating the insights gained from the reflection stage into future lesson planning, paving the way for continuous improvement in my teaching practice. Based on these reflections, I refined my pedagogical approach by incorporating additional affordances of the ISB, such as population modeling software, to further engage learners. Through this dynamic interplay of reflection and action, Shulman's model provided a valuable lens for comprehending the multifaceted journey of effective teaching. This study, reflecting on my specific teaching experience, utilised the framework of pedagogical reasoning and action. As a teacher in school settings, I leverage my professional knowledge to make informed choices about both content selection and teaching strategies. In conclusion, by applying the pedagogical reasoning and action framework, I gained a valuable tool to plan, deliver, and continuously improve my teaching including integration of the affordances of the ISB. This approach ultimately led to more engaging and effective learning experiences for my learners.

2.10.3 Substitution, Augmentation, Modification and Redefinition (SAMR) model

The SAMR model is a framework that offers educators a structured approach to think about and evaluate how they are using technology in their classrooms (Romrell et al., 2014). It serves as a foundation because it provides a starting point and a set of guiding principles for educators to consider (Hilton, 2016). Crafted by Puentedura, SAMR offers teachers a structured way to think about integrating technology effectively. It stands for and is divided into four levels namely, "Substitution, Augmentation, Modification, Redefinition" (Hilton, 2016, p. 68). The SAMR model categorises technology use into two main approaches: enhancement (substitution and augmentation) and transformation (modification and redefinition). Enhancement makes existing activities better with the integration of technology and transformation creates new and potentially more engaging learning experiences through technological tools (Puentedura, 2014). Each of these four levels delineates different stages of technological integration in the classroom. Figure 4 below represents the SAMR model by Puentedura (2014).

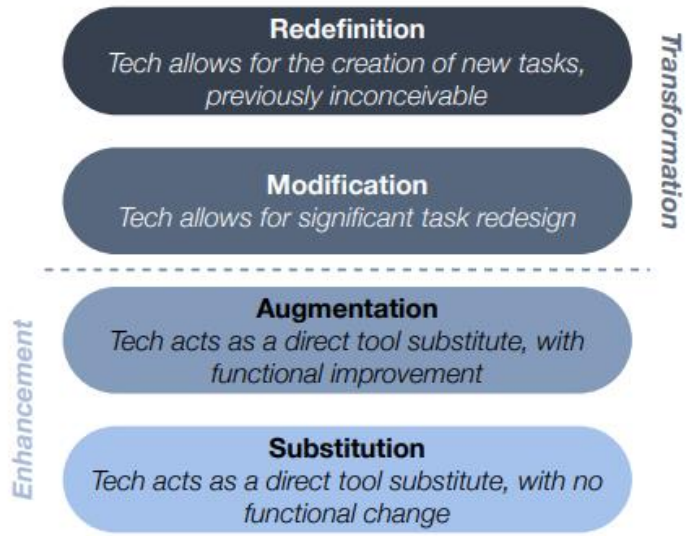


Figure 4:SAMR model by Puentedura (2014)

The SAMR model can be used to analyse the levels of technology integration when using ISBs to teach population ecology to grade 11 L.S learners. These levels are explained in detail below.

1. Substitution

This is the basic level where the ISB simply replaces traditional tools like textbooks for presenting information (Hilton, 2016). A ladder developed by Puentedura (2014) posed the question, *what will I gain by replacing the older technology with the new technology?* (p. 21). Romrell et al., (2014) define the initial level, substitution, as the use of mobile devices to replace traditional activities. An illustrative example is the substitution of a physical textbook and handouts on population ecology with an ISB. While the ISB introduces a novel mode of content engagement, the core learning activity remains fundamentally unchanged compared to its physical counterparts. However, the affordances of technology extend beyond mere replacement (Hilton, 2016). As one explores the functionalities of the ISB, opportunities for augmentation, the second stage of the SAMR model, may emerge.

2. Augmentation

Activities positioned within the substitution and augmentation phase are said to enhance learning (Hilton, 2016). Augmentation, as described by Castro (2018), involves seeking enhancements to the learning process through functionalities unavailable with traditional tools. For instance, the ISB supplements existing teaching materials or activities with basic functionalities. Annotating pre-existing diagrams and videos about population growth on the ISB during a lesson. Further functional improvements of the ISB include highlighting and underlining key points on the ISB.

3. Modification

With modification, technology integration becomes transformative, requiring a redesign of the lesson around the digital tool (Castro, 2018; Puentedura, 2015). It is modification and redefinition levels that learning is transformed. With the modification level, the digital tools give learners the ability to access environments outside the classroom (Romrell et al., 2014). For instance, using the ISB to interact with a simulation of predator-prey interactions, can allow learners to observe how changes in population size affects the ecosystem.

4. Redefinition

This is the highest level in the SAMR model where “technology allows for a creation of new tasks, previously inconceivable” (Castro, 2018, p. 11). Technology becomes central to a completely new learning experience that would not be possible without it. For instance, learners collaborating on the ISB to design and model their own virtual ecosystems, experimenting with different factors and analysing the resulting population dynamics. This activity creates an entirely new tasks for learners that would not be possible without the ISB. Traditionally, learning about ecosystems might involve reading descriptions or analysing static diagrams. The affordances of the ISB may allow learners to design and actively manipulate a virtual ecosystem, a task inconceivable without the technology's interactive capabilities.

2.11 Conclusion

This review of relevant literature underscores the multifaceted affordances of ISBs in potentially enriching the instruction of population ecology for grade 11 L.S. learners. The three frameworks presented in chapter will serve as a critical tool that will guide the data analysis and presentation of findings of this study. The next chapter will discuss the methodology that this study aligns with.

Chapter 3: Research design and methodology

3.1 Introduction

The purpose of this chapter is to describe and justify the research methodology of the study in line with the aims of the study. Accordingly, this chapter provides an overview of the research paradigm, research method and design, research site, demographic information of the critical friends, search instruments, data collection process, and data analysis, all of which were carefully considered and selected to obtain in order to acquire the data needed to address the research questions. Furthermore, the ethical considerations of the study are also noted.

3.2. Research paradigm

A research paradigm is a set of beliefs, values, and assumptions that guide the way a researcher conducts a study (Mugani, 2020). It influences the research questions, methods, and interpretation of the results. This study follows an interpretivist paradigm to understand the perspectives and actions of the researcher. Instead of focusing on isolated variables, interpretivism explores the interconnected factors that shape a specific context (Alharahsheh et al., 2020). Interpretivism as a paradigm recognises that humans are not simply objects like physical phenomena, but rather individuals who actively create and interpret meaning, making their study fundamentally different.

Axiologically, this study assumed the value of technology, particularly ISBs, as tools for enhancing science education (Yılmaz, 2023). The study acknowledged the importance of effective lesson planning and thoughtful integration to maximize learning benefits. Ontologically, it recognised the multiple realities within a classroom, where learning was influenced by individual learner experiences, teacher approaches, and the ISB's affordances. Epistemologically, knowledge about effective ISB integration was viewed as socially constructed through the researcher's (teacher's) experience, collaboration with colleagues, and reflection on learner learning. This interpretivist approach emphasized understanding the subjective experiences of the teacher-researcher and learners regarding ISB integration for teaching population ecology (Alharahsheh et al., 2020). The methodology reflected this by employing qualitative methods like lesson observations, reflective journaling, and critical friend interviews to gather rich insights into how ISBs impacted teaching and learning.

In this study, I investigated how I learnt to integrate the ISB, focusing on my experiences and how I made sense of its affordances in the context of teaching population ecology. The study was conducted in a natural setting to best understand the factors, if any, that affected the integration of the affordances of ISB when teaching population ecology to grade 11 L.S learners. This yielded a purely subjective response arising from an interpretivist paradigm hence its suitability in this study.

3.3 Research method and design

This study employed self-study, which is a research approach that encompasses both methodology and research design. A self-study delineated that I was both a researcher and a participant. Self-study methodologies often rely on qualitative research methods, such as reflective journals, interviews, and observations. In this vein, I employed qualitative approaches including reflective journals and discussions with critical friends to document how I integrated the affordances offered by ISBs and how they could be utilized for teaching population ecology to grade 11 learners. In the subsection below, I described the characteristics of self-study in order to contextualize this method for data collection and its appropriateness for this study.

3.3.1. Defining a self-study methodology

There are various definitions of self-study as a research methodology. Samaras et al., (2011) define self-study as a research methodology that is used to encourage researchers to be agents of their reform initiatives while working collaboratively with others. Furthermore, Buck et al., (2016) view self-study as a critical tool for teachers to analyse their teaching principles and how they manifest in the classroom, providing a platform for deep reflection and growth. This definition justifies self-study as a research methodology for this study because it will allow a level of reflection and growth that will enhance my understanding of the integration of the affordances of the ISBs. In terms of research in the field of education, Loughran et al., (2007) further emphasise that a self-study is taken from the word itself; “self-study of teacher education practices conducted by teacher educators of their practice” (p.136). In this instance, my own qualifications and experiences form part of the study in my capacity as an educator-researcher and an educator-participant.

Echoing previous work, Samaras et al., (2011) conceptualise self-study as a facet of systematic and critical reflection, where teachers scrutinise both their actions and the contextual factors influencing them. A self-study aims to foster a more deliberate and informed approach to physical activity instruction. Through self-study, researchers engage in a thoughtful and purposeful inquiry into their pedagogical practices, critically examining the underlying assumptions that inform their teaching decisions, thus aligning to the PCK and pedagogical reasoning and actions frameworks in Chapter 2. Focusing on professional development, I conducted a self-study examining my classroom teaching of population ecology to grade 11 L.S learners when integrating the affordances of the ISB.

LaBoskey (2004) and Nyamupangedengu (2024) assert that there are five key aspects of self-study, which involve: *self-initiated and focused, improvement-aimed, interactive, qualitative, and trustworthiness-oriented* (LaBoskey, 2004; Nyamupangedengu, 2024). All these five key aspects of self-study are explained in greater detail below.

a) Self-initiated

This first aspect of self-study, which involves self-initiated means that the study is driven by the interests and needs of the researcher (Nyamupangedengu, 2024). A teacher is the researcher and the researched at the same time, therefore it is their interests that drive the study (Samaras et al., 2011). As a high school L.S teacher, I observed a lack of learner engagement during traditional lessons on population ecology concepts like carrying capacity and population growth models. This personal observation, fueled by my desire to improve my teaching practice and led to this self-study of learning to integrate the affordances of the ISB in population ecology lessons, as explained in Chapter 1.

b) Improvement-aimed

The second component of self-study which includes improvement-aimed is focused on understanding and improving one’s practice, but also improving learners' understanding and their institutions and social contexts (Nyamupangedengu, 2024). My self-study aimed to improve and strengthen my teaching practice of population ecology. Additionally, I hoped to improve learner understanding by fostering active learning through the integration of the ISB affordances.

c) Interactive

Interactive is the third aspect of self-study that involves collaboration and feedback from colleagues, supervisors, critical friends, and learners (LaBoskey, 2004). This is a monitoring process where all the stakeholders mentioned interact with the researcher by asking questions, offering alternatives, and asking for clarifications about my planning and/or teaching. I sought collaboration and feedback from my supervisor and critical friends during the planning and implementation stages. They provided valuable suggestions on lesson design, ISB affordances integration, and other potential ISB affordances I could integrate. I also engaged learners by incorporating interactive activities such as online simulations, group discussions, and virtual biology laboratories.

d) Qualitative

A self-study uses multiple primarily *qualitative* methods for gathering data, which is the fourth aspect. This is to ensure that the data is captured from different viewpoints on the process being investigated to provide a more comprehensive view of the process itself (Nyamupangedengu, 2024). To capture everything that happened during the lessons, I employed qualitative data collection methods. I documented my observations, reflections, and challenges throughout the teaching process in a journal. I held discussions with critical friends and the supervisor. These discussions were audio-recorded to ensure that critical information can be captured and revisited later during the analysis process.

e) Trustworthiness-oriented

Trustworthiness-oriented is the fifth aspect of self-study and delineates that instead of relying on traditional statistical methods to judge the accuracy of research findings, exemplar-based validity focuses on concrete examples of teaching practice (LaBoskey, 2004). These examples, like lesson plans, video recordings, or detailed descriptions of classroom interactions, act as tangible evidence that researchers and teachers can directly examine and evaluate. To ensure the trustworthiness of my findings, I used exemplar-based validity. Specific examples, such as images (screenshots) of the affordance of the ISB being integrated were captured and pasted in relevant sections as supporting evidence (See Chapter 5). This study therefore followed all the key aspects of a self-study as described by Nyamupangedengu (2024) to strengthen the validity and reliability of the data collected.

3.3.2 Self-Study and Other Self-Reflexive Methodologies

Self-study methodology shares significant overlap with other self-reflexive research approaches, notably narrative inquiry (Kitchen, 2009). Both methods prioritise the researcher's experiences and perspectives as a primary source of data. However, self-study tends to focus more narrowly on improving practice, while narrative inquiry often aims for broader theoretical or conceptual understanding (Kitchen, 2009). Narrative inquiry, while similar in its focus on personal stories, places a stronger emphasis on constructing a coherent narrative to illuminate broader themes or issues. Self-study, on the other hand, is more concerned with practical implications and actions. Self-study analysis often involves identifying patterns, themes, and implications for practice. Narrative inquiry is more concerned with constructing a coherent story and exploring its meaning (Kitchen, 2009).

Nonetheless, the two methods can complement each other, with narrative inquiry providing a rich context for self-study and self-study offering practical insights to inform narrative analysis. By situating this self-study within the broader context of self-reflexive methodologies, it became apparent that the findings contributed not only to the specific context of ISB integration in population ecology but also to the broader understanding of how teachers can use self-study to enhance their practice.

3.3.3 The research site

This study was conducted at a secondary school located in Gauteng. In 2023, the school had an enrollment of 1409 learners (average class size exceeding 55). My own classroom reflected this range, typically accommodated 50 learners, with each lesson period lasting 45 minutes. I specifically taught one class with a similar learner population size (45-50 learners). The layout of this classroom is depicted in Figure 5 below.

Figure 5: Layout of the classroom showing the ISB

My classroom is a well-equipped learning environment featuring an interactive smartboard and a traditional whiteboard. Additionally, the room is secured with steel burglar bars on the windows and door for enhanced safety. Window blinds are available to adjust the natural light and optimize the visibility of the interactive smartboard. Just above the boards, there are charts explaining how to access e-content on a windows device, the do's and the dont's of tablets, and suggestions of what to do when in trouble with the ICT tools. The school was chosen for two key reasons: firstly, because I was employed there, and secondly, due to its implementation of smart classrooms equipped with ISBs.

3.3.4 Demographic information of the critical friends

This research incorporated critical friends as a key element of the self-study's data collection processes. Ms. Zulu, Ms. Lunga, and Mr. Mthembu (pseudonyms) served as my primary critical friends, reviewing my lesson preparations and detailed lesson descriptions presented within my journal entries. Professor Nyamupangedengu, who served as my supervisor, also adopted the role of a critical friend. For clarity, I referred to her as Eunice when specifically mentioning her role as a critical friend. Table 1 below summarises the demographic information of these individuals who served as my critical friends in this study, since self-study thrives on collaboration (Berry et al., 2014).

Table 1: A summary of the critical friends' demographic information

Critical friends' name	**Teaching years of experience**	**Qualifications**	**Subjects taught**
Miss Zulu	13 years	Bachelor of education, Hons, MSc Ed	L.S and Natural Sciences
Miss Lunga	14 years	Bachelor of Education, Senior Phase and FET	L.S., Life Orientation and Natural Sciences
Mr Mthembu	23	Bachelor of Science, Physics, PGCE	Physical sciences

As shown in Table 1 above, these critical friends are qualified and experienced acquaintances who were able to give me feedback on some of my teaching activities. This is because according to Berry et al., (2014), researchers engage in dialogue with learners, colleagues, and critical friends, venturing beyond their own perspectives to gain fresh insights, as previously mentioned. That is why the critical friends reviewed my lesson plan presentations and journal entries, providing constructive feedback on my teaching approach and suggestions for future lesson strategies. Their invaluable insights, as emphasised by Berry et al., (2014), offered nurturing support throughout the research process. This study integrates these insights gleaned from my teaching practice, enriched and validated through the collaborative perspectives of critical friends. Their feedback significantly shaped the analysis and interpretation of the collected data.

3.3.5 Participants

This self-study involved me (the researcher) acting as both the researcher and the subject of investigation as earlier mentioned. The research took place in the presence of grade 11 learners studying L.S. as a major subject; however, these learners were not considered key participants in this specific study. Wits Research Ethics emphasises that when a researcher becomes part of the classroom environment, the learners automatically become participants, but in this case, the research focused solely on the researcher's experience since it took on a self-study methodology. While Chapter 1 introduced my background details, Table 2 below again summarised this information to remind the reader.

Table 2:Summary of my demographics information as a participant

Name	Age	Teaching years of experience	Qualifications	Subjects and grade taught
Ms. Magwaza	<35	5	Bachelor of Science, Biochemistry and Human Physiology PGCE, L.S. and Natural Sciences Bachelor of Educator, Honors- L.S.	-Natural Sciences Grade 8 & 9 -Technology Grade 8 -Life Sciences grade 10-12

3.3.6 Research instruments

To collect data, journal entries, discussions with critical friends, video-recoding of the lessons and audio-recording of the discussions were used in this study. Based on the objectives of this research, these techniques will assist exploring the ways these affordances were integrated in my classroom when teaching population ecology to grade 11 LS learners. Table 3 below shows a summary of the methods used to collect data in this study.

Table 3:: Summary of the methods I used for data collection.

Method of data collection	Time of data collection
Journal entries which included my reflections	For two weeks in Sept 2023
Audio recording of discussions held with critical friends	Done after each presentation with inputs from Miss Lunga, Miss Zulu, Mr Mthembu and my supervisor Prof Nyamupangedengu
Presentations to fellow students	Every Thursday for a duration of 20 minutes
Video recording of the lessons	During the lessons. All 8 lessons, with a duration of 45 minutes each.
Lesson planning	Every day in all 8 lessons

3.3.6.1 Journal entries

This study used journal entries as a primary method of data collection. As described by Makaiau, et al., (2015), a journal serves as a permanent record of thoughts, experiences, and reflections. In the context of a self-study, journals act as a repository for educators' classroom narratives, allowing them to capture unique observations, analyse experiences, and reflect on teaching practices (Nyamupangedengu, 2024), hence its suitability in this study. In addition, Tidwell et al., 2020) further highlight the versatility of journaling in self-study, emphasising its use for recording daily thoughts, feelings, classroom experiences, examining specific events or challenges encountered during teaching and gaining different perspectives through critical friend feedback. Throughout the self-study, I used journal entries to document various aspects of my teaching experience with ISBs in a L.S. population ecology class. Selecting journal entries offered the valuable advantage of allowing me to revisit and contemplate my earlier reflections (Hiemstra, 2001). I also used it for recording routine activities, challenges, successes and detailing the events and content of each lesson. Lastly, I used the journal to reflect on personal observations and to integrate key takeaways and feedback from critical friends.

3.3.6.2 Discussions with critical friends

I collaborated with Ms. Zulu, Mr. Mthembu and Prof. Nyamupangedengu using Microsoft Teams, WhatsApp calls, and face-to-face meetings. All discussions were audio-recorded with the permission of the critical friends. My discussions with Ms. Lunga who worked at the same school as me, were always held face-to-face. As earlier mentioned, after each discussion, I transcribed our conversation from the audio-recording and used the information they shared with me to inform my next lessons. Below is an example of a transcribed discussion I had with Ms. Zulu in lesson 1.

***Ms. Zulu**: What made you think that the GDE PowerPoint [ppt]had more overwhelming content?*

***My response**: Population ecology is abstract and has a lot of dynamic and complex systems influenced by multiple interacting factors such as birth rates, death rates, migration, competition, etc. I am always reminded of when I was still a learner and how my L.S. teacher never taught long and theoretical topics like population ecology and how she always referred us to the textbook should we not understand something. The topic being overwhelming for me as a teacher and a learner also stems from my experience.*

***Eunice:** Oh okay... That had me thinking. Was there a reason you used the GDE slides and did not prepare your own?*

***My response**: I figured that since they are already provided as resources then I might as well use them. The fact that they also help with providing coherence to my lesson...*

In most instances, discussions with critical friends prompted me to reconsider my thinking and pedagogical reasoning and actions. They offered valuable insights into my lessons, suggesting ways to facilitate greater interaction given the self-study nature of the project. They reminded me of the key principles of self-study and how I needed to integrate them into my lessons. Interestingly, we engaged in more discussions after implementing the lesson plan compared to before, which helped surface alternative approaches for future lessons. In essence, collaborating with critical friends proved crucial for conducting a successful self-study.

3.3.6.3 Video recordings of the lessons

Video recording served as a valuable tool for data collection and analysis in this study, particularly considering the importance of understanding social interactions, behavior, and lived experiences (Griffin, 2019). Ethical considerations, technical challenges, and data interpretation difficulties were carefully addressed to ensure responsible and accurate research practices. The learners were informed about the use of video recording beforehand. Due to the unavailability of a video camera within the timeframe, I utilised my cellphone. The phone was password-protected, and the recordings were immediately transferred to an online storage solution after each lesson. In the absence of a dedicated tripod stand, the phone was positioned on a desk to capture the full view of the ISB. Ms. Lunga, as a critical friend, was only able to observe one of the eight lessons due to scheduling conflicts during my teaching times. Therefore, I video-recorded my lessons to provide my critical friends with visual and audio recordings for post-lesson feedback.

3.3.6.4 Audio recordings of the discussions with critical friends

Audio recording served as a powerful tool for collecting and analysing rich data in this qualitative research study. This method proved particularly valuable for capturing the different perspectives and interactions about my practices from the lens of my critical friends, understanding voices, communication, and lived experiences for me as a researcher. As discussed previously, all discussions with critical friends, whether held on Microsoft Teams, WhatsApp, or face-to-face, were audio-recorded for later analysis. After each discussion, recurring themes were identified and coded for further analysis.

3.3.6.5 Lesson planning

Lesson planning serves as a roadmap, guiding my instructional decisions and learner engagement (Panasuk et al., 2002). This involved consciously and unconsciously shaping the learning environment and fostering learner interaction with the material. Drawing upon the four domains of teacher knowledge (Chapter 2, Section 2.10.1.1), I meticulously planned my lessons (refer to Appendix A). I used resources such as the Understanding Life Sciences Grade 11 learner's textbook, the annual teaching plan (ATP), the Grade 11 GDE content application on the ISB, past exam papers, and various reliable online sources. The GDE lesson plan template provided a strong foundation, outlining the content to be covered, incorporating diverse teaching methods (discussions, group work), and suggesting learner activities (simulations, practical's, textbook exercises). This framework was further tailored to encompass my specific role as a teacher, ensuring clear expectations and effective facilitation within the classroom. My pedagogical reasoning and actions were evident in these lesson plans.

3.4 Data collection process

This study utilised a variety of methods to gather data about my own teaching practices, experiences, and reflections, as outlined by Samaras et al. (2011). Data collection methods employed included:

a) **Journaling**: I critically examined and analysed my own thoughts, feelings, and actions as a teacher through journaling.
b) **Collaboration with critical friends**: I collaborated with colleagues as critical friends to gain external perspectives on my teaching practices. Additionally, I presented my research study to fellow students to receive feedback and explore different interpretations of the data.
c) **Video recordings**: I video-recorded my lessons to observe and analyse my teaching practice, particularly focusing on the integration of the ISB affordances.
d) **Audio recordings**: Discussions with critical friends were audio-recorded, providing a detailed record of the interactions and conversations that took place.
e) **Lesson planning:** I developed eight comprehensive lesson plans outlining the content, teaching strategies, learner activities and my facilitation as a teacher. These lessons were used to gather evidence of pedagogical reasoning and action as described in chapter 2, section 2.10.2.

This data collection process allowed me to identify alternative ways to integrate the ISB affordances more effectively into teaching population ecology.

3.5 Data analysis

My data analysis was done using deductive and inductive approach. The deductive approach begins with a theory whereas the inductive approach starts with data and then uses this data to develop a theory or hypothesis (Scott et al., 2005). The same idea is echoed by Elo et al., (2008) when they mention that inductive analysis is useful for describing a phenomenon from data, while deductive analysis is useful for testing previous theories in different situations or comparing categories over time. It is important to note that data analysis was occurring concurrently with data collection. All the methods of data collection were written in a form of text and analysed as explained in the subsections below

3.5.1 Video and audio recordings

The subsections below detail how the data obtained from video and audio recordings was analysed in three steps.

Below I outline these steps:

Step 1: I played back each of the 8 video lessons three times in chronological order. I did not transcribe the videos but familiarized and engaged with what had happened in the lesson. First playback was to familiarize myself with the video. Second playback, using the lesson plans as templates, I would play and pause to make detailed annotations of what was happening in the lesson video. These notes included descriptions of any thoughts that were triggered by watching myself teaching during the playback. Third playback, I would take screen shots of all notable aspect of my attempts at integrating the ISB affordances to support the notes I had made during playback number 2.

Step 2: Analysis of descriptive notes of the video-recording made in step 1. This chapter employed a deductive lens, using the SAMR levels to analyze and discuss the integration of ISB affordances within my lessons. Figure 6 provides an illustrative example of how I analysed my video-based notes for affordances from lesson 7 & 8. This serves as an exemplar for the reader, outlining the analytical approach used.

Today's lesson was short as learners were starting with cycle tests the following day which means this was the last lesson before the formal assessments. A consolidation of what has been covered on population ecology was done using a game quiz called Kahoots! (affordance-online platform) [M] on the ISB and using cell phones. Learners grouped themselves and they answered questions on their phones as they appeared on the smartboard (affordance-display function) [S]. They seemed to enjoy doing this as it gave them a chance to work with each other. However, Kahoot! caused chaos with some questions as they would sometimes debate with each other in the same group as to what the correct answer was. By activating the stopwatch feature in Kahoot (affordance-stopwatch), [S] I aimed to promote discussion and prevent impulsive answering. This approach seemed successful, likely due to the initial training session on gameplay using non-relevant questions. The provided screenshot illustrates the Kahoot game interface, showcasing the question prominently displayed at the top, answer options listed below, and a timer on the left-hand side.

Figure 6: Illustrative example of how these affordances were analysed using the SAMR model

(Key: M-modification and S-substitution)

Step 3: Discussion of the coded notes with a critical friend

Critical friends received video recordings and video-notes of the eight lessons for review. Following their independent viewing, a Microsoft Teams meeting facilitated a discussion. The focus of the discussion centered around the coded notes, specifically the alignment with the SAMR model and ISB affordance integration.

3.5.2 Journal entries and lesson plans

The analysis of lesson plans involved a three-step process that is again explained in greater detail below:

Step 1: I began with a thorough reading of the journal entries and lesson plans, aiming to gain a comprehensive understanding of their content. This approach prioritised open-mindedness and discovery of emergent themes, setting aside any preconceived notions.

Step 2: This stage focused on identifying the affordances of the ISB embedded within the lesson plans and how they were implemented during the lessons. Additionally, I looked for instances of both successful and challenging integration.

Step 3: Following the initial analysis, I identified emerging themes from the findings. To strengthen the validity of my interpretations, I sought out alternative perspectives through discussions with peers and critical friends.

3.6 Validity and reliability of a self-study

Issues of validity were important in this self-study. As Feldman (2003) points out, when engaging in reflective processes, the accuracy of one's claims can be uncertain. Therefore, validity in a self-study refers to the trustworthiness of the claims made based on the collected data (Nyamupangedengu, in 2024). The goal was to create a credible and accurate portrayal of my practice. Pinnegar & Hamilton (2009) asserts that validity is achieved by constructing a well-written and insightful account that resonated with readers and offered valuable lessons and improvements for other practitioners. Self-study research can be challenging to ensure validity and reliability because it relies heavily on the researcher's own judgments and interpretations (Pinnegar et al., 2009). For this reason, one of the key characteristics of self-study is exemplar-based validation, where concrete documents and practice examples are presented for evaluation of validity (LaBoskey et al., 2015; Samaras, 2011). To address this challenge, I collaborated with critical friends and also presented my preliminary findings to a group of students. This collaboration aimed to gather feedback on the accuracy and resonance of these findings. By employing these strategies, the self-study achieved a robust and trustworthy exploration of learning to integrate the affordances of the ISB for teaching population ecology.

3.7 Ethical considerations

Since the study involved human participants, it was conducted with careful consideration for their rights (Scott et al., 2005). During, and after the study, I informed all participants of their right to confidentiality. I ensured the rights of each individual, and participants who chose to withdraw did so freely and without any consequences. The parents were informed of the study's focus on my teaching and the additional teacher's presence in the classroom. However, the study itself did not affect the learners in any way. Nevertheless, as they were part of the observed teaching and learning interactions, their assent to participate was required. I provided learners with information letters and asked them to sign assent forms. Parents were also presented with information letters and consent forms to sign. Ethical clearance was obtained from both the University of the Witwatersrand Human Research Ethics Committee with the protocol number 2023ECE035M and the GDE (see Appendix 3 & 4 respectively). Upon receiving the ethical clearance certificate, I sent an informed consent letter to the principal of the secondary school requesting permission to conduct the study with the Grade 11 L.S. learners. I used pseudonyms to avoid conflict of interest for critical friends. The journal was stored in a locked drawer, and audio and video recordings were kept on a password-protected computer.

3.8 Summary

In this chapter I have laid the groundwork for the study by outlining its methodology and design. I also included the details of the chosen research approach, the participants, and the procedures employed throughout the investigation. To ensure the research's trustworthiness, I also discussed the issues of validity and reliability specific to the self-study approach. Additionally, I addressed the ethical considerations that were paramount during the research. The subsequent chapter will explore the research findings, presenting them in detail and offering a concise summary.

Chapter 4: Planning for my teaching

4.1 Introduction

In this chapter, I describe how I planned my teaching of the topic of population ecology. During the lesson planning process, I drew upon the four identified pedagogical domains to guide the development of each lesson namely knowledge of context, knowledge of learners, content knowledge and pedagogical knowledge (detailed in chapter 2, section 2.10.1.1). Reflective journaling served as a key tool, fostering introspection on my pedagogical reasoning and actions. Data for the study was collected through text-based journal entries documenting these reflections, along with discussions with critical friends. The data and the findings from this chapter helped me to answer research sub-questions 1: *What affordances of the interactive smartboard can I integrate in the teaching of population ecology to grade 11 learners?*

4.2 Knowledge domains

4.2.1 Knowledge of context

The context of the lessons conducted as part of this research is a suburban school located in Gauteng. The lessons took place in September 2023 at a quintile 5 school. According to Ogbonnaya and Awuah (2019) quantile 5 schools are those regarded to be in the wealthiest communities, receiving the least government funding and typically charging fees with classes from grade 8 up to 12, and an enrolment of about 1500 learners. This school in which the lessons were conducted has a total of 38 classrooms, with only 8 of the classrooms with an ISB.

To be able to teach grade 11 learners, my knowledge of the current curriculum (CAPS) used at the school was important. I had become familiar with the CAPS curriculum from three periods in my life, my high school years as a learner, my initial teacher program (PGCE) as well as 5 years of experience as a teacher at the school. I had already received the CAPS document and Annual Teaching Plan (ATP) from my senior education specialist (office-based educators that provide curriculum support to educators in schools in areas of specialization (Schlebusch et al., 2016) which helped me understand what was expected of me as a grade 11 L.S. teacher. As such, I was acquainted with the ATP which sets the pace for teaching and learning in schools. For instance, the ATP indicated that the topic of population ecology should be taught in term 3 for a period of two weeks. This school in which the lessons were conducted has a total of 38 classrooms, with only 8 of the classrooms with an ISB.

In my past experience using an ISB for teaching and learning, I carefully considered the context of the situation. This included the physical environment, the social dynamics of the classroom, and how learners interacted with information presented on the board. The size of the classroom was a key factor. The classroom was large enough and designed such that 60 learners, regardless of their position, could comfortably view the ISB (See Figure 5 in Chapter 3). However, the ISB lacked internet access, requiring me to utilize my personal phone and a mobile router to create a hotspot for internet-based activities. Understanding the social context involved knowing if learners owned cellphones and had access to mobile data. While I observed most learners brought phones to school, I needed to plan for those without. One activity, Kahoot! required individual phone usage. Therefore, I facilitated group work, allowing learners to share one phone with data access (connected to my hotspot or personal phone) after group discussions.

Prior interactions revealed the learners enjoyed group work and presentations more than traditional teacher-led lectures. Furthermore, they consistently displayed excitement when visuals were presented on the ISB, allowing them to actively engage with the material. While the specific simulation used in this lesson was new, previous topics incorporated similar simulations, providing them with some background knowledge. By considering this context, I was able to design lessons that addressed the specific needs of my learners while maximising the potential of the ISB. This ensured a well-rounded learning experience that catered to individual needs and learning styles.

Reflections: *Firstly, the context of the classroom environment is crucial when planning to teach. While the observed class size of 60 could comfortably view the ISB, limited internet access necessitated alternative solutions like a personal mobile hotspot. This highlighted the need for adaptable lesson plans in case of unforeseen limitations. Secondly, understanding the social context is vital. While most learners had personal phones, some lacked data access. This experience emphasizes the importance of incorporating activities that do not solely rely on individual technology use. Finally, learner preferences should be considered. Their interactions of group activities and visual presentations suggests incorporating these methods into population ecology lessons. Leveraging the ISB for engaging visuals and facilitating group discussions can enhance engagement.*

4.2.2 Knowledge of Learners

I was fortunate to have conducted my self-study with the same group of learners whom I taught from grade 9 to 11. This vantage point allowed me to gain prior insights into their learning. I developed some understanding of their prior knowledge, learning styles, personal interests, language barriers, and unique capabilities. This familiarity played a significant role in shaping the planning of my self-study. Below I discuss one example of what I did during the planning of the lesson to improve my knowledge of my learners. For every lesson I planned, I had to assess learners' prior knowledge. Shulman (1987) defines prior knowledge as the knowledge that learners already know and understand about a topic before a teacher introduces new information. I had to go back to the grade 10's ATP in order to understand what they know about population ecology. I found that in grade 8 Natural Sciences they were taught about the ecosystem, and population ecology was briefly mentioned. The grade 10 content in L.S. also addressed population ecology under the broader topic of biomes and the ecosystem. This helped me understand what they had been taught in previous grades so I could consciously understand my contribution to their existing level of knowledge.

For instance, in order to gauge learners' prior knowledge of predator-prey interactions, I utilized the ISB to display a short quiz. This allowed learners to directly demonstrate their understanding of the topic through answering the provided questions. I also employed video analysis as a means of assessment. I presented a video relevant to predator-prey interactions on the ISB and subsequently instructed the learners to directly annotate the video itself. This annotation process served as an engaging method for them to visually showcase their existing knowledge about the concepts depicted in the video. By combining these assessment methods, I aimed to gain a comprehensive picture of the learners' prior understanding of predator-prey interactions before exploring into the topic.

Knowledge of learners also included knowing their preferred learning styles. Although I had taught others in grades 9 and 10, I still struggled to grasp all their learning styles. As a result, I always ensured in my planning that the lessons included at least two learning styles so that learners did not feel left out and lose out on the learning experience. I had noticed through the years, however, that the majority were visual learners, therefore I could leverage this information to plan lessons with a lot of visuals using the affordances of the ISB. In my past lesson, I catered to diverse learning styles by incorporating presentations with population growth graphs for visual learners, annotating diagrams for those who prefer writing, and utilising a virtual lab simulation requiring learners to virtually count organisms for kinesthetic learners. Recognising the potential abstractness of population ecology, I aimed to enhance engagement through these varied visual presentations.

My reflection: *Reflecting on my approach to addressing learner needs, I acknowledged the potential presence of misconceptions regarding population ecology concepts. While directly addressing specific misconceptions was not initially planned, I remained open to addressing any that surfaced during the lessons. Catering to diverse learning styles, particularly beyond the typical three (visual, auditory, kinesthetic), presented a challenge. Nearly every lesson required specific consideration for kinesthetic learners, prompting me to explore ways to leverage the ISB for their active participation. This experience revealed the limitations of catering to every single learning style in every lesson. To address this, I adopted a strategy of rotating the emphasis on different learning styles throughout the lessons. This ensured a broader range of learners were actively engaged throughout the population ecology unit.*

4.2.3 Knowledge of content (Subject matter knowledge)

As previously mentioned, I had to read through the CAPS document to gain knowledge of the prescribed content of population ecology that needs to be taught in grade 11. CAPS is a policy document that is used by teachers to familiarize themselves with the prescribed content for each grade and subject as asserted by DBE (2014). The CAPS document is written in detail in terms of the topics and subtopics that need to be covered in population ecology. For instance, it mentions that at least two examples of predation should be made and must be related to the South African context. The annual teaching plan (ATP) on the other side provides a breakdown of the subtopics and exemplary activities that can be given to learners. I planned on using the sequence as noted in both the CAPS and the ATP. I did not feel the need to change this sequence because each topic follows the other. Prior to this experience, I had a history of teaching Grade 11 Life Sciences dating back to 2021. This included previous instruction on population ecology. However, as highlighted in Chapter 1, Section 1.1.1, I was motivated by a prior reliance solely on the textbook, mirroring my own teachers' approach despite having an ISB available in my classroom. To ensure the lesson content aligned with current curriculum guidelines, I reviewed the CAPS document. While the core content of CAPS remained unchanged, the ATP had undergone revisions following the

COVID-19 pandemic (DBE, 2013). These revisions resulted in a "recovery ATP" addressing the learning disruptions experienced during the pandemic. Consequently, the allotted time for teaching population ecology was reduced from 4 weeks to 3 weeks. This necessitated the exclusion of topics like social organization and succession from the curriculum due to the shortened timeframe.

My reflection: *Reflecting on the initial planning stages, I encountered unexpected challenges. My focus was drawn to how learners might react to the teaching approach. I had concerns regarding the potential for the ISB to become a distraction, hindering their focus on the content itself. This echoed the sentiment expressed by Lloyd (2005) regarding the seamless integration of ICT tools. Driven by this concern, I recognized the need to prioritize interactive lessons. The goal was to actively engage learners with the content presented through the ISB, ensuring they utilized it as a learning tool rather than solely focusing on its technological aspects. Exploring the affordances of the ISB further heightened my anxieties. Seeking suggestions for interactive activities from colleagues and fellow students yielded limited results, as their recommendations largely mirrored my existing lesson plans. This experience highlighted a potential gap in teachers' knowledge regarding the full range of ISB functionalities. Consequently, I felt compelled to explore mastering the ISB's capabilities myself. Fortunately, upon reviewing the revised ATP, I discovered a reduction in the time allotted to population ecology. Two sub-units and one week were removed. This adjustment, while initially unforeseen, presented a positive outcome. The compressed timeframe alleviated my anxieties about balancing instructional time with the effective integration of ISB functionalities.*

4.2.4 Pedagogical Knowledge (PK)

My PK was heavily informed by the three knowledge domains explained above. The three knowledge domains discussed in the previous section as knowledge of context, knowledge of learners, and knowledge of content. It is important to note that I planned for each lesson and not for the whole topic in one go. My planning was affected by what happened in the previous lesson and what could be done to teach it better. I had 8 lessons to prepare for in population ecology.

Outline of planned lessons

Below is an outline of the subtopics that were covered in each lesson, the detailed version of these lessons in available in Appendix 1 in this outlined order:

Lesson 1: Introduction to key concepts

Lesson 2 and 3*: Estimating population size- Direct and indirect methods.

Lesson 4: Estimating population size- Mark-recapture method (Practical activity)

Lesson 5: Limiting factors and carrying capacity

Lesson 6: Interactions in the environment- Predator-prey relationships

Lesson 7 and 8*: Interactions in the environment- competition- inter- and intraspecific competition

*Indicates the lessons where there were double periods instead of having one 45-minute period.

The selected topics encompassed approximately 90% of the population ecology curriculum as outlined in the authorized ATP. The remaining 10% of the curriculum, specifically the subtopic of succession, was intentionally omitted due to its exclusion from the ATP. My initial teaching approach for population ecology involved using the GDE L.S. PowerPoint presentations. These presentations appealed to me as they offered a comprehensive introduction to key concepts by integrating both textual information from the textbook and various visual elements. However, I did not fully consider the potential impact on diverse learning styles within the classroom.

Reflections: *Reflecting on the initial use of the pre-made GDE PowerPoint presentation for population ecology in lesson 1, I identified a potential shortcoming. While the visual elements might have resonated with visual learners, the sheer volume of information on the slides could have overloaded all learners and hindered their active engagement. This passive learning approach, with me solely presenting and learners simply listening, did not align with effective integration of the ISB affordances. Recognising the potential for information overload and a lack of interactivity, I made a crucial decision to discontinue using the GDE slides after the first lesson. This shift was driven by the need to cater to diverse learning styles and promote learner interaction. Consequently, I embarked on developing new PowerPoint presentations specifically tailored to my learners. These revised slides aimed for a more concise and strategic use of visuals.*

4.2.4.1 Affordances of the ISB drawn upon during the lessons.

I drew upon different affordances of the ISB when teaching the topic of population ecology to grade 11 L.S. Drawing inspiration from Drennan's (2017) model of iPad capabilities and affordances, I adapted it to the context of the ISB affordances and capabilities.

Table 4: Some of the ISB capabilities matched with their affordance.

ISB capability	Technological affordance	Pedagogical affordance
Multimodal content display	Versatility Dynamic content creation Enhanced visual representations	Enables the presentation of various media formats like text, images, videos, and interactive elements.
Touch screen interaction	Direct manipulation	Efficient movement between different multimedia functions without taking time off the teaching of the lesson
Intuitive surface	Quick and easy to use	Teachers can integrate seamlessly and enhance learning with minimal confusion of the functions and options of the ISB
Connectivity	Resource access	Allows for connection to other devices like computers and the internet, expanding the range of accessible resources.
Integrated audio and video	Take and playback audio and videos	Audio recordings cater to auditory learners and learners with visual impairments, allowing them to access the information through listening. Recordings can be offered at different speeds or with transcripts, catering to diverse learning paces and needs. Learners can revisit specific parts of a lesson or explanation by replaying the recording.
Screen sharing	Data sharing	Allows for sharing lesson plans, presentations, and other digital materials between teachers and learners onto the main display.
Annotation capabilities	Active and collaborative learning	Users can write, draw, and highlight directly on the displayed content.
Apps (Online platforms)	Content diversity and expansion	Online apps often come with built-in features like simulations, games, quizzes, and polls that actively engage learners in the learning process.
Assessment	Variety in assessment methods	Interactive assessments can make the process more engaging compared to

		traditional paper-based tests, potentially reducing test anxiety and encouraging active participation

Table 4 presents a selection of the ISB's capabilities and their corresponding affordances utilized during population ecology lessons to grade 11 learners. It is important to acknowledge that table 5 does not represent an exhaustive list of the ISBs potential functionalities, it only highlights those which were most notable in this study. Further exploration is necessary to identify and leverage affordances for future instruction.

4.2.4.2 Planned and enacted strategies in my teaching

My teaching plan for population ecology incorporated a variety of teaching strategies tailored to the specific subtopics covered each day (see lesson plan attached in Appendix 1). Brahier (2013) argues that a well-prepared lesson plan is essential for a successful lesson. My lesson planning aimed to leverage the affordances of the ISB to facilitate learning about integrating them [affordances] effectively when teaching population ecology.

Selected teaching strategies and the rationale for selecting them

Various teaching strategies were used in this study (see table attached in Appendix 2). These included question and answer technique, visual aids, formative assessment, virtual laboratory practical, and dialogue-driven Socratic method. Question and answer technique is an inquiry-based teaching technique where a teacher asks questions that learners can draw insights from and learners think critically and respond to those questions (Rehorek, 2004). In my lesson, I designed questions directly related to the day's content. This aimed to promote learner autonomy and encourage them to actively engage with the material beyond simply receiving information (Palaming, 2017). These questions reflected the types of assessments learners might encounter in examinations. While some questions were prepared beforehand and presented using the ISB's presentation function, I also incorporated spontaneous elements. This involved generating additional follow-up questions based on the responses I received from learners, fostering a more interactive learning environment.

It allowed me to assess what learners already knew about population ecology which could be a springboard for further learning. Use of visual aids such as PowerPoint slides, videos and simulations had eye-catching graphics and diagrams that assisted make the abstract concepts more tangible and relatable (Hashemi et al., 2012). This is also emphasised by Berk (2012) and Evangorou et al., (2015), where they further assert that using visual aids encourages engagement. Building upon the emphasis on learner participation, I strategically incorporated visual aids throughout the lessons. In one instance (Lesson 6), I directly encouraged learner engagement by prompting them to annotate directly on the visuals presented. To effectively deliver the visuals, I harnessed the online platform function of the ISB. This allowed me to leverage the vast resources available through the Google interface. My selection process prioritized visuals that resonated with the learners' interests and experiences, aiming to maximize their engagement with the presented content.

Formative assessment specifically through a multiple-choice quiz was designed to gauge learner comprehension during the learning process, allowing me to adjust instruction as needed. I adopted the quiz questions from the GDE PowerPoint presentation in relation to the focus of the lesson. For instance, I gave the class a five-question multiple-choice quiz based on how to estimate size of a population. The five-question quiz allowed me to briefly assess learners understanding before continuing with the lesson. The quiz helped me to see that learners were struggling to complete the formative assessment given based on estimating the size of the population, I then employed the use of a virtual laboratory practical activity. Virtual labs facilitated the application of learned theoretical concepts within a practical context. This shift from theory to practice aligns with the pedagogical value of virtual labs (Potkonjak et al., 2016).

Virtual labs cater for visual learners by providing simulations and experiment representations, potentially encouraging learner interaction (Potkonjak et al., 2016). Additionally, the immediate graphical feedback inherent to virtual labs aligns with their benefit of offering instant results or visualisations based on learner choices within the simulation (Liu et al., 2022). Furthermore, Liu et al., (2022) suggest that virtual labs can potentially enhance learner interest due to their increased interactivity and visual appeal compared to traditional textbook-based labs. This aligns with the established effectiveness of visual representations in fostering participation, as advocated by Ainsworth et al., (2014) and Buckley et al., (2020). In summary, the implementation of a virtual laboratory practical aimed to achieve three primary objectives: bridging the gap between theoretical knowledge and practical application, providing visual support for learning, and potentially sparking greater learner interest in the subject matter.

A Socratic method refers to a structured discussion that encourages participants to seek deeper understanding of questioned concepts through disciplined dialogues (Delić et al., 2016). In my class, I utilized a dialogue-driven Socratic method to assess learner understanding and promote critical thinking (Delić et al., 2016). This involved posing a question, such as *does a population grow continuously?* sparking a discussion that revealed learners' grasp of the concept and potential knowledge gaps. This approach aligned with research by Bennett et al., (2015) highlighting the benefits of dialogue in promoting diverse perspectives and communication skills. The back-and-forth dialogue encouraged learners explaining their reasoning and understanding of the topic. This method not only assessed prior knowledge but also fostered critical thinking and communication skills within the learners.

My teaching incorporated a game-based learning platform called Kahoot! This approach aligned with research that highlighted the value of experiential learning and increased engagement facilitated by games (Licorish et al., 2018; Tan Ai Lin et al., 2018). Kahoot! exemplified gamification, utilizing game principles and learner response systems to motivate, engage, and enhance knowledge retention (Licorish et al., 2018). Studies, similar to my experience, showed that game-based learning fostered a more engaging learning environment (Kaur et al., 2020; Tan Ai Lin et al., 2018). Kahoot! seamlessly integrated with existing classroom technology. Teachers could create quizzes, and learners could participate using their own devices. In my classroom, I specifically used Kahoot! to review previously learned material in a stimulating way. My aim was to solidify understanding, reinforce key concepts, and encourage active participation from the learners.

4.3 Insights drawn from planning for my teaching

Explicitly considering the four knowledge domains during lesson planning fosters a deeper understanding of how to integrate technology effectively. This approach encouraged me to explore various teaching strategies that leverage the affordances of Interactive Smart Boards (ISBs) while ensuring alignment with the lesson's objectives. Overlooking knowledge of context and pedagogy limits the potential of ISBs. Without considering the learning environment and appropriate teaching methods, teachers might miss opportunities for engaging activities, multimedia integration, and collaborative work. Additionally, a lack of contextual awareness can lead to frustration when using unfamiliar technology during lessons. Planning with context in mind allows teachers to explore the functionalities of ISBs beforehand, enabling a smoother implementation during class time. ISBs alone are not sufficient to address the varied learning styles. Failing to account for existing learner knowledge can lead to situations where some learners fall behind. Lastly, focusing solely on interactive activities offered by ISBs can overshadow the core learning objectives of the lesson. Without a clear understanding of the content being taught, these activities might become irrelevant or confusing for learners. In essence, integrating the affordances of the ISB effectively necessitates a comprehensive approach that acknowledges the interplay of various knowledge domains. This paves the way for a more stimulating and impactful learning experience for all. Planning to integrate the affordances of the ISB effectively requires planning, sufficient time, dedication, and enough resources, this supported the findings of the study conducted by Ramorola (2013).

Chapter 5: Beyond lesson planning: Integrating ISB affordances during the teaching of population ecology.

5.1 Introduction

In this section, I explored the manifestations of ISB affordances within the context of my own teaching practice. Following this exploration, a detailed analysis ensued, examining how these affordances were integrated during actual lessons. I also presented the successes and challenges associated with integrating these affordances in my lessons.

5.2 How I integrated the affordances of ISB when teaching population ecology to Grade 11 Life Sciences class

The analysis of the video-recordings from my lessons was described in chapter 3 (see section 3.5.1). This analysis showed explicit manifestations of the integration of the ISB during the lessons. The results of the analysis showed that I made use of a total of 9 multiple affordances and below I detail how these were affordances were integrated in my various lessons. are discussed below.

a) Touch function

The ISB touch sensitivity served as the primary mode of activation. All interactions, including opening applications, selecting and manipulating objects, zooming, and scrolling, necessitated the use of a finger on the touch screen. Similarly, navigating between slides and annotating them relied on finger contact with the display. Figure 7 below shows an image depicting the use of touch affordance on an ISB to select and drag images during a learner research activity on elephant habitat destruction. A more detailed account of this lesson where learners were using the ISB is provided in Appendix 1. This inherent characteristic of ISBs, their touch sensitivity, dictates that all functionalities.

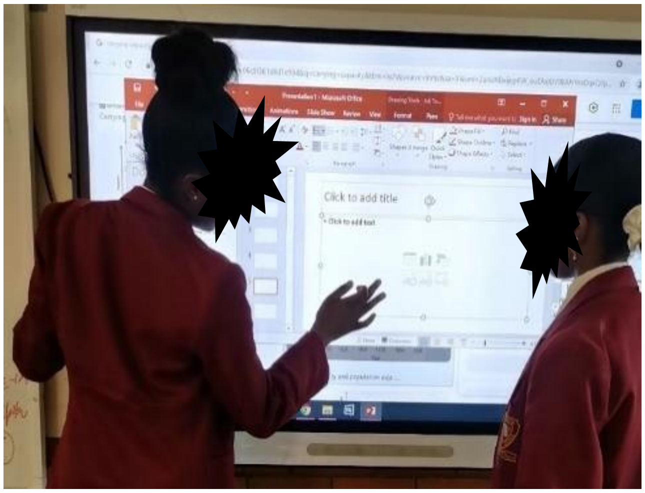


Figure 7: Learners using the touch function of the ISB

The touch function or affordance is classified within the substitution level within the SAMR model. This is because, this touch affordance essentially substituted the traditional methods of interacting with a board, where a learner or teacher would typically use a marker or pointer. However, using this touch function or affordance I and the learners were able to directly manipulate objects, write, and navigate through applications.

b) Presentation and display function

The presentation and display function facilitated the projection of pre-designed slides as well as all the contents displayed using the ISB. Beyond the presentation affordance, the ISB also functioned as a traditional whiteboard. Figure 8 show the pre-designed PowerPoint presentation I projected using the ISB for instructional purposes.

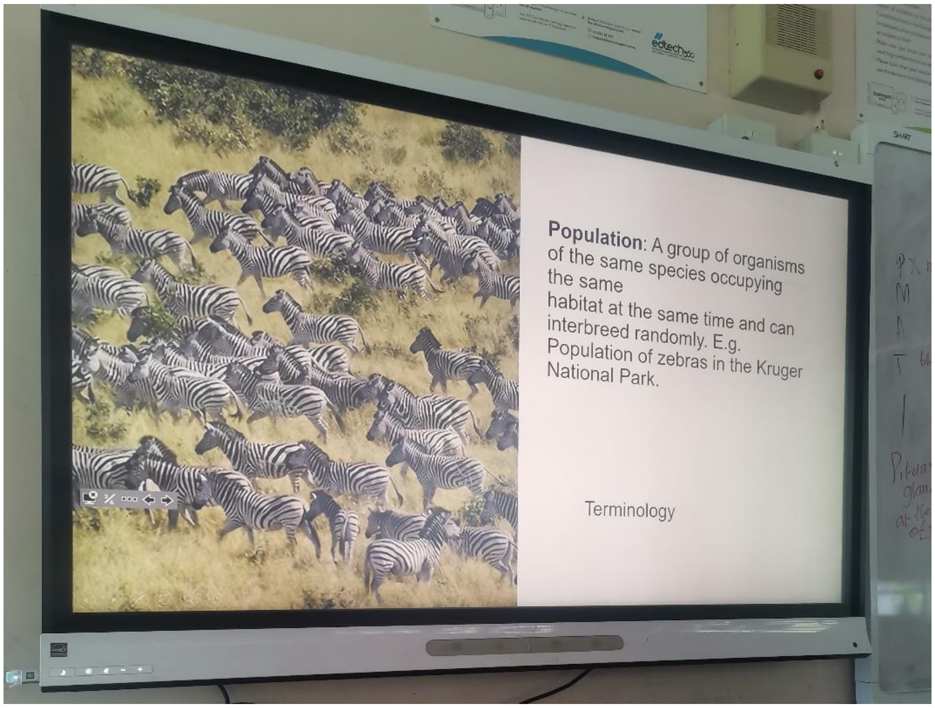


Figure 8: A presentation and display of the PowerPoint presentation

Figure 8 above illustrates how learners were introduced to the concept of population during lesson 1. The use of presentation and display affordance enabled learners to visually see a population of zebras, thereby reinforcing their understanding of the definition provided on the same slide.

A discussion with the critical friend prompted me to explore alternative uses of the presentation function, beyond mere substitution for the textbook. This conversation marked a turning point in my approach to utilizing the ISB. I have inserted this discussion below:

Ms. Zulu: What made you think that the GDE ppt had more overwhelming content?

My response: Population ecology as a whole is abstract and has a lot of dynamic and complex systems influenced by multiple interacting factors such as birth rates, death rates, migration, competition etc. I am always reminded of when I was still a learner and how my L.S teacher never taught long and theoretical topics like population ecology and how she always referred us to the textbook should we not understand something. The topic being overwhelming for me as a teacher and a learner also stems from my experience. This GDE ppt had more content than it had representations of the content. It was like using a textbook but using PowerPoints.

I consider this the turning point of the integration of the presentation function from the ISB. I describe a turning point (adopted from Nyamupangedengu, 2015) as a moment of realization that changed my perspective on the way I was integrating the affordances of the ISB. The integration of the presentation and display function within in instance can again be categorised as my study exemplified the concept of substitution as outlined in the SAMR model. This is because, during this instance, the PowerPoint replaced traditional methods of information presentation, such as textbooks, overhead projectors, or whiteboards with markers. However, in other lessons, the use of the ISB extended beyond mere substitution. However, in lesson 3 rather than merely substituting this presentation and display affordance of the ISB, I further leveraged the presentation and display function by augmenting the affordance (SAMR level) which was characterised by the incorporating multimedia elements, such as embedded videos, to enhance the presentations thus reaching the augmentation. This was exemplary in lesson 5 when I paused and annotated the video. Even so, both methods of integration were essentially aimed at increasing learner engagement but integrating the affordance using augmentation (SAMR level) further helped to place and improve the emphasis on key concepts by making the presentations more visually appealing and interactive (Castro, 2018).

c) Annotating function

The digital pen and highlighter functionalities of the ISB facilitated real-time annotation of both pre-prepared slides and content directly displayed on the ISB surface. This capability proved valuable for enhancing presentations, fostering collaborative exploration of ideas, and transforming information into visually compelling representations. Figure 9 shows a depiction of various annotation techniques employed during lessons. The first figure (reading from left to right) is 9A, second one is 9B and the third one is 9C. These three images are group as figure 9 because they show the same ISB function.

A **B** **C**

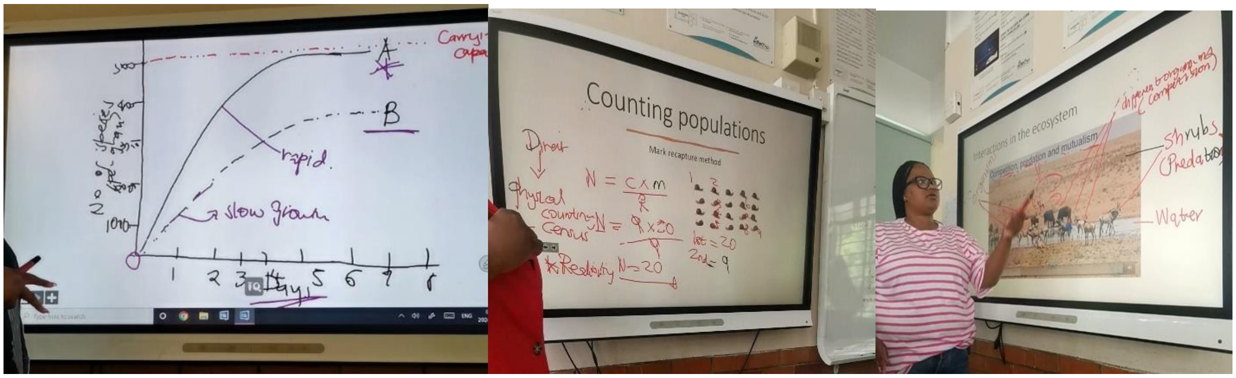


Figure 9: Various annotating techniques depicted

Figure 9A illustrates the use of the IQ Interactive platform's teaching tools in conjunction with the ISB for annotation. In this instance, I employed annotation to explain the concept of carrying capacity to learners. While annotating on the ISB, I highlighted the initial slow population growth within a new habitat during the acclimatization period. A red dotted line was then added to depict the maximum population size sustainable by the environment.

Figure 9B show examples of counting the population size were tackled with the learners using annotation affordance of the ISB. When preparing the PowerPoint slide, I space was deliberately left spaces o showcases the integration of annotation within a pre-prepared PowerPoint presentation. Space was deliberately left on the slide to collaboratively solve population size estimation problems with the learners. Rather than presenting a pre-worked example as found in the textbook, I opted to guide the calculation process through annotation on the PowerPoint itself. This approach addressed the confusion sometimes experienced by learners when presented with pre-solved examples. Figure 9C demonstrates the application of annotation to enhance video analysis. By pausing the video and annotating with arrows and text, I was able to direct learner attention towards specific sections containing important information. This visual annotation of key interactions within the video served to reinforce learner comprehension and establish a shared reference point for subsequent discussions. The annotations employed in this instance are clearly visible within Figure 9C.

My use of the annotation function in Figure 9A and 9B were classified as augmentation within the SAMR levels of integration. This is because, like other previous instances that resulted in this level of integration, I simply added labelling lines and words to content, and these annotations did not fundamentally alter the way learners interacted with the information. In contrast, directly annotating on the video content, like in Figure 9C showed that the affordance in this instance ranged within the modification level within the SAMR model. In essence, while simple labeling falls under augmentation, annotations that encourage deeper analysis and learner interaction represent a shift towards modification within the SAMR model.

d) Video playback function

Figure 10 depicts a screenshot of a video played during a lesson, showcasing the full video playback bar. I utilized the video playback function for various purposes throughout my lessons. A primary reason was to improve learner engagement and interest. This video shows interactions in the ecosystem. I wanted learners to see the different interactions that exist in the ecosystem. Videos, in my experience, provide dynamic visuals that promote active learner participation. In Lesson 6, I employed a video as an introductory element to spark discussion and analysis amongst learners. Following video playback, I prompted them to discuss their observations and how these observations related to the lesson's focus on competition. This strategy proved successful, as learners were able to readily establish a connection between the video content and the concept of competition. Furthermore, video integration catered to diverse learning styles. The inclusion of video addressed the needs of both visual and kinesthetic learners. Finally, I utilised video to facilitate learner visualisation of abstract concepts. In the preceding lesson, I had explained competition using the whiteboard. However, I felt a need to introduce a more visual approach to solidify their grasp of the concept. The video effectively served this purpose as I could see learner interaction during annotations. Using the video playback and annotating function shows modification level within SAMR model. This qualifies as modification because I did not just passively present the video, instead I manipulated the content in real-time, drawing attention to specific parts, adding explanations.

Figure 10:Video playback function of the ISB.

https://www.youtube.com/watch?v=D1aRSeT-mQE

Reflecting on my renewed focus on the presentation function, a conversation with a critical friend prompted me to explore alternative functionalities of the ISB beyond presentation. However, this discussion also revealed that I had previously relied solely on the presentation function to showcase all the ISB's capabilities. Below is the discussion with critical friend.

Ms Lunga: *During your lesson today, I noticed you used PowerPoint presentations quite extensively. Yoou just used ppt to display a video. Why not douse the online function and play it from the internet? Could you explore utilising other features the smartboard offers, particularly for learners with diverse learning styles? You seem to rely heavily on visual elements like diagrams.*

My response: *I completely agree with exploring the full potential of smartboards. I'm always happy to incorporate more diverse affordances in future lessons. I pre-downloaded the video and inserted it on a ppt to avoid internet connectivity issues during the lesson. Also, catering to every individual learning style within a single lesson can be challenging. What I strive for is integrating elements encompassing various styles throughout the chapter itself. For instance, using a video today catered to both visual and auditory learners. Maybe if you can suggest different ways, I could integrate more affordances?*

Ms. Lunga: How about simulations, drag and dropping images, virtual-reality apps.

Reflection after discussion with critical friend

Reflecting on my past lesson designs, I recognized an overreliance on PowerPoint presentations as the primary teaching tool. While I did integrate other functionalities, PowerPoints often dominated my pedagogical approach. This likely stemmed from a desire to leverage visual *representations, considering Rau's (2017) emphasis on the importance of visual aids in STEM education, particularly for abstract scientific concepts. However, this reliance on PowerPoints warranted rethinking. The overreliance on presentation and display function risked mirroring traditional textbook-based instruction, neglecting the need to cater to diverse learning styles within a single lesson. Additionally, my aspiration to explore the interactive potential of ISBs was not fully realized by favoring a single affordance. Moving forward, I aimed to diversify my technology integration. This would involve deliberately incorporating resources that cater to various learning styles and engaging learners through the full spectrum of ISB functionalities. This shift promised to not only enrich the learning experience but also align with my commitment to exploring the pedagogical capabilities of this dynamic platform.*

e) Underlining and highlighting function

In my teaching approach, I utilised the underlining function to emphasize key points for learners. For example, when explaining the term *species*, I underlined the important terms that define a species, as shown in Figure 11 below. This underlining aimed to equip learners with the knowledge required to identify a species effectively.

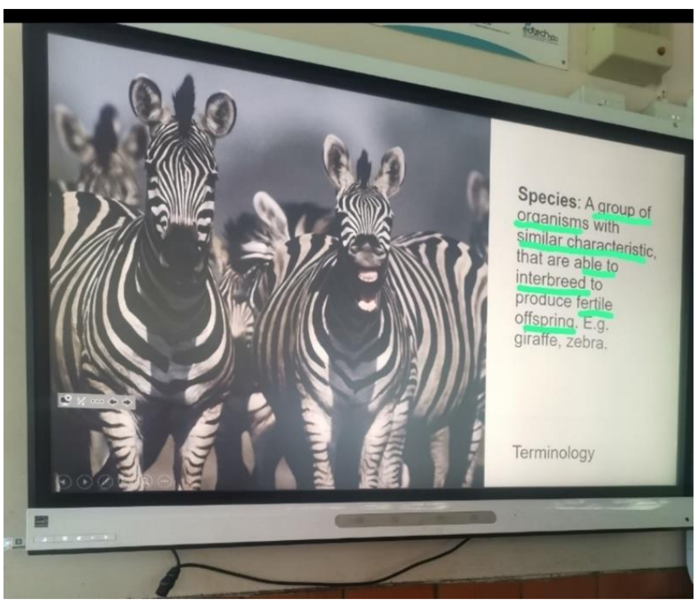


Figure 11:Underlining function of the ISB

While I initially attempted to incorporate the highlighting function during lessons, I encountered difficulties as I had to stop the slide show and then choose the highlighters. Therefore, I opted to utilise underlining as my primary method of emphasising key content. In the lesson slides, I had previously applied bolding to certain concepts, reflecting an augmentation level on the SAMR Model. Bolding text visually distinguishes it, drawing attention to important information intended for learner recall. Recognising that the slides for the first lesson were content-heavy, I deliberately chose to bold only the key points to direct learner focus. Figure 12 shows bolded text in a PowerPoint presentation.

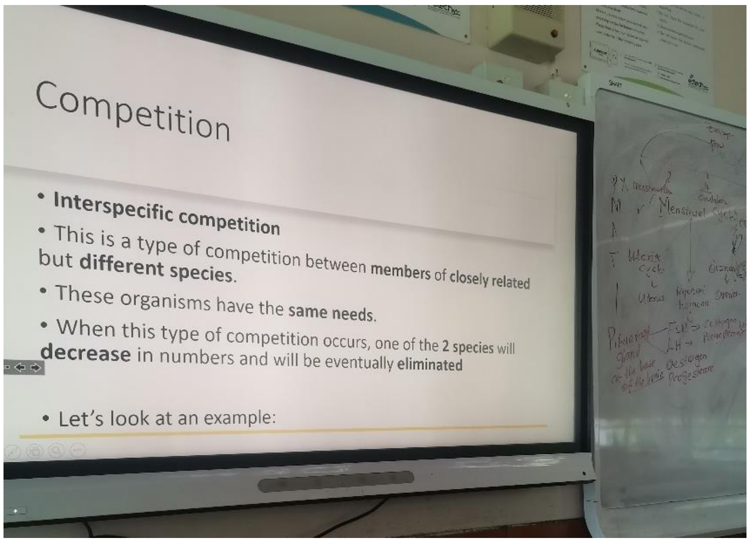


Figure 12: Bolded text in a PowerPoint presentation.

Nishimura & Kuwahara (2017) argued that underlining and highlighting key information can improve learning efficiency and overall learner engagement. This notion seemed to hold true in my experience. For instance, a learner inquired whether the term species I was using aligned with the definition they encountered in grade 10 studies of biomes and ecosystems. This question indicated that learners were making connections between the current material and their prior knowledge, suggesting an understanding of the concept. Traditionally, highlighting and underlining are employed on physical textbooks or printed materials, allowing learners to focus on important passages. However, these methods lack interactivity and collaboration opportunities. While the core task of identifying key information remains unchanged, the ISB augments the activity by introducing elements of interaction, collaboration, and potentially, greater engagement. Integrating the highlighting and underlining functions on the ISB directly is classified in the augmentation level within SAMR model. Augmenting the highlighting and underlining affordances were important in adding emphasis and visual cues to existing projected materials, consequently enhancing learner engagement and promoting a deeper understanding of key concepts.

f) Simulation function

Figure 13 below shows how the simulation function enabled the learners to directly manipulate variables like rabbit, shrub, and wolf populations within the simulation. This allowed them to observe the real-world consequences, such as an increased rabbit population leading to shrub depletion and the introduction of wolves causing a rise in rabbit predation and subsequent shrub regrowth.

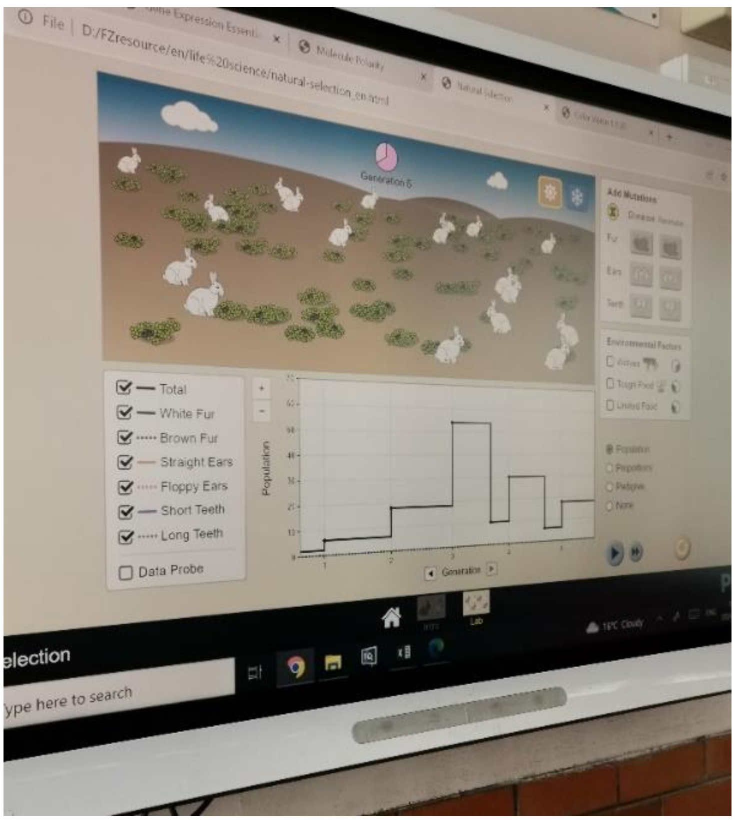


Figure 13: A simulation to show predator-prey relationships

This approach aligned with the established benefits of simulations in education. Research by Summers & Summers (1976) and Buckley and & Nerantzi (2020) which emphasized their affordability, adaptability, and effectiveness in promoting learners' engagement and understanding of complex concepts like population dynamics. While the simulation offered valuable interactive learning, a minor drawback existed - a five-minute loading time before learners could actively participate. Overall, this lesson exemplified the redefinition level of the SAMR model (Castro, 2018). This finding suggest that teachers must load the simulation before starting the lesson to avoid wasting any valuable lesson time. The simulation transcended simply presenting information; it empowered learners to actively explore and experiment with population ecology concepts through direct manipulation of variables and observation of dynamic consequences, thus this type of integration can be categorised as redefinition level of the SAMR model (Castro, 2018).

g) Writing function

The ISB's writing function significantly transformed the traditional act of writing on the board, exemplifying the modification level of the SAMR model as shown in Figure 14. This versatility within the IQ software is evident in various applications. In Figure 14A, myself and the learners directly wrote brainstorming ideas, fostering a collaborative environment and promoting active participation compared to a teacher-led approach. Figure 14B, learners could directly draw graphs to visually represent population dynamics. Figure 14C, the writing function facilitated active learner engagement in problem-solving activity.

A B C

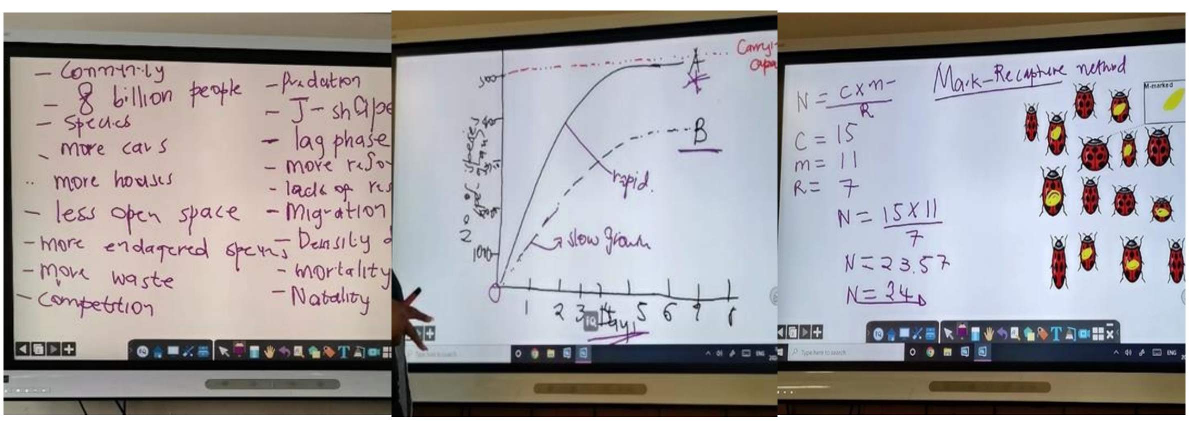


Figure 14: Incorporation of writing function

However, limitations were present. My handwriting could occasionally hinder learner participation, and the function was not ideal for intricate diagrams compared to dedicated drawing tools. Additionally, using a stylus was slower than a marker, potentially limiting information presented. Despite these drawbacks, the writing function effectively transformed traditional board writing by enabling new methods of learning and interaction. This shift aligns with the SAMR model's modification level as learners were actively contributing ideas for concept map creation and as they directly participated in solving problems. Therefore, the ISB's writing function, while not without limitations, demonstrably modified traditional classroom interactions and promoted a more engaging learning environment.

h) Stopwatch function

Seeking to evaluate both learners' understanding and the efficacy of my teaching strategy, I engaged learners in a five-question, multiple-choice quiz (activity) at the beginning of lesson 2. An initial five-question quiz (Figure 15) assessed prior knowledge, though concerns arose about learners rushing through answers.

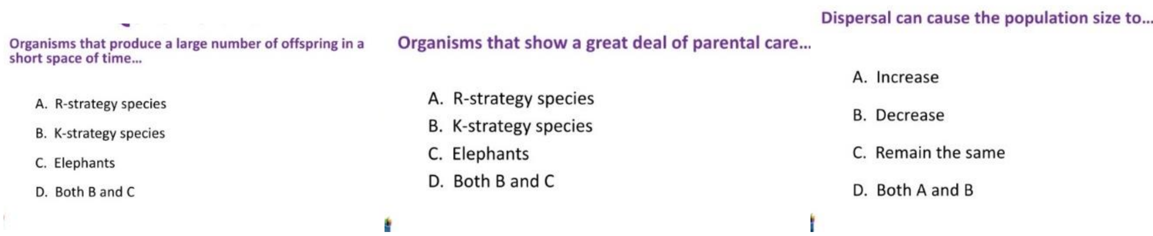


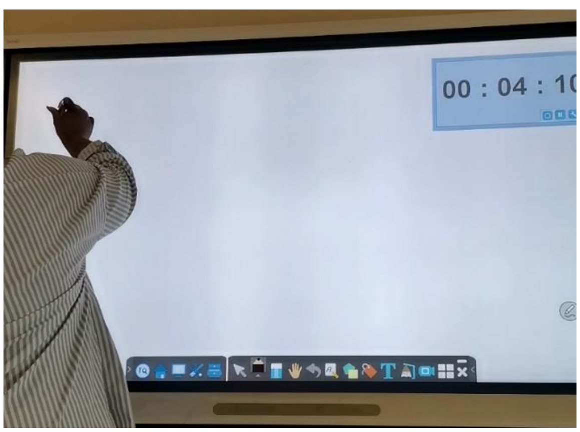
Figure 15 :An insert of the quiz to gauge prior learning.

The ISB's built-in stopwatch function was used. ISBs stopwatch ensured sufficient time for learners to gather their thoughts more comfortably during group activities like virtual lab simulations and Kahoot! games (shown in Figures 15 and 16). The analysis positioned the ISB's stopwatch function under the SAMR model's substitution level. ISB stopwatch replaced the traditional physical stopwatch with a digital counterpart within the ISB's environment.

Stopwatch counting down

Figure 16:Kahoot! used as an online platform

Although the stopwatch is present on the ISB, I had to use it as a background app due to it not being transferred to any other open tab. Figure 17 below shows an image of the stopwatch being used on the IQ interactive learning platform as a background of the ppt.



Stopwatch counting down

Figure 17: An insert of a stopwatch function added on the IQ interactive platform

In my experience, integrating a stopwatch function on the ISB offered the potential to significantly improve efficiency and convenience during time-sensitive activities. Previously, timed quizzes presented a challenge, as some learners struggled to answer quickly while others required more time for reflection. However, the ability to utilize a stopwatch within the ISB facilitated a well-paced learning environment, ensuring that all learners had sufficient time to engage with the questions and gathered their thought processes thus participated equitably. A discussion with a critical friend led to the realization that the quiz I had come up with was based on level 1 questions. Below is an insert of the discussion:

Ms. Zulu: *The observed eagerness during the quiz made me curious. Do you think the questions were well-structured and grade appropriate?*

My response: *Yes, the Level 1 quiz focused on previously covered material, which allowed for rapid responses for most questions. However, an interesting situation arose when a stopwatch function was implemented. This presented a valuable learning opportunity as learners engaged in collaborative discussions to critically analyze the options and come to a reasoned conclusion. This demonstrated the effectiveness of both recall and critical thinking skills, enhanced by their strong teamwork.*

Reflections after discussion with critical friend

In the past, I utilized a stopwatch to time learners during quizzes. While the quiz questions were designed at Level 1 of Bloom's Taxonomy, focusing on recall of facts and definitions, I anticipated that learners would find them relatively easy to answer. This expectation stemmed from their apparent understanding demonstrated in the previous lesson. However, upon reflection, I realized none of the questions required learners to apply their knowledge or analyze information. Moving forward, I acknowledge the need to increase the complexity of the quiz questions, particularly if my goal is to cultivate critical thinking skills in my learners.

i) Online function

The ISB offers the ability to use online platforms (Sen et al., 2014). An example of the online platforms used included the virtual biology laboratory application shown in Figure 18 below showing how mark and recapture methods work. Kahoot! game shown in Figure 16 above and the google interface shown in Figure 19 below are other online applications that I integrated in my lessons.

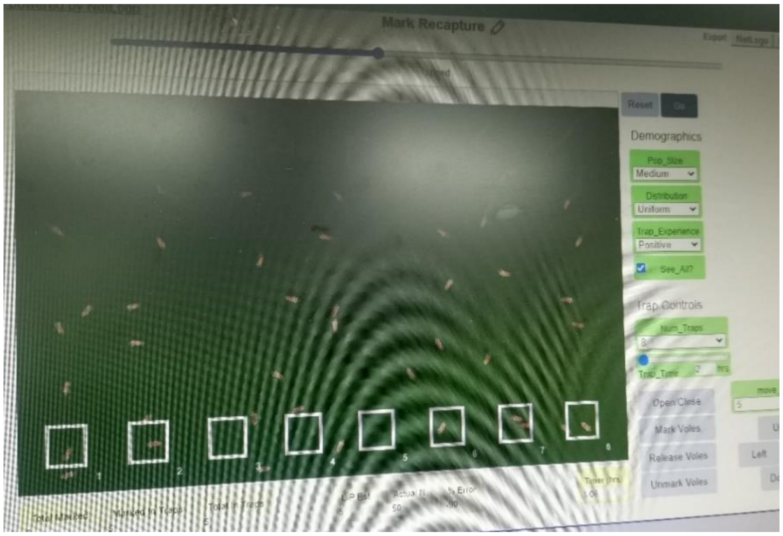


Figure 18:A virtual laboratory application showing mark recapture

The virtual lab activity using the ISB yielded mixed results. While some learners displayed disinterest and reluctance to participate actively, the majority actively engaged and even expressed interest in exploring the virtual lab further independently. This suggested the activity's visual representations effectively fostered participation, aligning with research by Ainsworth & Newton (2014) and Buckley & Nerantzi (2020).

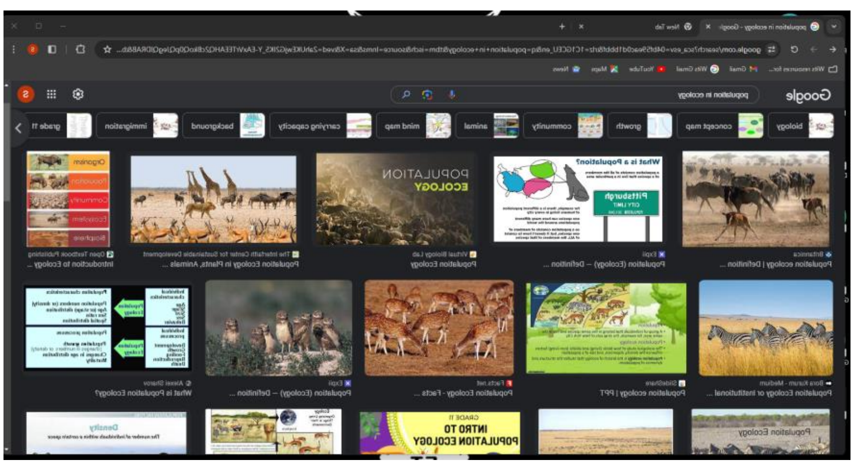


Figure 19: Evidence of the google interface used on the ISB.

However, integrating online platforms via the ISB presented challenges. Lesson 1 highlighted the time-consuming nature of using external resources like Google due to limited internet connectivity. The Google interface is shown in Figure 19 when the ISB was used to seek more relatable examples of a population. The reliance on a mobile phone hotspot hindered efficiency compared to the ISB's built-in functionalities, which operate faster without an internet connection. The analysis positions the virtual biology lab app under the augmentation level of the SAMR model. It allowed learners to manipulate variables beyond physical lab limitations, fostering learner interaction. Conversely, using Google primarily substitutes traditional resources and falls under the substitution level. While convenient, Google as an example of an online affordance does not fundamentally change how learners engage with the content. This experience underlines the potential of the ISB's built-in features for effective learning, while also highlighting the limitations of relying solely on external online resources with potentially unreliable internet connections.

5.3 Insights drawn from integrating the affordances of ISB when teaching

I drew three key insights from my teaching of population ecology integrating the affordances of the ISB. Firstly, knowledge of ICT tools empowers teachers to adapt their teaching to address unforeseen situations. Research by Umar et al., (2015) supports this notion, highlighting the positive correlation between teachers' ICT skills and their ability to create engaging lessons. My own experience exemplifies this. Despite lacking formal training, I was able to leverage the capabilities of ISBs in my classroom. This demonstrates that a proactive approach and a willingness to learn can be instrumental in overcoming the limitations of limited professional development opportunities. While research suggests a generally low level of ICT integration among teachers (Umar et al., 2015), advocating solely for self-learning might not be a sustainable solution. Therefore, a combined approach is recommended. Schools should prioritise providing adequate training opportunities for educators, while teachers should actively seek out resources and embrace self-directed learning to further enhance their ICT skills.

Secondly, recognising the potential applications of ISBs is crucial for successful integration. This knowledge can be acquired through various avenues, including self-directed exploration and collaboration with colleagues. By dedicating time to learn the functionalities of the ISB beforehand, I found seamless integration possible. Discussions with critical friends and research colleagues revealed the potential for integrating a wider range of ISB affordances within my lessons. This aligns with the emphasis Samaras et al., (2011) place on collaboration in self-study research. While I initially focused on the planning process itself, my understanding of self-study as a research methodology was incomplete. This became evident when I conducted the lessons without presenting the plans to critical friends beforehand. Consequently, I relied heavily on familiar ISB affordances, limiting the exploration of their full potential. Collaboration primarily occurred after lesson completion, but earlier engagement could have significantly enriched the study. As Hug et al., (2005) suggest, collaboration during the planning phase could have opened doors to a broader range of ISB functionalities. A more comprehensive perspective might have allowed me to integrate functionalities beyond my initial repertoire. The prompting questions raised by critical friends after lesson presentations further exemplified the value of collaborative exploration, as advocated by Samaras et al., (2011). Without ongoing collaboration, self-study research risks becoming an echo chamber, as Sun (2018) warns. In an echo chamber, existing beliefs are reinforced without exposure to diverse viewpoints, potentially leading to research blind spots. In conclusion, collaboration plays a crucial role in enhancing the richness and effectiveness of self-study research. Engaging with a diverse community of practice from the outset allows researchers to gain valuable insights, challenge blind spots, and ultimately improve the quality and impact of their self-studies.

Lastly, integrating ISB affordances offered both advantages and disadvantages. Integrating ISB functionalities was advantageous because it offered a diverse range of learning resources, including GDE content textbooks loaded directly onto the ISB, pre-installed simulations and real-time internet access. While using the ISB itself proved straightforward, achieving all levels of the SAMR model presented a challenge. While I aimed for the highest level which is redefinition, my findings did not align with existing research. Studies by Geer et al., (2017), McKnight et al., (2016), and Savignano (2017) reported that teachers primarily utilised the substitution and augmentation levels thus enhancing their existing practices. My observations mirrored this, with 44.4% of ISB integration categorized as enhancement and the remaining 55.6% demonstrating transformation. A summary of the SAMR model integration levels for ISB affordances is included in Appendix 5 for reference.

There were several limitations that hindered my experience with the ISB due to its reliance on external factors. Firstly, I encountered weak internet connectivity because I was using my devices as a hotspot for the ISB, the same is echoed by Salehi et al., (2012) in the study findings. This indicates that the school is not provided with a stable and reliable internet connection, making it difficult to utilize the ISB's full potential, which likely requires online resources. Secondly, unexpected power outages posed a significant challenge. Since the ISB presumably lacks an internal battery and requires a constant power source, any electricity disruption would render it unusable. This highlights the importance of the school having a backup power source, such as a generator, to ensure uninterrupted use of the ISB during outages in turn highlighting the importance of infrastructural changes for ISB integration (Chisango et al., 2021). Finally, outdated software on the ISB further restricted its functionality. I was unable to use other installed software like SMART Notebook, likely due to incompatibility with the ISB's operating system. This shows that the school does not have a proper system for maintaining and updating the software on the ISBs, limiting the available features and hindering my learning experience.

In conclusion, the exploration of integrating ISBs in teaching population ecology yielded valuable takeaways. Firstly, strong ICT competency empowers teachers to adapt to unforeseen circumstances. Secondly, understanding ISB functionalities beforehand is crucial for seamless integration. While the ISB offered a diverse range of resources achieving the highest level of the SAMR model proved challenging. My experience aligned with existing research where teachers primarily utilized the tool for enhancement and substitution. My observations mirrored this, with the majority of ISB usage categorized as enhancing existing practices. Addressing infrastructural issues through a stable internet connection, backup power supply, and proper software maintenance is crucial for a more effective integration of affordances of the ISB.

Chapter 6: Conclusions, recommendations, limitations and implications of the study

6.1 Introduction

Starting with the summary of the study, in this chapter I addressed the research questions that emerged from my interest in learning to integrate the interactive smartboard (ISB) effectively while teaching population ecology to grade 11 Life Sciences learners. Structured into three sections, the chapter provides answers to each research question. Section one focuses on the first research question, section two addresses the second research question and section three explores the answer to the third research question. I presented personal reflections on my experiences of using SAMR model as well as reflections on the methodology of a self-study. Beyond the research questions and reflections, I presented the implications, limitations of the study and potential avenues for future research. Lastly, I concluded the study.

6.2 Summary of the study

The purpose of this self-study was to learn how to integrate the affordances of ISBs when teaching population ecology to Grade 11 Life Sciences learners. My concern when I began this study was how I could learn the affordances offered by the ISB and how I could use these affordances to teach population ecology to grade 11 Life Sciences learners. The study was designed to address the following main research question: How could I integrate the affordances of interactive smartboards in my teaching of population ecology to Grade 11 L.S. learners? To further refine and guide the investigation, the following sub-research questions were also considered:

1. What affordances of the interactive smartboard can I integrate in the teaching of population ecology to grade 11 learners?

2. How do I integrate the identified affordances of interactive smartboards when teaching the topic of population ecology in grade 11 L.S.?

3. What are the challenges (if any) of integrating the affordances of interactive smartboards in my teaching of population ecology?

6.2.1 Affordances of the interactive smartboard I can integrate in the teaching of population ecology

In this section, I present the affordances of the ISBs that I integrated in the teaching of population ecology. Table 5 below presents the affordances that I integrated in all 8 lessons.

Table 5: Integrated ISB Affordances in Population Ecology Lessons

Integrated ISB affordances	**Frequency of integrated affordance**	**Brief explanation of how the affordance was integrated**
Touch	All lessons	ISB are touch sensitive. This allowed me to open applications, select and manipulate objects, zoom, and scroll, necessitated the use of a finger/stylus on the touch screen.
Presentation and display	All lessons	This allowed me to present and display population ecology content that learners could see thus eliminating the abstractness of the content. This brings population ecology concepts to life and learners were able to label diagrams.
Stopwatch	3 lessons	This was used when collaborative activities were done to allow learners to think comfortably before sharing their answers.
Writing	All lessons	Writing was used in all lessons as a way to provide clarity and further explanations of the concepts. I was able to draw population growth curves and annotate every displayed content
Online platforms	4 lessons	I used the online platforms to assess interactive simulations, virtual laboratories where learners were able actively manipulate

		variables therefore directly interacting with the content.
Annotation	All lessons	Annotating allowed me to draw, write, and highlight directly on what was displayed on the ISB, allowing for interactivity during the lesson.
Video playback	2 lessons	This allowed for engaging learners and bringing population ecology concepts to life, removing abstract nature of the topic. For instance, I used it to explain predator-prey relationships and population fluctuations. I was also able to pause at key moments and explained those key concepts.
Underlining and highlighting	2 lessons	This function allowed me to emphasise the key terms in population ecology to help learners focus their attention on specific concepts

Table 5 presents the ISB affordances I integrated into my population ecology lessons. It's important to note that this list is not exhaustive, as I continuously explore further functionalities.

6.2.2 How do I integrate the identified affordances of interactive smartboards when teaching the topic of population ecology in grade 11 L.S.?

This section details how the functionalities highlighted in Table 5 were utilized to teach population ecology lessons depending on the lesson objectives. To assessing prior knowledge, the presentation and display function facilitated a 4-option quiz, gauging learners' understanding before teaching new information. To introduce interactions in the environment, a video introduced the topic, followed by annotations using the annotation and writing function to emphasise key points. To further explain and emphasise certain concepts, annotations were made directly on the presented information. Additionally, underlining and highlighting functions emphasised crucial concepts. To encourage interactivity and diverse learning styles, simulations and online platforms like the virtual biology lab increased engagement, catering to kinesthetic learners. Videos with annotations and the writing function provided opportunities for visual, auditory, and kinesthetic learners to brainstorm for concept maps. To encouraging reflection among learners, the stopwatch function provided a timed space for learners to gather their thoughts before participating in discussions. To explain limiting factors and carrying capacity, the IQ interactive learning platform's writing and drawing functions facilitated the exploration of these concepts. Lastly, to summarise and conclude the topic, online functions like the game-based activity Kahoot! offered an interactive way to summarize and conclude lessons. Deducing from the results, they show that I am still not yet advanced in the integration of the affordances of the ISB. Given that most of the integrations I made either involved substitution or augmentation of the affordance thus contributing to the enhancement of my teaching practice, although some attempts of modification and redefinition were also made. These results reveals that I still need to develop a better mastery of integrating the affordance of ISB in such as that will bring about transformation in my pedagogy.

6.2.3 The challenges of integrating the affordances of interactive smartboards in my teaching of population ecology

I encountered three factors that challenged the integration of the affordances of ISBS in my teaching of population ecology. These are a weak internet connectivity, which is also presented as a challenge as echoed by Salehi et al. (2012), this posed a challenge, necessitating the use of a personal mobile hotspot to maintain connectivity something that as teachers cannot always afford to do. Outdated software on the IQ interactive learning platform prevented its integration due to a lack of technical support within the school. Despite reporting the issue to the GDE ICT department five months' prior, no resolution was provided. Loadshedding and unexpected power outage forced a shift to traditional whiteboard and marker methods, limiting the intended ISB functionalities. The same is echoed by Chisango et al., (2021) on the infrastructural limitations that hinder ICT integration in educational settings. These challenges highlight the importance of addressing infrastructure and resource limitations when implementing ICT integration initiatives in schools. Reliable technical support, consistent electricity access, and robust internet connectivity are crucial for educators to fully leverage the potential of technology in the classroom.

6.3 Reflections on the experiences of the SAMR model

The SAMR model proved valuable in analysing the integration of ISB affordances while teaching population ecology. This framework categorizes technology integration based on its level of transformation beyond simply replacing existing practices. The model encouraged me to progress beyond the initial levels and explore more engaging activities that significantly impacted learning. For instance, using annotations and simulations on the ISB actively involved learners with the presented content, fostering higher participation compared to passive lessons. However, implementing higher SAMR levels like utilising the virtual biology lab demanded more extensive planning and time investment. This highlights that the SAMR level achieved depends heavily on how the ISB affordance is utilized. Simply incorporating simulations might not automatically translate to the modification or redefinition level.

The SAMR model provided a valuable lens to assess the effectiveness of integrating ISB functionalities. While it encouraged venturing beyond basic levels and fostering deeper learning, practical limitations like time constraints came into play. Therefore, effectively utilising the SAMR model requires careful consideration of both the chosen affordance and the depth of its application to truly transform the learning experience.

6.4 Reflections on the methodology of a self-study

6.4.1 Focusing on self-reflection

As highlighted by Samaras (2011), self-study offers a unique opportunity for systematic and critical reflection. Teachers can explore deeper into their practice, scrutinising both their actions and the contextual factors influencing them. A thorough understanding of self-study methodology is crucial before embarking on the journey. Effective self-study requires heightened self-awareness. Teachers must be constantly mindful of everything transpiring within the classroom environment, including evaluating the impact of implemented strategies on achieving desired learning objectives, and critically reflecting on one's own choices and instructional methods. While meticulous lesson planning is essential, the ability to adapt is crucial. Flexibility allows teachers to modify plans when initial approaches don't effectively address learning objectives.

6.4.2 The challenges of doing a self-study

This reflection explores my unexpected journey into self-study methodology. Initially, I envisioned a different research approach. However, unforeseen circumstances necessitated a shift, leading me to explore the realm of self-study. While I opted for a self-study approach in the end, embarking on this path presented significant challenges. Limited knowledge within my research community regarding self-study methodology meant I primarily relied on my supervisor's guidance and the available literature. A pivotal moment occurred when I expressed my concerns about the research direction to Prof. Nyamupangedengu. Her enthusiastic response, along with the introduction to Samaras' et al., (2011) article, proved to be a turning point. Samaras' et al., (2011) article served as a crucial resource, providing a clear understanding of the nature and expectations associated with self-study research. This newfound knowledge significantly aided me in grasping the theoretical framework and methodological approaches involved in conducting a successful self-study. However, despite the initial challenge, access to relevant resources and supportive guidance proved instrumental in navigating the unfamiliar territory of self-study methodology.

My recent experience with a self-study for my Honors degree highlighted the crucial role of a critical friend. Secondly, the lack of a dedicated critical friend proved to be a significant obstacle. Initially, I sought the assistance of colleagues at work, hoping they would critically analyze my lesson plans and suggest areas for improvement. However, their consistent agreement with my proposed approaches raised concerns. This outcome was concerning as it suggested a potential lack of constructive criticism, an essential element for effective self-study. Without a critical perspective at the beginning of the study, the opportunity to identify blind spots and refine my research methods was significantly diminished. Fortunately, I eventually secured the support of research colleagues who agreed to be critical friends on top of my supervisors. However, this collaboration came at a later stage in the process. Having already implemented the lesson plans, critical friends relied on the implemented lesson plans as well as my journal entries.

6.5 Implications of the study

One of the insights drawn from lesson planning is that learning to integrate affordances of the ISB when teaching population ecology requires training and time. If teachers were to train themselves like I did in this study, then there would be an increase in teacher development as well as pedagogy. Teachers will likely improve their ICT skills thus enhancing their personal development and pedagogy. With the use of the affordances of the ISB teachers would be able to design activities that are interactive thus increasing learner engagement and changing the myth that population ecology is boring. In terms of learning and assessment in Life Sciences, teachers will develop a deeper understanding of population ecology from integrating the affordances of the ISB. With the ISB affordances in place, teachers are also likely to explore alternative assessment methods, rather than the traditional way of assessing learners. In conclusion, this study highlights the potential of utilizing ISBs effectively in Life Sciences. By investing in teacher training and fostering a culture of exploration with technology, teachers can create a more engaging and enriching learning experience for learners, while simultaneously furthering their own development and pedagogical skills.

6.6 Limitations of this study

While I involved four critical friends, including my supervisors, for feedback, scheduling conflicts limited in-person classroom observations. Consequently, only one critical friend could observe a lesson directly. The remaining friends relied on video recordings, lesson plans, and journal entries to provide feedback, which can be less comprehensive than witnessing the classroom dynamics firsthand. The inherent subjectivity of self-study research presented a challenge in ensuring the credibility and reliability of my findings. Having a limited number of critical friends further restricted the opportunity to gather diverse perspectives and identify potential biases in my research design and implementation. Securing critical friends solely during lesson implementation presented a significant time constraint. This limited their ability to thoroughly analyse my lesson plans and suggest additional affordances that could have been integrated for a richer learning experience. Since this self-study focused on acquiring the skills to integrate ISB functionalities, my knowledge regarding effective integration stemmed primarily from applying these affordances within the specific context of teaching population ecology. This limited the opportunity to explore the broader applications of ISBs across diverse subject areas.

6.7 Recommendations for future research

This study explored using ISBs to teach population ecology to grade 11 Life Sciences learners. While self-studies offer valuable insights, their inherent subjectivity can be mitigated by incorporating a larger group of critical friends (more than four) in future research. One aspect not fully addressed in this study was definitively gauging learner comprehension through ISB integration. Future research should aim to bridge this gap by specifically examining the impact of ISBs integration on learner understanding. The findings highlight the need for subject-specific training on ISB functionalities. Instead of focusing solely on general integration techniques, future training should equip teachers with the knowledge to effectively utilise ISBs within their specific disciplines (e.g., Life Sciences). This targeted approach empowers teachers to explore resources specific to their subject area and tailor their teaching strategies to maximize the learning potential of ISBs. Therefore, Life Sciences teachers are encouraged to actively seek out professional development opportunities, such as workshops, online courses, or online communities focused on technology integration in education. This continuous learning will equip them with the necessary skills to leverage ISBs effectively in their classrooms.

The key findings of this study revealed the importance of critical friends in one's development and better implementation of the affordances of ISBs. For example, through the discussions I had with my critical friends, they always challenged me to explore other affordances that are offered by the ISBs. Thus, this study therefore encourages other teacher like me who teach in smart classrooms to form collaborative clubs (with teacher in the same school or other schools) where they can share best practices of using the ISBs, as means of strengthen their ICT integration endeavors. Especially taking to consideration that the workshops and/or trainings provided by the department are often not targeted or advanced and mainly focused on developing basic ICT competencies such as composing of emails as explained in Chapter 1.

Also, these findings of this study revealed several challenges that hinder the integration of ISB in smart schools. Therefore, to strengthen the effective use of ISBs and other ICTSs in T&L, the study recommends especially quantile 5 schools and department to work together in highlight the importance of addressing infrastructure and other resource related issues such as airtime, electricity generators or any other form of back, internet connectivity and many other limitations. For instance, my school since it is a quantile 5, can allocate budget strictly for installing reliable connection around the school or alternatively subsidise teachers who use smart classes with data. Also, the school should invest in alternative forms of electric backup gadgets or again buy small back up sources for smart classes. All these initiatives can help us as teacher using these smart classes to fully harness of power of ISBs in our teaching practices. On the other hand, the department must support teacher with smart classrooms in providing them with designated technical support agents, who will also update the software and provide further training for teacher on how to use these updates in their lessons.

6.8 Conclusion

This self-study explored the process of learning to integrate Interactive Smartboard (ISB) affordances when teaching population ecology to Grade 11 Life Sciences learners. Key findings suggest that effective ISB integration hinges on several crucial aspects; discussions with critical friends and engaging with a community of practice during the planning phase allowed for incorporating diverse perspectives and refining teaching approaches. Collaboration with critical friends provided valuable feedback on pedagogical reasoning and actions, facilitating continuous improvement. Developing a strong foundation in ICT proved essential for effectively utilizing the various affordances offered by the ISB. These findings imply that while teacher training is beneficial, self-directed learning, as demonstrated in this study, can be a viable approach for acquiring the necessary skills to integrate ISBs effectively. This integration has the potential to by fostering deeper engagement and exploration of population ecology concepts through interactive activities, equipping teachers with a wider range of pedagogical tools to deliver engaging and effective lessons.

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6.10 Appendices

Appendix 1: Lesson plans

<u>Lesson 1: Introduction to key concepts</u>

<u>Duration: 45 minutes</u>

Lesson objectives:

The learner must be able to:

- Define what a population is
- Understand what the characteristics of a population are
- Identify the factors that determine the size of a population and how these may affect changes in the size of the population over some time
- Manipulate data using formulae that illustrate how population parameters affect population size

TEACHER ACTIVITIES	LEARNER ACTIVITIES	TIMING	RESOURCES NEEDED
1.1 Introduction Pre–knowledge: The concept of ecosystems, habitat, species, and energy flow within ecosystems (Grade 10) Use the interactive smartboard and emphasise the following points with the learners using the presentation and display affordance: • How communities are made up of populations and populations are made up of organisms of the same species • Have a class discussion with the learners on energy flow within the ecosystem and discuss producers, consumers (herbivores, carnivores), and decomposers. Through a class discussion, I listen to and consider learners' different viewpoints of what they know about energy flow within an ecosystem. • Discuss food chains and food webs, emphasizing the interaction of organisms. Discussing these food chains breaks the monotony of traditional teaching and provides learners with an opportunity to actively participate in their learning. Learners will be giving examples of food chains and food webs through discussions. • All ecosystems contain populations of organisms that interact with other organisms, the environment, and each other • Each ecosystem consists of producers, consumers (herbivores, carnivores) and decomposers • Many food chains make up food webs in ecosystems and each level is dependent on the next	1. Class discussion: concerning the concepts of ecosystems and their components and energy flow within the ecosystem	15 min	Pictures of an ecosystem such as a wetland or savanna from the Internet, a poster or photograph • Diagram of a food web from the Internet or Understanding Life Sciences Gr.11
2.2 Main Body (Lesson presentation) • The following must be emphasise by use of the interactive smartboard and class discussion: • Population ecology is the study of populations and how factors may affect the size and composition of these populations • The definition of a population is the total number of individuals of the same species that occupy a specific area and that can interbreed or reproduce with each other. •Have learners give several examples of populations E.g. flamingos in a dam, kudu in a nature reserve, acacia trees in the Kruger park • Characteristics of populations apply to the group of organisms but not to the individuals within the population • These include: density (the number of individuals per unit area or volume); sex ratios (ratio of males to females in the population) and distribution patterns (random, clumped, or uniform) • Population parameters are factors that determine the size of a population and the changes that occur to the size of the population over time • These are death rate (mortality), birth rate (natality), immigration (individuals moving into the population from somewhere else), and emigration (individuals moving out of the population to go somewhere else)		15 min	
• Stress to the learners that the parameters are reflecting rates of change and there will always be a period associated with parameters • Parameters may cause the population to get smaller (if mortality and emigration are greater than natality and immigration), to get larger (if mortality and emigration are less than natality and immigration), or to stay the same (if mortality and emigration are equal to natality and immigration) • Have learners complete the activity on population parameters **2.3 Conclusion** • Summarise the lesson. It may be necessary to restate the important concepts • Give learners assistance with calculations involved in the activity as needed • Activity may be completed as homework	2. Learners complete classroom activity on population parameters	10 min 5 min	Class Work: Solutions for all: Life Sciences Gr. 11-Activity 1

Lessons 2 and 3: Estimating Population Size – Direct and indirect methods

Duration: 90 minutes

The learner must be able to:

- Describe several ways to determine the size of a population
- Understand that a direct count may not be possible for all populations when determining the size of a population
- Describe the procedure for conducting a quadrant sample of an area to estimate a population's size
- Discuss the procedure for conducting a mark-recapture sample for estimating a population's size
- Perform calculations for both the quadrant method and mark-recapture method for estimating population size
- Discuss the limitations of sampling populations using the quadrant and mark-recapture method

Teacher activities	Learner activities	Timing	Resources needed
1.1 Introduction • Pre–knowledge: The concept of populations (Grade 10)- Recap using a quiz presented and displayed using ISB ~~(see Fig. 4)~~ as a quick and efficient way to gauge the previous lesson's learning outcomes and assess the effectiveness of my teaching strategy. A quiz will also help identify areas that I still need to revisit before I add more information. • The smartboard will allow me to display the quiz and annotate on the board should there be a need to emphasise a certain concept ~~(see Fig. 5)~~. Emphasise ~~Highlight~~ the following points with the learners using a smartboard:		15 min	• Interactive smartboard • Quiz questions
• Population size may change because of the parameters discussed last lesson (natality, mortality, immigration, emigration) • To manage populations and predict how to best budget for services for human populations, numbers of organisms must be counted in populations • There are various ways to estimate population size. **2.2 Main Body (Lesson presentation)** • The following must be highlighted by use of the annotation and writing function of ISB (IQ interactive) : • The size of a population refers to the actual number of individuals making up the population • The most direct way to determine a population's size is to do a direct count where all individuals are counted E.g., a census of the human population • Large plants in small areas or large vertebrates such as elephants can be counted by direct methods • Smaller, more mobile organisms are harder to count by a direct means and a sample of the population must then be counted		30 min	

• An example of how to determine the population size using the quadrant method is as follows: • A frame measuring 0,5 m long would be used to measure the population of an organism in a $0,25m^2$ area • All organisms would be counted in this area E.g., beetles • If 5 individuals were counted in the quadrant then in 1 m^2 there would be 4 x 5 = 20 beetles. If the total area being sampled was 1000 m^2 then there would be an estimate of (20 x 1000) 20 000 beetles in this population • Population size of plants and invertebrates may be estimated in this way • Population size of small, mobile organisms may be estimated by the indirect technique of mark-release. • A large number of animals are captured in an area, marked, and then released to mix with the unmarked animals of the population • A second large sample of animals is captured in the same area and the number of marked animals in the sample is recorded • The population size may then be estimated using the following formula: P = M x S T (P = estimated population number, M = total animals marked in first			

sample, S = total animals caught in the second sample, and T = total number of animals marked in the second sample) • An example would be estimating a population of fish in a dam. • If 106 fish were caught in a net and marked by clipping off a small section of its tail fin, then they were released. (M = 106) • A few days later we caught a second sample of 180 fish. (S = 180) • 47 of the 180 had a notch in the tail fin. (T = 47) • The population size would be estimated to be: P = (106 x 180)/47 = 406 • Have learners complete the activity on estimating population size **<u>2.3 Conclusion</u>** • Refer to the annotations and summarise the lesson. It may be necessary to restate the important concepts. • Give learners assistance with calculations involved in the activity as needed • Activity to be completed	1. Learners complete classroom activity on estimating population size	10 min 35 min	Class Work: Understanding Life Sciences: Gr. 11- Activity 1

Lesson 4: Estimating Population Size – Mark – Recapture method
Practical Activity
Duration: 45 min
Lesson objectives:

The learners must be able to:

• Work together in a group
• Follow instructions
• Estimate a population size by using information gathered and applying it by using the formula given
• Answer questions related to results gathered during practical activity

Teacher activities	Learner activities	Timing	Resources
1.1 Introduction • Pre – knowledge: • Use the smartboard and annotate/write the following points with the learners: • Remind learners that the mark–recapture method of estimating population size is used for animals that tend to move around and in areas that are large in size using the saved IQ interactive platform from previous lesson • The samples should be taken randomly and animals should be given enough time to mix back into the population. • Marks used for identifying the animals captured should not harm the animal or change its behaviour		10 min	**Reference for practical activity**: Virtual biology laboratory (online function) Interactive smartboard
2.2 Main Body (Lesson presentation) • Divide the learners into groups (not more than 6 per group) • Ask the learners to copy down the table (at the end of the lesson plan) for recording their observations NB: Remember to time the learners using a stopwatch function for everyone to be able to participate. • Give learners the following instructions for estimating the size of the population (estimating how many rats are in the cage) • Follow the link to the virtual biology laboratory provided. • Follow the instructions on the directions indicated on the Mark/Recapture Directions handout • Using the following formula M x S to estimate the number rats in the cage • Record your answer under the column labelled P • Repeat the sampling process 6 to 10 times as time allows • After you have completed the sampling process take an average of your population estimates by leaving out your smallest estimate and your largest estimate and dividing by the number of samples you have • E.g. If you have taken 8 samples and thrown out the largest and smallest values in column P, add the 6 numbers you are left with together and divide by 6. This is your population estimate. • Learners should use the table provided to start a SMART Notebook Spreadsheet so they can record their results.	1. Group work: Estimate the number rats in the cage by following the instructions indicated on the Mark/Recapture Directions pdf	25 min	https://virtualbiologylab.org/population-ecology/
2.3 Conclusion • Remind learners of the reason for estimating population size using the mark-recapture method • Give learners informal assessment (give questions based on the results of the estimated number of beans in the jar that the learners have calculated)	2. Each group must record the values from their samples in the appropriate columns in the table provided on the SMART notebook spreadsheet and complete the calculations using the formula Homework: 3. Learner's answer questions based on calculations and estimates arrived at	5 min 5 min	Homework: Understanding Life Sciences: Activity: 1 and 2

Table to use for recording

Lesson 5: Limiting Factors and Carrying Capacity
Duration: 45 minutes
Lesson objectives:

The learners must be able to:

• Discuss how environmental factors limit birth and death rates in a population
• Describe the factors that affect population sizes
• Understand the difference between density-independent and density-dependent factors
• Explain the concept of a carrying capacity in an ecosystem and how the carrying capacity affects the growth and stability of populations
• Complete an activity concerning the control of elephant populations

Teacher activities	Learner activities	Timing	Resources needed
1.1 Introduction • Pre-knowledge: Quiz questions are used to recap the lesson. • Use the smartboard and highlight the following points with the learners: • Re-emphasize the concept of population density (number of individuals per unit area or volume) • Go through the parameters of natality (birth rate), mortality (death rate), immigration and emigration • Make sure that learners understand that the parameters of population size can determine population size over periods	Quiz questions	10 min	Interactive smartboard (Presentation and display function)
2.2 Main Body (Lesson presentation) The following must be emphasised by use of the smartboard and class discussion: Ask these questions in a dialogue-driven Socratic discussion method displaying the questions using ISB: • What is the meaning of the term population? • Can organisms' population size increase continuously? • What resources are essential for species survival? • What factors could cause a population to decline even if resources are abundant? • What are the potential consequences of exceeding population carrying capacity? • What can be done to manage human populations and resource sustainability? From the responses learners give, emphasise this content: • If resources are plentiful, then the parameters of natality, mortality, immigration, and emigration will determine the growth of a population • Limiting factors in the environment may lower the birth rate or increase the death rate and include density-independent and density-dependent factors • As populations increase in size, density is higher • The more crowded the population, the more likely interactions between the organisms of the population may include factors such as disease, competition, predation, and territoriality • These factors are known as density-dependent factors and tend to reduce the population size when densities are high and help increase the population when density is low. • Over long periods, they can also help keep the population density steady • Density-dependent factors include: the effect of disease and predation, competition for food, space, and breeding partners, and build-up of waste products • Factors that affect all populations whether they are large or small are said to be density independent factors • These factors usually cause a sudden reduction in population size • Examples of these factors include floods and drought, fires, volcanic eruptions and earthquakes, or the effects of pollutants in the environment • As long as the limiting factor is density-independent, the population will recover (as long as the habitat has not been permanently damaged) • The carrying capacity of an ecosystem determines the maximum number of individuals of a population that the ecosystem can support • It is linked to the availability of resources • As a population grows and approaches the carrying capacity, the combined effect of all the limiting factors (environmental resistance) will cause the birth rate or immigration rate to decrease and the death rate or emigration rate to increase.	Classwork: Ask two learners in the classroom (one from the left side and one from the right side) to research elephant population control using the smartboard. This research will be presented to the class on the following lesson. Whilst these two learners are preparing	15 min 10 min	Interactive smartboard Simulation activity (Use ISB to simulate carrying capacity and limiting factors)

• Can organisms' population size increase continuously? • What resources are essential for species survival? • What factors could cause a population to decline even if resources are abundant? • What are the potential consequences of exceeding population carrying capacity? • What can be done to manage human populations and resource sustainability? From the responses learners give, emphasise this content: • If resources are plentiful, then the parameters of natality, mortality, immigration, and emigration will determine the growth of a population • Limiting factors in the environment may lower the birth rate or increase the death rate and include density-independent and density-dependent factors • As populations increase in size, density is higher • The more crowded the population, the more likely interactions between the organisms of the population may include factors such as disease, competition, predation, and territoriality • These factors are known as density-dependent factors and tend to reduce the population size when densities are high and help increase the population when density is low. • Over long periods, they can also help keep the population density steady • Density-dependent factors include: the effect of disease and predation, competition for food, space, and breeding partners, and build-up of waste products • Factors that affect all populations whether they are large or small are said to be density independent factors • These factors usually cause a sudden reduction in population size • Examples of these factors include floods and drought, fires, volcanic eruptions and earthquakes, or the effects of pollutants in the environment • As long as the limiting factor is density-independent, the population will recover (as long as the habitat has not been permanently damaged) • The carrying capacity of an ecosystem determines the maximum number of individuals of a population that the ecosystem can support • It is linked to the availability of resources • As a population grows and approaches the carrying capacity, the combined effect of all the limiting factors (environmental resistance) will cause the birth rate or immigration rate to decrease and the death rate or emigration rate to increase.	Classwork: Ask two learners in the classroom (one from the left side and one from the right side) to research elephant population control using the smartboard. This research will be presented to the class on the following lesson. Whilst these two learners are preparing	10 min	Simulation activity (Use ISB to simulate carrying capacity and limiting factors)

Lesson 6: Interactions in the Environment: Predator –Prey relationships

Duration: 45 minutes

Lesson objectives:

Teacher activities	Learner activities	Timing	Resources needed
1.1 Introduction • Pre- knowledge: Definition of a community, structure of food chains (from Grade 10) Highlight the following points with the learners: • Review the concepts of community and how populations interact with each other • Review where carnivores fit into a food chain • Predator – prey relationships may be considered to be density-dependent since prey represent a food source in the ecosystem for the predator		10 min	Video playback function Competition, Predation, and Symbiosis | Biology | Ecology (youtube.com)
2.2 **Main Body (Lesson presentation)** The following must be highlighted by use of whiteboard: • Interactions in a community can be harmful or helpful to individuals or have no effect • The interactions in a community may affect population growth • There are three main categories of interactions: feeding relationships, competition and symbiosis • Food chains show feeding relationships between organisms where plants are eaten by herbivores, who are then eaten by carnivores • Carnivores usually hunt and kill their prey (known as predation) • Predators are therefore animals that kill other organisms (prey) for food • Predators must be adapted to catching and killing their prey • For example most predators will have sharp teeth and claws to catch and kill prey, whereas the prey will have good eyesight and a keen sense of smell to avoid the predator with • The feeding relationships between the predator and the prey determines the size of the two populations, and therefore the two populations can be said to regulate each other in size and may lead to fluctuations • Examples of predator- prey relationships in South African ecosystems are fish eagles preying on fish, the secretary bird eating a snake or the leopard eating an impala • When predators hunt and kill their prey, they decrease the size of the prey population • When the size of the prey population is reduced, the predator population will also decrease • With a decrease in the food supply, some of the predators will die of starvation or emigrate, which causes a decrease in the predator population • As the predators become fewer in numbers, the prey population is able to increase and the predator population then may increase because of the availability of food		20 min	Reference: Predator - prey graphs: Understanding Life Science Gr. 11 (Simulation)

• This starts the cycle of population growth again for the predators • This pattern continues in regular cycles, maintaining a balance between the two species • Learners must be able to explain the fluctuations illustrated in a graph showing the interaction between the predator and prey population • Have learners do the activities from the text book to reinforce the principles behind predator-prey relationships **NB**. Play the video again after explaining and annotating key points Play a video showing competition to introduce the following lesson. https://www.youtube.com/watch?v=v7p6VZiRInQ			Introductory video
2.3 Conclusion • Summarise the lesson. It may be necessary to restate the important concepts • Give learners assistance with the activity as necessary • The activities may be used as an informal assessment **NB**: Remember to ask learners to bring their cell phones to class tomorrow as the Kahoots program will be used to recap.	1. Learners do textbook activities in their notebooks	10 min	Classwork: Understanding Life Sciences Gr. 11 Activity 5

Lesson 7 and 8: Interactions in the Environment: Competition- Inter and Intra-specific.

Duration: 90 minutes

Lesson Objectives:

The learners must be able to:

• Understand that limited resources in the ecosystem create competition between organisms

• Describe how species and individuals occupying similar ecological niches compete for resources

• Explain the concepts of inter-specific and intra-specific competition

• Discuss the different types of inter-specific and intra-specific completion for resources in the environment

• Understand how inter-specific and intra-specific competition affects populations

Teacher activities	Learner activities	Timing	Resources needed
1.1 Introduction • Pre-knowledge: Using the Kahoot program recap what the learners have learnt. The passcode is provided to the learners. **NB** Start the lesson by playing yesterday's video on predation. Highlight the following points with the learners:		25 min 5 min	**Kahoot game** Learners cell phones (at least one cell phone per group) **YouTube video on predation** https://www.youtube.com/watch?v=v7p6VZiRInQ

• Review predator-prey relationships emphasizing that prey represents a food source in the ecosystem for the predator • Review the concept of logistic growth patterns within populations and how carrying capacity will determine the maximum size a population will reach • Discuss how the carrying capacity of the environment organisms find themselves in is related to the resources such as food, space and mates that are available to the organisms **2.2Main Body (Lesson presentation)** . Ask learners to sit in groups (of not more than 6 each). They need to be able to discuss their answer before answering. • Use the smartboard simulation from the previous lesson and present it as showing the predator-prey relationship. • Play a video from YouTube with the link provided below: Competition in ecosystems (youtube.com) The following must be highlighted by use of the smartboard and class discussion after the simulation and video: • Organisms compete for limited resources so that they can survive • Plants compete for light, space, water and minerals and animals compete for food, space, shelter, mates and water • The functional role and position of a species and the resources it uses within a community or ecosystem is known as its ecological niche • This determines where an organism lives and how it interacts with other members of the community • The greater the similarity between the ecological niches of two organisms or species, the greater the competition for resources • There are two different types of competition: inter-specific and intra-specific • Inter-specific competition refers to competition of two or more species competing for the same resources that are in short supply • It occurs where different species occupy similar ecological niches • An example would be when the wild dog, the lion and hyena compete intensely for impala. • The larger lion and hyena often steal the wild dog kills causing a decrease in the wild dog population. • Intra-specific competition refers to competition between individuals of the same species for resources • An example would be the springbok population in the Kalahari which is limited by the supply of food. • With large populations, food becomes scarce and weaker individuals will not have enough to eat • The stronger and fitter or better adapted individuals will survive • Competition is intense because their habitat and resources are identical • As a result, the larger and stronger males will establish territories and guard them and the females • They will keep out other males and reproduce and pass on their genes to their offspring	Group work	15 min 10 min 30 min	**Simulation on competition in the IQ interactive software** **Video on competition** Competition in ecosystems (youtube.com)

• Review predator-prey relationships emphasizing that prey represents a food source in the ecosystem for the predator • Review the concept of logistic growth patterns within populations and how carrying capacity will determine the maximum size a population will reach • Discuss how the carrying capacity of the environment organisms find themselves in is related to the resources such as food, space and mates that are available to the organisms **2.2Main Body (Lesson presentation)** . Ask learners to sit in groups (of not more than 6 each). They need to be able to discuss their answer before answering. • Use the smartboard simulation from the previous lesson and present it as showing the predator-prey relationship. • Play a video from YouTube with the link provided below: Competition in ecosystems (youtube.com) The following must be highlighted by use of the smartboard and class discussion after the simulation and video: • Organisms compete for limited resources so that they can survive • Plants compete for light, space, water and minerals and animals compete for food, space, shelter, mates and water • The functional role and position of a species and the resources it uses within a community or ecosystem is known as its ecological niche • This determines where an organism lives and how it interacts with other members of the community • The greater the similarity between the ecological niches of two organisms or species, the greater the competition for resources • There are two different types of competition: inter-specific and intra-specific • Inter-specific competition refers to competition of two or more species competing for the same resources that are in short supply • It occurs where different species occupy similar ecological niches • An example would be when the wild dog, the lion and hyena compete intensely for impala. • The larger lion and hyena often steal the wild dog kills causing a decrease in the wild dog population. • Intra-specific competition refers to competition between individuals of the same species for resources • An example would be the springbok population in the Kalahari which is limited by the supply of food. • With large populations, food becomes scarce and weaker individuals will not have enough to eat • The stronger and fitter or better adapted individuals will survive • Competition is intense because their habitat and resources are identical • As a result, the larger and stronger males will establish territories and guard them and the females • They will keep out other males and reproduce and pass on their genes to their offspring	Group work	15 min 10 min 30 min	Simulation on competition in the IQ interactive software **Video on competition** Competition in ecosystems (youtube.com)

• This means that not all males are able to reproduce and helps keep the population numbers low reducing the growth rate of the population • This behaviour known as territoriality is very important in helping to control population size in large mammals and birds **2.3 Conclusion** • Summarise the lesson. • It may be necessary to restate the important concepts stressing the two different types of competition and how this affects population size and growth	Homework: Understanding Life Science Gr. 11	5 min	Homework: Understanding Life Science Gr. 11

Appendix 2: Table showing the teaching strategies used in this study

Teaching Strategies and Integrated ISB Affordances in Population Ecology

Lesson topic	Lesson objectives	Teaching strategy	Integrated ISB affordances
Introduction to key concepts	• Define what a population is • Understand what the characteristics of a population are • Identify the factors that determine the size of a population and how these may affect changes in the size of the population over some time • Manipulate data using formulae that illustrate how population parameters affect population size	Class discussion Visual representation Summary Class/home activity	Presentation and display Online platforms (Writing) IQ interactive platform
Estimating population size- Direct and indirect methods	Describe several ways to determine the size of a population • Understand that a direct count may not be possible for all populations when determining the size of a population • Describe the procedure for conducting a quadrant sample of an area to	Quiz Examples Activity Formative assessment	Presentation and display Stopwatch Writing (IQ interactive)

	estimate a population's size • Discuss the procedure for conducting a mark-recapture sample for estimating a population's size • Perform calculations for both the quadrant method and mark-recapture method for estimating population size • Discuss the limitations of sampling populations using the quadrant and mark-recapture method		
Estimating population size- Mark-recapture method (Practical activity)	• Work together in a group • Follow instructions • Estimate a population size by using information gathered and applying it by using the formula given • Answer questions related to results gathered during practical activity	Group work Practical activity (Virtual laboratory) Recording results	Online platform Stopwatch Save SMART notebook
Limiting factors and carrying capacity	• Discuss how environmental factors limit birth and death rates in a population • Describe the factors that affect population sizes • Understand the difference between density-independent and density-dependent factors	Quiz questions Dialogue-driven questions Learner research Public opinion survey IQ interactive platform	Presentation and display Stopwatch Online platform, presentation and display Online platform and calendar reminder Writing and display

	• Explain the concept of a carrying capacity in an ecosystem and how the carrying capacity affects the growth and stability of populations • Complete an activity concerning the control of elephant populations		
Interactions in the environment- Predator-prey relationships	• To compare and contrast different types of predator-prey relationships. • To design a model or simulation that demonstrates a predator-prey interaction. • To explain the importance of predator-prey relationships for maintaining a healthy ecosystem.	Class discussion Introductory video Simulation activity	 Video and audio playback and annotation Simulation
Interactions in the environment- competition- inter- and intraspecific competition	• Understand that limited resources in the ecosystem create competition between organisms • Describe how species and individuals occupying similar ecological niches compete for resources • Explain the concepts of inter-specific and intra-specific competition	Game-based learning platform (Kahoot!) Video recording	Presentation and display Online platform Video and audio playback and annotation

	• Discuss the different types of inter-specific and intra-specific completion for resources in the environment • Understand how inter-specific and intra-specific competition affects populations		

Appendix 3: GDE approval letter

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**31 July 2023**
Validity of Research Approval:	**08 February 2023– 30 September 2023** **2023/291**
Name of Researcher:	**Magwaza SLS**
Address of Researcher:	**Stone Arch Estate**
	Village 7 Unit 15 Castleview
Telephone Number:	**073 795 5895**
Email address:	**1147517@students.wits.ac.za**
Research Topic:	**Investigating the integration of affordances of interactive smartboards when teaching population ecology in Grade 11 Life Sciences: A case study of a secondary school in Johannesburg.**
Name of University:	**Wits**
Type of qualification	**Masters**
Number and type of schools:	**1Secondary School**
District/s/HO	**Johannesburg West**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

31/07/2023

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001

1. *Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. ***Because of the relaxation of COVID 19 regulations researchers can collect data online, telephonically, physically access schools or may make arrangements for Zoom with the school Principal. Requests for such arrangements should be submitted to the GDE Education Research and Knowledge Management directorate.***
4. ***The Researchers are advised to wear a mask at all times, Social distance at all times, Provide a vaccination certificate or negative COVID-19 test, not older than 72 hours, and Sanitise frequently.***
5. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
6. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
7. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
8. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
9. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
10. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
11. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
12. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
13. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
14. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
15. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
16. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

....

Dr. Gumani Mukatuni
Acting CES: Education Research and Knowledge Management

DATE: 31/07/2003 ....

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix 4: HREC Approval letter

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | WSoE Wits School of Education

SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: 2023ECE035M**
PROJECT TITLE	Investigating the integration of affordances of interactive smartboards when teaching population ecology in Grade 11 Life Sciences: A case study of a secondary school in Johannesburg
INVESTIGATOR	Sinothile Luyanda Silindile Magwaza
SCHOOL/DEPARTMENT OF INVESTIGATOR	WSoE
DATE CONSIDERED	10 July 2023
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	Minimal Risk
EXPIRY DATE	Date of submission of the Research Report
ISSUE DATE OF CERTIFICATE	24 July 2023
CHAIRPERSON	Dr. Batseba Mofolo-Mbokane

cc: Prof Eunice Nyamupangedengu & Ms Nomzamo Xaba

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

Signature **Date** 25./ 07. /2023

27 St Andrews Road, Parktown, Johannesburg, 2193 | Pvt Bag 3, WITS, 2050 | T +27 11 717 3007 | www.wits.ac.za/education

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Appendix 5: Summary of analysis of the ISB affordances using the SAMR model

Summary of the SAMR level of ISB affordance integrated in teaching population ecology

SAMR model level	Affordances aligning to each level
Substitution	Video-playback Stopwatch Online platforms
Augmentation	Underlining and highlighting Video- playback Annotations
Modification	Video-playback Annotation Simulation Writing Online platforms
Redefinition	Online platforms

Appendix 6: Information letter to the principal

Title of the research: Investigating the integration of affordances of interactive smartboards when teaching population ecology in grade 11 Life Sciences: A case study of a secondary school in Johannesburg.

21 June 2023

The principal

Secondary School

Dear Principal,

I, Magwaza Sinothile am doing research under the supervision of Ms. Nomzamo Xaba and Prof. Eunice Nyamupangedengu from the faculty of Humanities under the Science Education division at the University of the Witwatersrand. I am a registered Masters' degree student in Education.

The aim of this study is to investigate how the affordances of interactive smartboards can be integrated into teaching and learning as an ICT tool to teach the topic of population ecology to grade 11 learners. This secondary school has been selected because it is one of the districts where interactive smartboards are installed, which makes it key in this study and it is easier to access because the research works here.

The study will entail observing a lesson, using questionnaire, and interviewing of teachers in one selected secondary school. Interviews will take place on-site at the schools after the necessary consent forms have been signed. The dates and times will be discussed with the principals of the schools to cause minimum classroom disruptions in the school day. The results of the study will assist the realising the importance and impact of the affordances of interactive smartboards to improve teaching and learning in schools. There are no potential risks, physically or otherwise, involved in this research as the topic is non-sensitive. Participation will be voluntary, and participants' identities will be kept confidential. Participants will have the choice to withdraw from the study without any penalty. There shall be no reimbursement or any incentives for participation in the research. Please note that participants anonymity cannot be granted as data collection includes the use of video recording and interviewing the two teacher participants.

The feedback procedure will entail participants contacting the supervisor or researcher of this study for the outcome of the research. The researcher will provide contact details to them.

Yours Sincerely,

Magwaza Sinothile (M.Ed. Student) C: 073 795 5895 E: 1147517@students.wits.ac.za

Nomzamo Xaba (Supervisor) C: 0617947792 E: 588607@students.wits.ac.za

Prof. Eunice Nyamupangendengu (Supervisor) T: 011 717 3752 E:

Eunice.nyamupangedengu@wits.ac.za

Appendix 7: Consent letter: The principal

The Principal: Secondary School

I,……………………………………………… principal of ………………………………..grant permission to Ms. Sinothile Magwaza to conduct her study at a Secondary School. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree that my schools' participation will remain anonymous.

YES NO

I agree that the researcher may use anonymous quotes in her research report.

YES NO

I agree that the observation may be audio recorded.

YES NO

I agree that the information I provide may be used anonymously after this project has ended, for academic purposes by other researchers, subject to their own ethics clearance being obtained.

YES NO

Principal's signature: _____________________________ School stamp:

Date: ___________________________

Appendix 8: Information letter to the critical friends

<u>**Information letter for the critical friends**</u>

DEAR PROSPECTIVE PARTICIPANT

My name is Magwaza Sinothile am doing research under the supervision of Ms. Nomzamo Xaba and Prof. Eunice Nyamupangedengu from the faculty of humanities under the Science Education division at the University of the Witwatersrand. I am a registered Masters' degree student in Education. This study is titled; **Investigating the integration of affordances of interactive smartboards when teaching population ecology in Grade 11 Life Sciences: A case study of a secondary school in Johannesburg.**

You are invited to participate in this study where you will be requested to read and provide feedback to the researcher as a critical friend. I will provide you with more information about this study and your involvement. The importance and the impact of smartboards in learning and teaching is a very relevant situation in education, in South Africa. In this study, I will request your views and opinions on the topic. This information may be used to improve the quality of education by improving the pedagogy of the teachers. The study will involve an interview and a hardcopy questionnaire of approximately 30 minutes in length in a mutually agreed location and time convenient to you.

You may decline the offer if you wish. Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. Please note that participants' anonymity cannot be granted as data collection includes the use of video recording and interviewing the two teacher participants.

Your responses will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. All information you provide is considered completely confidential. Data collected during this study will be retained on a password-protected computer for 5 years in a locked office. The benefits of this study are to highlight the affordances of interactive smartboards used by teachers during a Grade 11 lesson on population ecology. There are no known or anticipated risks to you as a participant in this study and you will not be reimbursed or receive any incentives for your participation in the research.

If you would like to be informed of the final research findings, or if you have any questions during or afterward about this research study, feel free to contact me or my supervisor at the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), by telephone at +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,

Researcher: Magwaza Sinothile, 1147517@students.wits.ac.za, 073 795 5895

Supervisor: Nomzamo Xaba, 588607@students.wits.ac.za, 0617947792

Prof. Eunice Nyamupangendengu (Supervisor) T: 011 717 3752 E:

Eunice.nyamupangedengu@wits.ac.za

Appendix 9: Participants consent form

PARTICIPANT'S CONSENT FORM

Title of project: **Investigating the integration of affordances of interactive smartboards when teaching population ecology in grade 11 Life Sciences: A case study of a secondary school in Johannesburg.**

I, ………………………………………. (participant name), agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.

YES / NO

I understand that I can volunteer to take part in the study.

YES / NO

I agree that the interview/focus group/other activity may be audio and video recorded.

YES / NO

I agree that direct quotations from my interview may be used by the researcher in their research report/manuscript/book chapter.

YES / NO

I agree that my participation will remain confidential (my name or other identifying data will not be used by the researcher in their research report/manuscript/book chapter)

YES / NO

I agree that other researchers may use the information I provide in my interview (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on.

YES / NO

I agree that I may be video recorded during teaching and that my anonymity will not be guaranteed.

YES / NO

……………………………………. (signature)

……………………………………. (name of participant)

……………………………………. (date)

……………………………………. (signature)

……………………………………. (name of the researcher)

……………………………………. (date)

Appendix 10: Information sheet and consent form to the parents

INFORMATION SHEET (Parents)

My name is Magwaza Sinothile, and I am currently completing a Bachelor of Education Masters at the Wits School of Education. I am interested in investigating the integration of the affordances of interactive smartboards when teaching the topic of population ecology to grade 11 learners.

This study aims to investigate how grade 11 secondary school teachers integrate the affordances of interactive smartboards (if any) when teaching and learning the topic of population ecology at a school in Johannesburg.

I would like to let you know of the research that will take place in your child's presence. To ensure that enough reliable data is recorded, I request your permission to allow a colleague to sit in during the lesson and to audio record the lesson.

The participants (teachers) involved will not gain any form of advantage from this study. Those who choose not to participate in this study will not be punished. At any time during the data collection process if the participants feel uncomfortable due to unforeseen circumstances, participants can notify the researcher and the situation will be resolved. The observation guide and audio recording will be kept completely confidential. This study does not demand the names of the participants, only their teaching and learning experiences, and therefore participants will be kept anonymous in my final report. Once the study is complete, it will be formulated into a report. All participants will have access to the final report after completion.

If you require any further information concerning this study, please contact me via the details prescribed below.

Researcher: 073 795 5895 Email: 1147517@students.wits.ac.za

Supervisor: Nomzamo Xaba, 588607@students.wits.ac.za, 0617947792

Prof. Eunice Nyamupangendengu T: 011 717 3752 E: eunice.nyamupangedengu@wits.ac.za

CONSENT FORM FOR ALLOWING YOUR CHILD TO PARTICIPATE IN RESEARCH (PARENTS)

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | WSoE WITS SCHOOL OF EDUCATION

Dear Parent,

Kindly complete this form to indicate your willingness to allow your child to indirectly participate in this research project.

Title of project: **Investigating the integration of affordances of interactive smartboards when teaching population ecology in grade 11 Life Sciences: A case study of a secondary school in Johannesburg.**

Name of researcher: Sinothile Magwaza

I, ……………………………. (parent's name), agree for ……………………………….

(learner's name) to indirectly participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree that my child's participation will remain anonymous

YES NO

I agree that the researcher may use anonymous quotes in his / her research report

YES NO

I agree that the observation may be audio recorded

Appendix 11: Learner’s information letter

PARTICIPANT INFORMATION SHEET (LEARNERS)

UNIVERSITY OF THE WITWATERSRAND
JOHANNESBURG

DEAR PROSPECTIVE PARTICIPANT,

My name is Magwaza Sinothile am doing research under the supervision of Ms. Nomzamo Xaba and Prof. Eunice Nyamupangedengu from the faculty of humanities under the Science Education division at the University of the Witwatersrand. I am a registered Masters’ degree student in Education. This study is titled; **Investigating the integration of affordances of interactive smartboards when teaching population ecology in Grade 11 Life Sciences: A case study of a secondary school in Johannesburg.**

You are invited to participate in this study where I will be doing research of my own teaching with the presence of a critical friend in the classroom. I will provide you with more information about this study and your involvement. The importance and the impact of smartboards in learning and teaching is a very relevant situation in education, in South Africa. In this study, I will request your views and opinions on the topic. This information may be used to improve the quality of education by improving the pedagogy of the teachers. The study will involve an interview and a hardcopy questionnaire of approximately 30 minutes in length in a mutually agreed location and time convenient to you.

You may decline to answer any part of the study if you wish. Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. Please note that participants’ anonymity cannot be granted as data collection includes the use of video recording and interviewing the two teacher participants.

Your responses will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. A video recording facing the smartboard will be taken. However, should you appear in the video then your face will be disguised.

Data collected during this study will be retained on a password-protected computer for 5 years in a locked office. The benefits of this study are to highlight the affordances of interactive smartboards used by teachers during a Grade 11 lesson on population ecology. There are no known or anticipated risks to you as a participant in this study and you will not be reimbursed or receive any incentives for your participation in the research. During the research activity, I will be teaching as usual. This means that learners are only involved in this research because it will be done during the lesson. There will be a colleague that will sit in for observation. The lesson will be confidential and anonymous.

If you would like to be informed of the final research findings, or if you have any questions during or afterward about this research study, feel free to contact me or my supervisor at the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), by telephone at +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,

Researcher: Magwaza Sinothile, 1147517@students.wits.ac.za, 073 795 5895

Supervisor: Nomzamo Xaba, 588607@students.wits.ac.za, 0617947792

Prof. Eunice Nyamupangendengu (Supervisor) T: 011 717 3752 E:

Eunice.nyamupangedengu@wits.ac.za

Appendix 12: Assent forms

<u>ASSENT FORM FOR PARTICIPATING IN RESEARCH (LEARNERS)</u>

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | WSoE WITS SCHOOL OF EDUCATION

Dear prospective participant,

Kindly complete this form to indicate your willingness to participate in this research project.

Title of project: **Investigating the integration of affordances of interactive smartboards when teaching population ecology in grade 11 Life Sciences: A case study of a secondary school in Johannesburg.**

Name of researcher: Sinothile Magwaza

I, …………………………….., agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree that my participation will remain anonymous

YES NO

I agree that the researcher may use anonymous quotes in his / her research report

YES NO

I agree that the observation may be audio recorded

YES NO

I agree that the information I provide may be used anonymously after this project has ended, for academic purposes by other researchers, subject to their own ethics clearance being obtained.

YES NO

………………………………………………… (Participant's signature)

………………………………………………… (name of participant)

………………………………………………… (date)

………………………………………………… (Researcher's signature)

………………………………………………… (name of the researcher)

………………………………………………… (date)