EXPLORING GRADE 10 LEARNERS' PERCEPTIONS OF USING MICROSOFT TEAMS AS AN ONLINE PLATFORM FOR LEARNING TRIGONOMETRIC FUNCTIONS

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Declaration

I, Sibusiso Shandu, declare that

1) Unless otherwise stated, the research conducted in this thesis is all my own.

2) This thesis has not been submitted for a degree or examination at another university.

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As the candidate's supervisor, I agree to the submission of this thesis.

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Abstract

The poor national mathematics results at the secondary school level, in general, and Trigonometry, in particular, resulted in numerous interventions by teachers and researchers to improve learners' performance. In terms of teaching and learning, due to the coronavirus disease of 2019 pandemic, there was a shift to blended and online learning. The country's learners are exposed to different learning management systems (LMS). It is the next generation of online classrooms, or learning management systems (LMS) with many educational institutions embracing Microsoft Teams as their online platform of choice. This research illustrates the findings of the first doctoral research conducted that explores grade 10 mathematics learners using Microsoft Teams to learn trigonometric functions. The participants for this research are of 23 committed grade 10 mathematics learners. This qualitative research was conducted in a secondary school situated in KwaZulu-Natal, South Africa. The research was framed by the theories of connectivism and social constructivism. The research covered a variety of data collection, which were observations of classes taking place, a pre-task, learners approach interviews, and post-task, and a reflective journal of the researcher. The data collected for this research was coded and analysed using the ATLAS.ti software tool. Inductive coding facilitated the identification of significant themes from the data, which appeared to be the most significant. Thematic analysis facilitated the extraction of significant insights from the collected data. Research has pointed out that the participants perceive that Microsoft Teams platform is simple and user-friendly. However, to utilise Microsoft Teams efficiently, it is crucial to have faster and more reliable internet connections. This research has comprehensively analysed the findings, consequences, and recommendations pertaining to the views and experiences of blended learning utilising Microsoft Teams for teaching trigonometric functions in mathematics. Although conducted in a classroom setting, this research has broader implications for the use of technology to enhance teaching and learning in higher education. Thus, the research is valuable since it exhibits how using blended learning in educational contexts may enhance teaching learning, and performance in mathematics. Thus, this research has implications for mathematics, mathematics education, and higher education nationally and internationally. This research benefits learners, learners, teachers, teacher educators, academics, researchers, curriculum, and policy developers in mathematics.

Keywords: ATLAS.ti, Learning, Learning Management Systems, Mathematics, Microsoft Teams, Online Learning, Trigonometry

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Chapter One: Introduction

1.1. Introduction

This chapter provides the gateway to the research. The chapter explains the process of the research in a methodical way. The chapter has been systematically segregated into different sections under separate headings that form the basis for the thesis for protecting human subjects and research proposal. This research is a combination of both techniques and topics which requires detailed explanations. Furthermore, the research questions and hypothesis open the room for additional research and information on the subject matter. Finally, the research will conclude with which method is more suitable to research methodologies. It takes a deep plunge into the intricacies of the research subject, presenting the collective milieu that forms the cocoon enveloping the research.

Bearing in mind this forward movement, the second chapter opens with a historical exploration. The reader is treated to an engaging and informative trip through time, learning how online platforms have evolved from the first generation of web courses in the late 1990s to the most recent technologies available today. This journey is not only a chronological narrative, but also an excavation of the technological advances, pedagogical swings, and social changes that have led to the current expansion of distance education. An archaeology of the field reveals a dense body of knowledge that includes, among others, in-depth studies by Collins and Halverson (2010). They thoroughly described how internet access, augmented by both mobile technologies and personal computers, has restructured the educational landscape.

With widespread changes to the higher education space, technological advances, such as online learning platforms, have significantly impacted the pedagogical model as we have shifted from a traditional four-walled classroom to a flexible hybrid classroom, thereby enhancing learner learning. As this research explores the transformation of online learning technologies, it also examines the social and economic factors contributing to the oscillating growth of online learners across spheres of the globe. Central to this narrative was the emergence of coronavirus disease of 2019 pandemics, a defining international event that fundamentally changed society. For education systems around the world, the swift and often difficult move to virtual learning environments was an unprecedented shock to their routines. This section of the report takes up the more complicated matter of how this transition was undertaken and how challenging it sometimes was by educational institutions from nursery schools to universities and of the steps they took to create and stand up virtual classrooms. Also considered are longer-term changes to teaching methodologies, learner engagement and what might reasonably be referred to as the classroom.

This chapter explains the objectives, research questions, and structure of the whole report. It is fundamental to understanding the rest of the research. Section four, finally, gives an overview of the thesis structure and serves as a roadmap for the reader to proceed through the thesis in recognition of the route that will be followed. It gives the headings of chapters and a summary of the content of each chapter.

1.2. Background and Context of The Research

The past few decades have witnessed a surge in technology integration across all educational levels, particularly in Oman's tertiary education sector, mirroring the global trend of ICT in education. Microsoft Teams, a relatively new interactive application launched in 2017, has gained significant traction in education. While research on Microsoft Teams in this context is limited, existing studies provide valuable insights. Al-Qora'n et al. (2017) defines Microsoft Teams as "cloud-based team collaboration software" within the Microsoft 365 and Office 365 suite, offering core functionalities like business messaging, calling, video meetings, and file sharing.

Microsoft Teams was initially used for collaborative projects and has recently been adopted for teaching and learning, particularly due to the sudden shift to online learning during the coronavirus diseases of 2019 pandemic (Hai-Jew, 2020; Almutairi & Aljumah, 2023). Additionally, Microsoft Teams offers features like breakout rooms for group work, assignment tabs for creating tasks and quizzes, and the ability to create private channels within each team. Given its relative novelty as a socio-technological educational software, Microsoft Teams presents a significant research opportunity, especially considering the limited existing studies on its impact on users.

According to Canavan (2018), teaching comprises a diverse array of competencies and unique strengths that, when utilised effectively, can significantly impact the learning process. Utilising online education as a resource to facilitate instruction and learning is self-evident. Efficient pedagogy and acquisition of knowledge necessitate the prompt implementation of several methodologies, including explicit instruction, promotion of discourse, and independent or collaborative learning opportunities. To ensure that learners are adequately prepared for the future and that instruction is conducted effectively, it is crucial to integrate online education with these teaching methods. According to Mushipe and Ogbonnaya (2019), a considerable proportion of learners harbour an unfavourable perception of mathematics education on the grounds that they find it difficult and monotonous. Various research studies have shown that integrating online learning can enhance the instruction and acquisition of mathematics, ultimately offering learners a more captivating and enjoyable experience. Rather than just memorising and solving the math equations, the incorporation technology into mathematics education and learning implies that it can enable the learners to understand the relationship between the variables, which in turn enables a better comprehension to the whole learning experience. Virtual learning may prompt academic success by launching participant's curiosity, kindling learners' eagerness, and pulling attention of learners to the process of learning.

This is evidenced by their increased dedication to the learning task, improved capacity to operate autonomously and engage in self-guided research, heightened enjoyment, inquisitiveness, and sense of accomplishment in the learning process using information and communication technologies (ICT), and bolstered self-assurance. Blended learning may provide learners with the means to collaborate, share information, and generate new insights. Learning and achievement will be enhanced as a result. As stated by the South African Department of Education (2004), progressions in online blended learning present prospects, mitigate disparities, enhance the calibre of instruction and learning, and foster lifelong learning. Experiences from around the world indicate that online learning has had a significant impact on the direction of education and training. Providing educators and learners with the autonomy to forgo traditional approaches to instruction and learning has the potential to enhance educational progress. Moreover, the utilisation of online learning fosters an educational setting that recognises the variability among individuals with respect to their cognitive processes, learning styles, and cultural worldviews. Technological innovation embraces inclusive education by offering possibilities, alternative teaching strategies, and flexible assessment options for learners who face learning obstacles. Graduates from our educational system must be capable of using knowledge efficiently and staying current with technological advancements.

The technical developments of the twenty-first century, such as the accessibility of low-cost, high-speed internet, laptops, and smartphones, are quickly altering the educational landscape

(Hwang et al., 2019). With projections of an exponential rise in use shortly, online learning, the use of electronic platforms and apps for educational purposes, has experienced a relative uptick in recent years (Bell, 2011). Some educational institutions have also been compelled to switch from using online-only forms of instruction to online-only modes because of the coronavirus disease of the 2019 pandemic (Kacprzyk et al., 2022). The idea of online learning, or online learning, is not new. The flexibility of the learning process has been enhanced and is now a good complement to traditional learning techniques because of the development of cloud technologies and the accessibility of inexpensive, fast Internet connectivity (Hwang et al., 2019). According to the results of the literature currently in publication, the main goals of online learning, like the Microsoft Teams platform, are to lower the cost of education delivery while simultaneously expanding educational opportunities and improving the quality of instruction for the public (Hamidi & Chavoshi, 2018; Panigrahi et al., 2018). The terms online learning, web-based training, online learning, and computer-based training are often used simultaneously in literature (Charles, 2018).

Online learning refers to a specific form of online education that requires an internet connection. It encompasses both mobile-based and web-based training. Yang and Kwok (2017) argue that the definition of online learning in literature is subject to debate due to its evolution. According to the prevailing literature, overall, learners can derive advantages from online learning due to its flexibility in terms of self-paced research and location independence. The existing research indicates that learners generally hold favourable opinions towards online learning (Alqurashi, 2019; Valencia-Arias,et al., 2018; Rodrigues et al., 2019). Before the arrival of the coronavirus disease of 2019, various online learning platforms and resources were primarily supplemental, occurring in addition to the conventional classroom teaching offered at colleges and institutions. As a result, the coronavirus disease of 2019 scenario has created an unusual circumstance in which education delivery has drastically changed to occur only online.

Teachers are obligated to utilise an internet delivery platform for delivering lectures (Abidah et al., 2020). The digital disruption in the education business has occurred suddenly, conveniently, and unexpectedly, with minimal strategic planning or preparation for its global implementation. Therefore, it is essential to uphold a commendable degree of perceived usefulness for the online delivery platforms utilised for educational purposes during these tumultuous circumstances caused by the closure of educational institutions, particularly from the perspective of the learners. Perceived usability is a crucial component of user experience (Diefenbach et al., 2014). For this research, however, online learning refers to the Microsoft Teams platform, which is web-based and mobile software that distributes, monitors, and manages educational courses over the Internet. It utilises internet-based technical breakthroughs to strategies, generate, and distribute educational material while fostering engagement between learners and instructors to facilitate a meaningful learning encounter (Mattar, 2018; Yang & Kwok, 2017; Zahle, 2018). Today's learners face a digital divide since they lack equitable access to digital tools and resources (Iivari et al., 2020). Prior research has extensively examined the digital divide, particularly concerning the availability of contemporary devices and technology (Song et al., 2020; Srivastava & Shainesh, 2015) Nevertheless, there is a lack of awareness concerning this matter among learners (Iivari et al., 2018; Mariën & Prodnik, 2014). The digital divide can be significantly polarising in an African context, especially in developing countries such as South Africa, where the current research took place. This is especially true when considering the ownership of smartphones, tablets, or computers.

Online platforms allow learners to engage in four distinct types of interactions: contact between learners and instructors, interaction between learners and content, and interaction between learners and interfaces (Sims, 2003). Learning systems provided by the industry consist of Adobe Connect, Microsoft Teams, Google Meet, Zoom, Skype for Business, and WebEx. With so many online platforms on the market, this research will concentrate on using Microsoft Teams. Microsoft Teams, introduced in 2017, is a diverse online or hybrid learning platform that boosts confidence among learners using remote learning capabilities, according to the Microsoft website.

The notion that online education would displace traditional classroom instruction results from the quick development of technology (Bell, 2011; Charles, 2018). According to academics, online education has expanded the scope and accessibility of education while simultaneously bringing down the cost of providing that education (Kuznekoff & Titsworth, 2013). Additionally, as long as there is internet connectivity, it allows learners and learners to learn from anywhere. There is no clear research on whether online learning is more effective than the traditional classroom environment at helping learners learn appropriately. According to Charles (2018), learning is more successful in the online mode because learners engage all their senses, which increases learners' memory of the content they have learned (Gulosino & Miron, 2017).

1.3. Problem Statement

The issue of online education playing a crucial role in guarding and implementing all raining rights to education must not be ignored. Before achieving the maximum abilities of the marginalised, explicit emphasis should be placed on the community. South Africa, public education systems at this peril go, around who issued against Black people these obstacles particularly. These problems have to be tackled from different angles, starting with the overcrowded classrooms, the unavailability of clean water, poorly characterised 'bathroom' facilities, and the inadequate teaching quality and support, the disadvantaged communities in particular. Despite the coronavirus disease of 2019 pandemic's aggravating effects on a public high school educational institution that was already under pressure, the event provided a chance to investigate online learning as a solution to problems like having a lot of learners in inadequately structured classrooms. This research is essential because it will help policymakers understand how high school learners in low-resource environments perceive their usage of online learning platforms as the educational system looks for methods to guarantee everyone has access to education. For the education of their learners, online or virtual schooling offers families an option to the already taxing traditional public school system (Scheffer et al., 2008).

The researcher has 22 years of experience teaching mathematics and is a passionate trigonometry teacher in a public high school located in a semi-rural location catering to Grade 10 learners. (Joseph et al., 2020) asserts that the quality of mathematics education in South Africa ranks among the lowest globally. The researcher is enthusiastic about contributing to the progress of mathematics education. Due to the impact of the coronavirus disease 2019, the available time for in-person teaching and learning has been reduced. Therefore, promoting online trigonometry instruction at schools has become essential to ensure learners' academic achievement. Numerous studies have demonstrated the effectiveness of online learning as a pedagogical strategy for individualised instruction and flexible knowledge acquisition regardless of place or time (Guragain, 2016). In addition to adding to the body of information, the research makes important suggestions to guarantee successful trigonometric learning using Microsoft Teams. Canaries and van Schalkwyk (2022) report that as smartphones have become widely available, the opportunity to employ technology for education at scale has never existed. The presence of technology alone does not guarantee its appropriate usage for educational

purposes. However, the challenge with incorporating these new technologies into the framework of education lies in the ability to make these an actual part of the school system in a way that helps and enhances learning (Ruthven, 2013).
Furthermore, within the context of South Africa there is a large gap between rich and poor, so the effect of online higher education on equalising education is vitally important in South Africa. Virtual tools such as Microsoft Team can solve the detrimental problem of learners in third-world countries missing out on education because of an unavailability of well-rounded schools. Additionally, online education can facilitate a deeper, more personalised learning experience, catering for learners' unique learning pace and style; this benefit is especially crucial to subjects such as mathematics and physics, in which fundamental understanding would provide a platform for future learning (Wea & Kuki, 2021).

Yet, the biggest drawback to this rapid online transition is the question of how prepared both faculty members and their learners are to move into this new space. For teachers to teach a well-managed information literacy class, they need to be well-trained in two important domains: subject matter knowledge and instruction. The research must also consider how this shift will impact teachers' pedagogical approach and ability to engage learners from a distance (Barbour et al., 2020).

Another important point involves the learners' environment at home. One concern is that participants need the infrastructure and competencies required to access online courses, which may not be available in much of the world. Although greatly enhanced in recent years, many rural areas and disadvantaged communities lack the broadband connectivity that makes online learning possible. Even in areas with broadband and computer resources, not every learner has a quiet, comfortable place to work. If learners are not able to concentrate because of noise, or if they must research on a bed or a couch, they may not be academically successful. Asynchronous online courses may be challenging for those who lack these structural supports. Another vital factor is learner self-efficacy. Research evidence has shown that self-efficacy potentiates academic performance and continues to be found as a statistical predictor of performance. High-self-efficacy individuals have two essential characteristics: the ability to self-regulate and the skills necessary to motivate one's effort. The current research examines the correlation between self-efficacy, drive to learn, self-regulation abilities, and learners' academic achievement.

This research explores the Grade 10 learners perception of the use of Microsoft's Teams platform that supports mathematics concepts, which involve mainly trigonometrical functions of learning. This research focuses on understanding how distance-based technology can be utilised to better instruction in a virtual room by, for instance, deploying video conferencing technologies to make virtual office hours more humane. It also identifies how learning is benefited by video conferencing, shared documents, and interactive assignments. The difficulties learners face when making use of the functionalities and the way to address those challenges will also be probed in this paper.

Also, the research will investigate the level of parent's participation across their learners' online learning. While the parents in low-income families who are sometimes ill-educated function as the critical decision drivers of an online learning model, they play an important role in assisting and motivating learners in their classes. There will be an attempt to establish whether one educational platform, Microsoft Teams, can be used to instil high school trigonometry learners in South Africa (feasibility case study). The focus on Grade 10 learners' perceptions is intended to provide insights that may be useful in optimising support for online learning to deal with the unique difficulties that are a feature of South African educational conditions. The results of this research will be an addition to the existing body of research on online learning in educational discourses and yield practical recommendations for instructional designers, administrators, professors, teachers, policymakers, curriculum designers, and software developers on how to enhance the quality of online learning in South Africa.

1.4. Rationale of the Research

The integration of technology in education has become increasingly prevalent, particularly in the wake of the coronavirus disease 2019, which started at the end of 2019 and necessitated the adoption of remote learning strategies. Microsoft Teams, a collaboration and communication platform, has become popular for facilitating online learning experiences. Trigonometric functions, a crucial component of mathematics curricula, have traditionally been taught through conventional classroom-based methods. However, the transition to online learning environments has prompted educators to explore alternative approaches to effectively deliver this subject matter (Alayyar et al., 2018). This research aims to explore the perceptions of Grade 10 learners regarding using Microsoft Teams as an online platform for learning trigonometric functions. By examining the perspectives of learners, this research seeks to gain valuable insights into the efficacy, challenges, and potential opportunities associated with leveraging this technology for mathematics education.

The rationale for this research is multifaceted and holds significance for various stakeholders within the educational landscape. Firstly, it addresses the growing need for effective online learning strategies, particularly in light of the ongoing global health crisis and potential disruptions to traditional classroom settings. By investigating learners' perceptions, this research can inform the development of more engaging and efficient online learning experiences, ultimately enhancing the quality of education provided.

Secondly, this research contributes to the broader discourse on technology integration in mathematics education. Trigonometric functions are a fundamental component of the mathematics curriculum, and their mastery is essential for learners' academic progress and future success in related fields. By exploring the use of Microsoft Teams as a platform for teaching these concepts, the research has the potential to uncover innovative pedagogical approaches that leverage technology to facilitate better understanding and retention of trigonometric principles (Ababneh et al., 2021). Furthermore, the findings of this research can provide valuable insights for educators and curriculum developers. By gaining an understanding of learners' perspectives, educators can tailor their instructional strategies and leverage the features of Microsoft Teams more effectively. This, in turn, can lead to a hopeful and optimistic future with improved learner engagement, motivation, and academic performance in the subject area.

Additionally, this research aligns with the broader goals of promoting digital literacy and equipping learners with the necessary skills to thrive in an increasingly technology-driven world. By exposing learners to online learning platforms such as Microsoft Teams, they can develop competencies in using digital tools for educational purposes, enhancing their overall preparedness for future academic and professional endeavours. Moreover, the research contributes to the growing body of literature on online learning and the use of collaboration platforms in educational settings. The findings can inform future research endeavours, enabling scholars and practitioners to build upon the knowledge generated and explore new avenues for leveraging technology to enhance learning outcomes.

Finally, this research is relevant to educational policymakers and administrators. By understanding the perceptions and experiences of learners, informed decisions can be made regarding the adoption and implementation of online learning platforms within educational institutions. This, in turn, can facilitate allocating resources and professional development opportunities for educators and establishing guidelines and best practices for effective online learning experiences (Boudah, 2010). The rationale for this research lies in its potential to contribute to the advancement of online learning strategies, specifically in the context of teaching trigonometric functions. The research can inform pedagogical approaches, enhance learner engagement, promote digital literacy, and guide policymaking decisions by exploring learners' perceptions. Ultimately, this research aims to support the continuous improvement of educational practices and ensure that learners receive high-quality, engaging, and effective learning experiences, even in the face of potential disruptions to traditional classroom settings.

1.5. The Contribution of this Research to Mathematics Education

Several aspects of the learners' mathematics performance have been acquired by the literature research review. Nevertheless, there have been few studies of high school learners` way of looking at Microsoft Teams as a digital platform for researching trigonometric functions, which is also not yet known. Maths performance is always ranked as a key area of concern at high school because the majority of learners who join colleges do so with serious difficulties in this area. There is an absence of work in changing the studies to certain educational strata (Cinquin et al., 2019). The way hunger and poverty limit the possibilities for learners to access essential healthcare services is devastating and deeply disturbing. Additionally, the stark contrast between their current comfort and impoverished backgrounds often leads them to engage in risky and blind decision-making, disconnected from consequences. Most of the research has been conducted on a broader regional unit rather than a small-scale one, such as a province. Moreover, even research focusing on a particular grade level is usually conducted by an outsider observer rather than a teacher who plays a crucial role in classroom teaching. They only take note as independent researchers, which will also curb them from getting information that would be beneficial and which encourage them to engage in the activities and discussions that are facilitated by the learner. In addition, research relied on surveys that offered less depth and complexity about the causes of traffic congestion. While the survey does not measure body language, the interview and observation will.

This research limits its subject matter to one Grade 10 classroom to draw more accurate and trustworthy results. As a teacher of this class involved in this research, the researcher may devote greater energy to his observations and interviews. The fact that the learners are already familiar with the researcher allows them to be more honest with him about how they view Microsoft Teams as a learning tool. According to Mitry (2021), a small sample size yields more accurate results since the researcher exerts more effort to control the research process. Due to the research's modest sample size, the researchers could devote enough time to each participant to provide useful findings.

In the context of industrialised nations, there is a wealth of literature on Microsoft Teams as a learning platform for high school learners. Few articles have been written about how African high school learners have used Microsoft Teams or other online learning tools. The lack of online learning venues for most African learners may explain the paucity of literature. It is important to remember that certain African schools can offer their learners access to online learning environments. To fill this vacuum in the research, this research explores how high school learners in general and grade 10 perceived the Microsoft Teams platform.

The available literature demonstrates that much research has been done on mathematics as a high school subject. The majority of writing focuses on generalised mathematical principles rather than on subjects. The primary subject of this research is trigonometric functions. Eliminating generalisation and thoroughly examining the phenomena is made possible by focusing the inquiry on a particular mathematical idea (Boudah, 2010).

1.6. Context and Location of Research

This research was conducted in a high school in Kwa-Mbonambi, a municipality in the King Cetshwayo region of KwaZulu-Natal province, situated on the north coast. The selection of the research location was primarily influenced by the researcher's preference for the specific educational institution where she teaches mathematics and the convenient accessibility of the area. Approximately 899 learners are currently enrolled at this establishment, with 500 of them being in their senior year. During the FET phase, all learners in Grades 10 through 12 participate. The school's enrolment comprises learners hailing from diverse socioeconomic, cultural, and religious contexts.

In line with the school's commitment to inclusive education, the learner body includes learners who are immigrants, have special needs, are gifted, speak several languages, and belong to many racial groups. The school offers learners the chance to participate in a variety of sports as well as extracurricular and co-curricular activities, ensuring that they are developing holistically. The research investigation was conducted in one of the tenth-grade classes at this institution.

1.7. Key Research Objectives and Questions

Cinquin et al. (2019) shows that the expansion of online learning research has been driven by the need to increase educational access for decades. Indeed, one of the key vehicles for enhancing access to education and eventually promoting social inclusion will be technological advances. According to Attard (2018), numerous educational institutions allocate resources towards mobile technology or actively promote its utilisation via Bring Your Own Device (BYOD) initiatives. The intention behind these initiatives is to enhance learner engagement and, consequently, improve learning outcomes. This research investigates whether and how the Microsoft Teams platform is utilised to increase learner engagement in online mathematics courses, as perceived by the learners. Given the status of learners as "digital natives" and the pervasiveness and necessity of ICTs in their daily lives, concerns pertaining to technology engagement and utilisation were examined through the lens of the virtual classroom. The objectives of the investigation were the following:

i. To investigate the perceptions of Grade 10 learners about the utilisation of Microsoft Teams as an online learning platform for learning trigonometry functions in Mathematics.
ii. To find out how effective Microsoft Teams as an online learning platform is in helping learners improve their knowledge of trigonometric concepts.
iii. To find out whether or not Microsoft Teams as an online platform can be used to facilitate learning, collaboration, self-efficacy, and engagement. And why?

The key research questions to be addressed in this research were as follows:

i. What is Grade 10 learners' perceptions of using Microsoft Teams as an online learning platform for learning trigonometry functions in mathematics?
ii. How effective is Microsoft Teams as an online learning platform in helping learners improve their knowledge of trigonometric concepts?
iii. How can Microsoft Teams as an online learning platform facilitate learning, collaboration, self-efficacy, and engagement in trigonometric functions? Why?

1.8. Theoretical Framework (Social Constructivism and Connectivism)

Framework of the theories will be a stepping stone function for the researcher to uncover valuable principles to be used to formulate the research problem, probe into major research issues and finally select a research design to be used as a way of identifying the path of relevant lines of inquiry. Hence, this is also the stage where research data becomes amenable to evaluation and specific conclusions that will matter to a particular research question. This research investigated the approach taken to teach grade 10 learners in trigonometric functions. Regular interactions between educators and learners of diverse social and cultural contexts comprised the environment in which the research was conducted. Valero (2010) emphasises the complexity of the interconnected systems involving interest groups, communities, and practices that are crucial to mathematics education. Furthermore, he emphasises the necessity of conducting research that considers the interrelationships and variety of these social behaviours. Therefore, we recognise the importance of conducting research on the diverse communities and practices that educators and learners participate in, both inside and outside of the classroom. We are cognisant, on a local, national, and global scale, of the consequences that can result from institutional and policy constraints. A concurrent increase in scholarly investigations that emphasise social justice issues has accompanied this expanding emphasis on the social aspects of education.

The correlation between different social group memberships, gender, ethnicity, socioeconomic status, and linguistic heritage, and the academic achievement of learners in mathematics has been established. This correlation extends to education in general and mathematics specifically (Morgan, 2014). As a researcher, I conducted an exhaustive examination of the numerous variables that influence learners' comprehension of trigonometric functions in the classroom. This served as the foundation for the hypothesis of numerous influences. Lev Vygotsky, a Soviet psychologist who lived during the post-revolutionary period, formulated the theory of social constructivism. From his perspective, learning encompassed more than mere acquisition and modification of new information; instead, it involved learners becoming integrated members of a community of knowledge.

Furthermore, he argued that social interactions are the source of all cognitive functions, which must be explained as social interaction by-products. In addition to emphasising the significance of social connections, Vygotsky's theory asserts that knowledge is generated through interactions with the environment and other individuals. A component of this research entails learners engaging in smaller-group discussions through the utilisation of the Microsoft team's platform, both in person and virtually, in accordance with the socio-constructivist paradigm. Each group of learners had the opportunity to take part in activities and discussions cantered on assignments from a course. This kind of social engagement was thought to help clear up misconceptions and encourage learners to think back on their trigonometric functions' lessons. This research aimed to analyse the affective ties between learners at school and home, as well as the social elements that affect mathematics learning.

1.9. The Scope of this Research

Complex and static systems may find it simple for the learners to understand as some might have problems in comprehending such concepts (Kaplan & Alon, 2013). The main goal of the investigation was to explore how the application of Microsoft Teams was by the Grade 10 class in learning the trigonometric functions. The interpretative case research method with qualitative data was used to research the case into this research. According to Draper and Swift (2011), hardly any investigation involves the acquisition of data from just all the people who comprise a specific community. Deciding on whether your needs are general or focused on a very specific group of people will therefore be the first amazement in your project planning. Additionally, Larkin and Calder (2015) define a sampling plan the one that uses a specific sampling technique to gather and pick data sources you will use. The sampling technique is often applied when experienced researchers are carrying out fieldwork. For instance, they can sample specific areas during observation hours, or they may prefer to note down types of cites in their field books, during the day. The role of fresh researchers in terms of quality assessment involves the use of a targeted sampling strategy that is purposive in nature, that is, designed to match the objectives of the project. Researcher is another tool that is used in the precision of the participants by the use of several exclusion and inclusions criteria (Strydom, 2011).

The data for this research had to come from people who matched the sampling profile. The intervention and teaching methods encompassed the entire group of 23 learners in this Grade 10 class. However, only the learners who fulfilled the requirement of submitting agreement forms and obtaining parental authorisation were considered as part of the research sample. After the data collection was finished, all the responses obtained from the research instruments were thoroughly examined and assessed. An integral component of qualitative data analysis is the formulation of themes, which entails a systematic exploration for patterns to generate thorough descriptions that shed light on the phenomenon being investigated. Re-listening to the audio tape in its whole or segments can also be beneficial (Gale et al., 2013). After reading and rereading the transcripts, it was easy to spot important themes that pervaded the data gathering. Subsequently, the research inquiries were linked to the emerging patterns to establish a connection between the newly generated data and the specific research being examined. Noble and Smith (2014) contend that qualitative research is often subject to criticism due to its perceived deficiency in scientific rigour. The criticism arises due to the inadequate elucidation of the methodology utilised, a dearth of transparency in the analytical procedures, and the notion that the conclusions are simply a compilation of the researcher's subjective viewpoints, rendering them vulnerable to prejudice. In a similar vein, Carcary (2009) notes that consistency is crucial for ensuring reliability in qualitative research.

In qualitative research, a certain degree of variability in outcomes is acceptable as long as the technique and epistemological logistics consistently yield data that can be compared based on their ontological nature, notwithstanding potential differences in richness and ambience within similar dimensions. To ensure the dependability of the outcomes, qualitative researchers make an effort to develop and utilise methodological approaches (Noble & Smith, 2014). Employing various data collection techniques, such as spreadsheets and a semi-structured interview schedule, and subsequently triangulating the data, has the potential to bolster the credibility and reliability of the research's conclusions. The validity of qualitative research is contingent upon the appropriateness of the instruments, procedures, and data employed. To effectively investigate a research question, it is crucial to utilise an appropriate methodology, ensuring that the design is consistent with the chosen methodology, employ accurate sampling and data analysis procedures, and derive conclusions and results that are pertinent to the sample and context (Waterman, 2013). The probability of accurately transcribing data that contains a significant amount of information was enhanced by utilising audio recording technology to capture the material word for word. For research logistics to be considered transparent or methodical, each phase, such as theory creation, research design, sampling, data gathering and analysis, outcomes, and conclusions, must undergo validation. This guarantees that the research methodology and results are highly stringent and dependable (Noble & Smith, 2015).

1.10. Overview

This research elaborates exemplarily how to use Microsoft Teams for the learning about the Trigonometry Functions. Its chapters divide in seven sets with References and Appendix. By no means, every section of the research report is styled in a manner such that different characteristics of the topic are thoroughly explained. A structure of the research has been presented in this chapter and its main parts have been indicated.

Chapter Two

Chapter two entails issues relating to Mathematics teaching and learning both globally and nationally in education mostly pertaining with traditional teaching and learning. This chapter deals with how trigonometric functions has been taught using traditional methods. A literature review focuses on relevant literature comprised of different sources to create an effective theory for the research. It critically explores earlier studies, accounts, and theories on traditional approaches and collaborate learning.

Chapter Three

Chapter three entails issues relating to technology advancement in education, mostly pertaining to online learning platforms. The chapter above deals with how platforms such as Microsoft Teams are changing the learning processes of mathematical ideas, especially trigonometry in this case. The chapter details the advantages and disadvantages of Microsoft Teams and its application in teaching and learning. The review considers the challenges posed by online learning to learners.

Chapter Four

Chapter four of this work presents and discusses the theoretical framework guiding the research. Through the use of dialogues and descriptive writing, attention is drawn to the role of individual educational theories, such as socio-constructivism and connectivism. The theories upon which the research adopts an approach to online learning in this chapter are explored thoroughly to serve as a conceptual frame against which the research questions are viewed. Explanation of the main points of all trigonometry theories is given, as well as their interconnections and implications toward online learning with use of Microsoft Teams. This chapter also explores the theories; issues and implications that help the web instructors understand concept of effective teaching and learning on the web.

Chapter Five

The research methodology is covered by chapter four where approaches used in the research are discussed. The fourth section addresses the reasons behind the selection of the interpretive paradigm and the qualitative research methodology. The setting of the research is described detailing the context in which this research was undertaken, and the methods used in selecting samples. Chapter five describes in detail how the researchers designed the research giving detailed focus on the data collection measures such as interviews, observation and documents analysis. These methods are vital components towards comprehension of how leaner's see using Microsoft Teams for trigonometric function learning process. The chapter touches on the ethics involved and how the process undertaken was guided in a bid to ensure objectivity and authenticity.

Chapter Six

Chapter Five is critical in presenting, and discussing in a descriptive manner, the findings of the research. The chapter starts off with applying percentage using Microsoft teams' pre-and post-task responses. The research gives a close examination to all the responses made by the distance learners for both parts. The chapter provides a judicious comparison of the two response modes showing clearly how they influenced learners' learning. This section is excellent in placing the interviews into a proper context, it provides an understanding of the setting in which the interviews were conducted, the selection and learning about the respondents, and finally the rationale behind the questions, the actual questions and the overall objectives of the interviews. This context is crucial as it helps the reader to get to know the background of each of the respondents, their profile, my relationship and the meeting in which the interviews were conducted. It is very well-written and does not require any further explanation of the setting, the destination and the length of the research project. An interesting feature of the interviews is that bullet point format of questions, it makes the narrative more interesting and informative. Overall, the researcher rates this section of the chapter as excellent as it is easy to follow, very thorough and appropriate.

Chapter Seven

This chapter deals with emerging themes from the research findings and how these relate to the main research question. The chapter starts systematically by responding in a very clear and evidence basis for each of the main research questions. This chapter discusses at length the role of Microsoft Teams in comprehending trigonometric functions. The main features in Microsoft

Teams that make it useful for teaching mathematics are assessed, including interactive elements and visual aids, among others, as well as the capacity to provide instant feedback and collaboration.

Subsequently, the narrative traces the relationship between the research's theoretical framework and the evolving themes. The socio-constructivism approach and Connectivism intersect to provide better clarification to this research’s findings. This chapter seeks to unravel how various theories inform the complexities associated with internet-based education and why the Microsoft team facilitates the learning of Trigonometry.

Chapter two also discusses how these findings can further help improve the research regarding the use of educational technology in mathematics education. The paper also explains how to use the inferences from the research to enhance the design and implementation of online education systems for both learners and teachers. The final part of the chapter is an insightful conclusion reflecting on what this research did and did not reveal on the importance of tech use for math instruction

Chapter Eight

The final chapter of the research aims to bring together the key findings of the research, summarise the contributions of the research, and report on the conclusions of the research based on primary and necessary compounds. To achieve these objectives, Chapter Seven presents a comprehensive summary of the issues involved, synthesising how what was studied, as described in Chapter Two, has been brought together in Chapter Seven in the last chapter of this research.

It then sums up the insights acquired from the research while concentrating on the implications of these findings, which are related to the use of Microsoft Teams and other platforms in an educational environment. Additionally, the chapter provides practical suggestions for educators, policymakers, and software developers who strive to optimise online environments for learning. This chapter details how we apply the insights gained from the research in building more effective online learning tools for supporting the teaching of complicated subjects such as trigonometry.

Moreover, the chapter discusses the constraints that arose during the research. It provides a diagnostic of the problems faced in undertaking the research, including any restrictions in regard to the research design, sample size, or data collection procedures. The chapter also mentions the areas where the researcher needs to examine to find new questions regarding the research as well as it identifies problems with the research which is being done. To summarise the chapter (and by exten-sion the thesis), the chapter presents brief overviews of how each of the three ques-tions was addressed in the cor-pus data, offers a conclusion, and under-scores the significance of the work for learning from online collaborations in mathematics education. Most importantly, by systematically collecting and analysing log files of interactivity in an online learning environment, and by collecting chat data to complement this interactivity analysis, this research has established the potential of using Microsoft Teams as a plat-form for understanding mathematics learning, a poten-tial with-out which there is so much we still will not know, or not know as well, about learning with technology.

As the last segment of an investigation venture, the conclusion allows the author to reflect on and, in the long run, fuse the different times of the research or to clarify how the community of the paper's featured heading groups data. The conclusion at that point serves as a cut-off point for the examination venture and will be the most noteworthy and helpful content conclusion of every research.

1.11. Summary

Chapter one introduces the research. It emphasised the importance of exploring virtual platforms like Microsoft Teams in teaching Grade 10 learners in mathematics. The chapter provides an overview of the study's research objectives, which include investigating learners' perceptions of Microsoft Teams, its effectiveness in improving knowledge of trigonometric concepts, and its role in facilitating learning, collaboration, self-efficacy, and engagement. It also highlights the rationale of the study, emphasizing its contribution to addressing the need for effective online learning strategies in mathematics education. It outlines the research questions and discusses the theoretical frameworks of social constructivism and connectivism that guide the study. Additionally, the chapter provides context for the research, including the specific location and the rationale for choosing this setting. Finally, the chapter concludes by summarising its key points and setting the stage for the subsequent chapters.

The literature on various viewpoints about the teaching and learning of mathematics was explored and discussed in the following chapter.

Chapter Two: Literature Review: Mathematics Teaching and Learning

2.1. Introduction

Trigonometry is important to mathematics because it is used widely by scientists and aids thinking. Learning trigonometry in the early grades is very important since it prepares learners for many other more complicated mathematical subjects they will encounter at both colleges and workplaces. The present chapter will discuss different approaches used worldwide, including those in South Africa, to teach students trigonometry efficiently. Microsoft Teams constitutes a modern dimension in education brought about by the emerging online learning platforms. These platforms provide different tools and functions that can make the learning environment extraordinary. Their use in real classrooms, especially for mathematical subjects that greatly depend on problem-solving and interaction, is still an area that researchers have continued debating about (Wea & Kuki, 2021).

2.2. Mathematics Teaching and Learning: A Global Perspective

Angraini (2022) stated that mathematics is an essential topic that should be included in the curriculum at all levels of education. The main goal of researching mathematics is to nurture learners' mindsets and promote the growth of logical reasoning and expertise in the practical use of mathematical principles in everyday scenarios (Marchy et al., 2022; Mayani et al., 2022). The primary objective of the mathematics curriculum is to facilitate the comprehension of mathematical concepts and principles, which may be utilised to solve routine and non-routine problems. Additionally, it emphasises the development of logical reasoning skills, effective communication, and the ability to establish connections between mathematics and other scientific disciplines. The mathematics curriculum also aims to guide mathematics research towards future-oriented skills such as logical reasoning, systematic thinking, critical analysis, rigorous examination, honest evaluation, disciplined approach, fostering creativity, and cultivating an objective and open-minded mindset. The contemporary era demands more than mere mental knowledge. The capacity to utilise abstract knowledge and analytical reasoning is crucial to meeting the requirements of contemporary society. The concept of the 21st-century skills revolution has emerged as a prominent subject of debate, particularly within education. In order to be globally competitive in modern science and technology, a country must prioritise education (Mendrika et al., 2021). The pace of technological advancement in the present era is exceedingly rapid. This technological advancement has impacted nearly every sector.

Technology advancements have significantly affected the education sector (Nurtamam et al., 2024). Many lucrative and specialised career opportunities in the 21st century necessitate a strong emphasis on reading, writing, and mathematics proficiency. According to Prayudi et al. (2018), this profession requires critical thinking and problem-solving abilities, and the ability to collaborate, communicate, and exhibit creativity while using technology. In the 21st century, it is insufficient only to possess fundamental abilities like reading, writing, and mathematics. There is a demand for competent individuals who can effectively resolve intellectual and technical challenges. Koculu et al. (2022) posit that it is necessary to structure educational programmes to enable individuals to develop essential skills and competencies for the 21st century, including critical thinking, creativity, teamwork, and problem-solving.

Factors ranging from the nature of the mathematics problem itself to the inner and outer factors also influence one's math competency. Inside components embrace the mental abilities, motivation, personal attitude, abilities, knowledge, proficiency, and gender dimensions. In line with Canavan's (2018) outdoor learning theory, the external effects cts constitute a complex of factors, including tools, infrastructure, media, curriculum, lectures, professors, and learning environments. The number of learners from different backgrounds has become a challenge for teachers to tackle. The learners have varied math levels and, with this, various unique problem-solving skills. Having no one to stimulate and encourage the learner, who listens to lectures and gives no feedback, will prevent the learner from developing and harnessing his/her entire potential as an active learner. The screen window shows the user a blank screen. Critical thinking reflects cognitive ability in the order. Regular and focused instruction or supervision from an instructor is essential for developing an individual's capacity for critical thinking (Rasiman, 2015).

Critical thinking involves the cognitive process of organising information and actively engaging in an evaluation approach to solve problems. The scientific inquiry involves the analysing and evaluating data, which demonstrates the presence of critical thinking. The 1990 research from the Secretary's Commission on Achieving Necessary Skills highlighted the importance of critical thinking, decision-making, problem-solving, and reasoning skills in attaining exceptional performance (Cahyono et al., 2013). Critical thinking confers benefits in multiple domains, such as enhancing problem-solving abilities, facilitating effective decision-making, distinguishing between objective facts and subjective opinions, and maintaining emotional equilibrium when faced with difficult circumstances (Amin et al., 2020). Nunuk et al. (2020) conducted research which revealed that a significant proportion of learners, approximately 90%, demonstrate a decline in their level of activity. The evaluation outcomes for critical thinking, teamwork, communication, and creativity abilities during the early stage of online education revealed an average score of 68.78, indicating a subpar level of performance in these domains. This is due to the teacher's ineffective execution of their role as a facilitator (supporting learning), dynamicator (pushing change), and motivator (offering encouragement) in the learning process. Consequently, the endeavours to improve learners' cognitive capacities and 21st-century proficiencies, including innovative thinking, communication, teamwork, and creativity, cannot be fully achieved.

The Indonesian Ministry of Education has acknowledged critical thinking as an essential skill in their educational programmes since 2013. Therefore, it is crucial to offer extensive training to pre-service teachers to empower their active engagement in promoting critical thinking abilities (Rahayu et al., 2020). There has been a significant increase in research on critical thinking in recent years, especially in Indonesia (Siahaan et al., 2023). Therefore, it is crucial to thoroughly examine the literature related to this field. The bibliometric analysis method, as described by Phoong et al. (2022), can be utilised to examine research outputs in certain areas. Several literary studies have been conducted using analytical methods, as evidenced by the works of Muhammad et al. (2023). There was a lack of research on literature reviews related to critical thinking in Indonesia, specifically bibliometric analysis. Given this, researchers undertook a bibliometric assessment to analyse research patterns related to critical thinking in Pre-service mathematics Education Teachers from 2015 to 2023, using the Scopus database. This research aims to investigate the domain of critical thinking abilities in prospective mathematics education teachers, specifically in Indonesia, from 2015 to 2023. These studies assisted in reflecting on the need to improve learners' academic achievement in Indonesia, precisely in critical thinking. Hence, from these literature insights, it was essential to prioritise the development of critical thinking skills among future mathematics teachers in the context of this study.

Most people consider mathematics an essential subject affecting all facets of life. According to Ayebale et al. (2020), mathematics is highlighted as crucial to states' socioeconomic growth and serves as the basis of scientific and technical knowledge. According to popular opinion, mathematics is essential to all research disciplines since they all rely on it for problem-solving and outcome prediction. Japelj Pavesić et al. (2022) reports that several nations in Europe and

Asia have made significant advancements in learner achievement in mathematics. The TIMSS (Trends in International mathematics and Science Study) criteria have shown an improvement in the mathematics learner attainment of nations including Turkey, Singapore, Cyprus, and Japan. Improvements in the utilisation of digital content in education and a better learning environment are credited with this development (Japelj Pavesić et al., 2022). On the other hand, Sub-Saharan Africa (SSA) has been plagued by low mathematics learner achievement, primarily attributed to inadequate teacher knowledge of the subject (Pournara et al., 2015). A lack of necessary resources, a low socioeconomic status, the attitude of the learners toward the subject, and a lack of motivation (Davis et al., 2022). This demonstrates that a learner's total achievement depends on various elements, including the learning environment, the calibre of the teachers, and the learners themselves.

According to Pournara et al. (2015), most South African learners score badly in mathematics due to instructors' lack of expertise in the field. The majority of individuals hold upper secondary or post-secondary non-tertiary degrees as their highest level of education, according to the OECD (2019). Public funding of basic, intermediate, and post-secondary non-tertiary education accounts for a significant portion of South Africa's total educational expenditures (OECD, 2019). The achievement of learners in mathematics is still poor; nevertheless—substantial income disparities impact learner attainment. The South African government established the quintile system with five categories to address this issue (Ahuja, 2011). Quintile 1 represents the most economically disadvantaged people, while Quintile 5 represents those most economically privileged. Learners from disadvantaged backgrounds do poorly in mathematics due to their lack of access to sufficient learning materials (Nicholas et al., 2019), which indicates educational inequality in this subject—compared to learners in Quintiles 4 and 5, learners in Quintile 1 had more difficulty understanding, applying, analysing, evaluating, and synthesising mathematical issues (Ogbonnaya & Awuah, 2019).

According to Spaull et al. (2019), learners in Quintiles 4 and 5 excel more than their lower-performing counterparts because they pay higher tuition and can afford more resources for learning. The socioeconomic level of one's parents, according to Perera (2018), has a significant impact on learner outcomes. Compared to learners from impoverished homes, those from affluent families have better access to educational opportunities (Ogbonnaya & Awuah, 2019). In South Africa, the Coronavirus Disease of 2019 epidemic also impacted learners' achievement. To prevent the infection from spreading, learning had to continue from home. Although this was ascribed to a decrease in candidates retaking exams, the national pass percentage of South African matric learners fell from 81.3% in 2019 to 76.2% in 2020 (Reimers, 2019). Schools in low-income communities could not afford online education. A peaceful workspace, a desk, a computer, and the ability for parents to engage in home-based instruction were not available in disadvantaged homes (Cibi et al., 2024).

Two-thirds of learners in low-income homes, according to the South African democratic teachers' union (SADTU, 2021), had no contact with their instructors during the lockdowns. This indicates that they had various learning experiences and that the lack of learning inputs impacted their performance. According to Shepherd and Mohohlwane (2022), 3% of 15-year-olds and 9% of 17-year-olds dropped out of school in 2021. Illnesses, a failure to pay tuition, and poor academic performance are the causes of dropouts. Due to the Coronavirus Disease 2019 epidemic, there were more dropouts in 2020; remote learning was ineffective since there was little access to digital learning (Shepherd & Mohohlwane, 2022).

2.3. Mathematics Teaching and Learning: A South African Perspective

The South African Schools Act (SASA) of 1996 was enacted in the aftermath of the end of apartheid in 1994 to eradicate all inequalities present in the apartheid educational system. The SASA was created to establish an equitable and inclusive educational system that would not discriminate based on race, gender, or any other perceived inferiority by society. However, recent research suggests that despite the intentions of the SASA, inequalities persist in the South African education system. For example, research by Spaull and Taylor (2015) found that school inequalities in South Africa are still strongly linked to socioeconomic status, with learners from wealthier backgrounds attending better-resourced schools and achieving higher academic outcomes

The Trends in International Mathematics and Science Study (TIMSS) is a quadrennial survey by the International Association for the Evaluation of Educational Achievement (IEA). Additionally, it appraises and analyses the condition of mathematics education in South Africa. The primary aim of TIMSS is to evaluate the calibre of mathematics and science instruction on a global level. TIMSS is a prestigious assessment that offers insights into learners, their schools, and their households and how these variables are connected to their performance in Mathematics and science. The TIMSS research in South Africa is conducted through a collaboration between the Department of Basic Education, the International Association for the Evaluation of Educational Achievement (IEA), and the Human Sciences Research Council (HSRC). Recent research by Reddy et al. (2020) highlights the importance of TIMSS in providing valuable data for policymakers and educators to understand the state of mathematics and science education in South Africa and identify areas for improvement.

The findings of TIMSS offer vital information for participating countries to formulate policies and initiatives to enhance the standard of mathematics and science education. This is because TIMSS is closely linked to the curriculum content (Wijaya et al., 2020). Furthermore, research by Reddy et al. (2019) found that South Africa's performance in TIMSS has remained consistently low over the years, highlighting the need for targeted interventions to improve mathematics and science education in the country.

The South African educational system is governed by two separate institutions, notably the Department of Basic Education (DBE) and the Department of Higher Education (DHE) . The Department of Basic Education (DBE) oversees educational institutions spanning from Grade R to Grade 12 and adult literacy courses. Conversely, the Department of Higher Education and Training (DHET) oversees South Africa's institutions, post-secondary education, and the nation's strategy for cultivating human resources. The Department of Basic Education (DBE) oversees the provision, delivery, and performance of South Africa's educational standards to ensure they adhere to the Constitution. The legal jurisdiction of DBE is based on the 1996 South African Schools Act, the 1996 National Education Policy Act, and the 1998 Employment of Education Act. Extreme racial inequality characterised South African education before independence, and regrettably, these gaps continue to plague the sector even today (Lev et al., 2019).

According to Dilraj (2021), there is still evidence of apartheid's effects on the educational system in the form of a significant socioeconomic gap that prevents all learners from having equal access to school. The allocation of a significant portion of the national budget to the education sector demonstrates that the government of South Africa places the most significant domestic emphasis on education (Johnson et al., 2019). Although there are still many issues to be resolved, the nation has made tremendous progress in increasing the quality and accessibility of education for all (Maarman & Lamont-Mbawuli, 2017). Underqualified teachers and learners who lack the ability to compete globally are two of these issues (Johnson et al., 2019).

The school system's deteriorating infrastructure and subpar educational achievements, which support inequality, are another issue (Macintyre, 2020).

The 2019 Coronavirus Disease (COVID-19) epidemic significantly impacted the education sector. The pandemic exacerbated the already present educational system disparities (Chirinda et al., 2021). Due to the negative effects being kept out of school had on their capacity for research and social contact, disadvantaged learners become more susceptible (Duby et al., 2022). Since remote learning necessitates the use of infrastructure and technology like the Internet, TVs, and laptops, concerns have been expressed about the participation of underprivileged learners (Kamga, 2020). Depending on one's background, various resources were accessible, resulting in a variable learning experience (Reddy, 2016; Soudien et al., 2022). One of the teachers' unions stated that "there is going to be a generation of people who cannot read at all," which echoes what this meant for certain learners who lacked the facilities for online research (Macupe, 2021). According to calculations made by Spaull and van der Berg (2020), learners obtained just 5% of the education they would have in a typical traditional educational setting.

2.3.1. Curriculum Reforms in Post-Apartheid South Africa

The South African government has implemented curriculum reforms for citizenship education to specifically target the disparities and injustices resulting from the practices of the apartheid era. Education is utilised to accomplish this goal (Bantwini, 2009b). The main goal has been to remove any subject matter, teaching methods, and other elements that were introduced by the apartheid administration in education and utilised as a tool of oppression (Mnguni, 2013). To achieve social justice as mandated by the Constitution of the Republic of South Africa, new educational curricula have been established to provide the younger generation with updated knowledge and cognitive frameworks. The Constitution of the Republic of South Africa Act 106 of 1996 provides the foundation for enacting educational reform and modifying the curriculum within the South African education system (Gumede & Biyase, 2016). Since South Africa's first national democratic elections in 1994, several modifications to the curriculum have been introduced to democratise education and eradicate disparities within the post-apartheid education system (Jansen, 1998).

The South African Minister of Basic Education highlighted a notable shift in the post-apartheid era with the implementation of an outcomes-based curriculum reform, which marked a departure from the education system under apartheid. The government's primary educational initiative, Curriculum 2005, was launched in 1997 to fully integrate into the education system from Grades 1 to 12 by 2005. The curriculum, as stated by Motshekga (2009), was designed to completely replace the educational system that existed during apartheid and eliminate South Africa's lingering effects from that era. It represented a notable shift from a curriculum-focused method of education to one that prioritises the learner's needs and focuses on achieving specific results.

The National Department of Education (2004) outlined the core principles that formed the basis of Curriculum 2005. The principles encompassed in this framework are integration, holistic development, value, ownership and involvement, accountability and transparency, learner-centeredness, adaptability, critical thinking, progress, an unbiased approach, inclusion of learners with needs in education, quality benchmarks, and international comparability. Thus, the inclusion of Outcome Based Education (OBE) in the Curriculum (2005) marked a notable and sudden departure from the education system that existed during apartheid (Vithal & Volmink, 2005). The government aims to shift learners away from rote learning, characterised by the mere memorisation of taught material, towards an educational approach that fosters critical thinking (Khuzwayo & Mncube, 2017). To accomplish this, they employed an outcomes-based methodology.

The South African Constitution aims to create a society founded on democratic principles, social fairness, and fundamental human rights. The attainment of these objectives is greatly contingent upon education and the curriculum. Motshekga (2009) highlighted that a reassessment was undertaken in 2000 due to the introduction of OBE as a component of the Curriculum in 2005. Due to the OBE system's esoteric terminology and the Department of Education's inadequate training, educators found it difficult to comprehend. Implementing OBE in many schools has proven challenging due to its 67 Specific Outcomes, distributed across eight Learning Areas and designed to be integrated into Learning Programmes.

The National Curriculum Statement (NCS) Grades 10–12 and the Revised National Curriculum Statement (RNCS) Grades R–9 were established in 2002. In 2009, the Revised National Curriculum Statement (RNCS) of 2002 and the National Curriculum Statement (NCS) for Grades 10-12 were modified to create the Curriculum and Assessment Policy Statements (CAPS) because of ongoing difficulties in implementing them. In 2012, the two National

Curriculum Statements, one covering Grades R–9 and the other covering Grades 10–12, were combined into a single document known as the NCS Grades R–12. The National Curriculum Statement (NCS) for Grades R–12 seeks to augment and expand upon the previous curriculum by offering a more comprehensive and precise framework for the content that should be taught and acquired on a term-by-term basis.

Although the NCS experienced a period of relative stability, researchers, teachers, and other stakeholders expressed worries about the preparedness of instructors to embrace the NCS. Gumede and Biyase (2016) cited concerns about inadequate teacher preparation and the lack of government funding and support for effectively implementing the NCS curriculum. The National Curriculum Statement (NCS) was modified and put into effect as the Curriculum Assessment Policy Statement (CAPS) in 2012 (Erduran & Msimanga, 2014; Khuzwayo & Mncube, 2017). The CAPS curriculum has been implemented and has been accompanied by numerous initiatives for teacher training and distribution of resources. The CAPS curriculum document is an extensive and concise policy statement that offers instructors clear instructions on the content to teach and the methods to use for assessment. The text also outlines the fundamental aim, guiding principles, and objectives of basic education, which are presented within the context of each subject's CAPS paper. The CAPS document for each topic comprises an introductory section outlining the subject's aims and guiding principles and detailed information regarding its teaching methodology, learning outcomes, content requirements, and assessment criteria.

Similar to other developing countries, South Africa has concentrated chiefly on revising the learning goals, the given material, and the instructional design in its curriculum reform efforts (Chisholm & Leyendecker, 2008; Gumede & Biyase, 2016; Mnguni et al., 2020). Schools have also experienced significant infrastructure modifications, such as integrating computer-based learning. While these improvements have been advantageous, one may question their sufficiency in achieving the desired educational objectives related to citizenship, especially in STEM education. A curriculum is a deliberately designed and closely monitored sequence of educational activities developed by an educational authority and carried out by educational institutions (Mnguni, 2013). Therefore, it is essential for curriculum reform to comprehensively address all aspects of the curriculum in order to accomplish the desired reform goals. This is of utmost significance because learners are not acquiring reading skills, mathematical knowledge, scientific understanding, or any other subjects and abilities that all participants in the educational system universally support. Conversely, learners are being instructed to adopt a meek and obedient attitude, value competition rather than collaboration, and suppress their creative inclinations (Martin, 1976).

Hence, a curriculum reform that exclusively prioritises learning objectives, content knowledge, and instructional design may not adequately accomplish the intended outcomes related to citizenship. Mnguni (2013) proposes that any curriculum change should prioritise the pedagogical justifications for teaching learners specific content knowledge using a particular pedagogy, in a specific sequence, within a specific environment, and by a specific group of personnel. According to Curriculum Theory Network., & Ontario Institute for Studies in Education. (1968), a curriculum can be either disciplinary or citizenship-oriented. Various knowledge domains are organised into a curriculum that focuses on certain disciplines, ensuring that specialised knowledge is taught in corresponding subjects.
According to Healy and Perry (2000), the curriculum is structured around the belief that reality can be understood by using strategies specific to each field, as stated by. Therefore, in a curriculum that focuses on specific disciplines, learners acquire specialised knowledge and investigative techniques that are unique to those disciplines. Some experts contend that education should be influenced by the sociocultural environments in which learners are situated rather than solely focusing on the content being taught (Dewey, 2004).

The main goal of this curriculum is to cultivate the acquisition of skills, interests, and behaviours that will empower individuals to become more proficient and involved citizens (Waghid, 2016). As per this perspective, education is a societal phenomenon that occurs inside societal establishments, facilitating the possibility of societal change as individuals cultivate a collective awareness of society. The degree to which education can be geared towards discipline or citizenship in an absolutist manner is a subject of debate. Mnguni (2013) argued that a curriculum is unlikely to be specifically designed for either viewpoint but rather for a synthesis of both. Considering these arguments, our current research aims to comprehend the ideological orientation of STEM courses in South Africa, specifically in relation to recent curriculum modifications.

The following are included in the NCS Grades R–12, which is a statement of policy for learning and instruction in South African schools:

- CAPS for all approved subjects.
- National policy governing the NCS Grades R–12 program and promotion requirements.
- National Protocol for Assessment Grades R–12.

The Department of Basic Education replaced the previous Learning Area Statements, Learning Programme guidelines, and Subject Assessment guidelines for all subjects in the National Curriculum Statement (NCS) from Grades R through 12 with CAPS. CAPS is a comprehensive and concise policy document issued in 2011. Public schools from Grades R to 12 are presently implementing the Curriculum and Assessment Policy Statements (CAPS) as a substitute for the National Curriculum Statement (NCS) to improve the availability of the curriculum for learners.

Following the installation of CAPS, a comprehensive and concise policy document has been made available to all subjects in every grade. This document clearly describes the specific instructions and assessments that teachers must follow, organised by grade and subject. This curriculum reform aims to enhance instructional uniformity and clarity while simultaneously alleviating the administrative workload on instructors. CAPS enhances the previous NCS curriculum by implementing more specific criteria for the content and skills that need to be taught and acquired in each grade on a term-by-term basis across all schools. The text provides an overview of the number of subjects accessible to learners in each grade, together with the requirements necessary for progression.

The CAPS curriculum outlines the specific courses and subject areas that must be taught in each grade, together with the allocated time, the significance of the subject areas in each phase, the desired results, and the relevant evaluation instances. All educational levels foundational (grades 1-3), intermediate (grades 4-6), senior (grades 7-9), and advanced education and training (grades 10–12) include mathematics instruction. Unlike the former curriculum, which granted instructors the freedom to teach according to their judgment, CAPS is prescriptive and mandates uniform implementation throughout the entire country (Jojo, 2019).

This curriculum aims to provide learners with practical knowledge and skills that apply to their everyday lives. The curriculum promotes the acquisition of information in local contexts while also considering global priorities, as mentioned in the curriculum and assessment policy statement (DBE, 2011).

According to Govender and Hugo (2018), the basic education curriculum in South Africa has been criticized for not meeting stakeholders' expectations. The efficacy of the latest CAPS curriculum in classrooms and its capacity to enhance educational benchmarks and transform the nation's schools have both been examined.

2.4. Trigonometry Teaching and Learning from a Mathematical Perspective

Trigonometry presents difficulties due to the intricate derivations and identities of many formulas (Kayla & Soylu, 2019). Aside from the multitude of shapes and identities, there are other diverse factors to consider, like quadrant placements, angles, and radians. Learners must comprehend foundational knowledge, such as the Pythagorean Theorem, and demonstrate proficiency in employing modelling approaches in conjunction with other mathematical principles, including quadratic equations and other interrelated ideas. Therefore, learners frequently face multiple challenges when acquiring knowledge in trigonometry. Obstacles to learning contribute to low learner accomplishment. Ratnaningsih (2020) defines learning attainment as the acquisition of knowledge or abilities, typically assessed by tests or grades assigned by the teacher. Learning barriers refer to the challenges or difficulties learners encounter during the learning process, leading to suboptimal learning outcomes (Subroto & Sholiha, 2018; Balkist, 2019).

Khaerunisa et al. (2022) contend that learning hurdles refer to the challenges learners have when comprehending content over many sections, which are mainly comparable to the difficulties faced by their peers. Furthermore, Fauziah and Cahyono (2022) disclosed that learning impediments may arise due to learners' inadequate comprehension of both the content and learning objectives of the examined material. Based on the various definitions provided, it can be inferred that learning barriers refer to the difficulties encountered by learners during the learning process, ultimately leading to poor academic performance. Challenges in acquiring trigonometry knowledge typically arise from inaccuracies in calculating or procedural skill deficiencies (Mensah, 2017; Rosjanuardi & Jupri, 2022). One of the main obstacles to learning trigonometry is the inability of learners to establish connections between different concepts and principles. Specifically, their understanding of the fundamental principles is restricted (Balkist, 2019).

Jatisunda and Nadi (2019) stated that the challenges faced in learning Trigonometry are caused by learners' limited comprehension of concepts, incorrect identification of formulas, and difficulty in addressing non-routine questions. Additional challenges arose from a deficiency in comprehending the linkage between the content of one subsection and other subsections (Janah et al., 2018; Sakinah et al., 2019; Saputra et al., 2021). Proficiency in mathematics is an essential skill that learners in the 21st century must possess. Mathematical proficiency serves as a key indicator for evaluating the effectiveness of a nation's educational system. The Organisation for Economic Cooperation and Development (OECD) conducted a comprehensive assessment of success through the Programme for International Student Assessment (PISA). This assessment has been conducted annually since 2000 and is repeated every three years. One of the three talents assessed is mathematical literacy.

As defined by the OECD, mathematical literacy refers to an individual's capacity to apply, utilise, and comprehend mathematical concepts in many contexts. Kurniawati et al. (2020) defined the capacity to comprehend mathematical issues and use them in practical situations. Conference on Husniati et al. (2020) examined the ability to arrive at logical and rational conclusions and judgements. Yudiawati et al. (2021) emphasized the capacity to conceptualise, apply, and decipher within diverse frameworks. Ugler et al. (2022) underscore the significance of attaining proficiency in applying mathematics to resolve tangible challenges. Andriyani and Wilujeng (2022) emphasise the significance of analytical, logical, and communicative proficiencies in resolving mathematical dilemmas. Supianti et al. (2022) explore the application of mathematical expertise in the context of problem-solving and interpretation.

Due to its connections to algebra, geometry, and pictorial reasoning, trigonometry is a crucial component of the mathematics curriculum in high school (Hokor & Arhin, 2021). Later studies like surveying, architecture, and engineering also depend on trigonometry. Learners must connect triangle diagrams to numerical relationships. According to South Africa's Curriculum Assessment Policy, Grade 10 learners must be able to draw trigonometric graphs and answer arithmetic problems to fulfil the curriculum requirements (Department of Basic Education, 2022).

Teacher-centred, learner-centred, and school-centred variables affect how difficult it is for learners to master trigonometry (Mabena, Mokgosi, & Ramapela, 2021). Learners' perceptions of mathematics as a challenging topic are among the learner-centred aspects. According to lhan et al., (2022), society's impression of mathematics as difficult is the cause of this perspective. As a result, learners develop a negative attitude that is anxiety- and fear-filled about the subject. The major focus of teacher-centred elements is the calibre of the teachers. Math teachers in South Africa are underqualified, which is a problem (Pournara *et al.* 2015). The state of the learning environment and the availability of resources are school-centred issues. According to Ogbonnaya and Awuah (2019), schools in South Africa's Quintile 1 lack access to sufficient resources to adequately prepare learners for life beyond school. This dearth of materials for at-home learning was also made clear by the coronavirus disease 2019 outbreak. For many learners from disadvantaged homes, resources like computers and internet access are out of their price range. This adversely impacts their performance. Information and technological tools like GeoGebra have been included in the teaching process to help learners grasp trigonometry. Innovative and artistic methods of learning are made possible by incorporating technology (Mokotjo & Mokhele, 2021). GeoGebra aids conceptual comprehension and fosters a learning environment where learners can find, investigate, and visualise topics (Mosese & Ogbonnaya, 2021). This fosters a conducive learning atmosphere.

Furthermore, Juan and Visser (2017) asserted that factors influencing academic success are influenced by factors outside the school setting, such as the family environment. Both learning settings give learners access to material and immaterial resources that might affect their proficiency in mathematics. The results show that school and home settings significantly impact learners' success, with the most substantial relationships being shown with using the test language at home. Furthermore, research has demonstrated a correlation between learners' motivation and engagement with the social environment and teacher-learner interaction in the classroom (Spangenberg, 2017). Their traits and unique methods of engaging with one another as part of their many existing connections and affiliations both within and outside of the classroom impact the changes in their learning as an outcome (Chan et al., 2018).

Umugiraneza et al. (2017) provide evidence that a positive affective disposition towards the subject is associated with a favourable attitude towards mathematics, while the inverse holds for a negative attitude towards mathematics. These emotional tendencies affect how people behave because they are more likely to succeed in a topic they love, are confident in, or find beneficial. Results from the South African portion of the TIMSS study showed a correlation between success and a positive outlook, with learners who reported being confident in their mathematical abilities scoring 89 points higher on average than the other group (Reddy, 2016).

2.5. Traditional Teaching Theories and Learning Approaches for Trigonometry

Trigonometry, a mathematical topic specifically with trigonometric functions, is now included in high school mathematics courses. Trigonometry is a unifying and overarching term for various mathematical areas, including geometry, functions, and calculus (Weber, 2008). Traditional learning occurs in a classroom with a teacher and employs instructional resources such as a blackboard or whiteboard (Fabriz et al., 2021). This type of instruction is used worldwide and enables verbal and visual dialogues. Traditional education also boosts learners' competitiveness and social skills since it allows them to engage with one another personally (Kumari et al., 2021). assert that there is general agreement that conventional face-to-face learning cannot be replaced by technology. Although it has gained popularity, many nations still favour conventional education, particularly for high school or secondary school learning (Kumari et al., 2021). This type of instruction is used worldwide and enables verbal and visual dialogues. Traditional education also boosts learners' competitiveness and social skills since it allows them to engage with one another personally (Kumari et al., 2021).

2.5.1. Traditional Learning Theories and Teaching Approaches to Trigonometry

A fundamental component of human cognitive processes is learning. It is a process that incorporates cognitive, emotional, and environmental elements in education and psychology to acquire or enhance one's knowledge and abilities. A great deal of scholarly investigation has been devoted to learning, leading to the formulation of many theories and models by authorities to elucidate its mechanisms. Recent research in educational psychology and cognitive science has continued to shed light on the complex nature of learning processes. For instance, Brod's (2020) research emphasises the importance of considering individual differences, motivation, and self-regulation in understanding how learners acquire and retain knowledge. Additionally, Shenaar-Golan (2021) highlights the role of social and emotional factors, such as classroom environments and teacher-learner interactions, in facilitating effective learning experiences. Furthermore, the rise of digital technologies and online learning platforms has prompted researchers like Greenhow and Galvis (2020) to explore the potential and challenges of integrating technology into learning environments. Primarily, learning theories fall under the following philosophical frameworks: Behaviourism, a theoretical framework formulated by John B. Watson (1878–1958), an American psychologist, posits that learning occurs when individuals acquire new behaviours under the influence of contextual elements, with no consideration given to autonomous mental processes (MSEd, 2019).

Cognitivism emerged as the prevailing learning theory in the 1960s, supplanting behaviourism. According to Mendonca et al. (2007), the proposition is that knowledge can be conceptualised as the formation of symbolic mental constructs, and learning is delineated as the modification of an individual's cognitive structures. To provide further clarification, the learning process involves encoding the stimulus input, wherein the memory is employed to locate the relevant input information. The interpretation of the input data to produce new knowledge then ensues. Furthermore, this knowledge is then generalised to apply to different situations and categorised within the learner's existing cognitive schemata. By adopting this approach, individuals can access, as needed, novel information from their cognitive framework and apply it to resolve relevant issues. Observations of the learner's actions indicate the cognitive processes in their head. Cognitive theories delve into the neurobiological mechanisms of learning, going beyond just behavioural observations. Recent research in cognitive neuroscience has shed light on the neural correlates of learning processes. For instance, research by Cabeza et al. (2018) examined the role of different brain regions in encoding, consolidating, and retrieving memories. Additionally, Schweppe and Rummer (2014) highlight the involvement of specific neural networks in attention, working memory, and long-term memory formation during learning.

Constructivism is a philosophical paradigm derived from Jean Piaget's theory of learning. Von Clasersfeld et al. (2019) formally introduced the concept during the 1970s. Constructivism posits that knowledge is not passively acquired from the environment but actively constructed by the learner. The adaptation process is perpetually modified in response to the learner's experiences, which influence it (Taber, 2011). Commonly, this framework is referred to as cognitive constructivism. The integration of constructivism and Vygosky's theory of social development resulted in the formation of the theoretical framework known as social constructivism (Crawford, 1996; McKinley, 2015). Learning, according to Vygotsky, takes place in a sociocultural environment. Using negotiation within the learning environment, shared meanings are established, which culminates in forming collective knowledge. Communities of Practice (CoPs) consist of members who possess specialised knowledge or are active practitioners within a particular domain. They come together to improve their skills and knowledge through regular interaction, allowing personal and professional development (Doabler & Fien, 2013). The fundamental distinction between cognitive and social constructivism is their respective views on the relationship between thinking and language.

Cognitive constructivism posits that thinking comes before language, whereas social constructivism supports the opposite perspective. The purpose of teaching is to facilitate the acquisition of knowledge in the relevant subject. Although theory offers methods for analysing learning, teaching mostly lacks theoretical underpinning. Theories serve the purpose of analysing and explaining; however, they seldom offer explicit guidelines for practical application. Explicit instruction (EI), founded predominantly on cognitivist principles, was the dominant method of mathematics education. To maximise the learning experience, the instructor plays a pivotal role in this methodology by employing clear statements and explanations of the mathematical context and facilitating the transmission of new knowledge to learners via guided practice (Smit et al., 2007). An important critique of EI is its potential to impede conceptual comprehension and critical examination (Kinard & Kuzolin, 2008). Consequently, numerous educators, embracing the principles of constructivism, enhanced educational instruction (EI) by incorporating a set of thought-provoking inquiries to engage in dynamic discussions with learners, thus fostering the development of mathematical reasoning (Chaijaroen et al., 2020).

Nevertheless, after the unsuccessful implementation of the "new mathematics" in schools, constructivism and socio-cultural learning theories have gained significant popularity in recent decades as foundations for teaching and learning mathematics. This is particularly true among elementary and secondary school teachers. A multitude of novel pedagogical approaches have been adopted, including problem-based learning (Research on applications of PBL teaching model in higher mathematics teaching in application-oriented colleges, 2018b), application-oriented teaching integrating mathematical modelling (Voskoglou, 2019a), inquiry-based learning fostering creative exploration, and the formation of teacher-student Communities of Practise (CoPs) (Doabler & Fien, 2013). One prevalent pedagogical approach that adheres to this structure is the "5 E's" educational method. The five sequential phases of treatment are denoted by the acronym "5 E's": engagement, exploration, explanation, elaboration, and evaluation (Voskoglou, 2019b). The "5E's" approach promotes constructive interaction between educators and learners, enabling the creation of novel insights through the expansion of prior knowledge and experiences. Efforts to implement these teaching methods in mathematics departments of scientific universities have also been documented in the literature (Lahdenpera et al., 2019; Voskoglou, 2019b). However, the results are complex and interconnected. Over the past two decades, significant advancements have been achieved in examining the mechanisms via which learners develop comprehension of mathematical concepts (mathematical cognition) and learn numerical skills (numerical cognition). By combining experimental psychology, neuroimaging, and single-cell recording techniques, scholars have collaborated to ascertain how these foundational capabilities support the comprehension and implementation of abstract mathematical principles (Gallistel, 2005).

2.5.2. Advantages of Traditional Teaching and Learning Approaches to Trigonometry

By its nature, traditional teaching is dynamic because it offers face-to-face instruction in real time and prompts creative inquiries (Jeganathan & Fleming, 2020). The learning process in traditional teaching is more engaging because the teacher can respond quickly and provide feedback. The majority of studies that favour traditional teaching are of the idea that it is beneficial because it offers a conducive learning environment. Traditional classrooms are well-prepared learning environments that incorporate pre- and post-class dialogues between fellow learners as well as teachers or instructors.

Another advantage of studies that favour traditional teaching is its easy accessibility of the teachers and other staff members to learners. With conventional schooling, learners can access other teachers, librarians, and administrators who may help them choose courses and locate learning materials. Learners learn to cooperate with their work when they engage with numerous staff members (Chinenye & Divine, 2020). Some researchers believe that traditional teaching is also beneficial because it offers a conducive environment for social interactions through contact with fellow learners before and after class, as well as during extracurricular activities. Salim et al. (2019) claim that learners who participate in classroom learning tend to enhance their social skills quickly. This also helps learners' communication abilities and shapes their personalities (Paul & Jefferson, 2019). In partnership learning, where learners are interested in how their peers learn, according to Chinenye (2020), learners communicate with peers. When learners are engaged in traditional teaching, they can participate in extracurricular activities, and it is through extracurricular activities like athletics and theatre that traditional learning enables a learner to discover more latent abilities (Salim, 2019).

The consistency and continuity that traditional teaching methods create for trigonometry are highly instrumental. Such a stable "classroom environment", wherein learners keep encountering the subject matter, becomes especially important in the case of trigonometry, a discipline within which concepts are interdependent (Naidoo & Parker, 2020). Frequent exposure to these concepts in a regulated setting can improve understanding and retention. This notion is supported by research in mathematics education, such as the research by Naidoo and Parker (2020), which found that "consistent and structured classroom environments promote better conceptual understanding and retention of mathematical concepts, particularly in subjects like trigonometry where ideas build upon each other" (p. 178). Additionally, a meta-analysis by Hiebert and Grouws (2007) concluded that "instructional approaches that emphasise connections among mathematical ideas and continuous revisiting of concepts in a coherent manner led to improved learning outcomes in mathematics, including trigonometry" (p. 383).

Immediate clarifications and resolutions at a teacher's discretion are another benefit of conventional instruction in trigonometry (Kissane & Kemp, 2009). Learners are free to ask questions and raise issues of concern immediately while still in the classroom environment, enabling teachers to solve them immediately. Instant feedback plays a significant role, especially in a topic such as trigonometry, where misconceptions usually result in additional learning problems. Different types of instruction, such as showing geometry examples or using real-life applications of trigonometry, will help the concept become more concrete.

Also, typical classrooms can develop a feeling of commonality and shared learning experience among learners. Most importantly, this can be very helpful when learning trigonometry, as learners can learn from one another and ask their peers for assistance. This involves collaborative learning activities that include group problem-solving or peer tutoring, whereby the learners discuss and analyse specific trigonometric concepts to appreciate them more. In addition, conventional classrooms commonly use tests with a fixed format, which may benefit trigonometry (Zamorano Urrutia et al., 2019). Learners are constantly evaluated through regular tests, homework, etc., for their mastery of concepts and advancement in classwork. Teachers can detect weak points in the learners with these assessments and direct attention to areas with more need for assistance.

Figueiredo and de Lourdes Bastita (2018) add that the cognitive approach is not the only benefit of traditional teaching methods in trigonometry but also the development of non-cognitive skills like resilience and perseverance. Learners may learn life skills such as persevering to complete a challenging task after working hard on understanding complex concepts over time. Traditional classrooms, characterised by routine homework and tests, make learners disciplined and good at time management, which is relevant for school and work environments.
Tactile or manual learning devices like geometric models and physical manipulations could be used by traditional methods (Prabowo et al. (2018). The tangible nature of these hands-on tools enables learners to envision abstract mathematical concepts vividly, making them more involved and efficient.

In contrast, modernised instruction arrangements typically provide cross-disciplinary approaches that involve trigonometry in pragmatic fields such as physical sciences, engineering, and art engineering. In return, an interdisciplinary approach, being the most effective response, offers the opportunity to make trigonometry on the syllabus relevant again, thanks to the fact that it shows how trigonometry concepts can be applied. Similarly, the example that the researcher could mention would be a discussion about the role of trigonometry in architectural design or the movement of celestial bodies like planets and stars. This might spark interest in the learners, motivating them to learn more.

Ultimately, the conventional school environment is nice for beginners to find mentors and mentees. The one good is often led by the example of professional experience and passion, which the best teachers have for their subjects and can also be taught to the learners. Perhaps in trigonometry, a teacher may give cases of real-life situations that he faced, and then he could explain to the learners how the different concepts were applied to arrive at a solution. Through that, the learners can know the available careers and opportunities associated with mastering the concepts.It should be acknowledged that although new forms of trigonometry teaching may have emerged in the education market, old ways still remain strong. They provide a regular, well-arranged, understandable process of researching this discipline. In addition, these approaches help learners' mental understandings of difficult trigonometry topics and develop vital skills and attitude necessary for life-long personal success and achievements in learning.

2.5.3. Disadvantages Of the Traditional Teaching and Learning Approaches to Trigonometry

Trigonometric functions, which are derived from the concept of trigonometry as ratios of the sides of a right triangle in a unit circle, are included in calculus classes. Various research has reached a consensus that the conventional approaches used to teach trigonometry are insufficient in familiarising learners with trigonometric functions (Kamber & Takaci, 2017; 2001; Weber, 2005). The conventional approaches described here entail instructing the courses step-by-step, focusing on definitions, theorems, proofs, and problem-solving related to trigonometry, specifically in the context of right triangles. Learning in traditional methods is costly in terms of time, money, and travel costs, traditional education is expensive (Aithal & Aithal, 2016). If online learning were used, schools might not have had to pay for things like energy (Bershadskaya et al., 2019).

The learning in traditional methods is passive, often teacher-centred, and mass education has a "one size fits all" philosophy (Klimov, 2012). This view is corroborated by recent research, such as research by Gill (2021), which found that "traditional, lecture-based teaching methods in mathematics classrooms tend to promote passive learning and a one-size-fits-all approach, which can hinder conceptual understanding and engagement, particularly in subjects like trigonometry" (p. 124). According to Tularam (2018), a teacher-centred strategy causes learners to cram material and lose it shortly after finishing an exam. Comprehending mathematical concepts can be rather arduous for learners. Nevertheless, if learners fail to engage in self-inquiry and problem-solving, they are not actively engaging in the field of mathematics. While completing a mathematical activity, a learner may make a mistake. Mistakes arise not only from lack of knowledge, uncertainty, or chance but also from previously held beliefs that were formerly considered valid and successful but are now proven to be erroneous or unimportant. Errors of this nature are not unpredictable and random (Brousseau, 2006).

This notion is supported by recent research, such as Gómez-Chacón et al. (2022) which indicate that an error can be discovered by observing the outcome of learners' work. In the research conducted by Kamber and Takaci (2017), a learner applies the property $\sin(mx) = m \sin(x)$ to calculate the value of $\sin 270°$. The learner gets the result that: $\sin 270° = \sin(3.\ 90°) = 3.\ \sin 90°$. The learner recognises the validity of the property in algebra and subsequently employs the equation to ascertain the remaining sine values of angles. During the analysis of this error, it prompts inquiries. Do the learners lack comprehension of how to determine trigonometric values? Are the learners employing incorrect concepts? Do the learners confuse the comprehension of algebra and trigonometry? Do the learners comprehend the significance of sine? Do the errors arise from the learners' pre-existing knowledge or during the learning process? Undoubtedly, every learner possesses explanations or arguments that bolster their answer. The learner employs a concept within a specific context and transfers it to another situation (Brousseau, 2006). This phenomenon of learners transferring concepts from one domain to another, often leading to errors, is also highlighted in recent research by Durkin and Rittle-Johnson (2023), who emphasised the need for explicit instruction to help learners distinguish between related but distinct mathematical concepts.

The learners may be unaware that their actions are erroneous, as they perceive them to be logical. The learners' error signifies the learning impediments they encounter. The hurdles emerged due to a lack of adequate scenarios experienced by learners, which hindered their ability to acquire accurate and comprehensive knowledge (Abrams., 2021). This view is consistent with recent research by Cárdenas et al. (2021), which suggests that "providing learners with a wide variety of contextual examples and problem-solving scenarios can help them develop a deeper conceptual understanding and avoid common misconceptions" (p. 82). Multiple scholars (Kamber & Takaci, 2017; 2001; Weber, 2005) have examined the challenges faced by learners in acquiring trigonometric skills. Nevertheless, there was a lack of examination of the comprehension of trigonometry among learners, specifically concerning the epistemological barrier. The categorisation of learners' difficulty based on identifying obstacles in their learning process will aid teachers and educators in effectively addressing misconceptions and errors.

However, teaching trigonometry in the traditional way only results in shallow understanding because learners mainly memorise or perform procedural practices without deep conceptual sense (Omer, 2015). It could lead to disoriented learning by learners who might perceive trigonometry as some unrelated jumble of ideas with no real-life application. Such a fragmented approach to trigonometry could lead to severe handicapping when applied to solving problems. Conventional trigonometry training is out of context, limiting learners' understanding of how to apply trigonometry in practice fields. Lacking contextual learning, many learners may view trigonometry as detached from reality. As a result, they may find that trigonometry is irrelevant or motivating to them (Kissane & Kemp, 2009). If the learners cannot relate to their learning, it can lead to low absorption and poor scoring.

In addition, the approach in trigonometry using a traditional approach is mostly designed according to only one specific learner profile or way of learning. However, in a typical classroom, all abilities and individual learning styles exist; therefore, old methods of learning are generally based on the "one-size-fits-all" principle and may be ineffective for those learners whose behaviour does not conform to a traditional model (Prabowo et al., 2018). It is essential in trigonometry as it heavily relies on visuality and spatiality. A traditional classroom may offer little support for learners who may excel in such areas at the same time.

In addition, typical ways of instructing trigonometry are seldom provided with mechanisms for teamwork and student input. Collaborative work is an essential competency that most professional settings may require; however, the conventional classroom setup tends to focus on individual assignments and grading, impeding learners' development of teamwork proficiency (Bueno-ravel & Gueudet, 2009). This isolation can harm learning trigonometry as working together in groups to solve complex problems can significantly improve comprehension.

Additionally, the evaluation techniques of the common trigonometry teachings concentrate mainly on memorisation and the ability for computations instead of comprehension and critical reasoning. Some factors that standardised tests and exams cannot prove include the comprehension aspect of trigonometry, how well a learner can use it outside of the textbook and how to solve problems. Emphasising rote learning can also turn learners' minds off the essence of creativity and the significance of original and imaginative thinking.

This also points to problems associated with traditional trigonometry teachings, such as the inadequate integration with advanced information and communication technologies, which are now key elements of mathematics education processes. Technological applications like simulation and visualisation can help trigonometry learners understand the concepts better (Urrutia et al., 2019). Nevertheless, trigonometric concepts could be applied in the context of a traditional classroom while using current-day technologies.
Traditional teaching methods for trigonometry are typically teacher-directed, in which the teacher is the only known and accepted authority. The consequence is that imposing such a

dynamic on the learners may prevent them from understanding mathematical ideas through independent learning or discovery. Many teacher-oriented settings also crush learners' creativity, thus hindering intra-personal independence skills. Additionally, many traditional trigonometry teachings do not fully equip learners for higher learning and job readiness, which requires an in-depth grasp of mathematical theories and their application in different situations. Zamorano Urrutia et al. (2019) argue that failure to incorporate problem-solving in traditional teaching may not prepare a learner to excel in higher-level mathematics and other related subjects.

Many advantages are associated with using traditional techniques for teaching trigonometry, but several drawbacks exist. Some limitations associated with the current instructional mode include an emphasis on procedural approach rather than concept understanding, lack of real-life applicability, provision of learning opportunities unsuited to various cognitive development stages, inadequate peer group activities, inadequate assessments, and poor adoption of information technologies. Therefore, this paper explores the limitations of the current methods used in teaching trigonometry to learners, such as the need for a more whole, learner-centred approach, which emphasises conceptual understanding, application, collaboration, and using technology.

2.6. Mathematics Teaching and Learning Using the Collaborative Teaching and Learning Approach

Mathematics teaching and learning have been characterised by many problems that are often considered the remedy to the learner's inability to construct their understanding of the subject matter. In particular, the search for an appropriate pedagogical approach within the context of specific educational cycles has inundated the literature in recent times (Asomah et al., 2022; Vernon et al., 2022). Literature exemplifies pedagogy as the bane of teachers' efforts to provoke learners' interest and understanding of concepts in the subject matter (Asomah et al., 2019; Core et al., 2020). The absence of educational approaches tailored to the content of mathematics results in the missed potential for developing thinking and understanding in mathematics (Ross et al., 2011).

According to Yasar (2016), numerous scholars have focused on adopting a practical, relevant, and student-centred approach to teaching. The cooperative teaching and learning approach

(CTLA) is a pedagogy that enables learners to individually and collectively comprehend the subject matter in a classroom setting. This technique emphasises collaboration among learners and has been supported (Johnson & Johnson, 1998; Slavin, 2013). This is because it fosters awareness among instructors to guarantee that learning experiences are customised to optimise learners' involvement during instruction (Johnson et al., 2014). Moreover, the utilisation of a collaborative teaching and learning approach as an instructional instrument in the classroom setting promotes a specific type of logical thinking that is superior, enhances motivation, and enhances both interpersonal and intrapersonal interactions among members of a group (Edekor & Agbornu, 2020; Slavin, 2013; Vernon et al., 2022).

By promoting collaborative work among learners, individuals can develop a strong sense of belonging and mutual support during the teaching and learning process (Senyefia et al., 2021; Gillies, 2003; Gillies & Ashman, 1996). However, its implementation in the classroom context has been researched to be problematic (Gillies & Boyle, 2010; Rešić et al., 2016). Again, the features of cooperative learning seem to be interrelated and interact in varying ways to influence teachers' decisions regarding its use as an instruction in the classroom (Johnson et al., 2014; Slavin, 2013). Thus, educators need to provide educators with the fundamental understanding and abilities to distinguish and label each of these characteristics of the collaborative teaching and learning approach to enhance learners' understanding of the subject matter. Consequently, strengthening the teacher's capacity to design, develop and enact lessons anchored on the collaborative teaching and learning approach (Hamadi et al., 2022).

Adopting a collaborative teaching and learning approach necessitates substantial change in conventional pedagogical approaches, usually teacher-oriented and oriented toward an individual (Hossain et al., 2012). This change entails transforming the teacher from the one with absolute knowledge provision to a guide or mediator as learners learn collaboratively. The teachers create an interactive learning environment which fosters communication through sharing discussions, explorations and co-teaching. Additionally, teachers must know how to manage groups and ensure that every student is active and participates in group tasks (Hossain et al., 2012).

Assessment approaches also need revisiting in the collaborative teaching and learning approach (Jaworski et al., 2017). It may mean that traditional assessment cannot measure the width and depth of the conceptual development learners reach while working together in class. Peer assessments, group projects, and reflective journals might work better when grading in a collaborative teaching and learning approach. Such types of assessment also help learners reflect on their and other team members' input, strengthening the cooperation learned.

Essentially, the feature of collaborative teaching and learning approach is its congruence with the 21st century's skills such as critical thinking, problem-solving, communicating, and teamwork (Lahann feature of collaborative teaching and learning approach is its congruence with the 21st century's skills such as critical thinking, problem-solving, communicating, and teamwork) (Lahann & Lambdin, 2020). Such competencies are becoming more valued nowadays in a rapidly changing contemporary environment. Collaborative teaching and learning approaches in mathematics education help learners internalise their learning process and think critically to solve complex problems (Lahann & Lambdin, 2020).

Furthermore, the collaborative teaching and learning approach addresses some equity issues in education (Chan & Idris, 2017). Allowing learners to learn from and teach each other presents chances for all learners to participate in and excel in mathematics, irrespective of their background or learning style. This approach can be particularly empowering for learners who might feel marginalised in a traditional classroom setting. This way, collaborative teaching and learning approaches create a more inclusive and equitable educational environment. Therefore, the collaborative teaching and learning approach has been considered one of the most practical strategies for tackling the issues related to trigonometry that learners experience. Trigonometry is an abstract topic and, therefore, hard for learners to understand. Cooperative learning helps learners discover the concepts related to the research on an interactive platform where other learners provide support. At the same time, they discuss the implementation of these concepts in different situations. It improves comprehension and gives the learners a feeling that trigonometry applies in everyday life situations like engineering, physics and architecture.

However, a precise strategy should be devised to apply a collaborative teaching and learning approach in trigonometry and other subjects. For instance, teachers should develop cooperative tasks and activities that support learning objectives while having an element of challenge that promotes higher-order thinking. Additionally, they should consider having varied and equally abled learning teams—the impact of online learning on classroom teachers' practices. Additionally, other levels of support must be administered by collaborative teaching and learning approaches in terms of the school or the system. The teachers should be equipped with professional development opportunities that they can use to learn and practice cooperative learning strategies. Additionally, school leaders must identify and foster the efforts and energies invested in making a collaborative teaching and learning approach.

Although the collaborative teaching and learning approach may pose difficulties, it improves learner comprehension and participation in mathematics. The learning further helps one understand complicated mathematics content as they learn how to work together with others, communicate effectively and think critically, among other essential life skills. Given the changing nature of the educational arena, it is critical to incorporate and adequately utilise the cooperative learning strategy in mathematics instruction. Such an approach has the potential to turn around learning mathematics in such a way that will suit modern times; hence, every learner should understand mathematics in their terms for math to be relevant and engaging.

2.6.1. Features of the Collaborative Teaching and Learning Approach

Positive dependency fundamentally drives cooperative efforts (Hamadi et al., 2022). Positive interdependence necessitates learners to recognise two key aspects: (a) their success is dependent on the success of their groupmates, and vice versa, and (b) the work of their groupmates has a positive impact on them, and their work has a positive impact on their groupmates (Johnson et al., 2014). In this way, positive interdependence is characterised by assigning learners to small groups and assigning problems for them to solve (Smith et al., 2005). The grouping of the learners into small teams affords facilitators an opportunity to ensure that content that is relevant to the subject matter is mastered during instructions by all the individuals who constitute the team (D'Eon & Zhao, 2022). It, therefore, lends credence to the effect that teachers create an atmosphere in a learning environment such that the learner learning environment success relies on the ideas, involvement, and accomplishment of the others in the group (Kaymak et al., 2022). As such, learners with a sense of positive interdependence rely on group members' ideas and contributions to promote the learning outcomes of all involved (Johnson et al., 1991; Kyndt et al., 2013; Roseth et al., 2008). This research defined positive interdependence as a teaching method where the classroom facilitator assigns learners particular duties within a group for a learning task. This is intended to enhance the collective mastery of the subject matter in a group learning environment.

Each participant in the group is personally responsible for contributing an equitable portion of the group's learning work (Teng, 2022). Thus, it entails carrying out one's part of the task and offering support to other group members to finish their task in the learning environment (Bores-García et al., 2021). Again, incorporating individual accountability, "learners learn together to gain greater individual competency” (Johnson et al., 1991, p. 419). Further, individual accountability is more pronounced among learners of diverse backgrounds with academic capabilities. Their assignment to teams of learning is purposed to influence weak learners positively (Fernández-González & Franco-Mariscal, 2021; Michaelsen et al., 1982). Individual accountability is one of the pillars teachers use to ensure that individual team members are held answerable in their participation in a learning task assigned to the group (Jurkowski & Hänze, 2015). This was purposed to ensure learners master the content of the concept taught. Thus, it ensures that learners learn together but perform alone (Johnson et al., 1991; Kyndt et al., 2013). To this end, Individual accountability was characterised in the current research by a lesson activity that ensures learners learn together but perform alone. Thus, the lessons are structured by

(a) Observing learners as they work together, noting the contributions of the individual members in the group,
(b) Having individual group members explain concepts taught to their colleagues, or
(c) Piecing their individual work output together in order to reach a consensus on a solution to a learning task or test (Jurkowski & Hänze, 2015).

Learners facilitate each other's achievement by aiding, assisting, commending, motivating, and bolstering each other's endeavours to acquire knowledge (Baghcheghi et al., 2011). Engaging in these activities leads to cognitive processes such as analysing the nature of the concepts being learned, verbally instructing others on problem-solving techniques, sharing one's knowledge with classmates, critically examining each other's reasoning and conclusions, and making connections between current and previous learning (Nam & Zellner, 2011; Van Ryzin & Roseth, 2019). Promotive contact encompasses interpersonal activities, such as providing support and encouragement for learning, as well as collectively enjoying the achievements of the group (Slavin, 2013). In this way, teachers have an opportunity in the classroom context to get learners to deliberate, question, and offer the needed assistance to one another to complete the work assigned to the group (Johnson et al., 2007). Hence, it is a significant step in establishing a collaborative teaching and learning approach in the learning environment. In this research, therefore, promotive face-to-face interaction was characterised by a lesson activity that positions the classroom facilitator to engage learners in groups purposed to share their individual and collective ideas on a learning task with the view to brainstorming on such task to proffer solutions to the learning task.

Interpersonal and small-group cohabitation abilities are necessary to contribute to the effectiveness of a cooperative effort (Choi et al., 2011). Learners must employ social skills in cooperative learning groups to create an environment conducive to learning (Tanner et al., 2003). According to Johnson et al. (2014), to foster the desired classroom environment, leadership, trust-building, communication, decision-making, and conflict-management skills should be imparted with the same level of intentionality and precision as is given to academic skills. Accordingly, social ability is one of the proficiencies needed for effective learning (Ning, 2011). Therefore, in a learning environment like this, learners are said to have mastered social skills if they work well with each other, respect and value the opinions of their peers, and hierarchically arrange group activities to resolve conflicts (Buchs et al., 2011). In order to have a meaningful conversation, learners must encourage class-wide debates about the necessity of living together in a setting that promotes learning (Opitz, 2008). The usual time permissible at the SHS in the Ghanaian environment prevented teaching the many qualities of social skills listed above. However, the authors operationalised social skills in the research based on Opitz's (2008) perspective (Canavan's, 2018). Thus, the social skill was characterised by a lesson activity that allows the teacher to foster whole class discussions on the guidelines that facilitate successful group activities in the learning environment with the view to creating conditions devoid of mockery and negative dispositions during intra and inter-group activities/discussions in the classroom context.

Group processing is necessary for learners (Havenga & Swart, 2022). Group processing is the process of evaluating how well group members use the process to optimise their own and each other's learning to find methods to improve the process (Van Ryzin & Roseth, 2019). Members of the group must explain whether their actions are beneficial. This is to guarantee that every member of the group: (a) establishes and preserves good working connections; (b) determines which behaviours to keep or modify; and (c) recognises and honours the efforts and accomplishments of other members of the group (Johnson et al., 1991; Kyndt et al., 2013; Roseth et al., 2008). This gives the group members a chance to explain to their peers the results of their collective labour based on the learning task (Bores-García et al., 2021). In assessing the success or otherwise of the work undertaken by a group in a cooperative learning environment, group processing affords the individuals who make up the team a platform in the learning environment to retrospect the quality of the work they execute (Johnson et al., 2014). To this end, group processing was characterised in this research as a lesson activity that maximises learners' understanding of the subject matter. Thus, an atmosphere in the learning environment where learners present/explain their solution to a task to the class. It further positions the classroom facilitator to solicit an alternative (superior) process used in solving the same task from other learners in the class. Following this, the teacher provides clarity to all questions from the learners.

2.7. Summary

The chapter comprehensively reviews literature related to teaching and learning trigonometry in mathematics. It begins with an overview of the global and South African perspectives on mathematics education, highlighting the challenges faced. The traditional teaching approaches for trigonometry and their advantages and disadvantages are discussed. The collaborative teaching and learning approach (CTLA) is introduced as an alternative pedagogy, emphasising its features such as positive interdependence, individual accountability, promotive face-to-face interaction, social skills, and group processing. The potential benefits of CTLA in addressing the issues faced in trigonometry education are explored, including improved conceptual understanding, real-world applicability, and the development of 21st-century skills. The chapter also touches upon the need for professional development and systemic support to effectively implement CTLA in mathematics classrooms. Overall, the literature review provides a strong foundation for understanding the current state of trigonometry education and the potential of CTLA as a promising pedagogical approach. The next chapter (chapter 3) examined the literature on technology-based teaching and learning approaches using the Microsoft Teams platform.

Chapter Three: Practices of Teaching and Learning

3.1. Introduction

The preceding chapter introduced and discussed the literature review on Mathematics teaching and learning globally and in South Africa. Incorporating technology in education has emerged as a valuable tool, providing instructors and learners access to a wealth of knowledge and innovative teaching methods. This chapter explores the blending of technology in mathematics teaching and learning, focusing on online learning platforms and their role in improving learners' understanding and attainment, particularly in trigonometry. The chapter begins by examining the integration of technology-enabled visualisations and interactive simulations in mathematics classrooms, highlighting their potential to enhance learners' conceptual understanding and problem-solving skills. It then delves into the concept of flipped learning(FL), a computer-assisted hybrid approach that combines traditional classroom instruction with online instruction, leveraging technology to facilitate self-paced learning outside the classroom. Furthermore, the chapter discusses various online teaching and learning methods in mathematics, including Massive Open Online Courses (MOOCs) and the challenges posed by online learning during the coronavirus disease 2019 pandemic. It also explores the benefits and disadvantages of online learning, emphasising its potential for flexibility, accessibility, and personalised learning experiences while acknowledging potential drawbacks such as technological barriers and the digital divide.

The chapter then focuses on Microsoft Teams' role as an online learning platform, examining its features, benefits, and applications in interactive learning, collaboration, and feedback. Overall, this chapter provides a comprehensive overview of technology integration in mathematics education, highlighting the opportunities and challenges presented by online learning platforms in supporting learners' conceptual understanding and attainment in trigonometry.

3.2. Blending Technology in Mathematics Teaching and Learning

Incorporating technology in education has emerged as a valuable tool, providing instructors and learners with access to a wealth of knowledge available on the internet. Recent research supports appropriate software to generate animations of figures and mathematical representations to enhance learners' creativity and problem-solving abilities, particularly in mathematics instruction (Yan, 2020).

Reverse or flipped learning (FL) is a computer-assisted hybrid approach to education that combines traditional classroom and online instruction. This approach is not limited to mathematics instruction. According to Akçayır & Akçayır (2018), "flipped learning leverages technology to facilitate self-paced learning outside the classroom, allowing for more active and collaborative activities during class time" (p. 334). The same sentiments were further confirmed in a meta-analysis by MSEd (2023).

While the incorporation of technology and innovative teaching methods can be beneficial, educators must have a thorough understanding of the theoretical foundations and pedagogical approaches before implementing them in the classroom. Effective implementation requires familiarity with the relevant computer tools and a comprehensive grasp of the underlying learning theories and instructional strategies (Liljedahl et al., 2021). The Flipped Learning (FL) concept calls for a reversal of the traditional learning process. This involves utilising digital technology tools such as video presentations and mathematical software to allow students to acquire new knowledge outside the classroom. Meanwhile, traditional homework is completed under the teacher's supervision during class time. According to Lee et al. (2017), this approach improves learning effectiveness and extends the time spent on problem-solving activities. FL originated from the work of Sams and Bergmann (2012) and Lage et al. (2000). These educators created online course materials that enabled learners to access and engage with the content at their convenience. FL heavily relies on social constructivist concepts.

Technological advancements in the past few decades have given rise to complex problems that require critical thinking and computational thinking (CT) - an advanced cognitive skill. The term "CT" was introduced by S. Papert in 1996 and popularised by Nardelli (2019) within the computer society. Nardelli (2019) defines CT as "the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively executed by an information-processing agent" (p. 33). According to Lin Liu and Wang (2010), CT involves constructive reasoning, logic, abstraction, algorithms, and modelling to solve problems. Modelling reasoning integrates various reasoning techniques to address a given problem. Weintrop et al. (2016) also describe CT as involving "problem-solving, system design, and understanding human behaviour" through fundamental concepts of computer science (p. 128). Fernandez et al. (2018) saw the issue as a difficulty that must be solved. They created a model that clarified the connection between critical thinking and CT during the solution process, with the knowledge base as that connection. Flipped or reverse learning (FL) is a blended teaching and learning approach that combines traditional classroom instruction with online instruction, leveraging computer technology. This methodology is not limited to teaching mathematics. According to Akçayır & Akçayır (2018), "The flipped learning model utilises technology to provide instructional content for learners to engage with prior to class time. This allows for more active learning activities, collaboration, and personalised guidance during face-to-face class sessions" (p. 334). Blended learning approaches like flipped learning aim to harness the advantages of in-person and online modalities, creating a more flexible and engaging learning environment for learners. Another example of a blended learning approach is the rotation model, where learners rotate between different modalities such as online instruction, collaborative activities, and direct teacher-led instruction (Staker & Horn, 2012). This model allows for personalised learning paths and caters to diverse learning styles and preferences.

The integration of technology and online components in blended learning approaches has been shown to promote active learning, increase learner engagement, and improve academic performance in various subject areas, including mathematics (Chan et al., 2018; Mihas, 2019) (Cheng et al., 2019; Mukhtar et al., 2020). FL calls for the didactic process to be reversed. Specifically, the employment of digital technology instruments (video presentations, mathematical software, etc.) that experts have carefully created allows for the learning of new knowledge outside of the classroom. On the other hand, traditional homework is completed under the teacher's supervision in the classroom. This reversal enhances learning efficacy and lengthens the time spent on problem-solving exercises (Lee, 2017). FL was inspired by the research of Sams and Bergmann (2012) as well as Lage et al. (2000).

3.3. Online Teaching And Learning Methods In Mathematics

Different scholars have different definitions of online learning. According to Mahmud & Wong (2021), online learning is a method of instruction connected to readily accessible computer-based resources. The materials are instantly available within a core programme (e.g., via online support). Rojabi (2021) asserts that online learning is another term for online education. Using various media, including movies and simulations, as well as web-based learning and learning customisation, instructors can impart the same knowledge. Because online classrooms offer 24/7 access to material and lectures, learners can learn when they are most attentive and engaged. Nguyen (2015) defines online learning systems as educational platforms that combine broadband connectivity with instructional activities. To summarise, this kind of instruction differs from conventional, in-person learning, necessitating learners' physical classroom attendance. In a traditional classroom setting, some learners may not feel comfortable speaking out unless they are confident and have quick responses. However, online learning provides flexibility and an interactive learning environment. Online education may be equally engaging, socially connected, and customised as traditional classroom instruction. While live sessions give the impression that learners and teachers interact in person, discussions allow them to stay in touch and support one another. Tasks are a helpful tool for instructors to evaluate their learners' progress in their everyday tasks. This enables them to avoid feeling cut off. Because they have a lot more voice when researching digitally, the majority of learners say they maintain stronger relationships with their instructors and peers than when they are in class. Like in the classroom, educators can improve their performance by utilising Teams' applications and capabilities.

The coronavirus disease 2019 , which forced the majority of schools throughout the world to close and transition to online, home-based learning, has contributed to the rise in popularity of online learning, also known as distance learning. With the ability to connect from anywhere without travelling to a school's campus, online learning makes education more accessible (Butnaru et al., 2021). Online courses can be hybrids that include the advantages of online and face-to-face learning, or they can be 100% online, according to (Kumari et al., 2021). For learners, instructors, and parents alike, it increases educational opportunities and makes the learning process more dependable and less stressful (Butnaru et al., 2021).

Particularly for disadvantaged population groups in developing nations, online learning offers a remarkable chance to increase access to education. The availability of low-cost, high-speed Internet connection and cloud technologies has led to a significantly increased usage of online learning, which is not a new phenomenon (Wang et al., 2019; Yau et al., 2009). The flexibility of the learning process has been enhanced through online learning, which has been shown to augment traditional classroom-based learning approaches (Wang et al., 2019). Panigrahi et al. (2018) suggest that the primary aim of online learning is to broaden educational access and reach while simultaneously reducing the costs associated with high-quality education.

Massive Open Online Courses (MOCCs) are online learning platforms that offer organised courses for learners enrolled in higher education (Sclater, 2016). Since 2011, they have become more relevant and well-liked. Since then, there has been a rise in MOOCs that focus on cutting-edge educational technologies and various learning theories, with their main distinguishing feature being that they are autonomous teaching and learning models that are constantly changing (Al-Rahmi et al., 2019; Palacios et al., 2020). Some MOCCs are cost-free, while others need highly disciplined and motivated learners with excellent digital literacy and research abilities to educate themselves using free online resources (Sclater, 2016). With no face-to-face interaction with the subject matter expert or other learners, the courses are also offered as lecture videos (Sclater, 2016). MOCCs like Coursera, Future Learn, EdX, and Udemy have become increasingly popular, especially with individuals.

3.4. Online Teaching and Learning During the Coronavirus Disease 2019

Over the past several years, the education sector has embraced online learning more and more as a teaching tool, especially in contexts of English as a Second Language (ESL) and English as a Foreign Language (EFL) (Agung et al., 2020). For math learners, online learning has several beneficial advantages. To improve their English language skills, they can use synchronous or asynchronous learning systems (Bailey & Lee, 2020). With synchronous learning, learners can interact with instructors and peers in real-time through video conferencing or virtual classrooms. Asynchronous learning allows learners to complete online courses at their own pace and anytime from anywhere (Fielder et al., 2013).

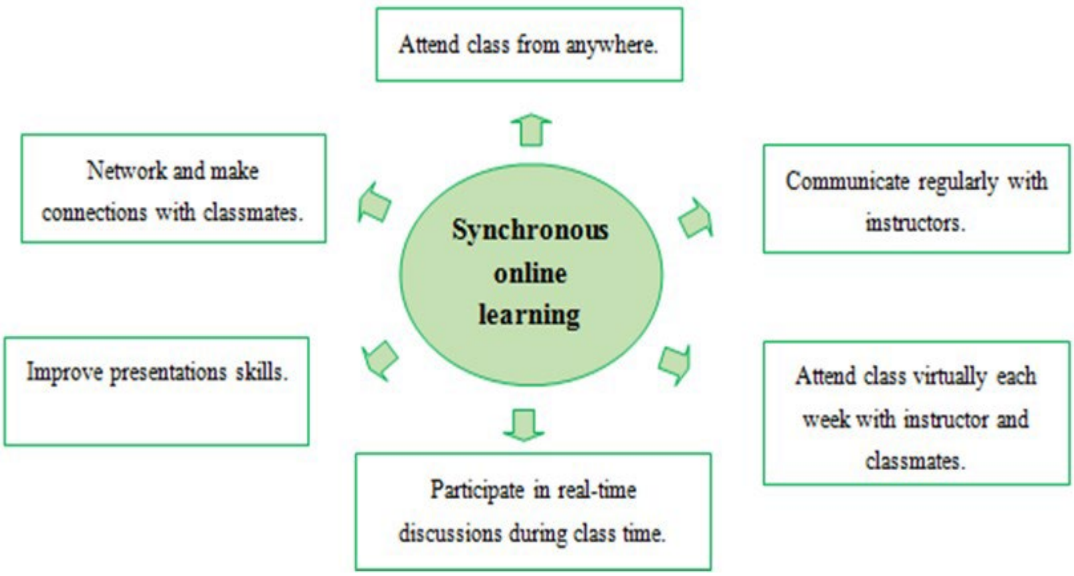
With the development of ICT tools and technology, language research is now possible for learners at any time and location. Synchronous learning and asynchronous learning are the two categories of flexible learning techniques. Synchronous learning happens when an instructor interacts in real time with learners enrolled in a predetermined course from a distance (Yang et al., 2019). This implies that learners and the instructor can communicate in a particular virtual location at a predetermined time. Teleconferencing, live chat, live-streamed lectures, and real-time video conferencing are common synchronous online learning techniques. However, learners can learn within a set timeframe and on schedule, thanks to asynchronous learning. They have unlimited access to and time to finish readings, assignments, lectures, and other course materials for one or two weeks. Short movies that cover essential concepts are included in online asynchronous classes, which you can view again if needed.

In some classes, learners can finish their homework and get feedback immediately rather than wait for their teachers to mark it (Carr, 2011; Scheiderer, 2020). Additionally, even though they were learning remotely, learners participating in synchronous learning would digitally participate in a class session every week at the same time as their teacher and classmates (Scheiderer, 2020). Beyond streaming lectures and having chats with an instructor, there are other types of synchronous online learning. Sometimes, learners stand up for themselves in class debates or independently present to their peers. In an online course, group projects are still the same; they only seem different (Scheiderer, 2020).

During synchronous learning, learners can control voice connection with teachers through video conferences. Gough (2006) defines it as the cooperative flow of information between two or more endpoints over a communication channel, including audio and video. Some teachers give their learners challenging questions, and before the class can debate the answers, the learners must work in small groups to find answers. Furthermore, according to Motamedi (2001), the technology used would affect the quality of instruction and the level of interaction between teachers and learners, hence determining the effectiveness of learning outcomes via video conferencing systems. Moreover, synchronous online learning necessitates motivating learners to engage with the material, as stated in Figure 1 below.

FIGURE 1

SYNCHRONOUS ONLINE LEARNING



(**Source:** Scheurich, 2014, p. 126)

Results from a number of previous studies (Adara & Najmudin, 2020; Agung et al., 2020; Sukmawati et al., 2022; Allo, 2020; Baber, 2020; Bailey & Lee, 2020; Wu & Liu, 2013; Khafaga & Shaalan, 2021; Karataş & Tuncer, 2020; Ma, 2020; Mahyoob, 2020; Rahiem, 2020) influenced how coronavirus disease 2019 learners perceived the advantages and disadvantages of synchronous online learning. According to Karataş & Tuncer's (2020) research, learners thought highly of online learning as a useful and fruitful way to improve their four main English language proficiency areas: speaking, listening, reading, and writing. Using the synchronous online flipped technique, learners may also improve their learning, get timely feedback from peers and teachers, and feel more confident in their ability to perform better (Ma, 2020; Sukmawati et al., 2022). Additionally, learners said they expected to do individual assignments and thought online learning was advantageous (Allo, 2020). However, there can be particular difficulties when utilising synchronous learning in online EFL courses.

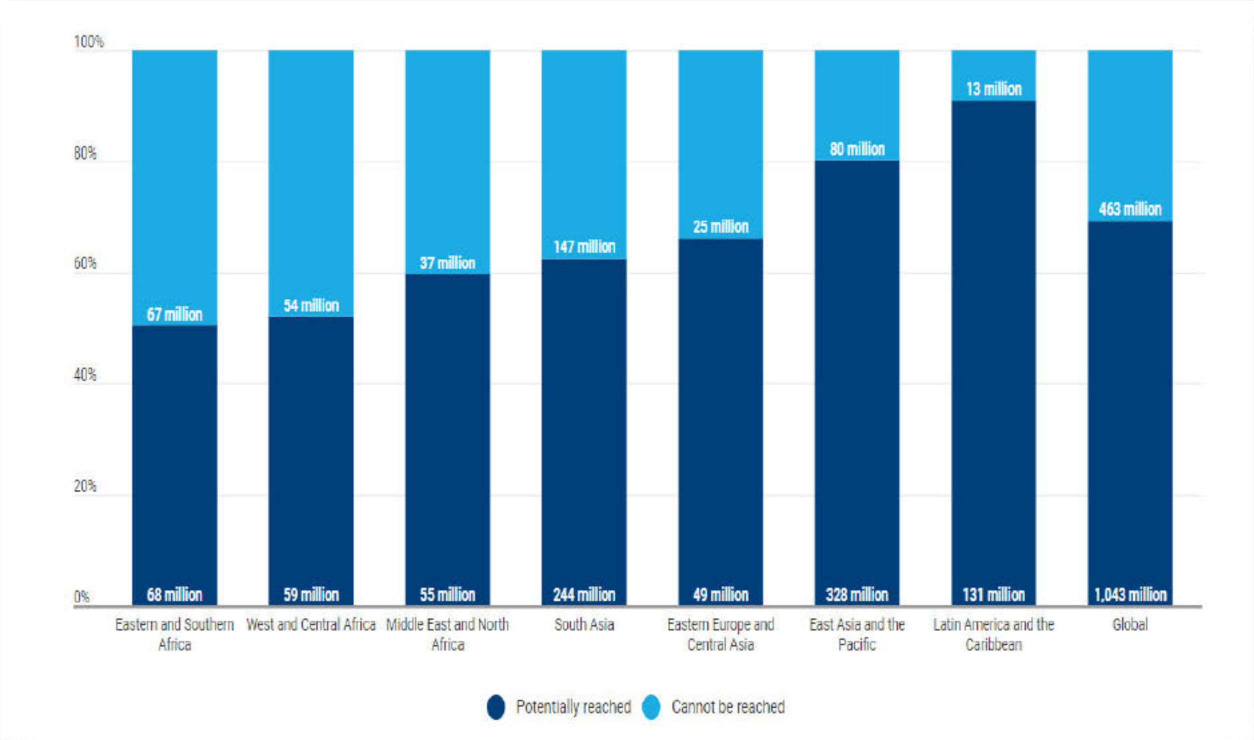
A study by Ma (2020) revealed that some Chinese learners thought that learning happened more successfully in traditional face-to-face classrooms than online. It might result from their inability to look their peers in the eye during discussions about their ideas and answers to particular online assignments. When learning online at home, family members' conversations and movements distract them from the synchronous online lessons (Ma, 2020). Studies on additional challenges related to online learning have been conducted by Mahyoob (2020) and Sukmawati et al. (2022). According to two assessments, the internet's accessibility was inadequate and constrained.

Most governments "played catch-up to the exponential spread of coronavirus diseases of 2019 and hence did not have enough time to prepare" as the pandemic struck nations (Daniel, 2020, p. 92). When schools unexpectedly ceased holding in-person sessions and transitioned to home-based online learning, it disrupted education (Harefa & Sihombing, 2022). As a result of the coronavirus disease 2019, there was a need for an urgent shift from conventional to online learning at all levels of education (Hodges, Moore, Lockee, Trust, & Bond, 2020; Misirli & Ergulec, 2021).

More than 94% of learners worldwide, including up to 99% in low- and middle-income countries, were impacted by school closures (United Nations, 2020). According to UNICEF, lockdowns would have cost school learners around 1.8 trillion hours of instruction by 2021. During the pandemic, at least one in three of the world's 99463 million school learners could not access remote schooling (Avanesian et al., 2022). In Europe, the pandemic resulted in learning losses and an increase in inequality rates, with nations like Ukraine hastily creating preparations for the education sector claim (Donnelly et al., 2021). The Coronavirus Disease of 2019 epidemic reportedly disrupted schooling for around 1.6 billion learners in roughly 190 nations, according to the (United Nations, 2020).

FIGURE 2

PERCENTAGE AND NUMBER OF STUDENTS POTENTIALLY REACHED AND NOT REACHED† BY DIGITAL AND BROADCAST REMOTE LEARNING POLICIES, BY REGION (PRE-PRIMARY TO UPPER SECONDARY).



(Adapted from UNICEF COVID-19 (2020, p. 6). UNICEF's calculations using MICS, DHS and other national household surveys)

Notes: (i) Figures are calculated using weighted averages based on the number of students across countries. (ii) The high potential reach in Latin America and the Caribbean does not indicate that children in this region had more access to communication assets in the household – access is shown in Figure 5. Rather, it reflects that the policies in this region targeted technologies that are available in most households.

† "Reached" indicates potential maximums; "Cannot be reached" indicates minimums, which are likely much higher.

As highlighted in Figure 2, since remote learning is inaccessible, people are prevented from gaining the advantages of education because every hour in school is precious, and every child should be allowed to go back to school (UNICEF, 2020). According to Amon (2020), during the height of the epidemic, many learners in African nations, including Zambia and the Democratic Republic of the Congo (DRC), did not get feedback or connect with their teachers. Parents in Kenya were handed revision papers via WhatsApp, and many South African learners struggled to maintain the discipline to learn independently (Amon, 2020). Learners were months behind in classes like mathematics because of the nationwide lockdowns (Namatende-Sakwa et al., 2023).

Schools in regions of armed conflict were shut down, putting learners in danger of joining militant groups and being forced into child labour (Amon, 2020). According to OECD (2019), 152 million learners between the ages of 5 and 17 were engaged in hazardous child labour worldwide, accounting for nearly one in ten learners. The epidemic made things worse for learners from low-income families. Learners's susceptibility to abuse was made worse by the Coronavirus Disease of 2019 epidemic (United Nations, 2020). Governments were pressured to reduce the risk due to the pandemic's potential to make more youngsters vulnerable (OECD, 2019).

Although the pandemic required homes to be transformed into learning environments, schools are still essential in learners' social lives, mainly through connection with classmates from varied backgrounds (Hodges & Fowler, 2020). During the lockdowns, learners complained of being frustrated and bored, received poor learning materials, and felt socially isolated (Dong et al., 2020). Parents must become significant players in the educational process to offer learners the digital tools, learning settings, and support they need (Hodges & Fowler, 2020). However, several parents struggled with the absence of appropriate learning surroundings, apathy toward technology, and ignorance of the courses their learners were enrolled in (Misirli & Ergulec, 2021).

3.5. Benefits Of Online Learning

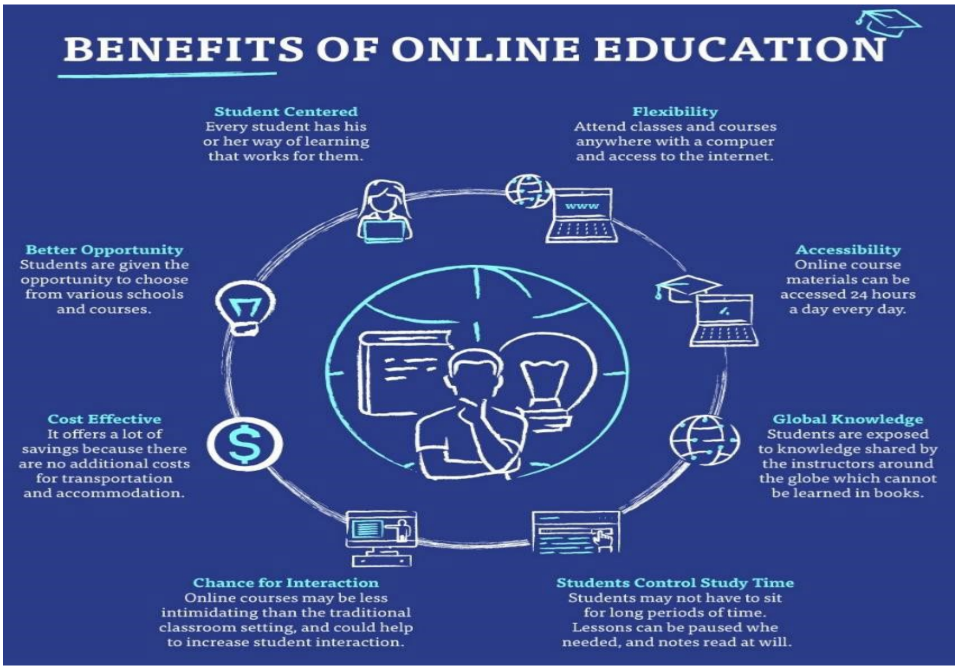
Online learning attracts diverse learner groups with various academic needs that traditional education programmes cannot meet or adequately address. The demand for online courses arises from a desire to offer high-quality education to all learners, regardless of their location and the time constraints they may have (Zhou & Zhang, 202). The increasing need for flexible learning environments has increased the number of available distance learning courses and programmes. These courses cater to potential learners who are hospitalised, have school-related phobias, are single parents, have been expelled, are dropouts seeking a diploma, and various other specific cases (Chaney, 2010). For those who might have encountered insurmountable obstacles before the proliferation of online educational programmes, online learning holds the promise of opening up educational opportunities.

According to a review of recent literature on the subject, online learning should be included in school curricula. Online learning is advantageous compared to traditional classroom instruction due to its flexibility, ease, and customised learning chances (Guragain, 2016; Smedley, 2010; Zhang et al., 2006). Judahil et al. (2007) have specifically emphasised the advantages of online learning in terms of flexible learning, with a notable reduction in the need to travel to physical classrooms, enhancing flexibility and convenience. Additionally, online learning offers learners significantly greater flexibility in time and location, letting them choose the most convenient time or location for their studies (Clark et al., 2003). As stated, learners are facilitated by easy access to materials like videos, PowerPoint lecture slides, and so forth for repeated learning at multiple locations, like home, a café, or even while travelling.

Seragen (2020) depicted a graphic illustrating eight benefits of online learning: flexibility, accessibility, global knowledge, learner autonomy in managing study time, potential for engagement, cost-effectiveness, improved opportunities, and learner-centeredness, as seen in Figure 3. The figure was produced by comprehensively examining recent pertinent studies and relevant literature.

FIGURE 3

BENEFITS OF ONLINE EDUCATION



(Taken from Seragen (2020) retrieved from: https://www.studyinternational.com/news/benefits-online-learning/)

According to Henninger (2016), learners can feel less anxious about their studies because they will likely receive the same calibre of instruction regardless of where they live. This is one of the benefits of online learning. According to Gu and Haung (2020), online learning could help learners with their personalised learning experience by allowing them to explore discussion boards, email, and chats. These platforms encourage learners to engage with one another and expose and respect differing opinions without worrying about looking foolish. As a result, learners can utilise their preferred learning devices, access materials continuously, ask teachers or peers for help, learn lessons at their speed, and receive immediate feedback to help them reflect on their learning.

When you enrol in an online programme, you can save a significant amount of money. Not only are your accommodation and transportation costs eliminated, but online programmes are often cheaper. Research conducted by You and Kang (2014) has demonstrated that learners who prefer self-regulated learning experience advantages when they choose to pursue online courses. A learner about online coursework in a research conducted by Kirtman (2009), stated, "the self-guided nature of the coursework allows me to spend more time on ideas I need help with, while spending less time on concepts I can grasp easily" (p. 110). According to You and Kang (2014), self-regulated learners often utilise cognitive and metacognitive strategies to achieve their learning objectives (p. 126). Learners who can enhance their self-regulated learning skills frequently employ effective time management, regularly review course material online, seek assistance from peers or professors, meet deadlines, and demonstrate the ability to capitalise on metacognition to reflect on their learning (You & Kang, 2014).

The advantages of online learning in terms of flexibility, a key element attracting learners, cannot be overstated. Online learning allows learners to have flexibility in choosing the most suitable time and location for their studies. Several educators and learners indicated contentment regarding their enhanced capacity to focus on the curriculum and minimise disruptions such as parking and traffic, which frequently arise in a conventional classroom environment (Thomson, 2010). A secondary school instructor explained that their timetable has no time constraints. They can meet and remain in the virtual area as long as necessary. In addition, she expressed her lack of nostalgia for the extensive periods of unproductive time that are bound to occur in a traditional school setting (Thomson, 2010).

In recent years, online education has notably emphasised in developing courses that award credit from secondary institutions and colleges to secondary learners upon enrollment and successful completion. Many colleges and universities avail themselves of subsidies previously provided in the United States to support initiatives that enable secondary school learners to enrol in university courses in subjects including foreign languages, mathematics, and science (Matuga, 2000). The very competitive landscape of education, especially in the post-secondary or higher education sector, necessitates increased avenues for learners to investigate their alternatives for the future, including courses in a range of degree programmes offered by numerous schools and universities. Every year, schools struggle to provide more possibilities for their learners while dealing with dwindling funding. Speculative cost simulations suggest that implementing a hybrid instructional approach in sizable introductory courses could yield substantial long-term savings on instruction compensation expenses (Bowe et al., 2014). Interactive learning online (ILO) refers to a specific category of virtual learning environments that involve highly interactive and adaptive online courses (Bowen et al., 2014).

In ILO, machine-guided instruction can partially replace traditional in-person instruction but does not typically substitute the entire instruction. ILO systems collect data from many learners and use that data to provide individualised feedback and guidance tailored to each learner's needs. Additionally, ILO can equip instructors to monitor learners' progress and provide more targeted and practical guidance in helping learners engage with new knowledge successfully (Bowen et al., 2014). While machine-guided instruction does not seem to replace face-to-face instruction entirely, it appears to be a tool that instructors can use to track learners' progress and deliver prompt feedback, complementing traditional teaching methods.

Chaney (2001) posits that learners attending small, rural, or low socioeconomic school districts may have enhanced access to courses not conventionally offered through online learning opportunities. There is an increasing worry that the US is losing ground to other countries regarding high school graduates' general readiness for the workforce. Other nations may, nevertheless, be capable of narrowing the disparity and alleviating the financial burden by providing additional opportunities at reduced expenses (Bowen et al., 2014). Long overdue changes in education may be precipitated by the expansion of distance learning, which progressively eliminates financial and geographical constraints that have sometimes acted as impassable obstacles to providing equitable and high-quality instruction to all learners.

Online learning, which makes use of technological advancements, can help professors and learners provide and access subject content simultaneously in the field of mathematics (Chan et al., 2018; Chai et al., 2013; Bertram, 2020; Reddy et al., 2021; Mahmud & Wong., 2021). Using Android on smartphones (mobile) is one of the uses of online learning media currently in high demand by various organisations. With the advancement of information technology, several schools are now utilising Android-based interactive learning resources that can be accessed via a PC or smartphone. Numerous groups respond favourably to using Microsoft Tems as a learning tool, and it also adds some convenience to the online learning process. According to Churiyah et al. (2020), there are several benefits to online learning for teachers, such as the ability to directly monitor learner learning outcomes, the ability for learning activities to transcend location, time, and distance, the ability for learners to participate with parents in the learning process, the ability for learners to access the internet and network, the ability for learners to utilise the media in their immediate surroundings, and the opportunity to spend a lot of time with family.

Learners can learn more readily on online learning without being constrained by time or place, nor do they need to carry books (Irfan & Wulandari, 2019). To lessen learner boredom during the learning process, multimedia components packaged as an Android application are being used in the development of educational media at the present moment. However, in addition to learner factors, teachers, media, and instructional materials also frequently present challenges that impede learners' ability to master and comprehend prerequisite material (Rohaeti et al., 2019; Tran et al., 2020; Wijaya et al., 2020; Sapulete et al., 2023; Hidayat et al., 2022).

Online learning is always accessible to learners, regardless of where they are in the globe (Aithal & Aithal, 2016). This enables learners to participate in classes from any place. With internet availability, people can connect anywhere by downloading smartphone applications for online platforms like Microsoft Teams and Zoom (Poston et al., 2020). In a research conducted at a college in Lahore in 2020, Mukhtar et al., (2020) found that learners appreciated the flexibility of online learning. They noted that teachers could quickly mute and unmute their microphones, and learners could comfortably sit, watch, and listen to the class.

Online learning makes it possible to tailor sessions to learners' needs (Aithal & Aithal, 2016). The teacher can schedule one-on-one face-to-face online sessions for learners to address their learning issues using Zoom and Microsoft Teams (EPC Group, 2022). The efficiency of online platforms in terms of transportation costs is one of its apparent advantages. Online learning is more affordable than traditional classroom learning because it eliminates the need to go to a school's campus to acquire knowledge (Alzahrani et al., 2022). In higher education, online courses are more affordable than those attended in conventional venues (Aithal & Aithal, 2016).

Choosing your learning environment is possible when you are learning online. The option to pick your learning environment has made online learning more comfortable for learners (Paul & Jefferson, 2019). Ngu (2021) claims that although the learner's physical environment during online lessons has the potential to affect the learner's overall performance, little attention has been paid to it. Most online learners take classes in places like their homes that are not intended for formal education (Alphonse et al., 2019). When learners select a location that can boost their attentiveness to courses, there is also an increase in comfort during learning (Mukhtar et al., 2020). This enables learners to research in a setting that suits them the best (Hafez & El-Din, 2022).

Online learning is self-directed learning; it enables learners to control their learning speed more, particularly in solitary research (Gilbert, 2015). They can exercise self-control using learning tools (You & Kang, 2014). Jeganathan and Fleming (2020) claim that online scheduling is more flexible when opposed to the back-to-back classes and extracurricular activities of traditional learning. They develop greater reliance and take charge of their learning (Miller, 2019). It helps learners to record and replay the lessons**, i**n particular during periods of review before exams, online learning enables learners and teachers to access information an endless number of times (Gupta, 2017).

3.5.1. Disadvantages of Online Learning

Aside from the advantages associated with using Android, detrimental effects also arise. One such effect is the distraction caused by excessive mobile usage for social media and gaming, leading to a lack of focus on learning among many learners (Rahayu et al., 2019; Irfan & Wulandari, 2019). Furthermore, specific demographics continue to encounter challenges accessing the internet, while other households lack access to mobile devices. Nevertheless, the beneficial effects outweigh the detrimental effects. In order to mitigate the adverse effects, the government has implemented initiatives such as offering support for research quotas and establishing research groups. This enables learners without personal devices to continue their studies by collaborating with peers who possess mobile devices.

Similar to other instructional approaches, online learning also possesses inherent limitations. It is improbable to supplant distinctive attributes, such as human emotional engagement and in-person connection, which are present in traditional classroom settings. Furthermore, Twomey (2004) asserts that an excessive reliance on computer skills and access to the Internet has hindered learners' ability to learn effectively.

Multiple research studies have indicated that the anonymity provided by online classes has led to an increased likelihood of learners engaging in cheating. The outcomes of this situation have been detrimental to assessment methods and the integrity of education as a whole. Additionally, it should be noted that online learning proved inadequate for a range of specialised subjects, including medical science, pharmacy, vocal arts, and graphic design. Research indicates that this is because it limited the practical involvement of learners (Arkorful, 2014; Hameed et al., 2008).

The proponents of online learning anticipated a significant increase in the popularity and use of it in education. However, Bell et al. (2016) found that the effectiveness has been far less than expected. Andersson and Gronlund (2009) conducted a systematic review to identify barriers to online learning. These barriers were classified into four conceptual groups: technological challenges, obstacles related to the course itself (including its pedagogy and activities), challenges associated with the course itself (including varying support functions), and challenges related to the institution, its management, and its environment (including the society that surrounds it and its activities). It might be difficult for teachers to creatively plan and conduct online classes since some instructors and learners are not digitally proficient (Aithal & Aithal, 2016). A teacher's inability to teach a lesson effectively creates a barrier to the learners' achievement.

Even while anybody in the globe may access online education, not everyone has the means to do so (Radu et al., 2011). It may result in learners skipping school for many low-income homes who cannot afford internet access and the gadgets needed to connect (Al Rawashdeh et al., 2021; Spaull & Kotze, 2015). Online education sometimes excludes individuals who cannot pay for the necessary materials. Having dependable internet access is another issue. Several connectivity issues with online platforms might interfere with learning (Sadeghi, 2019). Due to a lack of direct connections with teachers, a lack of independence, and self-motivation, learners may become less productive (Al Rawashdeh et al., 2021). Because they require continual supervision and frequently fail to finish assignments, learners who lack self-motivation are typically better off in traditional classroom settings (Vallespin, 2023).

The issue of digital divide and equity problems in online math teaching is among the most important. The lack of internet connectivity and computer access, especially in less advantaged areas, entails a lack of access to equitable quality education (Yuhana et al., 2020). In particular, low-status regions frequently lack access to high-speed internet and scarcely use computers and tablets concerning others (Alexander et al., 2012). In math education courses, these differences are especially emphasised because online resources and interactive tools serve as interventions that supplement and support learners' understandings/knowledge.

In addition to the limited chances for learner-involving activities, a lack of opportunity for hands-on experiences is a weakness in online or web course learning (Pikhart et al., 2023). Because many math concepts are based on visualisation, a lack of ability to manipulate figures as they are being learned can often lead to a surface learning demonstration. Mathematics concepts have often been taught to learners through tactile learning. Manipulating and finding images on the computer is not the same as being able actually to move around angles or physically draw a graph.

Furthermore, evaluating a learner's comprehension and performance of these ideas online can present difficulties. Traditional examination techniques might not be as valuable in an online platform, where the likelihood of dishonesty increases and the capacity to gauge hands-on exercise is checked (Pikhart et al., 2023). A significant aspect of mathematics education, immediate feedback and interaction, is often not part of the learning experience provided by the online resource. In a classroom setting, a teacher can quickly identify a learner's misconception and help them correct it. Online, that same learner may work with the misconception for a long time before being enlightened about their misunderstanding (Firmansyah et al., 2021).

Learners’ motivation and engagement can be influenced by the diminished chance for social interaction and collaboration in online settings (Yuhanna et al., 2020). Since mathematics education can benefit meaningfully from opportunities to collaborate in solving problems or talk with peers about mathematical topics, learners' understanding and interest would also likely be served well by similar experiences. Another challenge is the proficiency of teachers with online teaching. The switch from face-to-face traditional classroom instruction to an online format requires different skills and pedagogical approaches. The lack of certified teachers proficient with online teaching in mathematics and the abstract and complex nature of mathematics concepts can significantly influence the quality of learning (Dumford & Miller, 2018).

Additionally, online learning often necessitates a higher level of self-direction, a quality that might be hard for learners without self-discipline or those accustomed to a more regimented school atmosphere. The increasing concern of physical inactivity and extended screen time on learners's psychological welfare or health is expanding (Pikhart et al., 2023). Lacking a defined time structure each day and merging house and school settings has frequently resulted in escalated stress, fear and broader strain on learners. It has negatively impacted their entrance to learning knowledge and proficiency in Mathematics.

While online learning has widespread advantages, its drawbacks, especially in an area such as mathematics, are notable. Because of these obstacles, implementing online learning would require careful planning and building on what already exists, ensuring that the new learning complements traditional learning when necessary and is effectively efficient for the full range of learners.

3.5.2. Online Learning as a Learning Strategy to Improve Learners' Concepts and Attainment in Trigonometry

One of the mathematical subjects that can facilitate the growth of one's mathematical proficiency is trigonometry (Basir & Maharanib, 2018; Wijaya et al., 2020). In addition, trigonometrical material finds application in numerous scientific domains, including engineering, architecture, navigation, and the investigation of celestial body motion, including calculations about the sun, moon, and stars, as well as various branches of physics (Basir & Maharanib, 2018). This trigonometry material serves so many purposes that learners must comprehend it not only in high school but also at the collegiate level, where it is frequently encountered and is one of the graduation requirements. Amelia & Yosintha (2022) acknowledged that online learning is effective since it offers online breakout rooms that foster peer-to-peer learning and discussions. The emphasis on trigonometry continues to be disproportionately low compared to learners' mathematical critical thinking abilities.

Developing higher-order reasoning skills is a crucial educational objective in mathematics. (Lewis and Smith, 1993; Kurniati et al., 2015; Abdullah et al., 2016; Zetriuslita and Ariawan, 2021; Hendriana et al., 2022). Critical thinking is the capacity to resolve unconventional challenges (Mogari & Chirove, 2017; Kurniati & Asari, 2019; Sari & Hidayat, 2019). Therefore, critical thinking abilities are characterised by reasoned, logical reasoning to solve mathematical challenges (Agrawal, 2019; Lewis & Smith, 1993; Widyatiningtyas et al., 2015; Paul & Elder, 2019). Therefore, the capacity for mathematical critical thinking is a methodical aptitude that can be harnessed with mathematical reasoning capabilities to resolve mathematical dilemmas. Online learning platforms can deliver multimedia presentations; these visual aids effectively foster learner comprehension of abstract mathematical concepts (Pulak & Tomaszewska, 2014; Moyer-Packenham, 2020). Using multimedia presentation provides learners with a clear visual presentation of trigonometric concepts (Ebner, 2023).

Wadsworth et al., (2007) state that motivation, concentration, information processing, self-testing, and self-efficacy are some learning techniques that impact online mathematics grading. Bringula et al., (2021) demonstrate that a learner's performance relies not only on exposure to knowledge. Even though mathematics is a crucial ability, most learners find the subject frustrating and unfulfilling, which causes many to drop it (Akhter & Mahmood, 2018b). Learners' restricted working memory capacity (Reid, 2009) is subject to strong conceptual demands in Mathematics (Akhter & Mahmood, 2018b). Working memory, as defined by Cowan (2014), involves the retention of minute amounts of information in the brain to perform cognitive tasks. Mammarella et al. (2019) highlight the significance of working memory in learning since it involves the capacity to store and apply knowledge cognitively over brief periods in contrast to long-term memory. Learners choose not to take mathematics when they have the opportunity to do so because of its high demand (Akhter & Mahmood, 2018b).

The results of research conducted in the United States of America by Cho & Heron (2015) revealed that learner success was impacted by motivation. They concluded that teachers needed to rethink how subjects are taught and provide supplementary courses like orientation (Macblai, 2018). Ariyanti and Santoso (2020), in their research in Madiun City, Indonesia, found that mathematics learning outcomes were better before online learning started than after it had. This is related to a lack of resources for teaching mathematics ideas and distracting living conditions (Ariyanti & Santoso, 2020; Bringula et al., 2021).

According to Hoadley (2022), evaluated the COVID-19 pandemic's impact on South Africa's educational system, taking into account learning deficits, after the pandemic lasted for two years (2020 and 2021). Among other things, they found the following patterns based on the data that was available. First, they mentioned that the General Education and Training Phase (Grades R–9) has seen significant learning losses. According to the 2021 Western Cape Systemic Tests, learners in Grades 3, 6, and 9 fell behind in language and far further behind in mathematics. Wills & Van der Berg (2022) went on to say that sample-based reading studies conducted in free schools show significant reading skill losses among learners in Grades 2–4, aggravating South Africa's already-existing early grade reading crisis. Second, there is evidence that the existing high levels of learning inequality between the wealthier and poorer segments of the system are getting worse. A third, surprising tendency that emerged was a general decrease in secondary school dropout rates in South Africa during the pandemic but a significant learning losses occurred throughout the system, particularly in Grade 12, which missed significantly fewer school days than other classes. Last but not least, in an environment when education finances are being compressed, there have been twin pandemic shocks of learning losses and enrolment surges.

Since mathematics learning is cumulative, when learners do not receive the necessary instruction, they will find it difficult to grasp topics (Bringula et al., 2021; Hoadley, 2022). Mahlaba (2020) assert that because of teachers' inexperience or ignorance of multiple solution challenges, most South African learners do not investigate alternative mathematical answers. Tasks with several solutions enable learners to propose different solutions (Hoth et al., 2017). After receiving a solution, learners are not encouraged to look for further, more effective solutions, which results in learners passing exams without having a greater comprehension of the subject (Mahlaba, 2020). Teachers had little control over what learners could do during class, which jeopardised their learners' knowledge of mathematics and social construction (Mbhiza & Muthelo, 2022). In South Africa, mathematics teachers had to transform into learners as they experimented with instructional tools they had never used before, including Google Classroom, Zoom, Microsoft Teams, and flipped classrooms (Chirinda et al., 2021). On online forums and social media sites like WhatsApp, teachers have to learn to be creative and arrange timely talks (Chirinda et al., 2021).

3.5.2.1. Significance of Online Learning in Supporting Self-Efficacy, Active Learning, and Collaboration When Learning Trigonometry

Self-efficacy, learning, and cooperation among learners are all impacted by online learning. According to (Martin et al., 2021; Sarac & Tutak, 2017), self-efficacy is characterised as a learner's perception of their competency in a particular activity. Confidence in tackling mathematical difficulties is greatly influenced by motivation and flexibility. Adaptability is the ability to control one's behaviour reacting to unforeseen circumstances (Martin et al., 2021). Adaptability undoubtedly becomes crucial to learners' academic success. It is crucial to comprehend self-efficacy when learning trigonometry online.

Recent studies have inquired into the perspectives of both educators and learners regarding online education and instruction. Due to the coronavirus disease of 2019 outbreak, which has rendered social distancing and quarantine measures unnecessary, the ongoing discourse regarding the effectiveness and prospects of online education persists. The results illustrate the parallels and distinctions between the two cohorts concerning the variables that impact contentment with online education and instruction (Lei & So, 2021). Particularly for learners from marginalised backgrounds, the coronavirus disease of 2019 pandemic has highlighted the need for tools and methodologies to support autonomous learning and formative assessment practices among distance education learners. Feedback is more efficacious than alternative activities in motivating learners to take actions that enhance their performance, and the impacts are more significant in low socioeconomic contexts, according to Barana et al. (2021). Learners gain confidence in their ability to master trigonometry and discover that it is applicable in everyday life. In addition to addressing the subpar performance in trigonometry queries, acquiring a positive attitude towards mathematics and developing practical problem-solving abilities could contribute to achieving the mathematics curriculum's goal. Hence, the instructor's pivotal responsibility is to elucidate diverse principles to the learners and ascertain their comprehension of the presented material (Manman & Surajo, 2021).

The findings illustrate that exceptional performance in mathematical problem-solving requires determination, perseverance, and self-assurance. According to research by Ngussa and Mbuti (2017), improving learners' positive attitudes can potentially enhance their academic performance in mathematics. The learner's problem-solving success depends on her interest, attitude, and self-assurance level. Comparatively less assured than learners of life and physical sciences, accounting learners lack the confidence to solve trigonometric problems, it was determined. Therefore, instructors must implement reasonable measures to boost the self-assurance of their learners. In their research, Manfra and Holmes (2020) investigated the correlation between learners' mathematics achievements and the attitudes and components of those attitudes towards mathematics. Trigonometric achievement exhibited tenuous correlations with the five perspective components, encompassing the attitude towards trigonometry. The combined impact of all attitude components in trigonometry had a substantial, albeit modest, effect on learners' trigonometry achievement. The variable trigonometry achievement was significantly influenced by the gift of confidence but not by the utility, enjoyment, perception of the subject as a male domain, or teacher expectations of the other components. Confidence was the most significant contributor to trigonometry achievement in terms of knowledge, comprehension, and application.

Mathematics comprehension should be paired with self-efficacy (Negara et al., 2021). According to Julaihi et al. (2022), online learning impacts self-efficacy, influenced by domains, time management, and technology use. Some learners felt comfortable learning mathematics online since they could watch the lectures whenever they wanted. As a result, online learning is an effective method for teaching mathematics. Felder and Brent (2009) defined active learning as everything learners in a class do in addition to merely watching, listening, and taking notes relevant to the course material. Active learning encourages learning by utilising strategies including debate, reflection, and problem-solving (Niktinat, 2021). To let learners alter and visually track the changes and behaviour of graphs, Naidoo and Govender (2014) claim that active learning can also include technology-based tools like GeoGebra. Additionally, online learning allows mistakes to be made without causing embarrassment, allowing the learner to experience mathematics rather than merely do it (Naidoo & Govender, 2014).

Active learning is complex online because of the learners' high distraction levels and the prolonged screen periods. Maintaining attention on a screen for extended periods is challenging for learners, and other websites like social media can quickly divert them (Schmidt et al., 2022). It is challenging for many teachers to build facilities for learners to engage in active learning since they possess such rudimentary technological abilities (Halimis, 2022). Small groups organised to complete learning activities are called online teams or online groups in collaborative learning. To complete learning objectives or activities, learner groups can be formed through collaborative learning (Halimis, 2022). This enables teachers to monitor development and take appropriate action as necessary. Additionally, it encourages cooperation among learners. Group projects inspire learners and foster critical thinking, communication, and collaboration (Bennett, 2017). It enables learners to learn from one another.

Virtual learning communities in trigonometry encourage advanced reasoning and learner interdependence. However, since there are no pauses when learners interact with one another, like in conventional learning, online learning typically results in social isolation. Group work is now more difficult than in a conventional environment. Trigonometry is one subject where some learners may benefit from face-to-face instruction because Internet instruction does not allow for this. Additionally, collaborative learning will be difficult for underprivileged learners since they will likely be excluded and lack the funds for equipment and dependable internet access.

The perceptions of learners regarding blended, distance, electronic, and virtual learning were investigated by Cortez (2020). The results indicate that lifestyle and access to online learning tools do not significantly impact the participant's perception of the effectiveness of online learning or their capacity to engage in online learning sessions. This is despite the analysis of variance identifying a statistically significant disparity in the participants' perceived mathematical proficiency. Despite the diligent endeavours of educators, learners occasionally succumb to misconceptions regarding trigonometry. Additionally, there was a substantial improvement in the learners' attitudes towards mathematical instructional inquiry. Despite maintaining a high level of pleasure, mathematics classes remained motionless. Furthermore, instructors must recognise and value learners' preexisting knowledge gained from academic environments and daily life encounters to facilitate a pragmatic learning environment. It is crucial to employ a method or strategy that encourages active pupil participation in the learning process to increase knowledge retention and reduce or eliminate some of the challenges associated with learning trigonometry.

3.5.2.2. Challenges Posed by Online Learning for High School Learners

Online learning is the process of acquiring knowledge and engaging in learner activities from a distance through the Internet or an application. The phrase encompasses the complete scope of education, including distributing learning materials, administering assignments, and conducting assessments through online learning platforms. An effort has been made to streamline conventional procedures through the development and execution of an online formative learning system, which consists of a web-based homework structure and allows instructors to discuss required curriculum subjects and track learners' progress against corresponding standards via homework tools (Rakhmanina et al., 2020; Febriani et al., 2020; Anggitasari et al., 2020; Septinawati et al., 2020). In other words, every educational endeavour is conducted in a virtual environment.

This abrupt shift compels instructors to acclimatise themselves to utilising online platforms within the context of their virtual classroom. Complications consequently emerge during the implementation of online learning. Hazzan (2002) identified several issues with the online learning process, such as the following: (1) the absence of direct teacher-learner interaction and (2) a shift in the teacher's responsibility to navigate, guide, and connect learners' knowledge with English learning materials comprehensively. In addition to the inequitable learning resources in the teachers' residences, the learners' capabilities also present challenges (Alvarez-Trujillo, 2015). In other words, before implementing a virtual learning classroom effectively, it is necessary to resolve all pertinent concerns.

Because online classes offered flexibility and flexible class schedules, 70% of the research sample chose them, according to (Muthuprasad et al., 2021). However, using online learning initiatives posed significant difficulties for learners because of technological limitations such as erratic internet access, poor audio and video quality, the absence of feedback from peers and teachers, and the compatibility of equipment. Additionally, Muthuprasad et al. (2021) noted that although learners favoured online instruction, it was challenging to switch to online instruction for disciplines with a strong practical component, such as science, agriculture, and, to some extent, mathematics. This is because learners needed a hybrid mode gadget, which is expensive for those with less privilege.

According to research by Baczek et al. (2021), medical learners preferred face-to-face instruction over online courses because the latter did not improve social competencies or skill transfers. After all, online learners were generally less engaged than in traditional classes. Extrapolating, one would contend that if older learners have a harder time focusing when taking technically challenging subjects online, younger learners or learners in high school ought to have an even more challenging time. That is supported by Mather and Sarkans (2018), who demonstrated that there are fewer opportunities for one-on-one communication essential for a learner's academic performance in online classrooms.

Due to several obstacles, Mathera and Sarkans (2018) claimed that learners with impairments do not appear to have equitable access to the Internet and other technologies. They demonstrated how people with different impairments could not easily use the internet. Despite familiarity with online classes, learners were not entirely convinced they could completely replace traditional classroom instruction (Kulal & Nayak, 2020). This demonstrates that while technical accessibility is crucial, it is insufficient to provide efficient remote learning. Additionally, they emphasised how a lack of sufficient training impacts teachers' abilities to successfully teach online, implying that technological issues limit the efficiency of online sessions.

3.6. The Role of Microsoft Teams as an Online Learning Platform

Mahmud & Wong (2021) posits that Microsoft Teams is a digital nexus wherein educators can construct dynamic educational experiences by consolidating discussions, information, exercises, and tools in a single location. From a single platform, instructors can facilitate peer networking, partake in professional development groups, and establish collaborative classes.

Using Microsoft Teams, instructors can rapidly exchange files, disseminate notes, and grade assignments while interacting with learners. This technology enables instructors to develop captivating courses and deliver timely and effective feedback. Samritin et al. (2023) research finds that combining online and face-to-face learning promotes learner achievement in Mathematics more effectively.

Moreover, Microsoft Teams serves as a platform for pertinent discussions and announcements, facilitating cooperation and informing all institution members (administrators, personnel, and learners). By utilising professional learning communities, instructors can share educational resources. Worldwide, Microsoft Teams applications are generally straightforward to install and operate on desktop and mobile devices, and their functionalities are widely employed. Microsoft Teams possesses a greater array of features in comparison to alternative social networking platforms. These include videoconferencing, teleconferencing, discussion forums, and content sharing. One could posit that the sophisticated functionalities of the Microsoft Team application render it a viable platform for online learning.

Microsoft Teams (Microsoft Teams), according to Microsoft (2022), is a digital hub that connects interactions, information, assignments, and apps in one location, enabling educators to build lively learning environments. Create collaborative classes, join professional learning forums, and establish connections with co-workers from a single experience. Microsoft Teams enables and enhances learning like a traditional classroom by this concept. The platform supports hybrid, 100% online, and face-to-face learning, enabling interaction between teachers and learners (Mahmud & Wong, 2021). Since most people use cell phones for communication, Microsoft Teams makes it simple for learners to communicate (Pal & Vanijja, 2020). The flexibility of Microsoft Teams makes it ideal for adapting to the demands of both teachers and learners. Additionally, it enables instructors and learners to communicate, exchange files, give tasks, and grade them (Microsoft, 2022). Although Microsoft Teams is an effective educational tool, many learners in South Africa are disadvantaged because they lack the necessary gadgets and internet access (Dean et al., 2021). Online learning is difficult for impoverished households in South Africa because of the country's high data pricing (Dean et al., 2021).
The benefit of sharing information is one advantage of Microsoft Teams. It integrates with other Microsoft applications like Word, Excel, and PowerPoint to facilitate simple file management, creation, and collaboration in real time (Simon, 2021). Collaboration is made possible through Microsoft Teams, which offers a calendar, file storage, team spaces, and social

networks. The platform has also drawn criticism for being too difficult for individuals with just rudimentary computer abilities and for being out of reach for those unable to afford internet access (Simon, 2021). The platform also has a lot of technical problems, such as network problems and some functionalities not operating (Endicott, 2021). This poses a problem for the efficient operation of classes.

Microsoft Teams Platform offers a comprehensive chat and online meeting solution (Stanfield, 2024). The platform's Energy Performance Certificate from 2022 indicates it meets several standards for distance learning, such as providing access to research materials in various formats like PDFs, Word documents, slide presentations, audio files, images, links, and videos. By enabling face-to-face sessions to be recorded and streamed via Microsoft Stream, especially for those who miss classes, Microsoft Teams is considered revolutionary for how education is delivered globally (Akujuo, 2021). However, when compared to other online learning systems, Microsoft Teams has some drawbacks, including being less suitable for self-directed and collaborative learning (Almodaires et al., 2021).

Microsoft Teams is a dynamic platform that continuously evolves. Microsoft's (2022) Energy Performance Certificate highlights that the platform strives to adhere to evolving distance learning standards by providing accessible and diverse learning materials. Future advancements like AI-powered learning assistants and personalised learning paths within Microsoft Teams hold immense potential to enhance further the online learning experience (Ebner, 2023). However, it is crucial to remember that Microsoft Teams is not a replacement for the human element in education. It should be viewed as a complementary tool that empowers educators, not a substitute for their expertise and pedagogical approaches. Integrating technology with strong instructional design principles ensures that online learning environments fostered by Microsoft Teams are engaging, effective, and inclusive for all learners.

The success of Microsoft Teams as an online learning platform transcends its technical prowess. Simon (2021) emphasise the importance of user-friendliness in fostering a positive learning experience. Investing time training students and ensuring an intuitive interface design can significantly enhance user engagement with the platform (Ebner, 2023). However, building a sense of community and fostering learner engagement are equally crucial elements. Microsoft Teams' functionalities, such as breakout rooms and chat features, can be leveraged to facilitate interactive discussions, peer-to-peer learning, and real-time feedback (Amelia & Yosintha

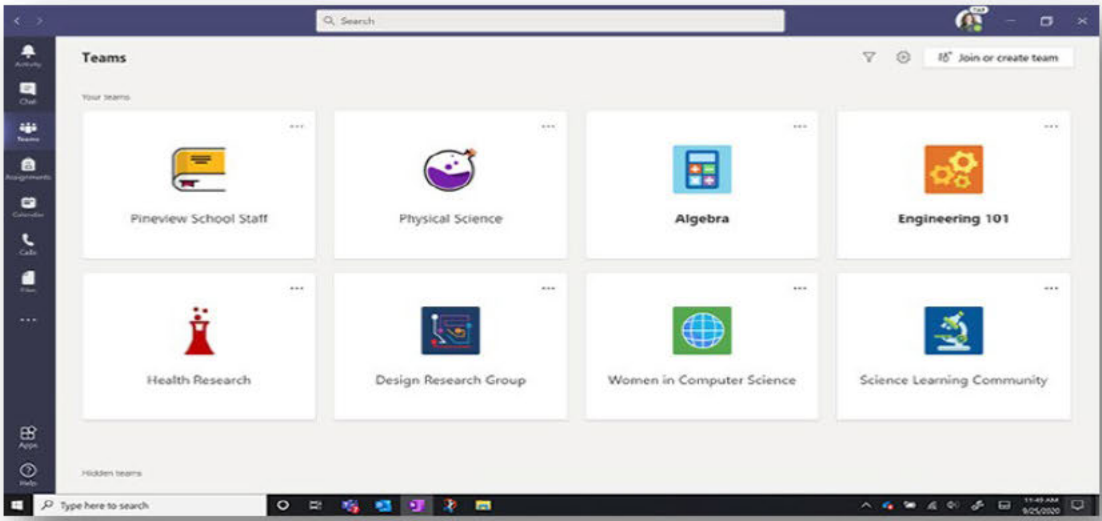
(2022). Regularly soliciting learner feedback through surveys and discussions allows educators to adapt their online teaching strategies and cultivate a supportive learning environment within Microsoft Teams.

The true potential of Microsoft Teams lies not just in its features but in its ability to integrate with diverse teaching approaches seamlessly. While concerns have been raised regarding its suitability for self-directed learning (Almodaires et al., 2021), Microsoft Teams can be a valuable tool in a well-orchestrated pedagogical symphony. Blended learning approaches that combine online and offline activities offer a promising solution (Mukhtar et al., 2020). Microsft Teams can be utilised for synchronous elements like interactive lectures and collaborative projects, while classroom settings can nurture self-directed learning and individualised support. Utilising the platform's asynchronous capabilities, such as recorded lectures and resource sharing, caters to diverse learning styles and paces, ensuring all learners have access to learning materials at their convenience.

While Microsoft Teams offers a compelling suite of features, its effectiveness hinges on equitable access. Studies by Dean et al. (2021) highlight the stark reality of the digital divide, where learners from resource-constrained regions lack access to essential devices and reliable internet connections. This disparity creates a significant barrier to online learning, potentially exacerbating existing educational inequalities (UNESCO, 2023). Addressing this challenge requires a multifaceted approach. Educators can explore alternative delivery methods like downloadable learning materials and offline activities to cater to students with limited internet access (Martin , 2021). Additionally, fostering partnerships with local libraries and community centres can provide crucial infrastructure for students to access devices and internet connectivity (UNESCO, 2023). By acknowledging the digital divide and proactively seeking solutions, educators can ensure Microsoft Teams becomes a tool for inclusive learning, not a barrier.

FIGURE 4

SCREENSHOT OF THE MICROSOFT TEAMS DESKTOP APP



(Taken from Microsoft, 2022)

3.6.1. Features of Microsoft Team's Platform

The functionality and ease of use of Microsoft Teams have made it particularly beneficial for education (Tomczyk et al., 2020). As a learning platform, Microsoft Teams must be functional to be useful (Almodaires et al., 2021). Because it is accessible on desktops and mobile devices, the platform is popular among learners (Taghizadeh & Hajhosseini, 2021). According to Almodaires et al. (2021), this improves platform work integration and cooperation. Microsoft Teams provides learners with visual impairments through its screen reader with inclusive online learning (Microsoft, 2018).

3.6.2. Microsoft Teams Platform as a Tool for Interactive Learning

Several researchers have examined the utilisation of Microsoft Teams for online learning. Rojabi (2020) investigated EFL learners' perspectives on online learning facilitated by Microsoft Teams. 28 university learners participated by completing post-course Google Forms questionnaires. The results suggested that utilising Microsoft Teams significantly improved the digital learning environment. When using Microsoft Teams for online learning, learners positively perceived learner-teacher and learner-learner interaction. Recommendations included examining learner satisfaction with online courses, a crucial aspect that requires further investigation, and the advantages of scheduling them through Microsoft Teams.

Similarly, Lin et al. (2015) argue that learner-student and learner-teacher interaction should facilitate communication and discussion in teaching and learning. Seyedaliyan & Salehi (2023) state that establishing a conducive learning environment fosters learner motivation and engagement.

Tran (2021) assessed the effectiveness of using Microsoft Teams as an EFL platform for incoming Van Lang University undergraduates. 80 first-year learners participated in a 15-item survey. Her research revealed that Microsoft Teams effectively taught and facilitated EFL learning at the university, with learners viewing the benefits positively. She highlighted some drawbacks of using Microsoft Teams for online education and instruction. Additionally, Ha & Ngo (2021) examined challenges English graduates at Van Lang faced in listening comprehension when using Microsoft Teams. 135 learners completed questionnaires and semi-structured interviews. Results showed that psychological factors, technological proficiency, English proficiency, listening activities, and research environment posed obstacles when learning to listen online via Microsoft Teams. Recommendations were provided for using Microsoft Teams to teach and learn listening skills.

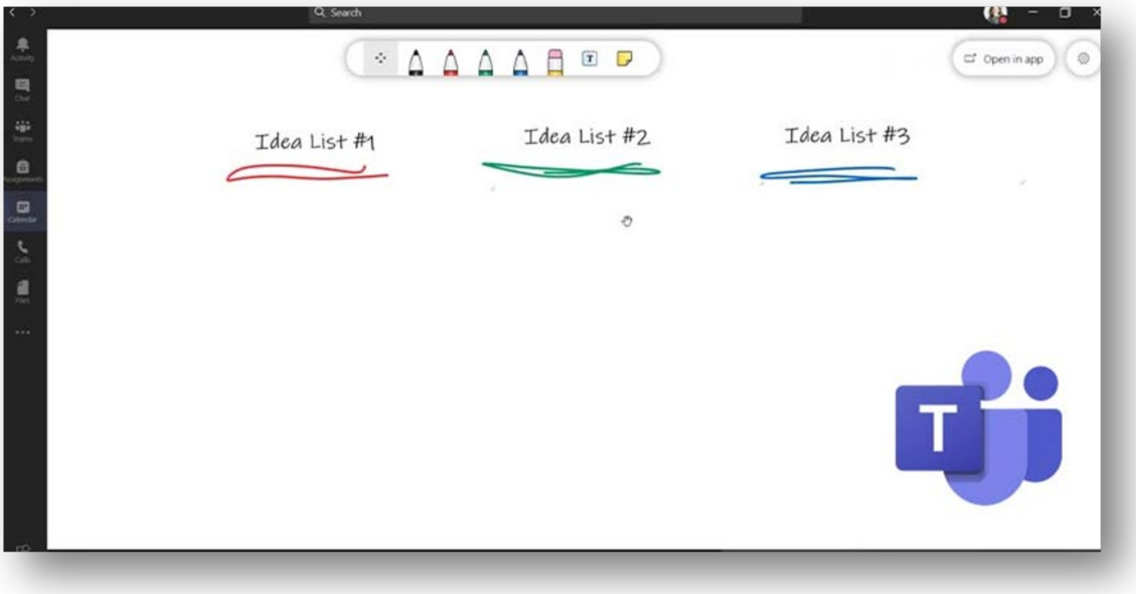
The coronavirus disease 2019 forced higher education institutions to enhance technical infrastructure. It encouraged learners/faculty to develop digital competence (Zarei & Mohammadi, 2022) as a prerequisite for establishing a modern educational environment and ensuring the research process. Though no longer mandated, online learning persists partially in higher education. Microsoft Teams is widely used due to its distinctive functionalities, which enable an inclusive, diverse digital learning environment. Research indicates Microsoft Teams effectively facilitates the educational environment (Rojabi, 2020), with learners viewing it favourably (Almodaires et al., 2021; Makhno et al., 2019; Wea & Kuki, 2021; Zakaria & Khalid, 2016) and easily navigating it (Nawi et al., 2022). However, optimal functionality requires faster internet (Laquindanum, 2022), a common learner challenge.

Digital technologies co-created, monitored and evaluated information dissemination during COVID-19, profoundly impacting education (Haleem et al., 2022). ICT advancements enabled online education technologically, economically and functionally, with its pedagogical efficacy acknowledged (Alam et al., 2022). Integrating online and in-person courses became fundamental in higher education. Said (2021) comparatively analysed grades of pre-COVID in-person and online learners at the same academic level, finding no statistically significant differences. However, online education showed reduced overall efficacy versus in-person (Tartavulea et al., 2020) and posed obstacles for learners and instructors (Hamdan & Amorri, 2022). It is generally considered less effective due to diminished learning outcomes, lack of social competencies, and limited participation (Bączek et al., 2021). Technological provision and infrastructure significantly impact online research process effectiveness (Gautam & Gautam, 2021) as it relies more on technology than the lecturer (Ritonga et al., 2022).

Effective online learning necessitates implementing deliberate pedagogical techniques and a proactive stance (Bączek et al., 2021). Additionally, learners must avoid diversion of attention from the issue and maintain concentration on the information (Atiles et al., 2021). It is imperative to tailor the course material's quantity and level of difficulty to the learners' academic readiness and online learning habits (Bao, 2020). Nevertheless, despite various challenges in the online learning environment, Hamdan and Amorri (2022) concede that online education does indeed surmount the temporal and spatial constraints during the research process. Moreover, it provides learners with convenience and accessibility, which are additional benefits. Due to the knowledge and skills gained during the global pandemic, educators and learners have adapted to using technological tools and solutions such as the Microsoft Teams whiteboard (See Figure 5 below).

FIGURE 5

MICROSOFT TEAMS WHITEBOARD



(Adapted from Carter, 2022, p. 23)

Virtual engagement is crucial to keeping learners engaged in classroom and group projects (Landrum et al., 2021; Almodaires et al., 2021). Microsoft Teams facilitates group work, conversations, and the exchange of information through videos, audio, and chats. As a result of this engagement, learners develop a culture of peer learning (Afif & Azhar, 2023). The whiteboard, in the words of Rath et al. (2021), enables learners to "ideate, create, and collaborate visually." Sharing drawings and words enhances engagement (Rath et al., 2021). According to Carter (2022), using the whiteboard engages people and provides space for developing and exchanging fresh ideas. In online classrooms, the whiteboard also has a visual effect and encourages interaction (Casement, 2021). Although underutilised, the immersive reader feature is critical in helping learners with learning disabilities learn by reciting text over a channel at different speeds (Kent, 2021).

3.6.3. Microsoft Teams as a Tool for Collaboration and Feedback

Microsoft Teams is suitable for face-to-face, hybrid, and online learning, claim Poston et al. (2020). Microsoft Teams reportedly enables both synchronous and asynchronous learning, according to Almodaires *et al.* (2021). Through chat rooms, material sharing, and video conferencing, the platform has been hailed for fostering greater communication and cooperation between learners and teachers (Dele-Ajayi et al., 2019; Genlott & Grönlund., 2016; Henderson et al., 2020; Nemec et al., 2020). Additionally, the platform unites messaging functions in one location, ensuring learners no longer need to hop between applications or leave class to access particular research materials (Corrales, 2022). This facilitates time savings.

The cooperation of extensive courses is possible with Microsoft Teams (Microsoft, 2022), which can accommodate up to 250 participants in a session. According to Buchal and Songsore (2019), Microsoft Teams is valuable for knowledge-building and collaborative learning. Feedback and iteration with every learner in the class are two crucial components of cooperation, according to (Faraj et al., 2011). They go on to say that Microsoft Teams offers iteration and feedback, is a helpful tool for collaborative work, and ensures effective outcomes, growth, and meaningful experiences (Faraj et al., 2011).

FIGURE 6

THE BEST FEATURES OF MICROSOFT TEAMS

(Taken from Stanfield (2024). Retrived from https://www.stanfield.com/microsoft-teams/)

Files shared during conversations, for example, are kept and accessible again later (Stanfield, 2024). As a result, one spends less time looking around to see where files are stored. Files are saved using standard or general channels and sent to the team. A distinct site stores files for private channels and SharePoint (Microsoft, 2022). The abilities of learners to communicate are improved through group discussions and interactions with teachers, which also allow them to pick up knowledge from others (Henderson et al., 2020). Additionally, it is linked to Office 365 applications like Skype, OneDrive, and SharePoint. Meetings may be shortened and more focused through real-time collaboration (EPC Group, 2022; Stanfield, 2024). By transmitting some communications from Microsoft Teams to Outlook, Microsoft Teams is likewise linked to Outlook (Corrales, 2022).

The use of other office apps, such as Outlook and Word, combined with Teams elevates it into an all-encompassing learning tool. Learning can become highly effective due to compatibility with tools like Skype, OneDrive, and SharePoint for organising and distributing educational resources. As suggested by (Buchal and Songsore (2019), this integration makes it possible for people to attend meetings in a less fragmented and concentrated manner. It then becomes easier for people to move some of their chats to Outlook, where they have a clean history of discussions and work activities (Almodaires et al., 2021).

It also fosters digital literacy in learners. Competency in using modern collaborative tools is critical in today's technology-driven world. According to Makhno et al. (2019), the platform helps learners develop their communication abilities by engaging in group talks and communicating with teachers. Besides assisting a child with learning, it also helps to build significant 21st-century skills such as teamwork, problem-solving, and digital competence. Microsoft Teams is an effective teaching platform because it can adapt to different instruction approaches, such as flipped classrooms and project-based learning. This makes channel creation possible for educators, who can dedicate some channels to specific topics or projects, leading to focused discussions and group work. This strategy conforms to modern teaching styles that focus on learner-centred education and participatory learning.

Nevertheless, it is essential to note that Microsoft Teams has limitations in education setup. Technical issues in places where Microsoft Teams is used can affect its efficacy. For instance, a poor connection can hinder learning, especially in areas with limited digital infrastructure (Jayothisa et al., 2021). Furthermore, dependence on digital devices and strong internet connections can worsen imbalances between different social groupings of learners. To address this, educational institutions should invest in training teachers and learners how to use Microsoft Teams and/or any other online learning optimally. This includes technical training and advice on sound online communication principles. Also, schools and colleges should consider assisting in providing requisite technology to learners who do not have access to it. This will prevent the inequality in the education gap resulting from the new approach towards digital learning.

Although Microsoft Teams are helpful in many issues, such as collaboration, comments, and instruction, they need to be adopted in the educational field, considering technical, pedagogical, and equity problems. Properly supported with suitable infrastructure, Microsoft Teams may effectively help improve the quality and accessibility of education in different learning situations.

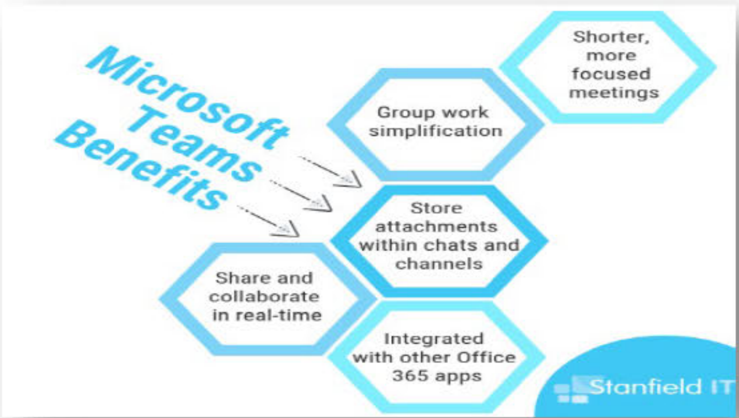
3.6.4. Benefits of Using Microsoft Team's Platform

Online learning is frequently recognised as an exceptionally efficacious pedagogical approach. According to Zayapragassarazan (2020), online learning improves the autonomy and self-control of learners as they progress through their education. Rojabi (2020) emphasises the importance of learner autonomy, self-regulation, learner engagement, and motivation in online education. Microsoft Teams is widely regarded as a highly successful online learning environment. Microsoft Teams is a robust application that is a centralised platform for communication, collaboration, and file sharing. It integrates many features, such as discussions, meetings, files, and applications, into a unified learning management system (Microsoft, 2018). Many learners and educators widely utilise Microsoft Teams due to its convenient availability on desktop and mobile devices. It offers impressive features such as chat rooms, collaborative discussions, screen sharing, and video conferencing (Henderson et al., 2020).

It is flexible because of its additional capabilities like the raise your hand button, which signals when someone wants to speak, and the together mode for groups, which enables learners to stay involved by communicating with teachers and classmates (Akujuo, 2021). Microsoft Teams platform also enhances communication. Learners can check their comments, alerts, and new assignments. To help learners get ready for class, Microsoft Teams provides a detailed daily timetable (Akujuo, 2021; EPC Group, 2022).

FIGURE 7

BENEFITS OF USING MICROSOFT TEAMS OVER EMAIL



(Taken from Stanfield (2024). Retrieved from https://www.stanfield.com/microsoft-teams/)

Microsoft Teams works excellently with other popular Microsoft education products such as Word, Excel, PowerPoint, and One Note (Yen & Thi, 2020). Such an integration helps in making the learning platform homogeneous. Therefore, learners and the teacher can effortlessly obtain and upload different researching stuff. It facilitates various forms of instruction and learner tasks, such as group work or independent projects, and thus contributes to better learning and education in general. For example, there is the integration with OneNote that can facilitate the creation of class notebooks where classmates can work out assignments and teachers can give personalised feedback.

Collaborative learning is promoted by Microsoft Teams (Khrisat & Fakhouri, 2024). The characteristic of the platform is that it allows learners to interact in different collaborative activities like online discussions, meetings, and file exchanges. It is important to develop cognitive strategies such as critical thinking and problem-solving wherein learners learn to work together, accept diverse opinions, and create shared solutions to complex activities.
One thing that makes Microsoft Teams valuable is its flexibility and ability to customise a teacher's channel according to learners' individualised interests and styles of perceiving information (Buchal & Songshore, 2019). Personalisation is especially valuable in catering to learners' various learning skills and preferences so that they can get adequate individualised attention.

With Microsoft Teams, teachers can instantaneously comment on assignments and classroom interactions (Sayeh et al., 2022). This instantaneous reaction is critical to learner learning, enabling prompt clarification of misconceptions and fostering perpetual learning. Also, the platform has provisions for Q&A forums where learners ask questions and get timely answers, not just from teachers but also from other classmates, promoting an environment of mutual support in learning practice.

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3.6.5. Issues of Using Microsoft Teams Platform

Microsoft Teams has some drawbacks. Initially, teachers cannot perceive the nonverbal cues exhibited by their learners. It indicates the absence of nonverbal cues, such as facial expressions of uncertainty, which assist the teacher in assessing the learners' comprehension (Rojabi, 2020). Learners do not have constant access to direct, in-person communication with their teachers. In addition, educators and learners must devote more time to assessing the development of learners participating in online instruction and learning (Koç et al., 2015). Furthermore, Sun (2014) emphasises that online learning is distinguished by the lack of a predetermined schedule, consistent evaluation, and individual motivation. Additionally, prior research has investigated the extent to which learners are satisfied with the level of engagement and the learning environment. Fortune et al. (2011) note that the various aspects of online learning include in-person communication, the learning environment, technology, personal preferences, and teamwork. These elements have effects on the instruction and acquisition of writing skills through online platforms such as Microsoft Teams.

Attendance: According to Poston et al. (2020), some learners will not be able to see recordings of the sessions they missed, and some learners may elect not to attend class without giving any reason.

Access to technology: Not every learner has the technology or internet access necessary to participate in online classrooms (Wea & Kuki, 2021). Additionally, internet-connected individuals may have sluggish speeds, which causes technical difficulties during classes (Rath et al., 2021). Almahasees, Mohsen, and Amin (2021) researched 280 learners and 50 faculty members in Jordan, and the results reveal that online learning platforms like Zoom and Microsoft Teams were used for learning and WhatsApp for contact outside of class sessions. Teachers and learners alike believe conventional classroom instruction is more successful than online learning (Almahasees et al., 2021). The hurdles highlighted were the adaption of online learning for learners with hearing impairments, a lack of learner connection and motivation, and technical problems with connectivity. The advantages of online learning were noted as being flexible and lower prices. An online poll was conducted by Harefa and Sihombing (2022) among 30 Indonesian junior high, senior high, and college learners. The results showed that due to poor interaction between teachers and learners and low computer abilities, learners were not particularly comfortable with online learning. Some teachers do not comprehend the obstacles to online learning, leaving problems unaddressed.

According to research by Iddrisu (2022), teachers at Ghana's 12 senior high schools had a favourable opinion of online education. In their opinion, internet education enables learners to collaborate on learning materials and obtain current knowledge. Learners thought online education might help them grasp topics and perform better on exams (Iddrisu, 2022). This is consistent with what Malekani (2018) discovered in Morogoro, Tanzania. Malekani (2018) surveyed 20 teachers and 60 learners to learn more about secondary schools' usage of and access to ICT resources. His research found that schools lacked the essential ICT resources and that those present were not being adequately utilised by teachers and learners due to a lack of knowledge on how to use them. Most learners were unaware that schools have ICT resources (Iddrisu, 2022; Malekani, 2018).

In a case study by Manuel, Buque, and Quiver (2021), learners were questioned about how they felt about online education. Most learners felt that ICT improves access to education through online learning, yet having a poor internet connection is never easy. Furthermore, the results are delayed in publication, and feedback for formative evaluation is essentially non-existent. This supports research by Musingafi et al., (2015), who spoke with learners in Zimbabwe about how they regard online education. This research revealed two issues: ineffective teacher feedback and restricted access to ICT tools.

However, one of the main disadvantages of using MS Teams is poor communication (Nguyen & Duong, 2021). Due to a lack of physical presence, subtle things such as body language, facial expression, and other nonverbal clues are lacking. This can limit a teacher's understanding of how much learners understand what is being taught or whether they are involved or not in the instructional process, which may result in misunderstanding or misrepresentation. Technical glitches, such as a poor-quality internet connection, can affect the running of the online classes in Microsoft Teams. The digital divide worsens matters, as there are cases where learners in regions with poor economic backgrounds cannot get reliable internet services and appropriate devices, thus resulting in unequal learning opportunities.Overusing technology could cause many problems. Prolonged exposure to digital devices may lead to screen fatigue in learners (Ha & Ngo, 2021). Secondly, virtual environments tend not to feature many hands-on activities or real-life experiences crucial for developing learners' practical skills, especially on subjects that involve manipulating or physically observing things.

Using Microsoft Teams and other online platforms sparks privacy and data security issues. Data breaches, unauthorised access, and other cyber threats could jeopardise private teacher and learner details (Almutairi, 2023). Although Microsoft Teams allows users to interact via chats and conferencing, it does not precisely recreate the social dynamics in a conventional classroom setting. The absence of face-to-face communication with fellow learners may adversely influence their ability to acquire the requisite social skills. Besides, this feeling of loneliness, among others, could be the outcome. In most cases, learning to use online teaching platforms like Microsoft Teams means increasing the number of tasks teachers must take care of. They must dedicate more hours to developing appropriate online learning resources, getting acquainted with technologies, and providing personalised feedback within a virtual environment (Ha & Ngo, 2021).

It is not easy to maintain learner engagement in an online environment. Home distraction, different levels of digitisation, and the impersonal character of e-interaction could result in lower motivation and involvement of learners. Ensuring academic integrity in online assessments. A controlled environment would be absent, making it hard to avoid cases of plagiarism and cheating on tests and exams. The physical presence of peers and teachers allows for on-the-spot feedback in a physical classroom. However, in an online environment, they may not get an immediate response to their queries, so their learning process may be interrupted.

Learners' technological literacy and the availability of resources such as computers at home determine the quality of the Microsoft Teams learning experience. This inequity may result in differentiation in learning outcomes. It is, therefore, important to discuss the challenges associated with using Microsoft Teams in online learning. These include communication gaps, electronic challenges, dependence on technology, data privacy matters, less socialisation, additional tasks for teachers, irregular learners' participation, assessment difficulties, support services delays, and learning experience disparities. There is no single solution to address these challenges; as such, there is a need to put in place technological, policy and pedagogical adaptations to guarantee practical, equal and enjoyable learning for all learners.

3.7. The Implications of the Literature Review for this Research

Any research project must begin with a literature review. It is part of the research when researchers learn what is already known in the field they want to examine. Because researchers need to be aware of the contributions other people have made to the body of knowledge on their issue, the review serves as the basis for the actual research (Hart, 2018). The learning of trigonometric functions in mathematics among Grade 10 learners was highlighted in this literature review, which also examined theoretical contributions to the research. The findings of numerous researchers were given in the chapter, and their contributions to interpreting and clarifying ideas important to this research.

The literature review makes it abundantly evident that there are still unmet research needs. To begin with, the concept of perceived efficacy within an academic setting pertains predominantly to the assessment of Moodle-based platforms that have been modified by scholars in order to fulfil their specific research goals (Rivers, 2021). While Moodle-based platforms may supplement conventional classroom learning, it is imperative to remember that they cannot entirely substitute it. Comparing online learning to classroom learning, Zhang, Zhao, Zhou, and Nunamaker (2006) investigated the viability of online learning as a future substitute for the more traditional mode of instruction. They concluded that although online learning has the potential for lifelong learning and training, it should be utilised in addition to conventional classroom instruction rather than as a replacement. Condie and Livingston (2007), who advocate for using integrated learning materials in which online learning supplements traditional classroom instruction rather than replacing it, reach comparable conclusions. Twelve recommendations are provided by the authors of a more recent research published in 2020 (Jong et al., 2020) regarding integrating MOOC videos into traditional classroom lectures to foster a welcoming blended learning environment and enhance learners' learning opportunities.

3.7. Summary

Chapter three presented the review of literature on several aspects of mathematics teaching and learning trigonometry. Further analysis involves conventional and contemporary approaches, such as online learning through Microsoft Teams. The realm of educational concepts is enormous and varied. In a single day, learners can watch videos with mastery quizzes that are influenced by behaviourism, engage in social media community practice for assistance with homework, use the responses to help build their understanding of a subject, and share their understanding and useful sources by leaving comments on social media (Campbell et al., 2019). This literature review reveals the importance of employing a balanced way while teaching trigonometry. The approach should make the strength of conventional processes, new learning strategies, and teamwork work concurrently. It develops a classroom culture that facilitates an environment of conceptual mastery, critical thought, and inclusion where learners work together to develop ideas. This chapter concluded by discussing the usage of the Microsoft Teams platform in the classroom and, more significantly, for this research, the use of the Microsoft Teams platform to teach and learn trigonometric functions. The next chapter presented the theoretical framework guiding this research.

Chapter Four: Theoretical Framework

4.1. Introduction

The preceding chapter introduced and discussed the literature review on technology-based teaching and learning approaches that underpin how Grade 10 learners perceive using the Microsoft team's platform to learn trigonometric functions. The theoretical foundation that served as the research's direction is highlighted in this chapter. We distil the many definitions of a theoretical framework to mean an explanation of how things operate. Those explanations vary in origin, extent, and force, but they are all based on understanding particular occurrences (Collins & Stockton, 2018). Theoretical frameworks usually identify the theory or theories that have affected the formulation of the topic under research, claim Hughes et al. (2019). The theoretical framework can connect the research topic, the particular research questions, the procedures used for collecting and analysing data, and the interpretation of the results.

According to Keleszade et al. (2018), frameworks can aid in framing research questions and hypotheses, anchoring background material, clarifying measuring constructs, depicting relationships to be evaluated, and contextualising results. They can also inform all stages of research, oversee implementation, assist in identifying implementation aspects, and provide guidance in the choice of implementation tactics. Frameworks provide people with a shared vocabulary, enabling evidence accumulation. According to Collins and Stockton (2018), a theoretical framework lies at the confluence of the researcher's epistemological inclinations, prior knowledge, and beliefs about complicated phenomena, a lens, and a rigorously analytical methodology. The theory becomes a great tool for the coherence and depth of research by working through these three aspects.

The realm of educational concepts is enormous and varied. In a single day, learners can watch videos with mastery quizzes that are influenced by behaviourism, engage in social media community practice for assistance with homework, use the responses to help build their understanding of a subject, and share their understanding and useful sources by leaving comments on social media (Campbell et al., 2019). The constructivist theory of learning, which provided the theoretical foundation for this research project, is presented in great detail at the beginning of the chapter. A number of learning theories, such as socio-constructivist learning, situated cognition, realistic mathematics education, activity theory, experiential learning, anchored instruction, and learning theory, are commonly categorised under constructivism.

Connectivism is a noteworthy and contemporary idea that shares similarities with constructivism (Mattar, 2018).

The current research is restricted to social constructivism, which appears to be the constructive in mathematics education that is most frequently acknowledged. The research is grounded in constructivist principles and employs the integrated perspectives of social constructivism and connectivism to gain a deeper insight into Grade 10 learners' perceptions of utilising the Microsoft Teams platform for learning trigonometric functions. Following a brief description of social constructivism's historical context, the theory's guiding principles are discussed. Following is an analysis of the tenets of the social constructivist theory, including anchored instruction, situated cognition, the zone of proximal development, scaffolding, and connectivism theory. In addition to these ideas, the framework for this research includes a sizable portion of the theory of multiple effects and the utilisation of the Microsoft Teams platform.

4.2. The Theory of Social Constructivism

In 1978, Lev Vygotsky introduced social constructivism as an educational paradigm. This viewpoint holds that language and culture act as the frameworks through which individuals interact, view, and comprehend the world. Vygotsky (1978) believed that language and culture have an effect on how people think, grow, and perceive their environment. As a result of language transmission, learning concepts are interpreted and internalised by experience and cultural context. Knowledge is produced by society and co-constructed because it requires a group of people who share a language and culture. The social constructivist viewpoint holds that learners learn by working with teachers, peers, and other learners. This type of cognitive constructivism promotes collaborative learning among learners or with a facilitator (Mohammed & Kinyo, 2020).

Social constructivism, in sociology and communication theory, is a theoretical framework that examines how individuals collectively develop knowledge and worldviews. According to this perspective, persons collectively obtain their comprehension, importance, and purpose. The theory emphasises two fundamental principles: firstly, individuals make sense of their experiences by creating mental models of the social world and its functioning, and secondly, language plays a central role in shaping people's perception of reality (Leeds-Hurwitz, 2009). According to Vygotsky (1978), social development precedes cognitive growth and occurs outside of an individual. Acquiring the ability to understand and interpret the thoughts and ideas of others, as well as generating new information in a social context, empowers learners to establish connections with various situations.

Smith (2010) makes a distinction between strong and weak types of social creation and critically examines a number of sociological phenomena. Smith suggests that whereas the latter are simply bankrupt, the former need some maintenance. The rise in popularity of strong constructionism in late modern thought can be attributed to the fact that many individuals in knowledge-based professions were inclined to embrace it despite its inherent self-contradictions. Searle (1995, p. 62) “argues against the strong theory and in favour of the weak theory, stating that not all details are institutional facts and that there are brute facts”. He asserts that the structure of institutional facts shows that they rely on brute facts logically. The account of institutional facts would experience an infinite regress or circularity if it were assumed that all facts are institutional or social. There must be certain raw [physical, biological, or natural] facts in order for some facts to be institutional. This is the outcome of institutional facts' logical structure."

According to social constructivism (Bruning, 1999), knowledge is initially created in a social context before being internalised and applied by individuals. According to social constructivists, learners build understanding collectively by exchanging individual viewpoints, or collaborative elaboration (Meter & Stevens, 2000). This building is not possible for learners to do alone (Dukas, 1996). Woolfolk (2010) presents a range of strategies for cooperative learning, such as planned debates, jigsaw classrooms, and reciprocal inquiry. Social constructivist academics advocate for the cultivation of guessing and intuitive thinking in learners, since they perceive learning as an engaged process wherein learners should acquire principles, concepts, and facts autonomously (Brown et al., 1989; Ackerman, 1996). In other words, the social constructivist perspective highlights that reality is not an objective entity that can be discovered, but it only comes into being through the collective creation of individuals within society. This is supported by other constructivist academics who stress that people create meaning through their interactions with one another and their surroundings. Furthermore, learning, according to Vygotsky (1978), is a continuous process that moves a learner from their present intellectual level to a higher level that more nearly resembles their potential. Social interaction precipitates the alteration in the zone of proximal development (ZPD). The zone of proximal development (ZPD), as defined by Vygotsky (1978), refers to the gap between a person's current problem-solving ability and their potential problem-solving ability when guided by an adult or working with more capable peers. According to Vygotsky, human mental activity is a distinct form of social experience. The power of the cognitive process thus arises from social contact, and a comprehension of human thinking and knowing rely on a grasp of social experience.

Towers, Takeuchi, and Martin (2018) assert that when educators and learners work together with parents and other social factors like peers and the media, they may create a world where mathematics is relevant. Therefore, the interactions that learners experience with mathematics are not just influenced by what takes place in the classroom but also by a much wider contextual environment in which learners are engaged. This environment influences how learners relate emotionally to the subjects as well as what they learn in school. This research examines literature that explores learning from a social constructivist perspective in order to gain a deeper understanding of how the broader social and environmental context can impact learners' emotional engagement with mathematics.

Maunder and Crafter (2017) highlight that the global focus on education is expected to shift from teacher-centred to learner-centred approaches due to ongoing changes in the field. Furthermore, it is expected that learners' requirements would be duly acknowledged to ensure the practical application of acquired knowledge throughout the entire educational journey. The social constructivist theory, which prioritises cooperative learning and highlights the importance of the learner's peers in the learning process, is particularly relevant in this context as it is centred around the learner. This research is based on the theories of Lev Vygotsky in order to gain a deeper understanding of social constructivism (Shaikh et al., 2017). According to Vygotsky (1978), knowledge is generated through social contact and the exchange of ideas through debate. In addition, Finnegan and Ginty (2019) state that Vygotsky (1978) places greater importance on social interaction in the learning process rather than solitary cognitive learning. Vygotsky believes that a significant portion of a learner's crucial learning occurs by social engagement with their teacher and peers. Vygotsky's theory of child development has exerted a substantial and ongoing impact on educational research, as well as teaching and learning. Ongoing investigations are being conducted on his theories, with scholars actively integrating his findings into their studies on pedagogy and cognition (Lerman, 2001). Additionally, the socially involved processes of group collaboration and collaborative learning among learners are incorporated into this research.

In light of the fact that social skills development occurs in a social environment, socio-constructivist theories incorporate both the personal and communal dimensions of learning. Socio-constructivism is the predominant form of constructivist pedagogy used in mathematics education (Noorloos et al., 2017). According to Vygotsky (1978), most educational events are experienced through social interactions and the consequences of the learning process are mostly influenced by social factors. Social interaction is the primary means by which organisations and individuals, including educational institutions and teachers, improve the process of learning (Chan et al., 2017).

The social evolution of learning theory and the emphasis on merging the method of learning within a socio-cultural framework serve as the theoretical foundation for this research investigation (Geiger et al., 2023). The investigation was guided by Lev Vygotsky's social constructivism theory, which significantly emphasises a participatory and communal approach. It is widely believed that the development of individuals is influenced by the places in which they live and the social and interactive relationships they have with others (Maunder & Crafter, 2017). The origins of socio-cultural approaches can be attributed to Vygotsky's (1978) research.

Nowell et al. (2017) proposed that socio-constructivism was developed to address the disparity observed by academics between the theoretical perspectives of cognitive constructivism and socio-cultural theories. According to Vygotsky (1978), learners shape their brains by their own actions in specific sociocultural environments. It is crucial to acknowledge that learners experience a sense of having the requisite information and skills to perform the assigned activities. The main goal of constructivist learning approaches is to understand how learners build their knowledge and the implications of these structures for mental processes. Teachers should adopt the viewpoint that every learner will generate knowledge in a distinct manner due to the adaptable nature of constructivist learning. Social constructivism posits that the process of knowledge construction by learners is influenced by social interaction, interpretation, and comprehension. The diverse manifestations of social constructivism in the classroom are illustrated in Figure 3.

According to Vygotsky (1978), socio-cultural theory offers a conceptual structure that facilitates comprehension of cognitive development via interaction and social and emotional learning that occurs in shared cultural school environments involving instructors and peers.

Meaning-making and comprehension are enhanced by means of socialisation, interpersonal connections, and guidance from others. Mediation, as proposed by Vygotsky, is the reciprocal process in which society and the individual mutually influence and shape each other (Maunder & Crafter, 2017). Instead of obviating the necessity for teachers, social constructivism redirects the focus of teachers towards establishing a secure environment where social mediation and the generation of learner knowledge take precedence. In order to effectively navigate the sociocultural realm, it is essential for teachers to possess a comprehensive understanding of the circumstances and stages that learners must go through in order to achieve comprehension. The main instructional requirement, essentially, is the use of scaffolding in the process of learning (Vygotsky, 1978).

The research investigation was carried out in a tenth-grade classroom where both the instructor and learners were involved in dialogue and instruction regarding the difficulties associated with acquiring knowledge of trigonometric functions. The classroom is a communal environment characterised by frequent interaction between learners, instructors, and fellow learners. As a result, this research is in complete accordance with the social constructivist viewpoint. Alongside the principles proposed by Vygotsky (1978), the research utilised a blended learning methodology, which integrated computer-assisted learning alongside conventional classroom exercises.

4.2.1. Background to the Theory of Social Constructivism

The zone of proximal develpment (ZPD), introduced by the Russian Lev Vygotsky in 1978, is further developed in socio-constructivist theory. According to Geiger et al. (2023), the idea may be viewed as the learner's cognitive field, which can be seen at the edge of their previous knowledge and outside-of-school worldview. Numerous procedures that learners use to experience educational phenomena and to put into practice what they have learned are primarily social in nature (Vygotsky, 1978). Humans are fundamentally social organisms, according to Shabani & Hui (2016). A range of social connections begins the moment we are born in our families, schools, and communities, and unquestionably in our learning environments. Learning was viewed less as a solitary process and more as the accumulation of the interactions that learners form with others (Macblain, 2018). Learning is a multifaceted and ever-changing process that happens organically and requires engagement among learners, educators, classmates, and a specific setting to enhance cognitive abilities (Shabani & Hui, 2016). Moreover, Geiger et al. (2023) argue that the learning zone is the space where learners may effectively and meaningfully interact with new knowledge, thanks to the inherent connection between their existing knowledge and new information. Vygotsky (1978) posited that learners' cognitive progress is derived from social interactions and encouraged learning from others, which facilitate knowledge generation. Vygotsky's primary focus was on the cultural context in which learners are brought up, rather than the individual characteristics of their learning process (Macblain, 2018).

Kearnely et al. (2019) stated that social constructivism posits that learners's understanding is influenced by their adaptive engagements with the tangible surroundings and their interpersonal discussions concerning a reality that is both culturally significant and relevant. Potential growth, as defined by Taylor (2018), pertains to the utmost degree of academic advancement that a learner is capable of attaining with the guidance and support of instructors or peers. His perspective on learning is that of a collective enterprise, which includes historical figures, family members, classmates, and incidental acquaintances. According to the theory of Social Constructivism, the essential elements for achieving learning goals are discussion, collaboration, and the utilisation of knowledge. Vygotsky claimed that social interaction is necessary for the continual development of one's personality and that social learning contributes to cognitive advancement. Put simply, learners have the option to engage in any activity, regardless of its level of difficulty, with the assistance of an adult or by collaborating with a peer. By establishing a strong basis, this approach enables learners to engage in collaborative learning with their instructor and fellow learners, with the ultimate goal of constructing knowledge and improving comprehension (Aljohani, 2017).

According to Fleury and Garrison (2014), the social production of knowledge occurs in various contexts and at varying degrees of complexity. For example, within a marketplace, an educational or training institution, a social media forum, or a religious setting. Engaging in social interactions and navigating both tangible and intangible environments enables learners to acquire understanding and practical knowledge that will benefit them in their adult lives. Social constructivism is an instructional approach that prioritises active involvement, dialogue, and collaboration among learners. This instructional method facilitates various formations and interactive strategies. Whole-class dialogues, small-group deliberations, and learner engagement in focused subjects (e.g., in pairs). Learners engage in collaborative idea-sharing and brainstorming sessions to identify cause-and-effect relationships, solutions to issues, or novel information to expand their existing knowledge (Al-Qaysi et al., 2021).

4.2.2. Characteristics of the Theory of Social Constructivism

The understanding of how social constructivism interprets learning and learning communities can be achieved by recognising the principles that illustrate how social constructivism perceives learning and learning communities. There are five primary sections that highlight the overview of social constructivism. It is imperative for all individuals, including apprentices, learners, and others, to proactively foster their knowledge, given that their minds possess the ability to produce original information and insights. Judgement, acknowledged wisdom, and reasoning are all essential components. Novel notions and ideas cannot be comprehended until they are connected to pre-existing ones. As Dewey asserted, education is a dynamic and fruitful activity, rather than a passive exchange of information through lecturing and listening. Information, ideas, and knowledge acquired from others undergo transformation and evaluation rather than being passively assimilated in their original state.

Educators transmit theoretical and conceptual knowledge to learners, whereas individuals acquire knowledge via their life experiences. Conversely, adult learners acquire academic knowledge by capitalising on their prior experiences to enrich the learning process, as well as by comprehending and evaluating the significance of the acquired information. Acquired knowledge is the result of practical experiences. In a comparable fashion, educators may supplement their explanations of particular theories and concepts such as the causes, effects, and classifications of pollution with personal narratives and illustrations derived from their own encounters. As an illustration, in the case where a teacher's personal health has been negatively impacted by pollution, they might utilise personal experiences to illustrate how air pollution can detrimentally affect an individual. This would serve to clarify the detrimental health impacts of air pollution.

Engaging in social interactions, establishing interpersonal connections, and actively communicating with members of the community all contribute to the acquisition of knowledge and skills in individuals. Cultures, language, and other social conventions and beliefs collectively contribute to the acquisition of knowledge by individuals. Learning is a communal endeavour that involves actively engaging with and participating in society. An individual possesses a diverse range of knowledge and acquires familiarity with many domains, objects, and items. Gaining awareness of various disciplines and fields is difficult when one remains secluded and avoids social interaction. The learners derive advantages from receiving both emotional and robust support from the community, enabling them to confront problems and assume command over their learning.

Social interaction is essential for acquiring knowledge, with attitudes, emotions, values, and behaviours playing equally significant roles in social constructivism. The connection between human acts and the body encompasses knowledge, pleasure, ethics, and aesthetics. Learners in educational institutions need many opportunities and support to cultivate their holistic lifestyle and effectively apply it to obtain academic knowledge. There is a connection between knowledge and popular culture, as both offer understanding, guidance, and improvement to one's life.

The desire for knowledge, information, awareness, and recognition of the social nature of learning indicates the necessity of inclusive and equitable learning communities. Dewey and Piaget prioritised fostering a sense of dignity and respect for learners' ideas, thoughts, conceptions, impressions, opinions, viewpoints, and way of life within the learning community. Institutions should uphold each other's distinctiveness and provide a basis for individuals to shape their understanding of reality based on their viewpoints (Rannikmäe et al., 2020).

4.2.3. Implications of Social Constructivism for Teaching Methods

Aljohani (2017) defines a teaching technique as the particular principles and approaches implemented by educators in order to facilitate the acquisition of knowledge by learners. These definitions demonstrate the existence of concepts and instructional strategies that maximise learner learning. Learning theories, including social constructivism, support these concepts and actions. Social constructivism posits that knowledge is obtained via social interaction and is therefore regarded as a collective asset rather than an individual possession. The teacher's primary responsibility is to provide assistance, direction, and supervision to learners as they progress in their learning journey. The teacher aims to cultivate learners' self-assurance while expanding their comprehension of the subject matter. This pedagogical approach represents a significant departure from traditional lecture-based teaching and learning methodologies. Problem-based teaching and learning are integrated into group work, as (Kharay et al., 2017) illustrate. O'Connor (2020) asserts that Project-Based Learning is an innovative educational methodology that imparts diverse skills crucial for attaining success in the twenty-first century. This pedagogical approach provides learners with the fundamental skills of critical thinking and productive cooperation. Jigsaw is a prevalent cooperative and collaborative learning strategy integrating guided discovery instruction. According to Kussmaul and Pirmann (2021), this teaching method is predicated on cooperative learning and its rudimentary principles. This pedagogical approach is maintained by clustering learners and encouraging collaborative effort throughout the teaching and learning process. Knapp (2019) asserts that the key factor contributing to the effectiveness of the Jigsaw teaching style is the interdependence between individual learner achievement and the group's overall success.

Social constructivism also focuses on cooperative training. It brings learners together to share ideas and experiences. One such strategy is cooperative learning, which often involves learners working together in small groups towards their common learning objectives. Fathi (2019) noted that cooperative learning improves learners' academic performance while promoting valuable social skills. Another social constructivism-related teaching approach is Project-Based Learning, which involves learners working on extensive, realistic issues for prolonged periods. Mitry (2021) states that PBL promotes the development of the learners' cognitive skills like critical thinking, problem-solving, and teamwork. From a constructivist perspective, it allows learners to constructively determine what they understand and know about the topic matter upon active discovery and inquisition. Social constructivism is also associated with the flipped classroom model, which reverses a course's traditional lecture and homework elements. This model suggests that learners watch lecture videos before they come to class, during which time they can use class time to discuss or solve problems. According to Rahman et al. (2018), this approach accommodates varied learning styles, enhances interactivity, and creates an inclusive classroom culture.

Contrary to Project-based learning, the Problem-based Learning approach entails facilitated problem-solving as a mode of pedagogy. According to Jumaaat et al. (2017), in PBL, learners are provided with an issue, and through individualised learning and group interactions, they create a meaningful understanding of concepts and mastery of skills. According to Jumaat et al. (2017), PBL follows social constructivism, making learners active problem solvers and emphasising social interaction's significance. Constructivism also supports the use of technology in educating learners or learners. Different tools, like educational software, online boards, or virtual simulations, present various culturally valid learning opportunities and promote this learning. Other technologies, such as Virtual Reality and Augmented Reality, give learners an immersive learning experience and conform to Constructivism since they can interact with and explore complex themes.

Küpper & Kobsa (2012b) state that social constructivism focuses on cultural relevance. This means that teaching methodologies must cater for the different cultures of learners. Such an approach respects learner culture and enhances diversity in opinions and experiences. Social constructivism has significantly impacted various recent education approaches, though it is also criticised. Paria (2017) claim that focusing too much on group work may lead to a neglect of an individual's own needs and learning styles. Constructivist teaching methods also present challenges, such as facilitating effective teaching in large and diverse classes.

Social constructivism has wide-ranging implications for teaching and learning, leading to learner-centred approaches. Collaboration, meaningful context, and cultural relevancy are key features of these approaches, which aim to facilitate engagement and enhance learning outcomes. Nevertheless, these techniques work effectively, but they should be planned meticulously based on specific learner needs and teachers' mediation.

4.2.4. Principles of the Theory of Social Constructivism

Many modern scientists and reformers base their work on social constructivist theories, among those most often mentioned in educational and psychological circles today (Knapp, 2019). According to research by Barak (2016), as the world has changed, the need for skills has changed from acquiring organised information to mastering skills, also known as 21st-century competencies. Adapting to rapid change and unpredictable conditions, cooperating and communicating in decentralised contexts, creating data and managing information, and abandoning control by promoting discovery are all characteristics of teaching and learning in the twenty-first century.

Nguyen (2017) has found that while human potential is theoretically limitless, its limitations are determined by the quality of social interactions and the family environment. Vygotsky posited that teamwork and exchanging ideas facilitate metamorphosis and cognitive advancement. Vygotsky (1978) posited that learning occurs through social interactions between individuals and their surrounding social settings, which may also involve utilising media (Korucu & Cakir, 2018). A setting that encourages group activities, dialogue, interaction, creativity, and communication is ideal for mathematics learning. This implies that the social dimension of learning must be acknowledged for teaching and learning to be effective (Geiger et al., 2023).

Along with supporting learners' learning and growth within their ZPD, instructors should also foster respect for one another's personalities by honouring every learner's degree of proficiency, uniqueness, background, and identity. According to Vygotsky, the teacher works with learners and offers support and guidance rather than enforcing rules and providing structure to the classroom (Nguyen, 2017). According to the social constructivist view, learning mathematics is a process that always takes the learner's whole person into account. According to researchers (Geiger et al., 2023), the learning process is mutually constitutive of the learner as an agent engaged within a particular global environment. Learning is not thought of as the acquisition of reliable knowledge or facts. It is a community-based social activity that initially tangentially takes place. Later, the level of participation and intricacy steadily rises. The most basic type of learning is engagement in social behaviours. It entails more than just linking the command to the immediate situation.

Keleszande et al. (2018) predict that the education field will shift from teacher-centred education to learner-centred education on a global scale. This change is expected to be driven by the ongoing transformations in the education sector worldwide. Emphasis will also be given to the requirements of learners to guarantee that they effectively use their acquired knowledge throughout the entire educational process. The social constructivist theory, which prioritises cooperative learning and highlights the role of a learner's peers in the learning process, is highly relevant in this context as it is centred around the learner.

In contrast to the traditional method of rote learning, Merriam and Caffarella (1999) argue that constructivist learning involves actively generating meaning, and individuals independently derive understanding from their own experiences. According to Piaget (1977), learners have transitioned from a passive position to an active part of the constructivist theory. Based on Vygotsky's theory, social constructivism posits that cognitive development initially occurs within a social context and then progresses to an individual level. This theory highlights the significance of the Zone of Proximal Development (ZPD).In the context of social constructivism, teachers initially offer assistance and guidance to learners, gradually reducing this support as learners develop the ability to research independently. In social constructivist classrooms, learners engage in active participation, the setting is characterised by democracy, and interaction plays a significant role in the learning process (Gray, 1997).

This research aimed to demonstrate how cooperative and collaborative tasks may be carried out in the context of learning trigonometric functions and how this can alter learners' cognitive processes. This was made clear throughout the research, particularly during the activity that allowed learners to work in groups, allowing for collaboration and social contact among learners as they learned.

4.2.5. How Mathematical Social Constructivism Differs from Constructive Mathematics

Although they share the same name, constructive mathematics and mathematical social constructivism differ. Strict constructability and provability requirements define constructive mathematics. In this context, "there is x" means we can construct x, and "p is true" means we can provide a proof for p. These conditions significantly impact mathematical methodology: constructive mathematics uses intuitionistic logic instead of classical logic. It does not adhere to the law of excluded middle (Bridges and Palmgren, 2018). There are various variations of constructive mathematics, including constructive recursive mathematics and constructive type theory, but L.E.J. Brouwer's intuitionism has had the most intellectual influence.

According to Brouwer, mathematical concepts are thoughtless, languageless mental constructions that result from the experience of time passing. The fundamental understanding of mathematics is the uniqueness of two moments, which produces natural numbers when repeated indefinitely. According to Brouwer, a mental construction of a mathematical statement's proof constitutes the statement's truth. Brouwer's intuitionism attempts to provide an ontological and epistemological foundation for mathematics through mental constructs (Iemhof, 2020). This is where the first distinction arises: Social constructivism explains the nature of mathematical existence from a broader ontological perspective rather than trying to provide mathematics with a foundation. The second primary distinction between constructive mathematics and social constructivism is how they approach mathematical practice. Fundamentally, constructive mathematics is a philosophy that specifies acceptable methods of proof, standards to follow, and how logical connectives should be understood in mathematical practice.

On the other hand, mathematical social constructivism does not impose limitations on the methods that mathematicians should employ, the types of things that are acceptable, or the definitions of mathematical entities that should be used to prove theorems. Regarding the disagreement between constructive and classical mathematics, Cole (2015) contends that social constructivism is unbiased by distinguishing between two facets of constructive mathematics (Bridges & Palmgren, 2018): epistemological constructivism, which holds that intuitionistic logic is the appropriate methodology for mathematics—and Brouwerian ontological constructivism, which maintains that mathematical entities are mental constructs—what this neutrality amounts to can be defined. Social constructivism is congruent with classical and constructive methodology; it is unbiased regarding epistemological constructivism. However, social constructivism is not ontologically neutral since it is a philosophical argument concerning the nature of mathematical reality. It should be highlighted, therefore, that social constructivism does not assert the existence of any particular mathematical entity; instead, it asserts the metaphysical character of mathematical entities. Several ontological inventories of mathematical reality are permitted by social constructivism due to its lax approach requirements. For instance, a social constructivist using intuitionistic techniques can concur with Brouwer's intuitionistic ontology regarding the existence of entities yet disagree with it regarding their metaphysical similarities. Social constructivism is a competitor of Brouwerian ontological constructivism in this latter sense.

While social and ontological constructivism holds that mathematical entities are constructs, social constructivism's construction definition differs from constructive mathematics' requirement for explicit building. Creation occurs within the theory in constructive mathematics, regardless of what is being constructed—a mathematician's mind on its own or an algorithm3. It has a different function in social constructivism. The argument is that although things proposed in mathematical theories do not always need to be explicitly defined in the theory, they depend on practices for their existence. The third distinction is that, in social constructivism, mathematical entities are produced in the sense that they are intentional or unintentional byproducts of mathematical social practices, as opposed to the physical fabrication of objects as in constructive mathematics (Haslanger, 1995).

Social constructivist pedagogical theories, however, run counter to conventional wisdom. Teachers must consider their work in order to apply these concepts. Teachers using the social constructivist approach encourage learners to assess their learning progress regularly. Additionally, social constructivist education encourages autonomous research and critical thinking. In a social constructivist classroom, learners ought to become authorities. Social constructivism places a strong emphasis on learner engagement through group activities. According to social constructivism theory, social interaction—in which learners engage in meaningful learning is the cause of meaningful learning. Teachers support their learners' development by using instructional practices that enable learners to discover and grow their knowledge while participating and working together throughout the learning process. As a result of social constructivism, learners' roles have evolved from passive recipients of information to active contributors and co-constructors of knowledge among themselves. This shift in role also shifts accountability for knowledge acquisition from teachers to learners.

4.2.6. The Zone of Proximal Development as Part of Social Constructivism

Charles (2018) defines the Zone of Proximal Development (ZPD) as the region between an individual's comfort zone and the fight-or-flight zone. All learning occurs within this designated area under an instructor's systematic and purposeful instruction. The ZPD, according to Eun (2017), is an all-encompassing notion that incorporates the foundational tenets of Vygotsky's theory of human development. The ZPD is initially grounded in its social, cultural, and historical context. It then develops into a metaphorical representation of the spatial and temporal aspects of human brain functioning, influenced by social and genetic factors. In order to assess the learners' proficiency and understanding in dealing with topics about trigonometric functions, this research offered learners many options for motivation, collaboration, and guidance from peers and mentors.

The Zone of Proximal Development (ZPD) delineates the disparity between an individual child's present level of autonomous problem-solving capabilities and the potential for further development that would occur under the supervision of an educator, mature person, or peer with more excellent expertise in problem-solving. Numerous scholars have examined and commented on this notion (Abtahi et al., 2017; Eun, 2019; Moll, 1990; Rieber & Carton, 1987; Silalahi, 2019). ZPD comprises activities an individual can effectively complete with minimal support, including solution step instructions, guiding queries, or keywords (Rieber & Carton, 1987). This depiction delineates the child's progression and incorporates the assistance of knowledgeable peers or adults who can guide within the child's zone of proximal development, thereby highlighting the child's capabilities (Rieber & Carton, 1987; Walshaw, 2017). ZPD includes functions that are either embryonic or undergoing the maturation process. In future, these characteristics will be fully developed; at present, they are in a rudimentary state (Petakos, 2018). The zone of proximal development is a forward-looking reflection of mental development, whereas the current stage of development is a retrograde reflection (Rieber & Carton, 1987).

Rieber and Carton postulated that an improvement in evaluating learners' potential for development was imperative. In order to go to a more advanced stage of development, it is necessary to provide learners with assistance, guidance, and direction in their learning process, enabling them to solve difficulties independently (Darling-Hammond et al., 2020). This prompts the inquiry: Under what circumstances might a teacher's assistance facilitate growth? What specific support should the teacher offer to guarantee that learning results in the advancement of mathematical skills? In order to address these inquiries, the instructor must possess a comprehensive comprehension of the cognitive advancement of learners when they engage in their Zone of Proximal Development (ZPD). If the signs point toward potential progress, the instructor may provide scaffolding assistance. Educators must maintain the conviction that each child can advance to a more advanced stage of development. Learners do not have intellectual deficiencies; instead, they are young individuals who struggle with understanding and necessitate support.

The ZPD, as described by Panhwar et al. (2016), is a theoretical endeavour to understand the interplay between internal potential and external demands that give rise to the dynamic and motivating force for growth. The Zone of Proximal Development (ZPD) concept is credited to Lev Vygotsky, who employed it as a conceptual structure to explicate the fundamental workings of communicative learning at both the individual and social levels. Vygotsky endeavours to exemplify the process by which individuals develop their identities through external interactions and active participation in the consequences of social activity.

The ZPD, as defined by Phillips et al. (2016), represents the disparity between a child's present stage of development and their potential to reach higher levels with the guidance of adults or collaboration with more proficient peers. A social constructivist course is founded on the core principle that sharing generates knowledge. The Zone of Proximal Development (ZPD) refers to the range of tasks a learner may accomplish with guidance, bridging the gap between their independent capabilities and their need for external support. Scaffolding refers to the temporary support a learner receives from peers or the teacher to enhance and extend the learning process. Hence, a logical progression was employed by the scaffolding framework and Vygotsky's Zone of Proximal Development (ZPD) to structure this research investigation. According to Abbas (2017), educators can benefit from Vygotsky's Zone of Proximal Development (ZPD) because it indicates the learner's present level of understanding and offers insight into their prospective learning trajectory. A teacher can structure the lesson to facilitate the utilisation of the Zone of

Proximal Development (ZPD) by both individual and group learners. Learners may need help managing the disequilibrium that might arise when new information contradicts their previous frames of reference or ways of knowing while acquiring new knowledge or skills (Clapper, 2015).

Numerous internal developmental processes are sparked by learning, but they only work well when the learner interacts with others in their environment and works cooperatively with peers (Colter & Ulatowski, 2017). Creating the zone of proximal growth is an essential element of the learning process. Furthermore, Abbas (2017) contends that cooperative learning activities can be organised for heterogeneous groups of learners, enabling them to support each other in acquiring knowledge. Scaffolding is a pedagogical approach employed to support learners in reaching their Zone of Proximal Development (ZPD). According to Vygotsky's Zone of Proximal Development (ZPD) concept, the initial phase involves learners collaborating in pairs or groups. This is considered the initial step towards fostering learners' ability to transcend social barriers. For Vygotsky's Zone of Proximal Development (ZPD) to be effective, it is essential to implement it within an educational setting dedicated to these principles, both in terms of management and learning.

The social constructivist theory put forth by Vygotsky in 1978 contends, according to Shaikh et al. (2017), that knowledge is constructed collaboratively in the environment with the assistance of others. While learning frequently happens in a group environment, it ultimately happens within the person. The primary source of individual learning is knowledge generation, which happens when people work together and share information in their environment. Furthermore, Vygotsky contends that individual learning occurs inside the Zone of Proximal Development (ZPD), which denotes the area where intellectual development is still in progress. Vygotsky asserts that learning entails expanding the Zone of Proximal Development (ZPD) into the Zone of Actual Development.

Similarly, Eun (2017) highlights that the Zone of Proximal Development (ZPD) places significant importance on collaborative activities, setting it apart from a simple explanation of human development based on social interaction. The participants of the ZPD are not mere coincidental individuals who happen to be simultaneously in the same vicinity. They are engaging in a collective endeavour with a distinct goal centred on attaining it. Establishing the zone is predicated on the need for collaboration and assistance in executing a specific job towards a set objective.

According to Vygotsky's conceptualisation (1978), the Zone of Proximal Development (ZPD) is the difference between a child's potential level of development—which is shown by their capacity to work with more advanced peers or with adult guidance—and their current level of development, which is measured by their capacity to solve problems on their own. Human learning is the process by which learners integrate into the intellectual communities of people around them, according to (Colter & Ulatowski, 2017). The ZPD (Shabani & Hui, 2016) should promote the development of skills such as memorisation, critical thinking, focus, problem-solving, and idea generation. Clapper (2015) suggests that the ZPD (Zone of Proximal Development) and cooperative-based learning might assist learners in navigating the disequilibrium process. This involves effectively integrating and assimilating new knowledge and skills into their practice. Shabani & Hui (2016) highlights two essential components of the Zone of Proximal Development (ZPD): firstly, the presence of a task or problem that requires the guidance of an expert in the subject matter, and secondly, the involvement of a novice who can improve their performance with proper assistance. An increasing body of research suggests that experts can encompass teachers or high-achieving learners and other peers, parents, or administrators. However, there have been some controversies in the past regarding the precise definition of the term "expert".

According to Abtahi (2017), active interaction and contact between people and between people and tools or instruments form the Zone of Proximal Development (ZPD). This research examined the perspectives and learning process of Grade 10 learners using the Microsoft Teams platform to solve trigonometric function issues. The Zone of Proximal Development (ZPD), a Vygotskian concept, was used in the research. The demonstration aimed to demonstrate how guidance-based technologies could aid in using a Zone of Proximal Development (ZPD). The research found that learners' perception of using the Microsoft Teams platform and their interpretation of trigonometric functions influenced their verbal and behavioural responses.

4.2.7. Scaffolding as a Part of Social Constructivism

Much variation exists in how scaffolding is understood in modern educational practice and research (Jacobs, 2001; Hammond, 2002). Stone (1998) noted that because the idea of scaffolding would not have made sense to a Russian speaker, Vygotsky did not use it in his research. Given that the scaffolding metaphor is commonly employed informally to express various unrelated concepts, its lack of systematic application and utilisation in educational research is unsurprising (Hammond, 2002). Scaffolding assists the growth and education of youth (Rasmussen, 2001). The phrase can be used as a general metaphor to explain how peers or teachers give learners the resources they need to learn new information (Jacobs, 2001). The scaffolding metaphor's practical use is expanded and enhanced by adding the systematic theory framework and additional theories of education (Jacobs, 2001; Rasmussen, 2001). Language and literacy training requires a more profound comprehension of scaffolding (Hammond, 2002). They emphasise how vital language is for providing support and structure.

Donovan and Smolkin (2002) provide a more thorough examination of scaffolding. They take a critical look at the idea of scaffolding in young writers. Researchers are looking at how varying degrees of scaffolding impact learners' comprehension and communication of various genres. The tasks themselves display a spectrum of help levels, from low or no support to high or intermediate levels of support, including visual and contextual assistance. Direct instruction with revision is the highest level in their scaffolding classification (Donovan & Smolkin, 2002). Donovan and Smolkin's (2002, p.428) found that “scaffolding can have both beneficial and detrimental effects on young people's ability to demonstrate their comprehensive grasp of various writing styles”. More precisely, providing comprehensive assistance through scaffolding impeded learners' learning to its highest degree. This discovery confirms our concern that scaffolding when seen as direct advice, may have an adverse effect. Additional investigation is necessary to determine the crucial elements of optimum scaffolding. Can the highest levels of scaffolding be categorised as explicit instruction, for instance?

Many definitions of scaffolding are found in the literature for pre-service teachers, including works by (Berk, 2000b; Said, 2021; McDevitt & Ormrod, 2020; Krause et al., 2003). According to Berk (2002), scaffolding is the proactive and adaptable help that adults give to learners during a lesson, modifying it to fit the child's present performance level. When a task is unclear, direct instruction is used, and as skill rises, the level of support is gradually reduced (Berk, 2000b). This phrase suggests that the highest level of scaffolding is where direct instruction is located. The significance of utilising scaffolding strategies is emphasised by other writers (McDevitt & Ormrod, 2020), asking questions (Said, 2021), dividing tasks into smaller parts, receiving adult assistance through demonstration, and giving instructions. One important aspect of scaffolding is the division of information into smaller, easier-to-manage segments (Berk, 2000b; Said, 2021; McDevitt & Ormrod, 2020; Krause et al., 2003).

The term scaffolding was first used in the research carried out in 1976 by Wood, Bruner, and Ross. The word scaffolding was used as a metaphor to represent the support a peer or teacher provides to help with the learning process. An action or topic that a learner first struggles to comprehend independently is supported by the teacher through scaffolding in order to help the learner achieve mastery. The teacher assists with skills that surpass the student's level of mastery (West et al., 2017). Armstrong (2019) asserts that scaffolding is closely linked to social interaction in the philosophy of social constructivism. Observations reveal that learners are naturally inclined to provide support and guidance by generating ideas, posing inquiries, and occasionally issuing directives during group-based activities such as creating something or participating in a game.

According to Wright (2018), Vygotsky's Zone of Proximal Development (ZPD) and his broader sociocultural theory are the origins of scaffolding. Scaffolding was thought of as a method that offered a single learner short-term support. Scholars have expanded the meaning of the scaffolding metaphor to include examples of successful scaffolding, peer help in group settings, and technologically assisted assistance. Juma et al. (2017) said scaffolding is based on the principle that providing learners with sufficient assistance when facing a challenge will ultimately enable them to accomplish the task independently. During the scaffolding phase, a commonly employed method is gradually withdrawing assistance as learners progress towards functioning autonomously. Colter and Ulatowski (2017) argue that scaffolding can be understood as a temporary form of supported learning that includes teacher explanations and learner feedback to promote the learner's autonomy. Like physical scaffolding, supportive strategies are gradually removed when they become unnecessary, allowing the teacher to transfer more control of the learning process to the learner.

The concept of ZPD assumes that by increasing interactions, engagement, cooperation, or receiving direction from a more skilled individual, the learner's present level or real progress is elevated to a higher level of cognition Juma et al. (2017). Evaluating the learners' current knowledge and experience is necessary to create projects that will challenge them to reach their Zone of Proximal Development (ZPD), connect with their existing understanding, motivate them, and offer opportunities for peer assessment. The instructor may provide scaffolding for specific tasks when peers cannot do so (Morgan & Skaggs, 2016).

West et al. (2017) argue that when teachers employ scaffolding in their teaching, they frequently break down a learning experience, concept, or skill into smaller, more manageable parts and subsequently offer learners the necessary assistance to comprehend and master each part successfully. Before assigning learners the complete reading, teachers can provide a selected portion from a lengthier book to read. They can then involve them in a discussion to enhance their understanding of the text's objective and instruct them on the specific vocabulary required to comprehend the topic. Morgan and Skaggs (2016) suggest that scaffolding, or assistance, is most effective when it is customised to meet the learner's specific needs.

They are currently in a favourable situation to accomplish a task they could not perform independently. Moreover, it grants learners more significant control over their education. Scaffolding is a procedure that helps enhance learning. Armstrong & Tsokova (2019) commonly employ the term to describe the interactions between the teacher and student as they collaboratively address challenges and construct shared understanding. According to Vygotsky, if a learner is in the Zone of Proximal Development (ZPD) for a specific activity, providing appropriate assistance will give the learner enough support to finish the task (Morgan & Skaggs, 2016). Vygotsky contends that peer interaction is a comparably efficacious method for cultivating abilities and techniques on par with the interaction between the learner and teacher. Cooperative learning tasks, including less proficient learners acquiring abilities with help from more skilled peers, benefit teachers and instructors (Wilkinson & Jones, 2017).

According to Colter and Ulatowski (2017), socio-constructivist strategies facilitate collaborative work by promoting group activities that empower learners to operate independently and democratically. Scaffolded learning enhances learners' comprehension of the course material over time and through social engagement. Given that learners may be unable to independently research the information, the learning process provides clear guidance in assigning tasks to learners at the outset. For this research, participants were grouped and provided with a task-oriented worksheet to complete as a learning activity before doing pre and post-task. Every group consisted of learners with diverse learning styles. The learners engaged in interactive discourse, where they stimulated each other's thinking by posing challenges and assisting in generating responses to the questions on the worksheet. This opportunity allowed learners to overcome any social obstacles they may have encountered and provided those learners who benefited from engaging in this collaborative learning activity with support and guidance.

Guidance or support appears necessary for a child's developmental process. In this Zone of Proximal Development (ZPD), temporary scaffolding is the support structure. According to the Zone of Proximal Development (ZPD) concept, scaffolding works best when tailored to each student's needs (Fani & Ghaemi, 2011; Moll, 1990). Customising support within the Zone of Proximal Development (ZPD) to learners unique requirements and developmental stage maximises its effectiveness (Bikmaz et al., 2016; Brower et al., 2017; Kim & Belland, 2018; Silalahi, 2019). According to the Vygotskian framework, the main feature of the Zone of Proximal Development (ZPD) is its dialogical nature, in which learners and tutors engage in discussions to decide on the best course of action for solving the problem and to come to an agreement on the structure of the problem (Fani & Ghaemi, 2011; Mutekwe, 2018; Silalahi, 2019; Tinungki, 2019). The idea of the scaffolding comes from cognitive psychology. According to Darling-Hammond et al. (2020), learners who possess advanced language abilities and are supported by favourable situations can assist learners in advancing their knowledge and skills during social interactions. Scaffolding refers to using supportive measures by teachers and peers to enhance and expedite learners' learning tasks. When scaffolding is employed in cooperative learning, it augments learning outcomes (Roschelle, 2010).

The principles of Zone of Proximal Development (ZPD) and scaffolding can effectively facilitate skill acquisition. Scaffolding entails skilled educators who guide learners as they work on tasks within their Zone of Proximal Development (Khaliliaqdam, 2014; van de Pol & Volman, 2019). The individual's Zone of Proximal Development (ZPD) encompasses tasks that require support to be accomplished. Scaffolding is not to give learners the answers but to support their learning through strategies such as encouragement, modelling, and guidance (Pol & Beishuizen, 2015). As learners become more proficient in a skill, they must decrease the level of support they receive (van de Pol & Volman, 2019).

4.3. Traditional versus Constructivist Classrooms

Unilateral, direct instruction that promotes learners' passive learning is a hallmark of traditional learning (Kumar, 2020). The lecture technique, which is a traditional teaching approach, is very used in the field of education. The traditional strategy disregards the learners, thereby neglecting their level of mental engagement. The process entails a comprehensive understanding of the context and the learners' acquisition of information through repetitive memorising. The exercises did not engage learners in creative thinking and active engagement in the creative aspects. According to the presumption that learners should have fixed information, there is minimal room for originality and creativity, and learners are not expected to challenge the teacher's perspective. Traditional education methods exclude critical thinking and place everyone in the class at the same conceptual comprehension level (Kumar, 2020). The learner-centred constructivist classroom encourages collaboration among learners to find solutions to challenges (Kumar, 2020). A teacher facilitates the learning process by helping learners develop new ideas since learners are highly involved in the learning process (Paria, 2015). Understanding in a constructivist class is developed through interactions between people in connection to their reality, claim Saleem et al. (202b). Discussion and exercises are the hallmarks of this instructional method.

A way of supervised engagement with learners is through discussion (Omwirhiren, 2015). Constructivists claim that learners do not possess a completely blank mind but actively bring forth past experiences and cultural influences to generate new knowledge within a specific context. Consequently, every learner possesses a distinct understanding and development of the process of acquiring knowledge, which is influenced by their mental representations. Constructivism harnesses the innate curiosity of learners to explore and understand the functioning of the real world. A prevalent misconception about constructivism arises from the conflation of the idea of pedagogy (teaching) with the theory of knowing. This misconception suggests that educators should refrain from directly imparting information to learners and instead always facilitate their self-construction of knowledge. Constructivism posits that knowledge acquisition depends on the learner's prior knowledge, irrespective of the instructional method employed. Therefore, even listening to a lecture requires intentionally creating new information. The constructivist perspective on learning might indicate several instructional approaches within the classroom setting. It generally refers to encouraging learners to use active learning strategies like experiments and real-world problem-solving to produce new knowledge. They are then invited to discuss what they did and how their understanding developed.

Although this strategy takes time, it helps learners communicate more effectively and evaluate other points of view (Jegede, 2010). Activity includes learners working in small groups to accomplish a task, and it promotes reflection and thinking (Saleem et al., 2021b). On the other hand, blended learning classrooms, as pointed out by Fradalé (2020), allow learners to participate fully in the learning process. Involvement is not only about contributing to discussion but also about doing things that involve deep thinking and solving challenges. In this regard, the learners can explore, query, and dispute notions in the learning environment, thereby enabling them to retain a lasting comprehension of their knowledge base.

According to Kaplan and Maehr (1999), this is one of the important features of constructivism, which acknowledges that every learner comes from a different culture and experience. Constructivist classrooms recognise this diversity and are designed to accommodate different ways of learning and varied views. First, this strategy enhances the participation of all individuals and adds more perspectives in education. Collaboration and social interaction are critical for constructivist classrooms. Learners are made to work as groups, hold discussions, and participate in mutual problem-solving. In this cooperative setting, learners develop their interpersonal skills, ability to communicate with others, and the spirit of togetherness that promotes success (Khalid & Azeem, 2012). This kind of environment provides conducive learning since it resembles actual situations where teams must work together and communicate well.

The constructivist classroom turns around teachers' roles. Unlike teachers, who have all their knowledge for themselves, constructivists facilitate learning by guiding, supporting, and challenging their learners. These are learning opportunities where the learners get a chance to develop their prior learning and experiences, which leads to great understandings regarding specific conceptions. Technology can be instrumental in improving constructivist classrooms (Mustafa & Fatma, 2013). Tools like interactive whiteboards, online forums, and educational software that provide access to a variety of resources and personalised learning pathways can support collaborative learning. These technologies enhance learning by making it more interesting and relevant to the contemporary digital world.

Lord (1997) observes that implementing a constructivist approach in the classroom will face various problems and offer some advantages. Thus, teachers should be prepared to effectively accommodate various learning styles to create a classroom where learners engage in higher forms of thought. This implies training, adjusting the way of thinking, and moving away from classical teaching methods. On the other hand, the possibilities of growing such leaders who can be independent and critical thinkers ready for the job market are infinite. Constructivists' approach to assessment is different from traditional methods, as indicated by Bishaw and Ejiiziabher. Assessments in constructivist settings are usually project-based and with real-world applications rather than a pure focus on rote memorisation and standardised tests. Besides the understanding, these examinations also test whether learners can use that knowledge in real-life settings. It is a significant move in the educational paradigm since it signifies changing pedagogical practices to the constructivist classroom. It is now aimed at promoting active classroom learning that requires learners to think critically, interact among themselves through communication skills, and integrate all the necessary tools, such as technologies, among others. These involvements help learners not only to be knowledgeable but also to apply what they know in different and changing settings.

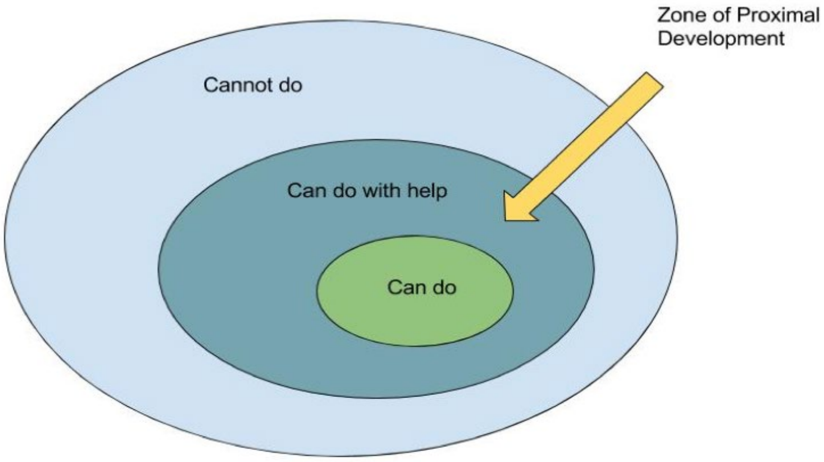
4.4. The Role of the Socio-Constructivist Teacher

According to Vygotsky, referenced by Mahn & John-Steiner (2012), social connection with others is the most excellent way for individuals to learn. A better, competent teacher might aid learners in achieving more tremendous success (Brau, 2020). In a social constructivist classroom, the teacher takes on the role of a facilitator, assisting learners in developing their knowledge, reflection capacity, and peer interaction (Alzahrani & Woollard, 2013b). By allowing learners to work together and solve issues as a group, the instructor creates a favourable environment for learning activities (Simmons, 2013). According to Alzahrani and Woollard (2013b), the instructor should focus on student learning rather than teacher results. According to Brau (2020), the learning environment should promote dynamic change, and the instructor should use a hands-on approach to teaching.

A diagrammatic description of Vygotsky's theory is provided here. The Zone of Proximal Development (ZPD) (see Figure 8 below), which is the boundary between what a learner already knows and what they still do not, needs greater attention from the teacher (Leong et al., 2018). In this zone, the learner needs supervision to help comprehend new information (Brau, 2020). In groups where participants learn from one another, the ZPD also explains collaborative learning (McLeod, 2019). The ZPD demonstrates that learning is significant when it extends beyond what is already known and comprehended. It also demonstrates that learners might differ in how quickly they assimilate new information (Watson, 2021).

Figure 8

Vygotsky's Social Development Theory



(Taken from Brau, 2020, p. 5)

Brau (2020) states that the distinction between teachers and facilitators lies in their respective approaches. A teacher imparts information through telling, while a facilitator elicits information through questioning. A facilitator assists with behind the scenes, whereas a teacher lectures from the front. A facilitator creates an environment where learners can come to their conclusions, while a teacher gives answers based on a predetermined curriculum. When teaching, a teacher usually speaks in one-sided speeches, but a facilitator converses with learners continuously.

The social constructivist method views teachers as facilitators rather than instructors (Social Constructivist views of mathematics 2008). As a teacher presents a comprehensive and educational lecture, a facilitator helps the learner come to their understanding of the subject matter. When an instructor only conveys knowledge, the learner plays a passive role; when the instructor facilitates learning and helps learners acquire knowledge, the learner plays an active role. According to Fradalé (2024), social constructivism moves the emphasis from the teacher and the subject to the learner. This notable shift in the role of the instructor implies that a facilitator instructor must possess a distinct set of skills compared to a teacher instructor (Brownstein, 2001). Rhodes and Bellamy (1999) suggest that the role of a teacher involves telling, lecturing from the front, giving predetermined answers, and mostly engaging in monologues. Conversely, a facilitator's job is to ask questions, offer backhanded support, offer guidance, set up a conducive learning environment so that learners can work through problems and draw their own conclusions, and have ongoing, interactive conversations with learners.

According to Di Vesta & Rieber (1987), the design of the learning environment should encourage and support the learner's cognitive processes at the same time. While it is recommended to grant the learner autonomy in the problem-solving process, teachers should be mindful that not all activities or solutions are suitable. The primary and paramount objective is to assist the learner in developing into a proficient thinker. This objective can be attained when educators assume various positions, such as consultant and coach.

4.5. The Socio-Constructivist Learner

The learner must understand the material in social constructivism lessons in light of their cultural background, experiences, and beliefs (Brau, 2020). Watson (2001) asserts that the Vygotskian idea of constructivist learning enables learners to pursue their interests and purposes, develop long-term learning, and develop their own goals and assessments, new knowledge, and skills. It also enables learners to work collaboratively with other learners, to appreciate different perspectives, and to reflect on their learning.

According to Duru et al. (2020), advocates of social constructivism, learners are aware of their strengths and capacity to make decisions and reflect on their views. As Zigelman (2018) points out, discussions among learners help them gain a deeper comprehension of concepts. In order to continually increase their cognitive capacities, the learner should demonstrate a willingness to share their knowledge with their peers. Individuals need to value and appreciate every occurrence and gain knowledge from them (McPhail, 2016). Knapp (2019) elucidates the several ways in which social constructivism enhances the credibility of the learning environment:

- Social constructivism promotes learner engagement and active participation in the learning process.
- Furthermore, it promotes active participation and interaction among learners, instructors, and other participants in the teaching-learning process.
- Fosters learners's autonomy and cultivates their capacity to generate and refine their ideas.
- Prevents learners from succumbing to rote learning or adopting a passive study approach.
- This enhances interest while simultaneously aiding with retention.

- It facilitates the cultivation of cognitive abilities such as critical thinking and problem-solving.
- In the classroom, it promotes both independent and collaborative learning.
- Collaborative learning in groups cultivates a strong sense of camaraderie among learners.
- By integrating activity-based teaching methods in the classroom, the instructor can stimulate the innate curiosity of learners.
- Fosters learners's robust self-esteem by instilling confidence in their aptitude for acquiring new knowledge. The teacher fosters the learners' self-confidence by cultivating trust in their talents and providing evidence of their capability to accomplish assigned tasks successfully.
- Promotes learners' exploration and engagement with the provided resources, fostering the active generation of knowledge.
- Enhances learning and knowledge retention as learners are more inclined to remember information that they discover and develop on their own, rather than being presented with data by the instructor.
- It facilitates the development of episodic memory, which pertains to the capacity to remember or reflect on a past event based on individual events or encounters related to the incident.

Their relevance in this research stems from the fact that learners actively involved with the trigonometric functions content through the Microsoft Teams platform experience all of these phases. According to Kanno (2018), these events act as reference points or memory cues that help maintain and recall information, which is crucial for successful learning. According to Wertsch (1997), social constructivism acknowledges and values each learner's uniqueness and complexity, much like constructivism does. On the other hand, social constructivism takes things a step further by actively recognising, utilising, and elevating the learner as a crucial part of the educational process. Social constructivism, sometimes called sociocultural, encourages learners to form subjective interpretations of reality based on their experiences, cultural influences, and general knowledge. The importance of the learner's social interaction with knowledgeable people in society is emphasised by social constructivism. According to Wertsch (1997), acquiring the social significance of significant symbol systems and learning how to use them effectively relies on engaging in social interactions with others with more excellent expertise. He also asserts that young learners enhance their cognitive faculties by engaging with peers, adults, and the tangible environment. Considering the learner's background and culture is crucial from a social constructivist perspective when engaging in the learning process. The learner's background influences the information and truth they generate, uncover, and achieve during the learning process.

4.5.1. Collaborative Learning as a Part of Social Constructivism

According to Phillips et al. (2016), social constructivism is the Vygotskyian interpretation of constructivism that emphasises cooperation with others as a significant element. Collaborative learning employs social interaction to build knowledge instead of relying on ideas that others have already put forth. It entails learning through interacting with one another as a group to solve challenges. Individuals cooperate through interaction to maximise their own and other group members' learning (Korucu & Cakir, 2018). By allowing for group activities in which learners are encouraged to operate democratically and autonomously, social constructivist techniques can use this apparent capacity for collaborative working and playing. Additionally, they offer constructive chances to experience and resolve the conflicts and disagreements that might inevitably arise when people cooperate (Armstrong, 2019).

Vygotsky (1978) proposed that learning occurs in social contexts when information is constructed to encourage interaction, inquiry, and discussion and to increase learning by active involvement (Korucu & Cakir, 2018). Throughout this research, the collaborative learning process was evident. The research comprised breaking up the learners into small groups, where they talked about trigonometric functions and tried to figure out answers to the tasks in the class activities. To help them in their efforts to answer questions, the learners used diagrams and graphs to give their responses. This kind of social interaction in the classroom demonstrates why the ZPD, scaffolding, and social constructivism are the best theoretical frameworks for this subject.

Social constructivist philosophy underpins collaborative learning. According to Korucu and Cakir (2018), learning is constructing knowledge within a social setting. Within the context of Vygotsky's more extensive socio-cultural theory, scaffolding originates in ZPD. Scaffolding was seen as a method that offered momentary assistance to a single learner. Researchers have expanded the scaffolding metaphor to include examples of efficient scaffolding, peer assistance in collaborative settings, and support in technologically mediated contexts (Wright, 2018).

Collaboration helps learners learn from one another, build self-esteem, and believe in their abilities as builders, problem-solvers, and creators (Armstrong & Tsokova, 2019).

Learners can apply their newly gained information to advance independently if the instructor has sufficiently prepared them to understand the complex nature of scholarly research (Colter & Ulatowski, 2017). The primary goal of this research project was to modify the social unit of the classroom, including individual, small-group, and whole-class conversations, to increase the complexity of group tasks in the classroom purposefully and the pre-and post-task being examined. Over time, the interaction's primary goal shifted from diminishing the teacher's authoritative role, mainly in encouraging learner collaboration, to gradually enhancing the teacher's role in the classroom by implementing lessons incorporating technology (Harfitt & Cha, 2017). Collaborative learning is, essentially, based on peer learning and interaction. According to Palloff & Pratt (2006) Learners get into a community of inquirers by interacting with their fellow learners, thus exposing them to different views and ways of solving problems. More than that, it makes them better at communicating, working in a group, putting themselves in other people's shoes, etc. Constructive dialogue encourages learners to express their ideas, listen to others' views, and seek ordinary meaning or agreement (Armstrong, 2019).

The teacher transforms into a facilitator in such a team-based interactive learning setting (Paria, 2015). Through this approach, the teacher can customise the nature of learning into a flexible process for all the learners in the group to acquire knowledge. It takes a central position in promoting openness as there is a willingness among the learners to share ideas openly without fear. Tools like Microsoft Teams, online forums, and interactive whiteboards in collaborative learning can improve this activity. The tools offer learners a place to discuss, share resources, and conduct group projects outside the conventional classroom. With technology bridging the gap between abstract knowledge and practice, learning becomes accessible and enjoyable (Doolan, 2013).

When learning together as a team, assessment can consider both personal results and collective outputs (Armstrong, 2019). This orientation's duality allows for collaboration and, at the same time, individual responsibility. The assessments can be in the form of group projects, presentations, and peer evaluations, which are all indicators of what the learners know and understand and their input into the learning process.

Collaborative learning has many advantages; however, its disadvantages include unfair participation, some people dominating others, and conflicts (Nyikos & Hashimoto, 1997). To tackle this challenge, teachers should create specific expectations, include frameworks for inclusive engagement, and formulate ways of resolving conflicts. These can be dealt with by carrying out regular feedback and reflection sessions.

Collaborative learning in social constructivism allows learners to collaborate to develop new ideas (Paria, 2015). This approach is important in terms of the teacher's role, technology use, evaluation methods, and tackling challenges. Collaborative learning is likely an important aspect of enhancing holistic learning in learners as education advances.

4.5.2. Activities Associated with Scaffolding

The learner's ZPD is expanded, and scaffolding is moved to the new edge of the learning frontier after completing the learning task. Scaffolding is a transient, adaptable system that is easy to install and dismantle (Morgan & Skaggs, 2016). Learning is more likely to occur when scaffolded instructions are given during the initial sessions, partly because learners feel effectively encouraged and partly because each scaffold directs the brain toward a thorough grasp of the information being used (Shabani & Hui, 2016). A well-researched and widely used educational strategy is instructional scaffolding, which provides temporary help as a person learns (Erdei et al., 2017).

Peer groups' social dynamics differ from the teacher's authority as an expert. The philosophy of "learning with peers and by peers" may promote a group approach that motivates learners to re-evaluate their positions. Peers may also provide more direct assistance rather than waiting for the learner to show signs of difficulty since they may view it as helping one of their own rather than as a step toward independence (Malik, 2017). Many different techniques may be used to enable efficient scaffolding. High-quality resources may be pointless if they are not adjusted to meet learners' ZPD and promote social engagement.

In turn, these tasks and activities catalyse higher-order cognitive processing among learners (Shabani & Hui, 2016). The concept of scaffolding originated in the socio-constructivist theory of teaching and learning and implies assistance given by a teacher to a learner. Modern learning environments provide teachers with numerous tools and techniques to scaffold the learners.

Moreover, teachers could motivate the learners to peer help where they can share their perspectives or methodologies that make them perform well in their classroom tasks and solve their conflicts peacefully. The research focuses on Grade 10 learners' opinions on learning Trigonometry in an environment where Microsoft Teams is used as an instructional scaffolding tool. By so doing, the learners' confidence improved, and they were able to acquire a foundation of knowledge for effective learning. For example, the group members who could scrutinise and understand the test material preceding and following the teaching aided the learners in finding it difficult to answer the specific questions. Learners were also involved in the pre-and post-task, which used manipulatives to help solve problems associated with trigonometric functions in Grade 10 by scaffolding them during the learning process.

Scaffolding becomes more helpful in teaching trigonometric functions because, most of the time, those are ideas a child has never thought about (Pea, 2018). Scaffolding helps learners understand how to undertake these learning processes step by step and, therefore, develop their knowledge of the functions; for example, a step-by-step approach can be used when solving problems, and the concepts of trigonometry can be introduced progressively. Scaffolding must be differentiated as it appreciates how learners learn in varied ways (Gönüllü et al., 2018). For instance, visual learners would be better off in most cases than kinesthetic learners as they understand such things through diagrammatic representation. In contrast, kinesthetic learners prefer interactive models and simulations. These teachers have been equipped with various pedagogical tools and resource materials that they may utilise. These include interactive software, physical models and learning platforms such as Microsoft Teams.

For example, collaborative learning activities like group problem-solving or peer instruction may act as scaffolding instruments (Drummond & Mecer, 2003). Learners can discuss their comprehension and strategies, providing mutual support and complementing one another's strengths. For example, older learners may help their fellow learners by explaining various concepts and reinforcing their understanding. Technology integration in scaffolding can be better achieved, mainly when it is supported by apps such as Microsoft Teams (Pea, 2018). These include offering extra materials, discussion forums, and instantaneous support, which constitute some pillars of efficient scaffolding. Technology enables a personalised learning environment whereby learners learn at their own pace and based on pre-determined paths (Pea, 2018).

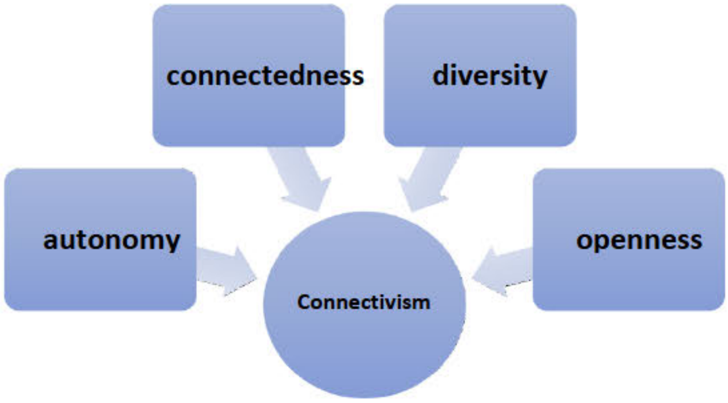
Feedback provided throughout is one of the crucial aspects of scaffolding (Van Der Stuyf, 2002). For that reason, teachers will have to track individual learners' progress and give prompt recommendations that will help them as they develop. Quizzes or reflective essays would be good formative assessments that could inform the scaffolding strategies. Scaffolding, however, has many advantages and some pitfalls. These involve providing optimum support without being either too much or too little and withdrawing at the right time when the student starts gaining independence (Veremika, 2008). Certainly, scaffolding is an indispensable pedagogic strategy in tutoring complicated math, such as trigonometry. Its role not only supports learners on their journey to success but also equips them to be self-dependent learners. Scaffolding involves using differentiated approaches, cooperative education, computer-assisted devices, ongoing feedback, and caution concerning the challenges to be addressed.

4.6. Exploring the Theory of Connectivism

Siemen (2004) proposed the notion of connectivism in response to the rise of the digital era. According to this hypothesis (see Figure 10), individuals acquire knowledge by forming new connections. Four guiding concepts for knowledge acquisition form the basis of this concept. Autonomy, connectedness, variety, and openness are all included in the fundamental values. First of all, learning in the online community is distinguished by self-direction. When learners take charge of and manage their learning activities, they participate in autonomous learning. In addition, connected learning describes how learners actively participate in their areas of interest with the support and direction of their mentors, peers, and the larger community. The infinite variety of experiences that learners bring to their formal education is referred to as learning diversity. Ultimately, the transparency of learning and surroundings fosters greater accessibility and encourages evaluating and incorporating novel ideas.

FIGURE 9

CONNECTIVISM SOURCE



(Taken from Sidik et al., 2021, p. 1353)

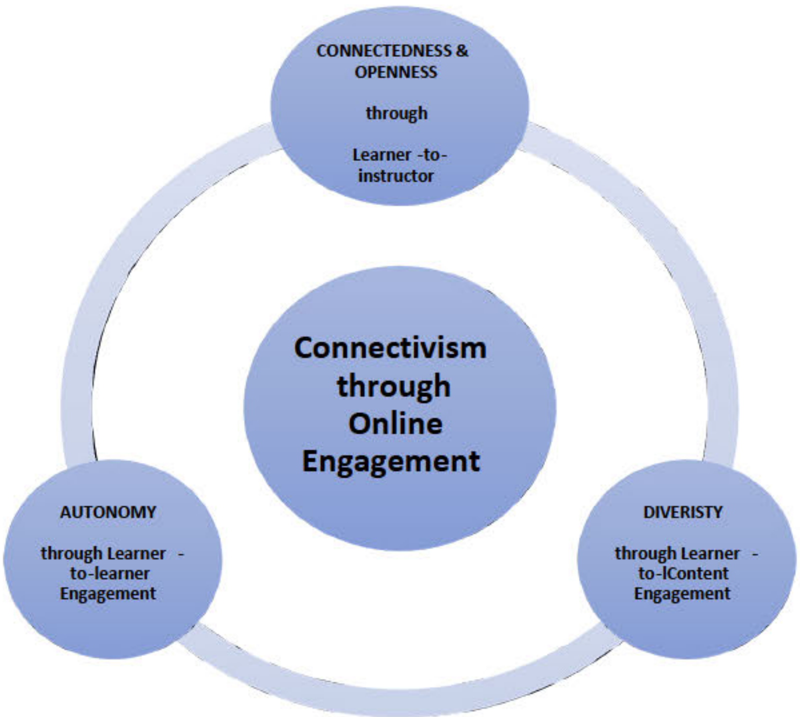
The proliferation of online learning and courses in educational institutions has experienced a significant surge due to the exponential expansion of technology, widespread internet connectivity, and the availability of top-notch digital resources, tools, and adaptable platforms. Due to the coronavirus disease 2019, which has caused significant disruption to the global education system, instructors quickly shifted to an online format to deliver instructional materials. The shift in teaching methods began with the adoption of blended learning and finished with teachers being forced to switch to online training exclusively (Watson et al., 2020). Academics and researchers express concern regarding insufficient learner involvement in online learning, as some learners perceive it as dull and unstimulating (Dhawan, 2020).

According to Yang et al. (2018), involvement in the academic environment refers to learners' actions, emotions, and thoughts, which are connected to their behaviour, emotions, and cognition. Assessing the efficacy of online learning in attaining learning objectives necessitates the consideration of learner engagement as a valuable indicator of educational excellence. Rothman et al. (2011) assessed six key areas to gauge learner engagement in online settings. These areas encompass the suitability of readings and assignments, technical tools, instructor feedback and communication, course organisation, clarity of results and requirements, and content presentation. Yang et al. (2018) conducted research identifying several characteristics used to evaluate learners' engagement in online courses. These factors include course design, teacher presence, learning environment and experience, models, and the connections between preconditions, engagement results, and MOOC-related technology. In summary, numerous researchers utilise comprehensive criteria to evaluate learner engagement. This research examined three crucial variables to explore the impact of online learning on engagement: learner-to-learner communication for fostering a conducive learning environment, learner-instructor communication, and the influence of course content on learners.

The level of connectedness and openness in online learning can be assessed by examining learner-to-instructor engagement, as outlined by (Sidik et al., 2021). Instructors are vital in ensuring that online activities facilitate enhanced lesson content comprehension. Furthermore, online contact facilitates variety by encouraging learners to participate in the content. By engaging with their peers, learners can expand their options for acquiring knowledge and broaden their understanding of how to apply it. Ultimately, learners could cultivate a sense of independence by actively engaging with instructors and making decisions to further their learning beyond the confines of the classroom.

FIGURE 10

CONCEPTUAL FRAMEWORK OF RESEARCH CONNECTIVISM THROUGH ONLINE ENGAGEMENT



(Adapted from Sidik et al., 2021, p. 1356)

4.6.1. Principles of Connectivism

a. **Autonomy in Learner-Centric Models**: Autonomy is a foundational principle in connectivism, emphasising the learner's control over their educational journey. In a connectivist framework, learners independently navigate through many digital resources, creating personalised learning paths (Harasim, 2017). Online platforms enable learners to select resources that align with their learning styles and goals, thus fostering self-directed learning.

b. **Enhanced Connectedness through Digital Platforms**: Connectedness in connectivism refers to the importance of networks in the learning process (Goldie, 2016). In an online context, this translates to using social media, discussion forums, and collaborative platforms like Microsoft Teams or Google Classroom, facilitating interaction and exchanging ideas among learners, thereby enriching the learning experience.

c. **Diversity in Learning Experiences**: The diversity principle in connectivism acknowledges the varied backgrounds and experiences that learners bring to an online learning environment (Guder, 2010). This diversity enriches learning by introducing multiple perspectives and approaches to problem-solving. Online platforms can cater to this diversity by providing a range of learning materials in different formats like videos, podcasts, and interactive simulations

d. **Openness in Online Learning Environments**: Openness in connectivism relates to the unrestricted sharing of information and collaboration (Kropf, 2013). Open educational resources (OERs) and Massive Open Online Courses (MOOCs) exemplify this principle. They provide learners worldwide access to high-quality educational materials, thus democratising education.

4.6.2. Application of Connectivism in Online Learning

a. **Learner-to-Learner Engagement**: Connectivism encourages collaborative learning. Tools like discussion boards and group projects in online courses facilitate this • engagement, where learners exchange ideas and learn from one another, creating a dynamic learning community.

b. **Learner-to-Instructor Interaction**: The involvement of an active instructor in effective online learning. Feedback, collaborative learning opportunities, and individualised attention are essential for instructors to encourage active learner participation. Such interaction simplifies challenging notions and guides learning (Bell, 2011).

c. **Content Interaction and Personalisation:** Learners tend to engage with content differently in online environments, where they are allowed some autonomous decision-making. Adaptive learning technologies can personalise content based on learner performance, ensuring a customised experience that caters to varying learning needs and preferences (Duke et al., 2013).

d. **Technology as a Facilitator of Engagement**: Technology is vital for connectivism. Learner engagement and response rate are evaluated using advanced learning analytics tools, which help Siemens continuously refine the learning process (2004).

Although connectivism provides a strong foundation for understanding learning in modern times, there are certain obstacles. Equal technological and digital resource provisioning for all learners represents one major challenge. Further investigations should determine how connectivism can be best implemented within different education settings and across diverse cultural and socioeconomic backgrounds (Bell, 2011). The connectivism theory covers most aspects and challenges involved in information-age learning. This promotes network, technology use, and learner-centred autonomy that aligns with education requirements and practice today. With time, it is clear that connectivism will become more expansive and diverse, leading to numerous prospects for educational innovations in future.

4.6.3. Connectivism as a Part of Social Constructivism

Connectivism, commonly called the theory of the digital age, is a newly developed educational theory that addresses the proliferation of online technology in the learning environment and the abundance of available information (Homanova et al., 2018). A learning philosophy created especially for the digital age is connectivism. Today's learners are made up of digital natives with distinct learning styles (Rice, 2018). Since the internet has made a vast diversity of people's thoughts and viewpoints accessible, it has created chances for new kinds of communication and information acquisition. Given these novel circumstances, conventional approaches to navigating and filtering the availability of information are likely to prove ineffective. Connectivism is a widely recognised network learning theory explicitly developed for online learning environments. Comprehensively understanding learning in technologically enabled networks is improbable to be adequately elucidated by a solitary theory (Goldie, 2016).

According to Homanova et al. (2018), connectivism is the newest didactic philosophy that emphasises the relationship between sources, interaction, and information exchange within a complex and dynamic network. According to connectivism, a contemporary and widely recognised theory of learning, building on prior knowledge is impractical because of significant changes in learning processes. To improve understanding of emergent events, a new conceptual framework needs to be developed (AlDahdouh et al., 2015). Connectivism, or distributed learning, is a modern take on constructivism, a complete educational philosophy modified for the digital age, according to Mattar (2018). It can be viewed as the progression of constructivism in reaction to the current state of extensive technology usage in education while simultaneously functioning as an educational philosophy. The Microsoft Teams platform is a prominent participant in the rapid transformation occurring within the educational setting. Advancements in online technology are significantly influencing the development of curriculum and the production of tools designed for the online classroom. The rapid advancement of online technology has posed challenges for educators to keep pace with it (AlDahdouh et al., 2015).

Connectivism is proposed as a more appropriate philosophy for the digital age, where action is necessary without relying solely on individual learning and personal knowledge. Learning has evolved beyond being purely an internal, individualistic process. It increasingly occurs in external settings such as groups of individuals, organisations, or databases. According to Mattar (2018), the external connections that enhance our learning are more important than our existing knowledge. This research examined how the Microsoft Teams platform might be included in the maths curriculum while Grade 10 learners were learning about trigonometric functions. The researcher wanted to see how the learners reacted when something new was added to the teaching and learning process.

4.6.4. The use of the Microsoft Teams Platform as a Part of Connectivism

According to Scherer et al. (2019), education has always had to balance ensuring continuity and stimulating innovation and change. Along with giving teachers and learners access to additional materials, technology integration in education has also increased the number of engaging and interactive learning methodologies used in the classroom. Teachers must employ innovations in ways that best meet the requirements of their learners to ensure and improve the success of technology-enhanced education (Nami & Vaezi, 2018). Technology significantly influences how we research and live our everyday lives (Vululleh, 2018). The rate at which technology has advanced is astounding. Working with online innovations like the Microsoft Teams platform, who have grown up with technological innovations as an everyday part of their lives, is a common task for school teachers in many nations today Scherer et al. (2019). The idea of technological integration in schools and its effect, or lack thereof, on learning outcomes has been the subject of much research (Perry, 2018).

Microsoft Teams platform has altered the ways that teachers and learners learn in recent years. Microsoft Teams platform, for instance, enables learners and teachers to exchange course materials in many formats, such as presentations and movies. This teaching strategy encourages using technological tools to access learning resources in unconventional ways. Facilitating individualised, in-the-moment interactions between learners, their classmates, and their instructors can potentially increase educational efficacy for all learners (Vululleh, 2018). This research used technology as a scaffolding or support structure to encourage learners in Grade 10 to comprehend trigonometric functions.

For both the realisation of efficient learning and teaching processes and the development of people with the competencies required to be a part of the 21st-century society, using the Microsoft Teams platform in education is of utmost significance (Durak & Saritepeci, 2017). Teachers now have more opportunities than ever to incorporate technological innovations into the classroom because of recent advancements in educational technologies (Bailey, 2018). The availability and accessibility of technology in the classroom context is the main focus of most literature on technology use in schools. This research examines how technology is incorporated into education delivery in the classroom (Perry, 2018).

To fulfil the demands of today's teachers and learners, a wide range of new innovative technologies promise customised and persistent learning possibilities (Bailey, 2018). Early use of technological innovations in the classroom may help learners better understand how to use them and increase confidence in their academic work, particularly in mathematics (Murphy, 2016). The primary objective of education is to help learners acquire the necessary skills to become proficient in using digital technology and effectively engage with the complexities and changes of modern societies (Fraillon et al., 2014).

Nevertheless, concerns over expenses, system prerequisites, and privacy concerns sometimes constrain enthusiasm for incorporating technology in the classroom. In order to fulfil the potential of emerging technologies to enhance and optimise the learning environment, administrators must initially tackle five primary areas of constraint. Both adults and learners value using technology as a tool for research. Does this rely on technological determinism as the basis for all of society? Alternatively, is there empirical evidence indicating that integrating technology into a classroom setting will enhance the effectiveness and efficiency of learning? (Bailey, 2018).

Creating environments where cutting-edge innovations are used is crucial for fostering knowledge exchange and imparting 21st-century skills. Consequently, the relationship between the teacher and the learning environment is crucial. Both synchronous and asynchronous interactions are possible in these settings (Korucu & Cakir, 2018). Microsoft Teams platform use in the classroom may improve the interaction between teachers and learners, motivate learners to learn, and promote learner engagement. Technology use may facilitate learner cooperation, improve the precision of mathematical calculation, make math more approachable for learners, and foster better knowledge of mathematical ideas (Murphy, 2016). In numerous academic establishments, the Microsoft Teams platform has been identified as a significant factor in the progression of instruction and knowledge acquisition (Yang & Kwok, 2017). By incorporating technological advancements into the curriculum, mathematics learners can cultivate higher-order thinking abilities that have applications beyond the confines of the classroom (Murphy, 2016). Integrating technology effectively makes the general education curriculum accessible to all learners. This empowers them with additional opportunities to complete assignments and fosters greater autonomy in handling tasks that were previously insurmountable or exceedingly challenging (Ahmad, 2015).

Therefore, incorporating technology into secondary school curricula is critical for enhancing mathematics education. Murphy (2016) predicts that educators will persist in employing technology in innovative ways within the classroom to more effectively equip learners for the swiftly advancing technological landscape of the present day. Hence, by implementing suitable modifications or alternative modes of engagement with the technology required to accomplish said tasks, learners can be granted access to a variety of methods to finalise their assignments, granting them increased autonomy in carrying out tasks that were hitherto unattainable or exceedingly challenging (Ahmad, 2015).

ICT integration in the classroom requires the collaboration of educators, learners, and school administrators (Yang & Kwok, 2017). Implementing technology in this research investigation enhanced the understanding of trigonometric functions among 10th graders. Learners accomplished the class activities after collaborating in groups and utilising manipulatives; they were subsequently administered a pre-task. After completing the course in which the Microsoft Teams platform was utilised to augment learners' comprehension of trigonometric functions, they were administered the post-task. A subsequent sequence of semi-structured interviews was conducted with the learners.

4.6.5. The Use of the Microsoft Teams Platform as a Part of Diverse Influences

Learner populations in educational institutions are experiencing growth in diversity due to the numerous origins and cultures of learners, their varied life experiences, and the presence of unique natural and acquired qualities. These disparities among learners may both enhance and limit the learning capacity of an individual in a given educational environment (Geiger et al., 2023). Likewise, Chan et al. (2018) underscore the notion that educational institutions function as an extensive, formalised arena for the advancement of knowledge on a global level. The learning process involves many participants within an educational setting, each possessing distinct knowledge and experience bases, levels, and varieties. The characteristics and distinctive approaches influence the learning outcomes they employ to interact with one another, which are developed through their diverse networks and associations within and beyond the classroom. Instructors can effectively address educationally significant discrepancies by implementing the necessary adjustments when establishing objectives, designing curricula, organising learner groups, instructing, and engaging with learners (Westwood, 2018).

Ashman and Conway (2018) posit that when a gifted learner is grouped with others and considered to be a slower learner in the classroom, an instructional dilemma may arise wherein instructors perceive themselves as having exceeded their capacity to instruct. The management and organisation of the classroom are critical determinants of the difficulties encountered in mixed-ability environments. Teachers who are incapable (or even unwilling) of catering to the varied learning requirements of their learners heighten the probability that control challenges will emerge in a classroom comprised of learners with a broad spectrum of learner attributes, ranging from those with below-average ability to those who are sluggish. In addition, a teacher of mixed-ability classes may be required to acquire new organisational skills in classroom management, learner self-regulation, and group work. In order to integrate the prior knowledge that learners possess into the mathematics curriculum, instructors are required to assess that knowledge. Unawareness and lack of familiarity with the local customs, knowledge, and culture may account for the disparity between achievement and lack thereof in a formal mathematics classroom. The learning process is intricately linked to learners' daily lives, and it is impossible to separate new pedagogical materials from the diverse forms of local knowledge in which they are embedded (Geiger et al., 2023). Consequentially, course participants must be completely comprehended.

Various factors may influence how instruction and learning are carried out in classrooms. Integrating social constructivism into mathematics education encounters various obstacles, including linguistic variables, cultural influences, conventional curricula and assessment approaches, inadequate class sizes, and apathetic and disadvantaged learners. Language components, human relationships (including peer interactions), and the educator's responsibility to transmit knowledge are all included in the social domain (Panthi & Belbase, 2017). Whether in a physical or virtual classroom, the diversity of the learners present may be influenced by several factors.

Chan et al. (2018) assert that classrooms are vast, institutionalised spaces utilised globally to facilitate learning. Furthermore, as Thompson and Timmons (2017) assert, most education systems in developed nations are committed to executing an inclusion policy. This entails that educational institutions must accommodate learners with diverse abilities, from exceptional aptitude to intellectual disability. In addition to diverse academic aptitude levels, life experiences, and cultural backgrounds, these learners frequently speak unique native tongues. In addition, their familial and socioeconomic backgrounds are diverse.

It is assumed that all educational institutions ought to endeavour to deliver a genuinely inclusive curriculum, given the perpetual diversity that will exist among learners. Given the inclusive nature of the research environment—which reflected learners of various socioeconomic statuses, learning abilities, races, and levels of language proficiency—it was imperative that the researcher employ a methodology that was considerate of the requirements of every participant. Throughout the research, no participant was ever excluded or subjected to any form of discrimination. To achieve this, various collection strategies and techniques were implemented while ensuring that the uniqueness of the learners remained uncompromised. In order to foster active and effective learner engagement in the learning process, inclusive classroom instructors predominantly depend on supplying appropriate resources that correspond to the level of difficulty expected of the learners (Westwood, 2018). Content in any course that adheres to the principles of universal learning design ought to be simplified or improved Cumming & Rose (2022). All learners can engage in the same subject matter and achieve the same curricular goals by utilising adapted or modified resources. Due to the lack of control over all classroom factors (e.g., changes in learner achievement, teacher-learner relationships, gestures, vocabulary learning, dialogic talk, meta-cognitive strategy, group dynamics, etc.), researchers are limited to focusing on a subset of classroom interaction. Consequently, the accounts of the learning process in classroom settings are diverse and often fragmented (Chan et al., 2018).

Due to demographic shifts, legal system developments, and political climate fluctuations, educational institutions nationwide are increasingly experiencing socioeconomic and ethnic segregation. A considerable number of school districts are currently exploring strategies to provide a diverse range of learning experiences in response to research indicating that learners benefit both academically and socially from integrating environments (Kotok & De Mathews, 2018) Within an educational setting, the learning process involves a multitude of participants, each possessing distinct knowledge and experience bases, levels, and varieties. The modifications in their learning outcomes are influenced by their characteristics and distinct approaches to interacting with one another as a result of their diverse existing affiliations and interactions both inside and outside the classroom (Chan et al., 2018).

Language is not just a tool for communication but also comprehension, claim Panthi and Belbase (2017). In their language, learners of language construct meaning. The best approach to understanding or developing an understanding of mathematics is through the language of one's mother. Because the learners' languages are different in school and home contexts, there is a lack of capacity and comprehension. Some social groupings are more favoured than others by the language styles and instructional methods employed in mathematics. State or national governments create the policies governing curricula. Therefore, content-driven curricula and pertinent teaching techniques directly affect teachers' demands. They concur with Ashman and Conway (2018) that teachers and other members of the school or institution must have opinions on how the curriculum can be taught and learned in order for it to be effectively implemented. New programs and online technological advances are assessed in light of the then-current modes of instruction and underlying ideologies. Therefore, teachers' ability to modify their present practices or tactics and make adjustments that align with curricular standards must be considered when evaluating new technologies.

The fundamental design of this research involved a progressive escalation in the intricacy of the classroom activities being examined, accompanied by a strategic realignment of the social unit of the classroom (including individual, small group, and whole class discussions) and the interaction foci. Specifically, the research aimed to shift the emphasis from learner-learner interactions to those in which the teacher played a less directive role (phase one of data collection). This framework facilitates optimal experimental control by utilising classroom activities familiar to instructors and students (Chan et al., 2018). Various pedagogical strategies were implemented in this research, considering the learners' diverse learning abilities: group projects, the application of manipulatives, and the utilisation of technology via Microsoft Teams.

4.7. Summary

The current chapter examined the theoretical framework, laying the groundwork for subsequent research inquiries. To enrich the abilities and comprehension of tenth-grade learners researching trigonometric functions, the research explored various concepts, including motivation, cooperation, the Zone of Proximal Development (ZPD), and peer and mentored scaffolding. The discussions on scaffolding, connectivism, and the ZPD followed an exposition of the socio-constructivist theory and its core principles. Reflecting on the theories guiding trigonometric learning for tenth-grade learners, the chapter analysed the integration of educational paradigms, incorporating motivation theory, cooperative learning, ZPD, and scaffolding within the modern connectivist knowledge-building model, shaping the research's objectives and methodologies. Motivation emerged as a significant driver for trigonometry learners, focusing on cooperative learning rooted in social constructivism. Both intrinsic and extrinsic motivations influenced learners' engagement and comprehension of trigonometric concepts. This approach enhanced learners' understanding through peer consultation and debate activities, facilitating information assimilation. The research design ensured tasks aligned with learners' ZPD, maximising their development and learning potential. From Vygotsky's theory, scaffolding provided initial support, gradually fading as learners grasped concepts, particularly in advanced trigonometric functions. Synchronous and asynchronous opportunities were leveraged for collaborative knowledge construction through platforms like Microsoft Teams. The next chapter gives an overview of the research design and methodology.

Chapter Five: Research Design and Methodology

5.1. Introduction

The theoretical frameworks that helped to shape this research were covered in chapter three. This chapter's primary goal is to provide an overview of the research design, research paradigm, methodological framework, data analysis, reliability and validity, and research constraints for this particular research. The research design refers to the method(s) and technique(s) used to gather, analyse, and interpret data. The paradigms in this research refer to the methods applied during the research. Different paradigms might be used to explain or predict occurrences. The interpretative paradigm was employed in this research to describe how research participants behaved.

This chapter focuses on articulating the research design and methodology. It discusses the intricate patchwork of methods, techniques, and paradigms employed in this research to unlock Grade 10 Learners' perceptions of using Microsoft Teams to learn trigonometry in mathematics. The research process is exploratory. The researcher can be guided by a research hypothesis or working assumption, but sometimes, it is exploratory (Casula et al., 2021). Research methodology is not just for research sharing but also involves broader logical techniques that apply to various problems. At the same time, the method of misconduct refers to how research is done scientifically. It is a topic of planning the research steps, developing the research plan, collecting the information from different sources, and preparing and presenting reports and findings. It is not directly concerned with research insights, but it is also concerned with philosophy. According to Rose & Johnson (2020), methodology is the method and system followed in a research project. It is the practical explanation of research design. It helps to guide the direction of the data collection and research process during a project. It is the blueprint of the procedure of the research work. The methodology chapter informs the reader of how the research was undertaken.

The realm of educational research presents many challenges to the researcher. The choice of an interpretive paradigm in exploring these challenges informs that the researcher is moving strategically. This paradigm allows the researcher to uncover the world of the Grade 10 learner, where we will be able to uncover and unfold the life world of the Grade 10 learner and their experiences of Microsoft Teams as a learning tool. The interpretative paradigm offers a lens with which to comprehend the complex nature of the life world the learner in grade 10 faces with the applications of technology tools in education. The interpretative paradigm allows researchers to search for the richness and depth of understanding from the learner's perspectives.

Research design and methodology can be likened to a floor plan initiating a research project; it details how to proceed with research. This chapter explains the different methods used in the research, what methods were used, and the motivations for using them. This chapter discusses the research paradigms in detail, and the interpretive approach is ideal for this research as it records the individual's behaviour. The methodology portion of the thesis is not just about how to do something or just describing the steps. It includes the method, frameworks, techniques, and tools utilised. In this research, every single method, technique, and tool was chosen deliberately for a specific reason and aim. This chapter discusses why the researcher chose such methods, techniques or tools and why they were used to answer the problem statement.

The analysis of data is a crucial part of the research. This research analysed the field data and elucidated the methodologies and strategies employed in the data analysis process to address the research inquiries. The chapter also explains how the obtained data can be interpreted. Moreover, this chapter also provides the approaches and steps taken to ensure the reliability e and validity of the research. Research in education centres on human experiences and what it means to be human. The experiences of individuals are very complex and different, which brings a challenge to the research process in education. This is also an opportunity to adopt different creative approaches, hence the unique characteristics. In this chapter, the researcher explores the challenges and opportunities associated with the subjectivity of human experiences in research design and methodology, clearly showing how this research has addressed this task. The chapter also highlights the ethical considerations considered in this research.

5.2. Key Research Questions

Learners, especially those who struggle with complex curricular topics, may find it easier to understand complicated and abstract mathematical ideas using modern technology like the Microsoft Teams platform (Kaplan & Alon, 2013). This research aimed to examine the perceptions of grade 10 learners regarding using Microsoft Teams as an internet-based platform for learning trigonometric functions. The information gathered throughout the investigation pertains to the subsequent research questions:

i. What are Grade 10 learners' perceptions of using Microsoft Teams as an online learning platform for learning trigonometry functions in mathematics?
ii. How effective is Microsoft Teams as an online learning platform in helping learners improve their knowledge of trigonometric concepts?
iii. How can Microsoft Teams as an online learning platform facilitate learning, collaboration, self-efficacy, and engagement in trigonometric functions? Why?

5.3. Research Paradigm

This research employed the interpretive research paradigm, which permits investigators to perceive and experience the world from the participant's point of view. By drawing from these experiences, the researcher who employs the interpretive paradigm constructs and interprets his understanding of generated data. In particular, interpretivism helps academics explore their environment by interpreting how others comprehend one another (McChesney & Aldridge, 2019). Additionally, according to Gunbayi and Sorm (2018), the interpretive paradigm has been widely used to guide qualitative research, including case studies, grounded theory, ethnography, and more. Examples include phenomenology, narrative research, systematic reviews, discourse analysis, etc. It is the research of how people view the world and how it appears to their conscious minds. The emphasis is on how people see the world. The interpretative paradigm guides phenomenological research since its goal is to investigate experiences. Phenomenologists try to comprehend and then explain what people say to gather data.

The researcher does not take any action. According to Neuman (2014), this paradigm aims to explain why individuals behave in particular ways and how they connect. To comprehend how individuals develop and maintain their social habitats, he describes it as the research of social acts in their natural contexts via careful observation of people. According to Grouws (1992), the interpretative method aims to answer issues such as why the phenomena happen and how they change through time. According to interpretivism, people create social reality by giving it meaning (Phothongsunan, 2010). The fact that interpretivism adopts the natural mode of human communication implies that people participate actively and are integrated into the data-collecting process, which is one of its benefits (Phothongsunan, 2010).

This methodology was suited to this research project because it was built on the engagement and experiences of the participants. The research conclusions, the answers to the research questions, and the data analysis were all formulated based on the interpretations and experiences of the learner participants. This research, which investigated the perspectives of grade 10th learners regarding their utilisation of the Microsoft team's platform for researching trigonometric functions in mathematics, was well-suited to and closely aligned with the interpretative paradigm. By coupling this research to the interpretative paradigm and employing a series of questions from an interview schedule, the researcher could gain a more comprehensive understanding of the participants' viewpoints. Participants' perspectives and experiences regarding the use of Microsoft Teams platform for the research of trigonometric functions enabled the researcher to comprehend the conversations that arose in response to the semi-structured interview inquiries.

McChesney & Aldridge (2019) note that when pursuing research questions, the interpretative paradigm-following researcher builds and interprets his knowledge from generated data using participant experiences. Since interpretivism embraces a variety of opinions from people in various groups, it is considerably more inclusive. When educational researchers need information from a population that is in-depth and insight rather than numbers by statistics, this will significantly help them (Johnson & Christensen, 2024) . In light of these viewpoints, the researcher had to evaluate the data derived from the audio recordings to understand better how learners perceive the use of technology in the research of trigonometric functions.

According to Alase (2017), the interpretive paradigm provides the most significant opportunity for researchers to understand the most profound aspects of the lived experiences of research participants. The interpretive approach, known for its focus on research participants' experiences, allows them to articulate their thoughts and experiences in any way they choose without fear of reprisal or distortion. The participants in this research comprised intellectually gifted individuals from diverse socioeconomic backgrounds. Using an interpretive approach, the researcher obtained more diverse and intricate information from learners directly impacted by the phenomenon under investigation—using the Microsoft Teams platform to research trigonometric functions in a tenth-grade classroom. The information the researcher gathered from the participants' responses to the pre-task and our conversations during the focus groups is based on how well the participants assimilated the learning material that was given to them.

5.4. Research design

According to Bellini & Rumrill (2018), research design is a particular design or arrangement used to investigate specific research issues within research methodologies. The ability of researchers to derive knowledge claims or inferences from research findings is inherently contingent on the methodology and structure of a specific investigation. The research, as previously mentioned, was set inside an interpretative paradigm. A strategy based on case studies and a qualitative design was employed in line with the interpretative paradigm. Information that is given in the form of words rather than figures is referred to as qualitative data. Quantitative data differs from qualitative data in that the latter is objective and involves statistics that can be studied scientifically, whilst the former involves subjective perceptions that are challenging to analyse and justify. Primarily, primary data and a minor amount of secondary data were used in this investigation. When learners participate in an online course on the Microsoft team's platform, primary data will be presented as case studies. Secondary data was obtained from statistics and published publications.

Digital media has become an indispensable instrument in the lives of both learners and adults, perhaps most significantly for communication (Christensen & James, 2017). As a result, this field of research on learners and adolescents has been expanding at an accelerated rate. The determination of the research topic was influenced by learners' discernible impact on the Microsoft Teams Platform. According to Chen (2015), information and communications technology (ICT) is the final point. ICT access in schools is impacted by the surge in mobile device use among learners and their families. Given the growing significance of digital literacy in the so-called information age, it is in the general public's best interests to investigate this topic and look at any potential digital inequalities within the public education system to influence future research and policy decisions. Families now use technology daily for communication, entertainment, and jobs. The Microsoft team's platform was used in the classroom as part of this research project to enhance technology usage by making it easier for Grade 10 learners to understand and be taught about trigonometric functions.

Using a qualitative research design to explore how learners utilise Microsoft Teams for trigonometric function notes strengthens the research. Using case studies allows for a detailed investigation of how individual learners experience, use, and decide learners’ benefits and drawbacks to using Microsoft Teams in the learning process of trigonometric functions. Thus, this approach is instrumental in investigating learners' experiences, as it is subjective. Aligned with the interpretative paradigm, the researcher adopted a holistic view as the standpoint enabling the understanding of learners’ experiences with Microsoft Teams. The learners' experiences were influenced by a complex array of factors, considering their familiarity with the technology, their expressive mode, and the extent to which the educators supported and recognised online engagement and teaching approaches.

Various methods to gather primary data were employed, including in-depth interviews, focus groups, and classroom observations. These methods were chosen specifically because of their ability to provide rich, descriptive data to uncover the complexity of learners’ experiences (Bellini & Rumrill, 2018). The interviews and focus groups allowed learners to verbally express their thoughts and feelings about using Microsoft Teams, contributing insights on attitudes, challenges, and successes hired to navigate thoughts and feelings. In contrast, classroom observations allowed for data collection on learners’ engagement with the system in a more naturalistic setting, adding strength to the findings from the learners’ self-report data.
Secondly, the research gathered data from primary sources to ensure its effectiveness. The research depended on several secondary data sources to provide a natural backdrop for the research. As part of the research, the researcher conducted an extensive review of the development of online education. All this was done to help understand what is already known about online learning platforms. This was followed by reviewing how Microsoft Teams can be effectively integrated in secondary and the higher education sectors. A significant result of all these findings was that online platforms play a significant role in discussions and other acts of collaboration, and several higher education institutions are using Microsoft Teams to shape this move.

The investigation considered some broader aspects, such as ascertaining the adaptability of Microsoft Teams, an online learning platform, to the teaching of trigonometric functions among Grade 10 learners and assessing the impact of the use of platforms such as Microsoft Teams on digital literacy and competence of these learners. The research also attempted to determine the potential of this type of platform in either closing or opening the gap in access to education through learning multiplication between learners in the context of different levels of access to technology.

Aside from the aforementioned pedagogical benefits, this research also discusses the pedagogical implications of Microsoft Teams for teaching trigonometric functions. Through this approach, we got a deeper insight into how instructors adapt their teaching strategies within the scope of the platform and the resulting relationship of those strategies to learners' level of interest and their comprehension rate of the skill. Given the aforementioned, this research examined how the fault lines and the intentions of Microsoft Teams introduce challenges and create new possibilities, especially in curriculum delivery, assessment and learner collaboration.

The research design and methodology utilised to examine the study's research problem were described in Chapter 3. A qualitative, descriptive, and explorative research design was used to gather information on the perceptions of Grade 10 learners using Microsoft Teams to learn trigonometric functions. By using a combination of primary and secondary data, together with the experiences of learners, within the broader framework of educational and technological context, the research had the potential to provide guidance, insight and direction on the possible effectiveness and impact of using Microsoft Teams as an educational tool.

5.4.1. Context of the Research

This research was conducted at a high school in the King Cetshwayo neighbourhood on KwaZulu-Natal's northern coast. The institution was selected because it was convenient for research there and since the researcher teaches there. It is a typical public school where isiZulu is the first additional language and English is the primary language of instruction. The school's teaching staff comprises the principal, deputy principal, four department heads, two administrative clerks, and twenty-five teachers. The school serves learners in grades 8 through 12. At this school, there are about 899 learners enrolled. This investigation was carried out in one of the two Grades 10 classes. Learners from various ethnic, cultural, and socioeconomic origins make up the learner population; some travel great distances to attend school. Because the learner body includes learners who are immigrants, have special needs, are gifted, have autism, speak other languages, or are multilingual, the school upholds the principles of inclusive education. The school offers a variety of sports, goes on field excursions, and involves learners in extracurricular and co-curricular activities to promote the overall development of its learners. After considering several variables, it was decided to undertake the research at Hope High School.

Since the researcher was expected to be at work all the time, there was no need for a substitute teacher to supervise the classrooms. Department of education's deadlines and regulations must be adhered to, because Curriculum and Assessment Policy Statement (CAPS) mathematics curriculum does not permit considerable disruption of notional time. The data required to finalise the study was readily available at the school where the researcher worked, included the details about the ages and attendance of the learners.

The researcher's position as a teacher at the institution where the research took place did not influence the conclusions drawn from the study. The investigation was conducted without being swayed by the researcher's beliefs, ideas, feelings, or attitudes. The complete transcription of the interviews used in this research ensured that the researcher's opinions did not affect the findings. Since the researcher taught mathematics in both Grade 10 classes, the participating class was selected randomly, without any considerations of preferences or biases. Moreover, the participation of the students was determined with the consent of their parents, independent of the researcher's views or preferences.

Tella (2017) highlights how important mathematics is to most human pursuits. Its importance in business, economics, education, science, math, and technology, as well as in the humanities, is almost equivalent to that of education in general. It is possible to define teachers' interest in mathematics education as a desire to teach and learn the subject. The mathematics teachers are passionate about the topic at the school where this research was done. In the senior and FET phases, four mathematics instructors each instruct all learners in a certain grade, from Grades 08 to 12. To ensure the best possible application of the CAPS curriculum's specified material in the classroom, the Department of Education organised training sessions for all of the school's math teachers. This mathematics department offers professional learning communities for senior and FET phases. Mathematics teachers can share information through professional learning communities by attending seminars or workshops for professional development.

Each phase's chairperson and committee members meet regularly to discuss any other mathematics-related activities and challenges teachers or learners may be experiencing. Topics covered include assessment tasks, learners' math proficiency levels, and strategies for improving results. The participation of learners during teaching may impact their learning at school, according to Bidabadi et al. (2019). The task-avoidant behaviour among learners impacted how well they performed mathematically. Math achievement progressed less and more slowly when task-avoidant behaviour was present at the beginning level. Additionally, a decline in task avoidance was linked to a rise in math learners' performance over time. Learners must be continually motivated using innovative teaching and learning strategies to promote interest in mathematics learning and build a preference for mathematics-related pursuits. The math organisation, which was established by a group of mathematics teachers in the King Cetshwayo area, organises various co-curricular mathematical events for the learners at this school. Grades 8 to 12 learners participate in contests where learners from rural and urban schools compete in non-routine mathematics problem-solving and activities meant to teach mathematics pleasantly. The learners are pretty excited to take part in these activities.

Problem-solving is the primary goal of mathematics. A person's depth of mathematical comprehension determines how accurate their decisions are (Ryna et al., 2009) . This implies that to function well in society, a person must comprehend or possess a solid understanding of mathematics, especially today. The Microsoft Team platform and technical advancements provide a solid basis for mathematics research in online learning (Tella, 2017). The National Curriculum Declaration (NCS), which serves as a declaration of policy for teaching and learning in South African schools, is incorporated into the mathematics curriculum at this school, as it is at all other public schools in the nation. This declaration, which has been put into effect in South Africa since 2012, consists of CAPS, a national policy for the programming and promotion requirements of the NCS (Grades R to 12), and a national Protocol for Assessment (Grades R to 12) (DBE, 2011). The NCS states that mathematics education aims to give learners the self-assurance and abilities to solve any mathematical problem without being constrained by a maths phobia. It also aims to give them a fundamental understanding of the applications of mathematical relationships in social, environmental, cultural, and economic contexts (DBE, 2011).

For learners to succeed academically, a conducive learning atmosphere must be created. Such a setting includes learning from home through online learning platforms like Microsoft team's platform in addition to the classroom and school. The surroundings at school and home significantly impact how well learners do in arithmetic. The resources that learners take from these environments, both material and immaterial, influence their educational experience (Visser et al., 2015). Regarding educational resources, the school where this research was done is comparatively well-resourced. Learners have restricted access to laptops and tablets at this school, but teachers can use the projector and screen in the library/media centre to offer lessons. Additionally, wall charts for math and other subjects are accessible as teaching and learning aids. Because the learners at this school come from various socioeconomic situations, the learning tools accessible in their homes rely on what is affordable for each family.

5.5. Qualitative Methodology

This research used a qualitative methodology to investigate the real-life experiences of high school mathematics learners enrolled in virtual courses. As stated by Creswell (2014), qualitative research serves as a means to investigate and comprehend the perspectives of individuals or groups regarding a social or human issue. By conducting in-depth interviews, the proponent gained an understanding of and delved into the lived experiences of mathematics instructors at the tertiary level using a qualitative research design. Moreover, this design is suitable for implementation as it facilitates comprehension of human situations, problems, and experiences (Neubauer et al., 2019). Furthermore, interview-based data collection is the prevailing technique, encompassing structured, semi-structured, and unstructured formats (Valunaite et al., 2020). All information was retrieved from the participants' locations.

The qualitative research design was associated with the Interpretive paradigm, investigative procedures, and data-gathering methodologies (Ngozwana, 2018). Leavy (2014) also asserts that inductive knowledge-building strategies focusing on producing meaning are a common feature of qualitative research. Researchers use this method to explore, examine, and learn about social phenomena, assess how individuals interpret particular actions, circumstances, events, or artefacts, or thoroughly grasp a specific aspect of social life. Qualitative research is generally suitable when defining, exploring, or clarifying the main goals.

Similar to participant observation, qualitative interviewing has long been a mainstay in classroom research, according to Pipere and Micule (2014). Several levels of structure are employed in these interviews to get participants' responses on the research subject. Although the formality of the interviews varies, there is a distinct line between the researcher and the participant. Inquiry into the respondents' opinions about the research topic indirectly and unobtrusively is one of the characteristics of qualitative research, which is especially advantageous for this research. Semi-structured interview participation was voluntarily given, anonymised, and under the condition of written consent. In this research, a qualitative methodology was employed since my main goal was to collect descriptive, information-rich data from the participants to investigate and understand how learners felt about using the platform developed by the Microsoft team to learn trigonometric functions in Grade 10 class. Information from the pre-and post-task, interviews, and interview responses was extensively analysed to clarify descriptive data relevant to this research.

This qualitative methodology played a key role in revealing the online experiences of high school math learners utilising Microsoft Teams' trigonometric capabilities in a virtual classroom. According to Creswell (2012), qualitative research is the way that individuals or groups perceive and navigate social or human problems. The abovementioned method was particularly useful for investigating how learners and instructors talk about virtual mathematics experiences. Creswell and Poth (2016) emphasised that qualitative research is vital when understanding experiences, human situations, or problems.

Researchers need to look through the lens of mass media to interpret the social world around them. The methodology employed in this research enabled a means to gather rich and descriptive information on learners' and teachers' experiences and perceptions of the e-room. Interviews, according to Litosseliti (2017), are an elemental part of qualitative research. Structured, semi-structured or unstructured. Each format has a different implementation method and a unique structure level. The use of semi-structured interviews in this research is crucial because it allows for flexibility or freedom for the interviewee. Moreover, the interviewer can deviate from the interview guide to probe further into the topics or gather more detailed information about a topic.

Another way to validate data as a qualitative researcher would be to use an interpretive paradigm. A qualitative research design would help because it seeks to understand the meanings and experiences of the subjects (Creswell, 2012). This research utilised a constructivist qualitative framework to understand how five preservice social studies teachers in Baku, Azerbaijan, perceived using Microsoft Teams for their learning, observations, and microteaching during their two-year teacher education program. The processes, communication, and activities the learners focused on within Microsoft Teams are outlined in Tables 3, 4, and 5.

A significant strength of qualitative research indeed lies in the dynamically inductive nature of the process, wherein a social researcher seeks to build knowledge and understanding of the subject at hand through exposure to, observation of, or documentation of lived experiences, typically framed by an explicit focus on the meanings, narratives, or stories embedded in, talked about, or shared by the participants in one's research (Creswell & Poth, 2016). Having chosen this approach, the research now delves into the specifics of the study, including the examination of interviews, pre-and post-task data, and observational notes, to fully understand the virtual learning environment.

History shows that qualitative interviewing as a method for collecting data has been present in educational studies for quite some time, according to Busetto et al. (2020). As has been the tradition, this research employed interviews to gain an elaborate view from participants on the subject of Microsoft Teams in education. The semi-structured interviews facilitated a deep, detailed, drawn-out probe of the research questions. The Microsoft Teams platform is what one might call innovative, as it has forever altered the format of the modern classroom platform, allowing learners and teachers to communicate on a private channel provided for each class. Upon analysis of this data, trends and themes were identified, and with due consideration, it was felt that these patterns aided in a richer comprehension of the impact of this virtual tool on the teaching and learning of trigonometric functions.

To aid in the process of data analysis, all of the following methods were used throughout the process: interview transcriptions, surveys administered at the beginning and end of the research, detailed observations taken and recorded throughout the research, and concise records kept to separate the field notes taken from each participant. Data analysis was undertaken using NVivo, guided by the principles of qualitative analysis. This computer program organises and manages qualitative data and assists with coding, sorting and retrieving knowledge to enable trend identification and comparison of themes and issues in the data (Bazeley & Richards, 2020).

The mission involved constructing an inclusive, comprehensive sketch of the childish learning atmosphere accentuating the internet's dilemmas, accomplishments, and fine points using Microsoft Teams. By choosing a qualitative methodology, the research was able to analyse the subjective experiences of learners and teachers to offer insights into how valuable, practical, and effective Microsoft Teams is as a tool for learning trigonometric functions and the problems and potential of using it. The expected outcome of this research is that it will provide significant information about virtual learning environments, which have practical implications for educators and policymakers of digital education and add further to the existing superintendent of professional studies in education.

5.6. Sampling

Qualitative research uses smaller samples than quantitative research, which uses sufficiently large sample sizes to yield statistically significant numeric estimations. Instead of reflecting populations like in quantitative research, the main goal of sampling in qualitative research is to gather information that helps comprehend the complexity, depth, variance, or context around a phenomenon (Gentles et al., 2015). Because the research aimed to determine how Grade 10 learners felt about using the Microsoft Teams platform while learning trigonometric functions in a single Grade 10 class, it had to be done in a classroom setting. The researcher had to obtain authorisation from the research office of the KwaZulu-Natal Department of Education before conducting any research at the school. The plan to research on campus must be communicated in writing to the school principal as soon as the letter confirming the DBE's authorisation is received. The letter is attached as Appendix A. After that, the research might continue.

According to Aksakal et al. (2018), the research question or questions substantially impact the population of interest from which the sample is drawn. As a result, a reliable sampling strategy is required to ensure that the information gathered can be utilised to address the research question or questions, ultimately determining the success or failure of the research. Participants who met the sample profile were chosen for this research, and their data was collected. Sampling is choosing people or groups from the target population and evaluating them to make inferences. The judgement sampling strategy is also known as ‘purposeful sampling’ because it involves intentionally selecting participants. In short, the researcher determines what data is required and then looks for sources who, given their knowledge or experience, can provide it. Finding and choosing examples with rich information is a standard procedure in qualitative research to guarantee that the resources are used as effectively as feasible. For this, locating and identifying individuals or groups knowledgeable about and proficient in the phenomenon of interest is necessary. Etikan et al. (2016) assert that communication abilities, willingness to participate, and availability are just as important as knowledge and experience.

Regarding sampling choices in qualitative research, Sim et al. (2018) claim that several variables come into play. These include practical issues like time and resources and methodological ones like the goal and scope of each research and the epistemological attitude underlying it. Specifically, there is a need to balance maximising participant numbers with satisfying practical requirements, such as indicating sample size in advance. This research's participants were chosen using a deliberate sampling method. Participants had to fulfil several prerequisites to be chosen for the research project. Participants were all Grade 10 learners taking math classes at an English-speaking school where English was the primary language of instruction. The learners in the sample included a wide range of ethnic and cultural orientations, learning styles, and genders. These elements, however, were not significant since they did not affect the research's outcome.

In-depth interviews or sample size selection is a crucial phase in the research process, according to Rosenthal (2016). Finding a generalisable sample is a top priority for researchers in quantitative investigations. The main goal for in-depth interviews or focus groups is not to build a generalisable knowledge of behaviour but to understand the underlying behaviour's meaning. Therefore, obtaining a comprehensive, experienced description from interviewers while maintaining an equitable representation of experiences throughout the community of potential participants is the goal of sampling for in-depth interviews or focus groups. Korstjens and Moser & Korstjens (2017) assert that the first few minutes of an interview are pretty important. The person must be at ease before sharing his or her experiences. In a semi-structured interview, you would start by posing open-ended questions to elicit genuine answers from the interviewee. In order to allow participants to relate their individual experiences, including sentiments and emotions, the questions usually concentrate on a specific experience or incident. You can also use follow-up inquiries, encourage the revelation of additional information by using probes and prompts, or keep quiet for a little while to extract as much information as possible. Asking what and why first, before asking how.

5.6.1. Purposive Sampling

Purposive sampling, a technique that requires researchers to specifically target respondents, underscores the crucial role of the researcher in shaping the study's direction. As Mikecz (2012) emphasizes, this method is often chosen by researchers who aim to follow a procedure by interviewing a pre-defined and accessible collection of elites selected based on specified criteria (Tansey, 2007). Before commencing their research, elite interview researchers using purposive sampling compile a list of the elites they intend to interview. Acquiring the respondents' names and professional contact information is straightforward for researchers employing purposive sampling because the research population is clear (Mikecz, 2012). However, access is not always that simple. Purposive sample researchers work independently in their access endeavour, whereas snowball sampling researchers receive significant assistance from their mediators to sample and access their respondents. The prospective interview subjects must be contacted and persuaded to meet and converse with them. Furthermore, as the methodology depends on speaking with certain people, switching out one interviewee could significantly impact the research's conclusions. Purposive sampling may make sampling simpler than many other techniques, but reaching the sampled people is undoubtedly more challenging.

Using this sampling technique, the researcher must carefully evaluate how to construct the sample population. According to Miles and Huberman (1994), saturation (i.e., gaining complete knowledge by continuing to sample until no new substantial information is collected) is the main objective of deliberate sampling techniques. The aim of the research is considered while selecting participants, and it is anticipated that each participant will provide valuable and unique information to the research. Statistical power analysis is not used to estimate sample size; data saturation is used (Suen et al., 2014). A purposive sample was used to choose the participants. Purposive sampling, sometimes referred to as judgement sampling, according to Guetterman (2020), is a conscious decision made by the proponent to choose the participants based on their attributes. In addition, the research participant must meet the inclusion criteria, which call for him or her to be a maths learner in grade 10 at a high school that uses the online Microsoft Teams platform for virtual instruction. Maximum variation sampling (MVS) was employed in this research investigation. MVS, also known as heterogeneous sampling, is founded on comprehending a subject better, which requires examining it from all relevant angles. Both learners who excelled and those who were disinterested in the Microsoft Teams platform were sampled as ‘typical’ learners. The observation schedule, pre-task, and post-task were used to define the sample population. This sampling is helpful when a random sample cannot be produced, such as when the sample pool is too small.

At the participating school, two grade 10 classes, Grade 10 A and Grade 10 B, are researching mathematics. Each class has 23 and 20 learners, respectively. The researcher, a teacher at the institution taking part, will include learners in grades 10A and 10B because of accessibility.

Using traditional and online teaching methods, learners were taught synchronously and asynchronously when learning trigonometric functions. The learners at this school are all black, yet they are a mixed-gender group.

5.6.2. Pilot Study

Pilot studies are early research projects that are carried out to determine the viability of more in-depth future studies by evaluating areas of methodological ambiguity, according to Story et al. (2018). Pilot studies frequently do not require a formal sample size since they are not intended to evaluate the efficacy of the intervention. Pilot studies are important for lowering research uncertainty before major observational and epidemiological investigations and are not simply helpful in evaluating upcoming randomised controlled trials. The pilot study involved participants from the other two Grade 10 learners at the same school. The key participants in the research were similar to the learners who participated in the pilot study. When preparing for qualitative interviews, familiarity with data-capturing technologies is essential. Considering the semi-structured interview venue is important as it could affect data collection. The timing and location of the interview should be convenient for the respondents and take place in a quiet environment free from distractions and noise(McGrath et al., 2018). A pilot study was conducted with a single class of Grade 10 learners. The pilot study was conducted with learners in Grade 10 B. The learners in the pilot study were taught trigonometric functions synchronously and asynchronously using an online platform once the research instruments had been improved to be valid and trustworthy. With the second group of 23 Grade 10 learners, the researcher lectured, watched, gave assignments, and conducted interviews. This group of learners is in grade 10 A. The Grade 10 A learners were not a part of the pilot study. The 23 Grade 10 A learners who participated in the primary research were the only ones.

To guarantee that the data transcription would be accurate, precise, and genuine, inspecting and assessing the audio recording apparatus employed to capture the focus group interviews was imperative. By altering the questions after the first interviews, the interview guide can be enhanced during the interview process in the pilot study. As per McGrath et al. (2018), specific inquiries can be ambiguous, whereas others might be extraneous or outside the scope of the research subjects. After assessing the feedback from the pilot study, the researcher was able to change the research tools and focus group interviewing strategies, which improved the validity and reliability of the research. Twenty-three learners from a single Grade 10 class participated in the primary research.

5.7. Research Methods

According to Netolicky and Barnes (2017), each research technique is the researcher's unique trip; it is a process rather than a final result. Data, summaries of findings, publications, and presentations are stops along the way; they are not the final products that allow the research to be neatly stowed away as accomplished. A method's evolution is influenced by several factors, such as the conceptual framework, literature, data, research questions, and participant choices: purpose and potential direct and form method. According to Patten and Newhart (2018), research methodologies constitute the foundation of scientific endeavours. They function as the 'how' in the methodical production of knowledge. One source of knowledge you may have is your personal experiences. The term 'empirical approach' is based on experience or, directly or indirectly, on observation. Bellini & Rumrill (2018) state that research design refers to specific configurations or designs that can be applied to research research methodology issues of interest. The technique and design of a particular inquiry play a key role in determining the strength of knowledge assertions or inferences that researchers may make from the research findings. These explanations of the research methodology state that the research aimed to ascertain the attitudes of Grade 10 learners regarding integrating the Microsoft Teams platform into their mathematical research of trigonometric functions. It was important to employ many tools to gather information to probe an in-depth examination of this issue. The use of pre-and post-task and an interview schedule were among these techniques.

5.7.1. Data Collection

The process of getting research data from participants involves several procedures. According to Yüksel and Yıldırım (2015), video recording, observations of the research setting, and interviews can all be used to gather data. Data collecting does not start until all of the first elements of the research design have been completed. To further the research goals, a research question is presented after concentrating on a subject that piques our interest and motivates us to care about the world. The primary determinant and starting point of the design is the research topic. The researcher plans to obtain this information (data collection) and examine it (data analysis) in order to make sense of it (Cypress, 2018). In qualitative research, the investigator needs to fully commit to collecting data. Because of this, the qualitative researcher needs to be an agile, perceptive instrument who can act quickly to follow up on leads. Unlike a quantitative report based on statistical data, a qualitative report is a tightly woven, pieced-together whole that is more significant than the sum of its parts (Padgett, 2016).

Halcomb (2016) states that innovative data-gathering techniques may improve data richness and participant engagement. Data may be generated using various methods to capture many realities and fully comprehend the human experience. The most popular techniques for gathering qualitative data may include interviews, focus groups, and observations; qualitative research naturally encourages innovation and cutting-edge techniques to understand the participants' lives. The following steps were taken to obtain the data for this research:

- Traditional teaching (Observations during this phase have been made, but it is unclear if they were included in the data presentation and analysis. More details are needed on who was observing whom and the purpose of these observations.)
- Pre-Task
- Intervention (Teaching using the Microsoft Teams platform; observations during this phase have also been done, but again, it is unclear if they were part of the data presentation and analysis. More information is needed on who the observers were and who/what was being observed.)
- Post-task
- Interviews (Interviews were conducted after analysing the pre and post-task data)

a. **Traditional Teaching Observations**: This phase involved observing learners during traditional classroom settings. As emphasised by Creswell (2012), observation provides an opportunity to gather data in the natural setting of the participants. The observation focused on how learners interacted with the subject matter and their peers in a traditional classroom environment. Details such as learner engagement, participation, and reaction to traditional teaching methods were noted. Observational data provided a baseline for comparing the effectiveness of traditional versus technology-assisted teaching methods.
b. **Pre-Task Implementation**: A pre-task assessment was conducted before the intervention was introduced. This involved giving learners tasks related to trigonometry to assess their baseline understanding and skills. As suggested by Creswell and Poth (2016), this step is crucial in understanding the starting point of learners before the intervention. The pre-task also included a survey to gauge learners' prior exposure to and comfort with using technology in learning.
c. **Intervention with Microsoft Teams**: The core of the research involved implementing Microsoft Teams as a teaching and learning tool. This stage was critical in

understanding how technology integration influences learning processes and outcomes. As learners engaged with trigonometry through Microsoft Teams, data were collected on various aspects such as user experience, ease of understanding, interactive engagement, and problem-solving approaches.

d. **Post-task: After the intervention**, a post-task was conducted to assess its impact on learners' understanding and skills in trigonometry. This stage was pivotal in drawing comparisons and conclusions about the effectiveness of Microsoft Teams as a learning tool. The post-task involved similar assessments to the pre-task but also included reflective questions to capture learners' perceptions of their learning experiences.

e. **Interviews** : Following the post-task, in-depth interviews were conducted with selected participants. These interviews aimed to delve deeper into the learners' experiences and perceptions. As Heath et al. (2007) highlighted, qualitative interviews offer rich, detailed data that cannot be captured through observation or surveys alone. The semi-structured interviews allowed flexibility to explore emergent themes while ensuring that all relevant topics were covered.

5.7.2. Ethical Considerations in Data Collection

- **Informed Consent**: Before beginning data collection, informed consent was obtained from all participants, ensuring they understood the nature of the research and their role in it.
- **Confidentiality and Anonymity**: Steps were taken to ensure that all data remained confidential and participants' identities were anonymised in any reporting or publication.
- **Sensitivity to Participants**: Special attention was given to the participants' emotional and psychological well-being, especially given the personal nature of some data collection methods, like video diaries.

The data collection for this research was multifaceted, incorporating various qualitative methods to capture a comprehensive picture of learners' experiences with Microsoft Teams in learning trigonometry. The blend of traditional and innovative data collection methods enriched the research's findings, providing a nuanced understanding of technology's role in educational settings. The ethical considerations ensured that the research was conducted with the utmost respect for the participants' rights and well-being. As we progress to data analysis, these diverse data sources will be instrumental in developing a holistic understanding of the impact of Microsoft Teams on learning outcomes and learner engagement in trigonometry.

5.7.3. Inclusion and Exclusion Criteria

In the realm of research, especially in educational studies, establishing inclusion and exclusion criteria is not just a procedural formality but a foundational aspect that significantly influences the integrity and direction of the research (Walliman, 2021). These criteria are pivotal in delineating the scope of the research, ensuring that the selected participants are best suited to provide the necessary data for addressing the research questions. This research focused on understanding the perceptions of Grade 10 learners regarding using Microsoft Teams for learning trigonometry; setting these criteria was a critical step in ensuring the research's relevance, focus, and precision. The inclusion criteria were carefully selected based on (Walliman, 2021) suggestions to encapsulate a group of participants whose experiences and perspectives would be most pertinent to the research objectives.

5.7.4. Inclusion Criteria

In the intricate tapestry of educational research, the threads of inclusion criteria play a pivotal role in weaving meaningful and accurate research findings. For this research, which delves into the perceptions of Grade 10 learners using Microsoft Teams for learning trigonometry, the inclusion criteria were meticulously crafted to encapsulate the most relevant and insightful participant profiles. The following criteria were established:

a) **Grade Level Specificity:** The research focused on Grade 10 learners. This juncture in the educational journey is significant as it is often the stage where trigonometry, a critical component of the mathematics curriculum, is introduced and emphasised. The experiences and insights of learners at this pivotal phase are rich in contextual relevance, providing a focused lens through which to understand their interaction with and perception of digital learning platforms.
b) **Active Enrollment in Mathematics:** The participants' active enrollment in a mathematics course was a fundamental criterion. This requirement ensured that the learners were currently engaging with trigonometry in their curriculum. Their ongoing interaction with the subject matter lent immediacy and depth to their perspectives, making their contributions highly pertinent to the research's focus.
c) **Experience with Microsoft Teams:** Given the research's emphasis on exploring learners' experiences with Microsoft Teams as a learning tool for trigonometry, prior

exposure to this platform was essential. This criterion was selected for participants who had tangible, first-hand experience with the platform, whether currently or in the recent past, particularly in the context of their mathematics classes. This experience was crucial for providing insights into the platform's practical application and effectiveness.

d) **English Language Proficiency:** The research was conducted in English, necessitating reasonable proficiency in the language. This criterion was not just about the ability to communicate but also about ensuring that participants could fully comprehend the research tools and express their experiences and perceptions effectively, thereby enriching the research's data pool.

e) **Voluntary Participation and Consent:** The participants' willingness to engage in the research was a core ethical component. Informed consent was mandatory, ensuring voluntary and conscious participation. For participants who were minors, this also included obtaining consent from their parents or guardians, aligning with ethical standards and ensuring a respectful and responsible approach to data collection.

f) **Availability and Accessibility:** The practical aspects of research necessitated that participants be available and accessible during the set research period. This included their ability to partake in interviews, surveys, or other data collection methods as required by the research. Accessibility and availability were crucial for the smooth execution of the research process and for ensuring comprehensive and timely data collection.

These inclusion criteria were the guiding parameters for participant selection, ensuring that the research focused on a group whose characteristics and experiences were directly relevant to the research questions. By adhering to these criteria, the research aimed to gather data that was not only rich in context but also precise in its relevance to the use of Microsoft Teams for learning trigonometry among Grade 10 learners.

5.7.5. Exclusion Criteria

In qualitative research, particularly in studies exploring the intersection of technology and education, establishing clear exclusion criteria is as vital as defining inclusion parameters (Creswell & Poth, 2016). For this research, which aimed to understand the perspectives of Grade 10 learners on using Microsoft Teams for learning trigonometry, certain groups were methodically excluded to maintain the focus and relevance of the research.

The exclusion criteria were as follows:

a) **Non-Grade 10 Learners:** The research specifically targeted Grade 10 learners due to their unique stage in the academic curriculum where trigonometry is introduced. Therefore, learners from other grades, including those with experience with Microsoft Teams, were excluded. The rationale behind this exclusion was to ensure that the participants encountered trigonometry in their curriculum at the time of the research, thus aligning with the research's focus on integrating Microsoft Teams in teaching this subject.

b) **Learners Outside the Mathematics Curriculum:** The research's emphasis on trigonometry necessitated participants actively engaging in a mathematics course. Learners who were not enrolled in such a course at the time of the research or had not recently completed one were excluded. This criterion ensured that the participants had a direct and current connection to the subject matter, thereby providing insights that were contextually bound to the teaching and learning of trigonometry.

c) **Inexperience with Microsoft Teams:** A central aspect of the research was to explore experiences with Microsoft Teams as a learning platform. Therefore, learners who had not previously used Microsoft Teams in an educational setting were excluded. This exclusion criterion was pivotal in gathering data from a cohort that had firsthand interaction with and understanding of the platform. It enabled the research to delve into nuanced experiences and perceptions of its use in an educational context.

d) **Language Proficiency Barriers:** Given that the research was conducted in English, learners who faced substantial language barriers impeding their comprehension of research materials or their ability to articulate their thoughts during data collection were excluded. This criterion was crucial to ensure that the data collected was reliable and that the participants could engage meaningfully with the research process.

e) **Reluctance or Inability to Participate:** Any learner unwilling to participate in the research or whose parents or guardians did not provide consent was excluded. The ethical framework of the research mandated that participation be entirely voluntary, respecting the autonomy and rights of the learners and their families.

f) **Accessibility Challenges:** Learners who were not accessible during the research period for reasons such as consistent absenteeism, relocation, or technological barriers preventing access to Microsoft Teams were excluded. Accessibility was a key factor in ensuring that data collection was feasible and effective. This criterion also considered the practical aspects of conducting the research, such as the availability of participants for interviews and other data-gathering methods.

g) **Technological Limitations:** Learners who did not have adequate technological resources, such as a stable internet connection or access to a device compatible with Microsoft Teams, were also excluded. Given the research's focus on a digital platform, participants needed the technology to engage with Microsoft Teams meaningfully.

h) **Geographical Constraints:** The research was geographically bound to a specific educational setting. Therefore, learners from schools or regions outside this predefined area were excluded. This ensured that the research context remained consistent and that the findings reflected a specific educational environment.

i) **Special Educational Needs:** Learners with special educational needs that the research was not equipped to accommodate appropriately were excluded. This was to ensure that all participants could engage with the research material and process on an equal footing and to acknowledge the limitations of the research in catering to a diverse range of educational requirements.

j) **Previous Participation in Similar Studies:** Recently, learners who had participated in similar research studies were excluded to avoid bias in responses and to ensure a fresh perspective in the data collected.

These exclusion criteria were carefully designed to refine the participant pool, ensuring that the research's outcomes were directly relevant to the research questions and that the data collected was highly relevant. By clearly delineating who would not be part of the research, these criteria helped to maintain the focus and integrity of the research, ensuring that the findings were representative of the targeted demographic and their specific experiences with Microsoft Teams in learning trigonometry.

5.7.6. Rationale Behind the Criteria

Establishing inclusion and exclusion criteria is a pivotal component of any research design, particularly involving human subjects (Litosseliti, 2017). These criteria were not arbitrarily chosen; they were carefully crafted to align with the research's objectives, ensuring relevance, focus, and integrity throughout the research process.

The rationale behind these criteria encompasses several key aspects:

5.7.6.1. Alignment with Research Objectives

a) **Targeted Demographic**: The choice to include only Grade 10 learners was driven by this grade level's specific academic and developmental context. Grade 10 is a critical phase in the South African education system, especially in mathematics, where learners begin to grapple with more complex concepts like trigonometry. The research aimed to capture insights and perceptions at a crucial juncture in the learners' educational journey by focusing on this grade.

b) **Curricular Relevance**: Including learners actively enrolled in a mathematics course ensured that the participants had recent and relevant exposure to trigonometry. This criterion was essential for ensuring the research's findings were grounded in current educational experiences and directly relevant to the mathematics curriculum.

c) **Technological Familiarity**: Given the research's focus on using Microsoft Teams as an educational platform, including learners with hands-on experience with this technology was crucial. This criterion was instrumental in ensuring that the research captured informed perspectives on the integration of this specific digital tool in the learning process.

5.7.6.2. Ethical Considerations

a) **Voluntary Participation**: Emphasising voluntary participation was vital to upholding the ethical standards of the research. It ensured that the learners' involvement was based on informed consent, respecting their autonomy and decision-making capabilities.

b) **Parental Consent**: Obtaining parental or guardian consent was a necessary ethical practice for minors. This not only aligned with legal requirements but also ensured that the learners' primary caregivers were aware of and comfortable with their learners's participation in the research.

5.7.6.3. Focus and Integrity

a) **Defined Sample**: The exclusion criteria were equally important in maintaining the research's focus. By excluding learners outside the targeted demographic, such as those not in Grade 10 or not enrolled in mathematics, the research avoided diluting its focus and ensured that the findings were explicitly relevant to the research questions.

b) **Avoidance of Bias**: Excluding learners with no prior experience with Microsoft Teams helped avoid biases arising from unfamiliarity with the platform. This decision ensured that the research captured informed and meaningful insights into using this technology in an educational context.

c) **Language Proficiency**: Given that English was the medium of communication and instruction in the research, excluding learners with significant language barriers was a practical decision. This ensured clear communication and effective participation, which were crucial for the integrity of the data collected.

d) **Accessibility Considerations**: Excluding learners who were not accessible during the research period for reasons such as absenteeism or relocation was critical to ensuring a smooth and uninterrupted data collection process. This decision ensured that the research could be conducted efficiently and within the planned timeframe.

e) **Technological Resources**: By excluding learners without the necessary technological resources to access Microsoft Teams, the research ensured that all participants had a baseline level of digital access. This was crucial for examining the integration of technology in the educational process under similar conditions.

f) **Socio-economic Homogeneity**: The criteria also inadvertently led to a certain level of socio-economic homogeneity, as they potentially excluded learners from lower socio-economic backgrounds who might not have access to the required technological resources. While this was not an intentional focus of the research, it highlighted an underlying socio-economic dimension that could be relevant for future research.

The rationale behind the inclusion and exclusion criteria was multifaceted, encompassing academic relevance, ethical considerations, and practical necessities. These criteria ensured that the research remained focused on its primary objectives, that the participants' involvement was ethically sound, and that the data collected was relevant, reliable, and insightful.

5.7.7. Implications of the Criteria

The inclusion and exclusion criteria established for this research significantly influenced its overall design and execution. While seemingly straightforward, these criteria had far-reaching implications for the sample selection and the research's validity, reliability, and ethical integrity.

a) **Homogeneous Sample**: Mathematics and Experience with Microsoft Teams: The research attracted a homogeneous group by focusing on Grade 10 learners enrolled in mathematics and experienced with Microsoft Teams. This homogeneity was beneficial for comparing and contrasting within-group experiences and perceptions, yielding more coherent and focused data.

b) **Sample Size Determination**: The criteria influenced the sample size. Since the research targeted a specific group, the potential pool of participants was narrowed, which could limit the size of the sample but also increase its relevance.

c) **Depth of Data**: With a defined participant group, the research could delve deeper into specific experiences and insights related to using Microsoft Teams to learn trigonometry. This depth of data is crucial for a comprehensive understanding of the subject matter.

5.7.7.1. Contribution to Validity and Reliability

a) **Enhanced Credibility**: The criteria contributed to the research's credibility. Participants with direct experience in the area of focus were more likely to provide relevant, informed, and nuanced insights, thus enhancing the data's validity.

b) **Consistency in Responses**: A uniform sample meant a higher probability of consistency in the responses, which is vital for reliable data analysis and interpretation.

c) **Contextual Relevance**: The criteria ensured that the participants were from the relevant grade and had experience with the specific educational technology under research. This ensured that the findings were contextually relevant and could be directly linked to the educational setting under investigation.

d) **Informed Consent**: The emphasis on voluntary participation and informed consent, particularly for minors, upheld the ethical standards of research. It ensured that the research respected the autonomy and rights of the participants.

e) **Parental Involvement**: Requiring parental consent for minors added an extra layer of ethical safeguarding. It ensured that the decision to participate was well-informed and consensual from both the learners and their guardians.

5.8. Data Analysis

According to Akinyode and Khan's (2018) approach, there are five processes involved in qualitative data analysis: data logging, anecdotes, vignettes, data coding, and theme analysis. However, the proponent emphasised the use of theme analysis and data coding in the context of this research. Pseudonyms were used to code research participants to protect their identity. A component of data organisation called coding divides the volume of raw data into manageable pieces that are most pertinent to the research questions. As a result, themes started to take shape. Furthermore, a code is more likely to be regarded as a theme if it appears frequently or is more similar to other codes (Vaismoradi et al., 2016). In the context of this research, significant and recurring themes were marked on the texts under analysis using coloured pens and highlighters. Next, brief phrases and words were labelled on the text using the same colour pens and highlighter. The content analyst chooses between emerging content as a theme and explicit content as a category in thematic analysis before proceeding to other stages of data analysis. Consequently, it aided the proponent in fully grasping the process of analysing qualitative data (Vaismoradi et al., 2016). The research's thematic analysis was conducted once the initial codes were identified. Subsequently, all of the participant replies were categorised and analysed in order from general to specific. Complete themes were created by extracting and grouping responses with related central ideas. To be considered genuine, each subject must have at minimum three main ideas (Vaismoradi et al., 2016).

Participants were given pseudonyms at the start of the process to protect their identity and privacy (Ahuja, 2011). This action was essential for upholding moral principles and encouraging participant and researcher confidence. A key component of qualitative data analysis is coding, a strategy for arranging and condensing the enormous volume of raw data into digestible, pertinent sections (Busetto et al., 2020). Coding was crucial in identifying essential themes and patterns pertinent to the research issues. The procedure comprised closely examining the data and annotating documents using coloured pens and highlighters to identify essential and recurrent topics. This visual method made recognising and classifying themes easier, allowing for a methodical and exhaustive examination.

Braun and Clarke (2019) noted that a code's frequency of occurrence frequently signals its relevance as a possible theme. Codes that surfaced frequently in this research were given special consideration because their recurrence indicated they were crucial to the participants' experiences. The passages that were labelled and coloured similarly were then grouped, providing the framework for the themes that started to emerge.

This research used thematic analysis to uncover developing themes while maintaining a transparent classification system. This method necessitated a methodical and methodical process in which the first step was to identify the initial codes, after which the participant replies were categorised and analysed from a general to a specific perspective. This approach ensured the analysis was thorough and targeted, enabling deep and nuanced data comprehension.

Next, the responses with related central themes were grouped for the thematic analysis. According to Walliman (2021), each theme had at least three central concepts to be accepted. This procedure was rigorous. This criterion ensured that every topic accurately reflected the participants' experiences and perspectives and was solid and well-supported by the data. The themes that surfaced from the investigation gave participants' experiences using Microsoft Teams to learn trigonometric functions and deep and comprehensive knowledge. These themes provided a comprehensive picture of the virtual learning environment because they were not merely isolated findings but rather interconnected ones. The investigation covered topics including how well Microsoft Teams works as a learning platform, what advantages and disadvantages learners face, how teachers use pedagogical tactics, and how this technology generally affects learning.

The analysis included not only the identification of themes but also a critical evaluation of the connections between various themes. This part of the analysis was essential to comprehending the relationships and influences between different elements in the virtual learning environment. For example, the research examined how teachers' pedagogical approaches influenced learners' impressions of the platform or how Microsoft Teams' usability affected learner participation.
The researcher repeatedly reviewed the data during the iterative data analysis process to ensure the themes appropriately represented the participants' experiences. This iterative method was crucial in qualitative research since it enabled a more in-depth and complex comprehension of the material. Additionally, it ensured that no biases or previous ideas were imposed and that the analysis stayed firmly based on the participants' perspectives.

This research's data analysis process was meticulous and rigorous, following the guidelines for qualitative research. The research identified significant and pertinent themes from the data by combining coding and thematic analysis. This allowed for the extraction of insightful information about how teachers and learners used Microsoft Teams to perform trigonometric functions. The analysis's conclusions add to the knowledge already available on virtual learning platforms and have applications for educational technology researchers, educators, and policymakers.

5.8.1. Data Management and Archiving

Research data handling and management is a complex and important procedure, mainly when human participants are involved, as in the case of the research on Grade 10 learners' opinions of Microsoft Teams as a trigonometric learning tool. This procedure is essential for protecting the participants' privacy and confidentiality as well as the validity and integrity of the research (Wagner, 2019). The present investigation followed the strictest guidelines for data management and research ethics when managing and storing the research's data, paying close attention to every last detail.

5.8.2. Data Handling

The recorded data, which included carefully managed audio and video recordings from classroom observations and interviews, was preserved. Timestamped and uniquely identified each recording to facilitate effortless retrieval throughout the analysis stage. A comprehensive learning environment assessment requires spoken interactions, non-verbal cues, and classroom dynamics, which were carefully documented in research logs. All information gathered was methodically arranged in a safe, well-structured database. The database's design gave each type of data (text, video, and audio) its unique category, and suitable tagging techniques were employed to make retrieval simple for analysis. This organisation made data analysis more efficient by streamlining the process, which made thematic categorisation and cross-referencing easier.

Since most of the data gathered was digital, reliable digital storage options were used. Every digital file, including audio files, video files, and electronic papers, was encrypted on password-protected computers with up-to-date security software to prevent unwanted access and possible data breaches. The data were kept on safe cloud servers in addition to local storage, which added another degree of accessibility and security. Because of its dependability and adherence to data protection laws, cloud storage was selected to ensure that the data were managed lawfully and securely.

Secure storage was important for tangible records like consent forms and handwritten notes. The records were kept secure in locked filing cabinets in a restricted area, making them accessible only to authorised people. This physical storage was routinely inspected and maintained to avoid loss or damage. Regular backups of all digital data were carried out to reduce the risk of data loss due to unanticipated events like technological malfunctions or physical damage. In addition to additional cloud storage services, external hard drives were used to store these backups. The external hard drives were stored separately and securely from the core storage, protecting them against physical damage such as water and fire.

This research's data management and storage were carried out with strict respect to methodological accuracy and ethical guidelines. This meticulous technique guaranteed the quality and dependability of the data, which is essential for the validity of the research findings, in addition to protecting the participants' privacy. The procedures for collecting, recording, organisation, and storage reflected A devotion to data management standards in educational research and a commitment to ethical research practices.

5.8.3. Data Destruction Protocol

An essential part of data management, especially when handling private or sensitive data, is destroying the data gathered during or after a research endeavour. In the context of this research on Grade 10 learners' opinions about utilising Microsoft Teams for trigonometry learning, strict data destruction processes were followed. These procedures were necessary to comply with legal obligations for data preservation and destruction and to uphold ethical standards and participant anonymity.

5.8.3.1. Timelines for Data Retention and Destruction

The research ethical rules mandated specified data preservation and disposal dates, followed by the research. Research data must usually be retained for a time-permitting analysis, reanalysis, and review; institutional regulations or laws frequently dictate this. Five years was the designated retention period for the data in this research (Blann, 2018). For as long as was required, the data would be accessible for any additional analysis, audits, or inquiries. The data were planned to be destroyed after this time. To maintain accountability and transparency, the timetable was shared with all parties participating in the research.

5.8.3.2. Secure Deletion of Digital Data

Secure deletion was applied to digital material, including audio files, video files, electronic documents, and any backups on cloud services. Specialised software was used to destroy files and render them unrecoverable permanently. The data was repeatedly overwritten during this process to ensure it could not be recovered or recreated in any way.

Digital data had to be secured with strong encryption and password security for the five-year retention period. Strict access control procedures were in place, and this data was only accessible to authorised personnel. The secure deletion procedure was meticulously recorded, including the date of deletion and the techniques employed, to record adherence to the data destruction policy.

5.8.3.3. Physical Document Destruction

After being digitalised, tangible records such as printed transcripts, handwritten notes, and consent forms were destroyed using a cross-cut shredder. Because cross-cut shredding shreds the paper vertically and horizontally, producing smaller bits that are very challenging to reconstruct, it is a more secure method. This approach was used to guarantee the highest level of security and eliminate any chance that the destroyed documents could contain sensitive information. Applicable ethical and legal guidelines are carried out in the data destruction procedure. This involved following the rules for storing and deleting research data, particularly regarding data about minors or sensitive material. The research's data management plan described these requirements and the procedures for ensuring compliance.

A thorough log of the data deletion procedure was kept. This record contained information on the kinds of data destroyed, the techniques employed, the destruction dates, and the individuals engaged in the procedure. Maintaining these records was essential for accountability and adherence to data management guidelines.

As part of the informed consent procedure, the participants were informed about handling and destroying data. They explained the length of time their data would be kept and the safeguards in place to ensure its secure disposal. This transparency was essential for upholding the participants' ethical obligation and maintaining confidence.

This research's data destruction procedures were thorough, safe, and compliant with all applicable legal, ethical, and environmental regulations. Long after the research was over, participant confidentiality was preserved thanks to the safe deletion of digital data and the physical destruction of papers. The research preserved the integrity of the research process by following these procedures, which also helped it comply with institutional and legal requirements and uphold its ethical duties to participants.

5.8.3.4. Informed Consent

Although there is no ideal protocol for informed consent, this researcher looked at informed consent under the assumption that it should be transparent, that participant satisfaction with the process is important, and that a well-thought-out consent procedure would increase adherence and retention in research. The intention is to provide participants with enough information to decide whether or not to join the research after fully grasping its objectives, risks, benefits, and obligations. However, rather than just getting people to sign up for research, the goal must help them make an informed choice (Hallinan et al., 2016). An informed consent process that is successfully communicated may help in recruitment.

Additionally, Ryen (2016) emphasises the three interconnected ethical concerns of permission, secrecy, and trust. With informed consent, the research subjects have the right to be aware that they are being studied, to be told about the research's purpose, and to withdraw at any moment. There is a need to protect the privacy of each participant's identity, location, and research environment to uphold confidentiality. Every learner in the selected Grade 10 class received a synopsis of the research and information about how the research topic fits into the school's curriculum and the Department of Education's mathematics curriculum before the start of the research. The research's goals and questions and the techniques and tools employed to gather data were explained to parents and learners. Parents and learners were also informed that leaving the experiment at any time during or after data collection would not result in repercussions and that participation in the research was entirely voluntary. Anonymity for the school and all participants was guaranteed. Parents and learners received pertinent information about the Department of Education and university personnel. Each has to provide written consent to participate in the research. Each participant's parents or guardians also had to give their written approval before their learners or learners could take part in the research. Only learners whose parents provided written agreement were included in the research. The parents of all 23 learners in the Grade 10 class gave their approval to take part in the research, and all 23 learners returned the consent forms.

This research took great care in obtaining informed permission, going above and beyond providing information and gathering consent forms. Understanding that research is dynamic, particularly in educational contexts, continuous permission was considered. As the research continued, this entailed following up with participants and their guardians frequently to ensure they remained comfortable and willing to participate. This method recognised that consent is a continuous process rather than a one-time occurrence, which is crucial when working with learners.

Additionally, the research focused mainly on the wording and layout of the informed consent forms. A concerted effort was made to guarantee that participants with different educational backgrounds could easily access and comprehend these resources. Using clear and straightforward language, avoiding jargon, and simplifying explanations were important tactics to make the consent process as inclusive and straightforward as feasible. In-depth information about the usage, storage, and sharing of participant data was also provided as part of the informed consent procedure. This transparency was essential to address any worries regarding privacy and data security. Participants were made aware of the security and anonymisation procedures used to protect personal data, which added to the research's legitimacy and trustworthiness.

As Creswell (2012) recommended, the research's informed consent procedure also included a summary of any possible hazards and discomforts connected to participation, per best practices. Outlining this component was necessary for ethical purposes even though the research posed little risk. Participants received assurances that any discomfort or inconvenience would be immediately and politely handled. In addition, the research informed participants of the possible advantages of the research for the larger educational community and themselves. This part of the informed consent procedure revealed the research's usefulness in advancing knowledge about Microsoft Teams' use in educational settings, which could impact practices and regulations in the future. Apart from obtaining informed consent from participants and their guardians, the research also secured essential authorisations and clearances from the educational authorities and the school administration. The research complied with institutional rules and educational regulations thanks to this multi-layered permission method.

When considering the informed consent procedure, it became clear that the strategy used in this research was crucial in building a rapport based on mutual respect, trust, and understanding between the participants and the researcher. This ethical rigour improved the participant-researcher interaction and the data-gathering procedure. Honest and considerate answers are more likely given by participants who feel valued and knowledgeable, improving the calibre and scope of the information gathered.

This research's informed consent procedure was a thorough and morally solid endeavour. It demonstrated a strong commitment to ethical research techniques and went beyond simply meeting procedural standards. The research established a high bar for ethical conduct in educational research by prioritising participant welfare, continuing consent, and clarity. This method not only made sure that ethical guidelines were followed, but it also made a big difference in the research's integrity and success. Appendix A contains copies of the letters to parents and learners requesting their informed permission. Table 3 provides details about the participating learners' age and gender.

5.8.3.5. Data Generating Techniques

Etikan et al. (2016) argue that data collection is crucial for research as it facilitates understanding a theoretical framework. Given that inadequate data collection cannot be compensated for by any level of analysis, it is crucial to use sound judgment when selecting the data collection method and the data source. The primary means of acquiring first-hand accounts of human experience are interviews, according to Sohn et al. (2017). Researchers are advised to establish a conversational atmosphere during interviews that encourages secrecy, safety, trust, and rapport. While it is possible to conduct interviews using distance technologies such as Skype, it is preferable to do audio-taped interviews in person.

Rosenthal (2016) also contends that interviewers should avoid being intrusive, actively encourage engagement among all interviewees, and use conversation summaries to assist the group in clarifying its ideas or justifications. It is important to consider the technical aspects of recording the data from the focus group or in-depth interview. Both in-depth interviews are frequently recorded on audio so a transcription can be made later.

5.9. Phases of Data Collection

According to Cypress (2018), data management, analysis, and collection are crucial and necessary for qualitative research investigations. These procedures improve the calibre and rigour of naturalistic investigations when appropriately used. Aspects of qualitative research that are frequently overlooked include data management and gathering. Whatever philosophical stance the researcher adopts and whatever the data-gathering technique (such as one-on-one interviews), Sutton and Austin (2015) stress that the process will include the creation of significant volumes of data. In addition to different research methodologies, there are many ways to record what is said and done during an interview, like handwritten notes. Before starting data analysis, complete transcriptions of any audio or video recordings made during data collection are required. Qualitative research involves the researcher comprehending the participants' concepts and emotions. This is a complex procedure because it involves soliciting folks to engage in conversations on potentially sensitive subjects. The researcher can document perceptions, contextual conditions, actions, and nonverbal cues in field notes that the audio recording may not have entirely captured. Field notes can aid in contextualising audio-taped data and serve as a memory aid for researchers, highlighting important contextual factors that may be relevant during data analysis.

As defined by Cypress (2018), data collection refers to a series of interconnected activities conducted to gather data that can be utilised to investigate novel research inquiries. It is important to include the planned data-collecting activities in the original design of a qualitative inquiry to ensure that they are conducted at different stages of the research. Data can be gathered from a variety of sources, including both living things and inanimate objects. The human instrument uses nonverbal cues, focus groups, one-on-one interviews with varying degrees of openness, participant and nonparticipant observation, and web-based interactions. Email texts, brief messages with multiple media formats, ongoing stories, metaphorical visual narratives, digital collections, personal life stories, written reflections, correspondences, dialogues, social artefacts related to the individual and their family, poems, music, sounds, ceremonial objects, and social media posts are just a few of the diverse types of data that have surfaced in recent years. A skilled qualitative researcher gathers information with caution. The data collection procedure for this research investigation consisted of five parts.

5.9.1. Stage One: Traditional Teaching Trigonometric functions

This is the classic approach to education, commonly referred to as going back to the fundamentals. It is a style of instruction that uses a textbook and a chalkboard. Learners have questioned me while teaching. The researcher did not use any Internet instruction throughout the classes the researcher taught using the traditional method. This is based on established procedures that the researcher employed for a long time at my school. The learners were hired before the researcher began my traditional teaching (Pre-task).

The first step of the data-gathering procedure concentrated on the basic approach, which is rooted in traditional pedagogical techniques in teaching trigonometric functions. This phase functioned as a reference point or control condition that allowed for a later comparison of the effects of using Microsoft Teams.

As this phase has shown, the old teaching method was more teacher-centred and direct, mainly relying on textbooks and chalkboards. According to Demir and Heck (2013), this approach is distinguished by well-organised lesson plans, teacher-directed instruction, and an emphasis on individual learning tasks. In this situation, the teacher's primary responsibility was to convey information by giving learners the material in an organised, step-by-step manner.

Most learners' participation in typical teaching sessions is passive, consisting of listening to lectures and taking notes. According to Kamber and Takaci (2018), this approach strongly emphasises the value of organised and transparent knowledge, allowing learners to take in and digest new ideas in a safe setting. Due to the paucity of digital resources, textbook activities and direct instruction are the main ways learners connect with the material. According to Siyepu (2015), traditional teaching techniques have long been used in classrooms to provide learners with a strong basis for comprehending fundamental ideas. The learners were given a pre-task before starting the traditional trigonometric function instruction. This pre-task was created to evaluate the learners' baseline knowledge and comprehension of trigonometric functions based on recommendations made by Demir and Heck (2013). The pre-task results were crucial since they offered a standard to compare the efficacy of traditional teaching techniques.

Close observation and note-taking were conducted during this phase to record the teaching process and the learners' replies. Weber (2005) noted that observation is a valuable tool in educational research for comprehending classroom dynamics and the efficacy of instructional strategies. Moreover, informal questioning and exchanges with the learners were part of the tradional teaching stage. According to Weber (2005), this method provided quick feedback and concept clarification, giving teachers insight into how well their learners understood and engaged with the topic.

Stage one of the data collection procedure was essential to provide a baseline understanding of how trigonometric functions were traditionally taught and learnt in the absence of digital instruments. This step prepared the groundwork for a later comparison between the Microsoft Teams-based training and offered insightful information about traditional teaching techniques.

Pre-task results, observational notes, and unofficial feedback were among the data gathered during this phase that helped to create a thorough picture of the traditional classroom setting and how it affected learners' comprehension of trigonometric functions.

5.9.2. Stage Two: Trigonometry Pre-tasks

The understanding of mathematical ideas among learners will be impacted by teacher-designed learning in each mathematics course, claim Amalia et al. (2018). Teachers must thus provide the proper teaching resources. Using learner activity worksheets is one way to boost engagement during instruction. Microsoft Teams platform should be used in worksheets created by teachers. Teachers must be able to create mathematical exercises that use an appealing, dynamic picture presentation to pique learners' minds and help them comprehend the subject. Researchers have frequently analysed the influence of educational resources on academic achievement in the field of mathematics instruction up until now (Kul et al., 2018). The argument for reforming mathematics instruction has focused heavily on manipulatives. Learners can develop a more thorough and long-lasting understanding of mathematical ideas by touching, seeing, and doing. Additionally, research shows that using manipulative objects first to convey mathematical ideas to learners of all ages is beneficial. To finally construct an internal representation, manipulative materials are utilised to produce an external representation representing a mathematical concept (Istiandaru et al., 2017).

Every learner in every class took a pre- and post-task. To answer the questions on the tests, learners were allowed to collaborate with their classmates and use diagrams and visual aids. All of the learners' intervention responses were analysed. In the second stage, pre-tasks were used to teach trigonometry, and the Microsoft Teams platform was included as a key teaching tool. This stage was created with the knowledge that, as Demir and Heck (2013) showed, teacher-designed learning activities significantly impact how well learners understand mathematical topics. The focus was on offering suitable educational materials that may improve comprehension and involvement.

Worksheets for learner activities designed for the Microsoft Teams platform were essential to this phase. These worksheets were intended to be dynamic and interactive, fitting with Microsoft Teams' digital environment rather than simple paper-based assignments. The aim was to develop mathematical activities with lively, eye-catching presentations. This instruction was designed to grab learners' attention and help them understand challenging trigonometric ideas.

In line with Kissane and Kemp's (2009) claims, manipulatives were also used in the learning process at this stage. Physical and digital manipulatives produced exterior representations of mathematical ideas, leading to a more profound and long-lasting comprehension of trigonometry. With the help of Microsoft Teams, this practical method made it possible for learners to research trigonometric functions more dynamically and excitingly.

Pre- and post-task implementation was a crucial part of this phase. The purpose of these examinations was to evaluate the learners' comprehension both before and after the Microsoft Teams-based activities were introduced. As is customary in modern education, the exams promoted group problem-solving among learners. To answer the questions, learners could collaborate, use diagrams, and apply visual aids. This cooperative method made learning easier and reflected situations in which teamwork and resource management are crucial when tackling problems in the real world.

This step included a critical analysis of the learners' intervention replies. It shed light on how well the Microsoft Teams-based pre-task improved the learners' comprehension of trigonometry. The intervention findings provided a comparative analysis of the learners' conceptual understanding and performance before and after the intervention. Additionally, the exams' inclusion of cooperation and use of visual aids aligned with studies on mathematics education, highlighting the value of peer collaboration and visual learning in boosting mathematical comprehension (Idris, 2005). This method was made possible by the interactive features of the Microsoft Teams platform, which let learners communicate more meaningfully and dynamically with the content and one another.

To improve the teaching and learning of trigonometric functions, Stage Two concentrated on incorporating cutting-edge teaching resources and cooperative learning techniques into the Microsoft Teams environment. Interactive worksheets, manipulatives, and collaborative exams introduced a significant departure from traditional teaching techniques to create a more enjoyable and productive learning environment. Pre- and post-task results analysis critically assessed how these Microsoft Teams-based pre-tasks affected the learners' trigonometry comprehension and added significant value to the research.

5.9.3. Stage Three: Online Technology-Based Intervention

The debate over how to shift education's focus from imparting and transmitting content knowledge to fostering learners' capacity for learning has been ongoing for a long time, which may be why technological advances are being used more frequently in the classroom (Ritz et al., 2023). According to Zakaria and Khalid (2016), implementing information and communication technology in the research and teaching of mathematics has impacted educators' teaching approaches. Applying the Microsoft Teams platform to teaching mathematics has several advantages, including increasing learner interest in the subject, improving motivation and performance, promoting lifelong learning, and facilitating interactions and connections. Bozkurt and Ruthven (2018) contend that despite the growing importance of new online technologies over the past few decades, traditional mathematics education has hesitated to adopt them. It has become clear that educators are key players in integrating online technology used in math classes. The final stage of the research project involves using the platform developed by the Microsoft team to assist learners in understanding trigonometric functions in mathematics.

Online Technology is frequently used in educational institutions in many different ways and for many different things. Integrating the Microsoft Teams platform is among the approaches, methods, tools, and resources that should be employed in the classroom setting to enhance the efficiency of the teaching and learning process (Islim et al., 2018). The current research studies how Grade 10 learners perceive using the Microsoft Teams platform when learning trigonometric functions in response to the increased demands for informed online technology integration into education. According to research by Kohen (2019), technology helps teachers design more engaging and intriguing courses, which in turn helps learners learn more. Additionally, online technology has been proven successful in promoting math learner learning when combined with reform-based teaching techniques, according to Naidoo and Govender (2014). To help learners unravel and address the problems that prevent a clear comprehension of the topics being taught, the Microsoft team's platform was incorporated into the lesson on trigonometric functions for Grade 10 learners of mathematics.

Moreover, Chen's (2015) research shows that, even while using online technology is a crucial ability for learners, it may also aid instruction and learning. Microsoft Teams platform may enable learning to occur outside of traditional classroom settings, new curricula that bring real-world issues into the classroom, and more rapid and formative evaluation methods.

At this point, using the Microsoft Teams platform facilitated a more profound comprehension of trigonometric functions. The platform's characteristics created an engaging and dynamic learning environment. Through exercises explicitly created for Microsoft Teams, learners could delve deeper into the fundamentals of trigonometry while being encouraged to work together to solve problems and apply what they had learned in various settings.

The Microsoft Teams platform also offered a flexible learning environment that catered to different learning preferences and styles. It made learning more individualised by allowing learners to interact with the content in ways that worked best for them and at their speed. Another aspect of incorporating Microsoft Teams into teaching trigonometric functions was rethinking assessment methods. The platform allowed for formative evaluations, giving learners instant feedback and allowing teachers to modify their lesson plans to meet individual requirements and knowledge gaps.

This research phase was essential to comprehend how online tools such as Microsoft Teams can change how mathematical ideas are taught and learned. It provided information about how these platforms could make learning experiences more dynamic, engaging, and successful. This phase's data collection included information on how learners interacted with the platform, how well they performed on tasks and tests, and how they felt about the overall experience. All of this information was crucial in determining how well Microsoft Teams supported the teaching of trigonometric functions.

5.9.4. Stage Four: Trigonometry Pre-task

According to Amalia et al. (2018), pre- and post-task created by the educator can help the teacher make a guided exploration of the subject matter. This is because the instructor is more familiar with their learners and is skilled at piquing their interests and knowledge. A worksheet might be created to assist learners in recognising and analysing key mathematical ideas. In the fourth stage of the research process, all the ideas that learners were introduced to within the subtopics of trigonometric functions in mathematics were reinforced.

The post-task played a crucial role in this phase. Designed to be comparable to the pre-task in both format and substance, the post-task played a crucial role in this phase. The assessment aimed to evaluate how utilising the Microsoft Teams platform affected learners' comprehension of trigonometric functions. The research sought to measure the efficacy of the Microsoft Teams-based teaching strategies by comparing the learners' pre- and post-task results.

The worksheet post-task was thoughtfully designed to correspond with the content taught using the Microsoft Teams platform. This alignment ensured that the intervention appropriately represented the breadth and depth of the learners' exposure to the material across the research period. The worksheet was created to help learners consolidate and show that they comprehend important mathematical ideas, and it also served as an assessment tool. All 23 research participants completed the post-task worksheet, yielding a sizable data set for analysis. Analysing the post-task results was an essential part of this phase, which provided information about how well the Microsoft Teams platform improved learners' understanding of trigonometric functions.

The post-task offered an opportunity to evaluate not only the mathematics, their engagement with the material, and their general confidence in solving trigonometric problems, which were affected by the incorporation of technology learners' academic performance but also the qualitative aspects of their learning experience. The research investigated how incorporating technology affected learners' attitudes towards mathematics, engagement with the material, and confidence in solving trigonometric problems.

In addition, the post-task activities considered the teacher's role in helping learners learn using the Microsoft Teams platform. According to several educational studies, optimising the advantages of technology in education requires educators to modify their teaching methods for a digital setting (Mishra & Koehler, 2006). The research examined how the educator's direction and assistance via the platform impacted the learners' comprehension and performance. Step Four was essential to the research's goal of determining how well Microsoft Teams taught trigonometric functions because it concentrated on testing comprehension through a post-task and reinforcing learning with pre-tasks. Comparative research of pre- and post-task results gave a quantitative assessment of the learners' development. At the same time, the qualitative components of the analysis obtained a deeper understanding of the effects of technology-enhanced learning on learners' mathematics comprehension and engagement.

Stage Four encompassed completing the learning process and evaluating how well the Microsoft Teams platform facilitated the teaching and learning of trigonometric functions. By thoroughly examining the quantitative and qualitative results of the post-task activities, the research offered insightful information about the possible applications of online technology in mathematics education, specifically trigonometric functions.

5.9.5. Stage Five: Interviews

A technique for gathering data called interviews includes exchanging information between two or more persons through a sequence of questions and answers (Kitchenham, 2006). Semi-structured interviews were employed in this investigation. Semi-structured interviews, according to Hofisi, Hofisi, & Mago (2014), are adaptable in that they let the researcher change the questions and go deeper. Using interviews in this research was acceptable since it gave the researcher access to the participants' thoughts and feelings. The researcher needed to establish trust and rapport with the participants so that they would be able to answer questions honestly and ensure that the interview went well. This was accomplished by outlining the interviews' goals, upholding confidentiality, and having participants sign consent forms before the interview (Alshenqeeti, 2014). The use of an interview guide or line of questions, according to Korstjens & Moser (2018), enables the researcher to get data from all participants on particular subjects. The participants have agency over their responses, while the researchers control the interview process. Nevertheless, the researcher should be adaptable enough to recognise that specific relevant queries for participants may not have been covered in the interview guide or line of inquiry and should be presented. Open-ended, generic, or more specialised questions, probes, and prompts may be used in the interviewing process. ‘Can you tell me more about this?’ is an example of a probe, or ‘What happened next?’ Prompts are signals and statements that invite participants to continue their stories.

Using a semi-structured interview format, the research evaluated learners' self-efficacy, sentiments, and justifications for using Microsoft Teams as an online learning platform to learn trigonometric functions. A semi-structured individual interview schedule and probing questions were employed to gather further information. Six to ten learners have been interviewed following the intervention class. Based on what the researcher saw while teaching, these learners have been specifically picked for each interview session—for example, the learner's facial expressions, speech tone, and pre-and post-task outcomes. The researcher spoke with the selected learners in person during interviews. This has been done to provide learners with a clutter-free environment and calm them, encouraging open communication.

Interviews employing semi-structured approaches, led by a schedule of open-ended questions, were conducted to complete the data-gathering procedure in this research project. Focus group interviews, according to Zahle (2018), involve the researcher asking a research subject question and allowing or encouraging them to ramble, elaborate on their answers, provide examples, and raise their problems. Focus group interviews are typically held in locations where the research subjects go about their daily activities. The researcher prepared various questions for the focus group interview, and she moderated the discussion to an extent that yielded information that enabled the researcher to comprehend the perspectives, experiences, viewpoints, and viewpoints of the research participants.

Park et al. (2015) state that qualitative interviews are a research technique that allows researchers to explore themes directly related to the respondents' experiences thoroughly. This enables researchers to gain valuable insights into the subjective experiences and interpretations of numerous phenomena of interest. Interviews have traditionally been employed as a method of gathering data in qualitative research due to the direct engagement between participants and researchers and the focus on investigating human phenomena. Qualitative interviewing is a versatile data-collection tool that may address various research issues due to its usefulness in various methodological methods. Qualitative research interviews are preferred when the researcher aims to comprehend the interviewee's subjective viewpoint rather than producing generalisable findings about huge populations. At this stage, only learners who had provided signed consent and assent forms and those whose parents or guardians had completed assent forms were eligible for participation in the interviews. Establishing rapport and fostering comfortable interactions are essential in a qualitative interview context. Ideally, these efforts should be made before and throughout the interview. The primary tool for gathering data in qualitative research is the researcher.

Considering this, the interviewer should possess introspective qualities and be aware of how their role can impact the dynamic between themselves and the interviewee (McGrath et al., 2018). In this semi-structured interview session, the researcher did not use prescribed ways to divide the participants into groups. In order to create a comfortable and non-intimidating environment for the participants during the focus group interview session, the researcher let them choose the group they preferred, thereby ensuring their active participation without any reservations or fears of being intimidated. I hoped this technique would enable me to collect participants' dense, information-rich data.

According to Lochrie et al. (2015), qualitative interviews are a well-known research technique that entails a dialogue between the researcher and the subject to comprehend the main themes and research topics. The interviewer must be able to listen, ask pertinent questions, and communicate clearly with the interviewee. A good interviewer builds rapport and trust with the interviewee by being approachable. It is far simpler to get helpful information from an interviewee who is at ease and enjoying themselves than from someone tense and wary. Interviews gave me, as the researcher, the opportunity to facilitate interactive discussions among the participants about their opinions and experiences with learning trigonometric functions. The researcher minimised the power hierarchy between the researcher and participants by fostering an informal environment where participants felt at ease and relaxed. The audio recordings were then converted to written text for additional examination once the interviews had been performed and concluded. The material was transcribed after the discussions were captured with a digital recorder.

5.10. Ethical Considerations

Cypress (2018) states that data gathering encompasses the many forms of data and the methods employed to obtain them. It involves considering the ethical concerns related to gaining access to and authorisation from the research site, protecting participant rights, such as obtaining informed consent, choosing and executing a suitable sampling strategy, planning the method of documenting information, securely storing the data, and appropriately utilising and sharing the findings. The objective, the number of times, and the interview details should all be disclosed to the respondents, along with how the data collected will be used. Semi-structured interviews follow a set process and are occasionally repeated. To make the process productive, the researcher should set up a semi-structured interview, execute the first steps, and pace the interview based on how the respondents respond. To preserve participant privacy and confidentiality, access to the research site should be granted with permission, participants should sign informed consent, and care should be given when recording and keeping data.

In this investigation, results were published objectively, truthfully, and with citations to the original, trustworthy sources and references. Moosavi and Hasani (2017) assert that ethical norms and considerations in qualitative research that include learners as participants are analogous to those in other qualitative research. The principles encompass assuring the active involvement of learners, obtaining informed consent, developing reliable and friendly connections, maintaining confidentiality, and being aware of the researcher's duty in disseminating information and resolving power dynamics. To encourage the learner's active engagement in the research process and to lessen the power disparity between the researcher and the learner, it is crucial to build rapport with the learner and earn their trust. To allow learners to voice their thoughts freely, research involving them should be conducted in an advantageous, encouraging, and safe atmosphere using suitable techniques that complement their social and cognitive capacities.

The confidentiality of information shared throughout the data generation phase and participant anonymity throughout the whole research procedure was guaranteed to the participants in this research. The talks and questions were thoughtfully and explicitly designed to avoid any misunderstandings or erroneous assumptions that may harm the data's quality. The process of acquiring informed consent was thorough and ongoing. In addition to obtaining initial consent, the research acknowledged the importance of continuous consent. This involved periodically reminding participants of their rights and their ability to withdraw from the research at any point without facing any negative consequences. This method acknowledged and accommodated the participants' developing comprehension and ease with the research procedure.

Ethical factors also guided the choice and execution of a suitable sampling approach. According to Sieber and Tolich (2013), when conducting educational research, it is crucial to sample participants in a way that considers their possible vulnerabilities, mainly when they are learners. The research ensured that the sampling technique was representative and ethical, focusing on avoiding coercion or bias. The research followed rigorous standards to ensure data recording accuracy and reliability, as Moosavi and Hasani (2017) recommended. The interviews were taped with the participants' informed consent, and all recordings were transcribed verbatim to maintain accuracy and faithfulness to the individuals' original statements. The rigorous method of capturing data increased the research's dependability and showed appreciation for the participants' contributions.

Data storage and secrecy management were conducted with the utmost gravity. The data were securely maintained and only accessible to authorised research team members. The digital data underwent encryption, while physical copies were securely stored in locked cabinets, guaranteeing the safeguarding of participants' information against unauthorised access or breaches.

The research also considered the ethical aspects, including the researcher's reflexivity. Reflexivity, as explained by Finlay (2012), refers to the researcher's consciousness of their biases, the power dynamics within the research partnership, and the possible influence of these factors on the research process and outcomes. The researcher actively employed reflective methods during the research to prevent personal biases or assumptions from affecting data collection, processing, or interpretation.Moreover, the research considered the ethical ramifications of sharing the results. Farrimond (2012) argues that ethical reporting in research encompasses not only accuracy and honesty but also the careful evaluation of the potential consequences of the findings on both the participants and the broader community. The research meticulously addressed this topic, ensuring that the dissemination of findings was conducted in a manner that was considerate and advantageous to all parties involved. The ethical considerations in this research were comprehensive, influencing every phase of the research process. Every step, from securing informed consent to gathering, storing, analysing, and sharing data, was carried out with a steadfast dedication to ethical research protocols. The thorough ethical framework ensured the preservation of the participants' dignity and rights and bolstered the research's general integrity and trustworthiness.

5.11. Validity And Reliability

A significant amount of research in the fields related to care necessitates the utilisation of qualitative methodologies, frequently employing semi-structured or unstructured interviews. These methods are utilised to collect extensive data for a more profound understanding of care practices and experiences. Interviews are often used as a prominent method for collecting data in qualitative research (Roulston & Choi, 2018).To ensure that these studies have a meaningful influence on the current knowledge that underpins practice and ultimately improve care delivery, they must demonstrate a rigorous approach that instils confidence in their findings. Noble and Smith (2014) contend that there is a dearth of agreement over the language and standards used to assess qualitative research. Drijvers (2009) recognises that determining the quality of interviews presents a unique difficulty. Historically, validity and reliability were mainly associated with quantitative studies and were not previously employed to evaluate qualitative research (Beck, 2009). Nevertheless, an ongoing effort exists to expand these notions to encompass qualitative research (Anderson, 2010).

Qualitative research regards validity and reliability as crucial elements of trustworthiness (Mischler, 1990). Validity pertains to the precision and trustworthiness of a depiction, inference, rationale, elucidation, or any other portrayal (Maxwell, 2010). Reliability refers to the appropriateness and soundness of the procedures employed and the ultimate conclusions derived (Noble & Smith, 2015). Arksey and Knight (1999) propose that the qualitative approach to ensuring reliability and validity requires researchers to demonstrate the suitability of their methodologies for their research objectives.

5.11.1. Validity

Campbell (2013) argues that the dependability of interview research is determined by its appropriateness for examining the topic area it claims to inform about and its precision in reporting. Although complete assurance of validity in research is unattainable, various strategies can effectively mitigate threats to validity and bolster the credibility of the research's findings (Maxwell, 2010). The tools encompassed in this list are mechanical recording, collecting extensive data, taking into account conflicting evidence, member checking, respondent validation, quasi-statistics, maintaining impartiality, triangulation, and fair treatment (Arksey & Knight, 1999; Salmon, 2013; Anderson, 2010; Bisman, 2010; Maxwell, 2010; Birt et al., 2016; Gray, 2018). Using audio or video recording equipment, instead of depending on researcher notes, allows for comprehensive analysis of raw data (Gray, 2018). Conversely, producing exact interview transcripts instead of partial interviewer notes, known as 'rich' data, provides a more thorough and perceptive representation (Arksey & Knight, 1999; Maxwell, 2010). Qualitative researchers intending to employ interviews to collect data are advised to use digital audio recording equipment to record the interviews. This can be effortlessly accomplished using a cost-effective or complimentary application on a smartphone. The recorded interviews can then be transcribed in their entirety, or if feasible, researchers can opt to hire an independent professional transcription service that utilises transcription software.

In qualitative research, it is possible to disregard data improperly (Gray, 2018). Therefore, it is crucial to detect and analyse contradictory data and negative examples to assess the validity of qualitative research (Maxwell, 2010). This method, also known as 'contradictory evidence' or 'deviant cases', requires the researcher to actively search for, analyse, and explain all data potentially challenging their conclusions. Doing so minimises the possibility of the investigator disregarding such findings in order to bolster their argument (Anderson, 2010; Smith & Noble, 2014). Contradictory evidence frequently arises during interviews, prompting researchers to document, present, and clarify its presence in their research.

Validity can also be confirmed by employing the member-checking method, wherein the researcher informally validates the accuracy of their understanding with participants while gathering data (Gray, 2018). Researchers can utilise member checking in interviews by reiterating, paraphrasing, and seeking further elucidation on respondent remarks that lack clarity. This strategy allows interviewees to verify or correct the interviewer's comprehension of their statements. Individuals should be attentive to the tone and emphasis used by the responders and themselves in their communication. It is important to consider the congruence between the verbal and non-verbal communication of each respondent, as this can suggest the genuineness of their response. Beuving and de Vries (2015) suggest that performing a thorough validity assessment for the results of a qualitative research investigation is advisable. One way to accomplish this is by distributing the report to participants and allowing them to offer feedback.

However, it is important to note that agreeing with the findings does not prove their validity. Likewise, if respondents reject the results, it may indicate an uncomfortable truth rather than an incorrect conclusion. Despite acknowledging these constraints, it is both preferable and recommended for researchers to employ this method when concluding their research. Respondent validation, a more rigorous version of member checking, allows respondents to review and amend their transcribed interview records at a later stage (Anderson, 2010; Birt et al., 2016). Introducing respondent validation in research can significantly amplify the workload for participants, which can be challenging when there are research time and resource constraints. In addition, researchers should also consider the counterarguments that may hinder the use of this approach. One of these claims is that interviewees may have a limited and biased perspective (Torrance, 2012). Furthermore, after reviewing a transcript, interviewees may claim that their responses were misinterpreted and should be modified to portray themselves or their organisation more positively (Alvesson, 2003; Miltiades, 2008; Cohen et al., 2013).

Haven and Van Grootel (2019) argue that language is frequently utilised as a primary data source in qualitative research. The acquisition of this data often occurs through an interview or observation. Qualitative research aims to clarify the viewpoints of the individuals who are the focus of the research study. The process employs emergent design, a cyclical methodology incorporating data analysis, initial evaluation, and data collection. The adaptability of the emergent design can augment and intensify the rigour and validity of the qualitative investigation rather than decreasing it. The qualitative researcher actively participates in measuring and plays a crucial role in deriving conclusions from the data. Triangulation is a technique used to reduce the probability that the researcher's findings reflect the inherent biases or limits of a particular source or approach. Furthermore, it enables individuals to acquire a comprehensive and secure comprehension of the subjects under investigation. The credibility of research is strengthened when data collected from multiple sources are deemed reliable. More comprehensive explanations of the phenomena yield conclusions that are more valid and precise (Cypress, 2018).

Triangulation has been used as a research approach because many data-generating tools, including pre and post-task and interviews, were used. It was possible to triangulate participant responses about using the Microsoft Teams platform for Grade 10 learners when researching trigonometric functions thanks to using several data-collecting procedures to support the findings. The research also included member-checking with learners in grade 10 to confirm the validity of the information gathered. Participants have been informed of the data findings, allowing them to explain their goals and, in certain circumstances, provide further details. The interviews and teachings have also been videotaped so the researcher may refer to them whenever necessary to confirm that the reality captured was not fake. Credibility in qualitative research should not be taken as absolute, nevertheless, as it would be challenging to ensure the subjectivity and views of respondents in this situation.

5.11.2. Reliability

In qualitative research, reliability is often described as dependability (Rolfe, 2006; Erlingsson & Brysiewicz, 2013), confirmability (Given,, 2008), or consistency (Arksey & Knight, 1999). Establishing the dependability of findings in qualitative research is difficult due to the absence of statistical tests commonly used in quantitative research (Sutton & Austin, 2015). Triangulation can enhance the credibility of research findings by corroborating them with consistent evidence from multiple data sources or collection methods. This can strengthen the reliability and integrity of the research conclusions, as supported by various studies (Brannen, 2005; McEvoy & Richards, 2006; Hesse-Biber, 2010; Gray, 2018). Exercising greater control and maintaining consistency throughout the interview process to enhance interview reliability is crucial. Nevertheless, using such a framework can potentially undermine the validity of the connection by introducing a more formal and less amicable atmosphere. This consequently heightens the likelihood that participants perceive limitations and are less motivated to offer comprehensive, sincere, and precise accounts of their experiences (Alvesson, 2003; Cohen et al., 2013). To ensure trustworthiness in research, the researcher must comprehensively describe the methodologies employed and the determinations made. This facilitates the reader in comprehending the researcher's cognitive process and activities, helping them to evaluate the rational consistency and reliability of the research (Arksey & Knight, 1999). Offering openness and comprehensive elucidation of the rationale behind the research design and its implementation (Elo & Kyngas, 2008; Fitzgerald & Dopson, 2011) enables the research reader to evaluate its reliability more precisely.

It is usual for participants to try to answer questions differently if they think their previous response was incorrect if the instruments were given to them again. Thus, the reliability of a research's conclusions can only be established by the impartiality, honesty, and depth of the researcher's data gathering. Transferability, as opposed to external validity, describes how easily research findings from one environment may be used to research in another. Interested readers can assess if the research's conclusions are transferable to their research environments. However, the researcher improved transferability by providing a thorough description of the environment and adequate information on the findings, leading to more prosperous and realistic outcomes (Creswell, 2009). No general conclusions may be derived from this research because it will be qualitative.

Improving reliability required a meticulous effort to strike a delicate balance between regulating the interview procedure to guarantee uniformity and permitting sufficient freedom to preserve the accuracy and depth of the data. According to Wilson (2016), an excessively inflexible interview structure can result in a formal and unnatural conversation, perhaps discouraging participants from expressing themselves freely. Hence, to ensure consistency in the interview process, deliberate attempts were taken to establish a relaxed and inclusive atmosphere that fostered participants' willingness to share candid and thorough narratives of their experiences.

In order to showcase reliability, this research employed the methodology advocated by Scheurich (2014), which emphasised transparency and furnished an elaborate account of the research procedure. The author provided a concise explanation of the reasoning behind each methodological decision and a comprehensive description of the data collection, analysis, and interpretation process. Such transparency enables readers to trace an 'audit trail' of the research, therefore evaluating the validity and credibility of the research method and findings. Beins (2017) further highlights the significance of thorough documentation in research design and implementation for assessing reliability. The research extensively documented and justified every aspect, including formulating interview questions and selecting data analysis procedures. This comprehensive approach gives readers the essential context to comprehend and assess the research process and its results.

Concerning transferability, described by Creswell (2012) as a substitute for external validity in qualitative research, this research made significant attempts to improve it. Transferability pertains to the degree to which research conclusions can be extrapolated or applied to different situations or environments. In order to enhance the applicability of this research, a thorough depiction of the research context was included, along with elaborate details regarding the participants and the environment in which the research took place. The level of detail provided in the research was intended to allow interested readers to assess the relevance of the findings to their particular research contexts.

The research also recognised the inherent limits of its qualitative character in deriving broad findings. Qualitative research offers profound insights and abundant data, but it generally does not seek to generalise findings to a broader population as quantitative research does. However, the emphasis was placed on delivering a detailed and comprehensive comprehension of the examined circumstances, namely using Microsoft Teams to instruct Grade 10 learners in trigonometric functions. Employing a rigorous methodology, maintaining transparency, and providing extensive documentation ensured the research's dependability and transferability. The research attempted to ensure the reliability and transferability of its results within the boundaries of qualitative research paradigms by maintaining consistency and flexibility in the research process and presenting a complete description of the research context and findings. This technique not only enhanced the reliability of the research but also contributed to the broader discussion on the use of qualitative methodologies in educational technology research.

5.11.3. Multiple Coding

An additional frequently suggested method for guaranteeing reliability in qualitative research is the utilisation of ‘multiple coding’, also referred to as ‘peer review’, ‘consistency checks’, or ‘intercoder reliability’ (Power & Williams, 2001; Vaismoradi et al., 2013; Smith & Noble, 2014; Gray, 2018). In this method, known as the quantitative research's interpretation of 'inter-rater reliability' according to Power & Williams (2001), one or more qualitative researchers assess the data separately (Ryan & Bernard, 2003). There is a debate regarding whether qualitative researchers should have their analyses verified or validated by a third party. However, it is also contended that this procedure can strengthen the analysis's precision and reduce bias (Burnard et al., 2008). It is advisable to have a second impartial party, who possesses knowledge in the relevant subject or field, review the codes or first themes. If the third party determines that the respondent's remarks are irrelevant or do not fit a specific code or subject, the findings should be revised based on this feedback. Any changes made should be documented in the report.

Using multiple coding in this research was a deliberate choice to augment the dependability and accuracy of the qualitative analysis. Multiple coding, also referred to as peer review, consistency checks, or intercoder reliability, is a technique that involves independent analysis of research data by one or more additional researchers, as outlined by (Power & Williams, 2001; Thomas, 2006 ; Burnard et al., 2008; Vaismoradi et al., 2013; Smith & Noble, 2014; Gray, 2018). Within the framework of this research, another qualitative researcher examined the method of coding the data to guarantee the strength and reliability of the theme analysis. This peer reviewer, who possessed expertise in educational technology and qualitative research methods, independently examined the coded data. The purpose of this exercise, as described by Ryan & Bernard (2003), was to ensure that the interpretations and themes derived from the data were not solely the product of a single researcher’s perspectives and potential biases.

The need for verifying analyses by an independent third party is widely recognised in qualitative research to enhance credibility (Creswell & Miller., 2000; Lincoln & Guba., 1985; Nowell et al., 2017). As Burnard et al. (2008) discussed, this process reduces potential bias and strengthens the rigour of the analysis. By engaging an additional coder, researchers aim to provide an objective perspective on the relevance and exclusivity of preliminary themes and codes (Nowell et al., 2017). When discrepancies or disagreements arise regarding codes or themes, findings are revised based on the third-party reviewer's feedback (Campbell et al., 2013; Vaismoradi et al., 2013). Documenting these revisions and rationales enhances transparency and allows readers to understand the thematic analysis evolution (Nowell et al., 2017).

This multiple-coding method aligns with qualitative research concepts of dependability (consistency across contexts) and confirmability (findings shaped by respondents rather than researcher bias) (Lincoln & Guba, 1985; Cope, 2014). The process establishes intercoder reliability while addressing dependability and confirmability concerns (Campbell et al., 2013; Nowell et al., 2017).

5.11.4. Replicability

Bisman (2010) contends that assessing a research's quality hinges on replicability. According to Roberts et al. (2019), replicability in qualitative research is defined as 'procedural trustworthiness'. Replicability relates to the ability to reproduce observations, considering contextual variations and assuring that the investigator's report precisely represents what others would have noticed. Procedural trustworthiness is considered an important factor in determining the reliability of qualitative research studies. Undoubtedly, utilising audio recordings and complete transcriptions may significantly contribute to establishing the credibility of procedures when interviews are employed for data collection. This further supports employing these approaches to improve the dependability of research studies conducted in this manner.

5.12. Trustworthiness

Trustworthiness refers to the quality of being deserving of trust and carries a normative aspect, indicating justified faith in research conclusions (Cusumano, 2010). Trusting findings based solely on the researcher's reputation without critically evaluating the research is unreliable (Adler, 2022). Credibility relies on compelling, high-quality evidence supporting findings' accuracy or approximation of truth (Bryman, 2016; Nowell et al., 2017). Determining when findings are reliable remains debated, but confidence should not be conflated with reliability (Golafshani, 2003).

Trustworthiness is inherently subjective and dependent on individual perspectives (Lincoln & Guba, 1985; Cope, 2014). Credibility assessments may differ between academics, non-experts, or policymakers (Cash et al., 2003). The public often lacks foundational understanding, while policymakers consider practical strategic factors beyond knowledge alone. Hence, findings may be deemed reliable when the relevant academic community can confidently trust them (Bryman et al., 2008; Nowell et al., 2017).

According to Cypress (2018), the credibility of qualitative research findings relates to their quality, authenticity, and honesty. It concerns how much readers believe the outcomes are trustworthy or reliable. The concept of reliability focuses on procedures that can guarantee proper research execution. Researchers must develop the protocols and methodologies required for research to be deemed acceptable by readers (Amankwaa, 2016). In order to ensure the production of pertinent and beneficial outcomes, qualitative research must be conducted with meticulousness and systematicity, as it garners acknowledgement and worth. Qualitative researchers can demonstrate the credibility of their data analysis by thoroughly documenting, systematising, and disclosing the analysis methods. This allows readers to assess the process's precision, consistency, and comprehensiveness (Nowell et al., 2017). The required practices and conventions were followed throughout data collection to validate the data in many ways.

5.12.1. Trustworthiness and Kinds of Replication

As noted, three distinct replication types differ in dependability: reproductive, direct, and conceptual (Nosek & Errington, 2020; Romero, 2019). Replicating research improves the findings' dependability and reduces initial analysis errors by re-examining the same data/methods (Pratt et al., 2020; Hüffmeier et al., 2016). Using modified analysis can verify consistency across methods if the original is insufficient (Kerr, 1998). Consistent results enhance reliability (Hantula, 2019).

There are key distinctions between robustness, evidence for accuracy, and validity (Romero, 2018). However, all contribute to enhancing the initial findings' reliability. Direct replication using new data is a reliable way to bolster original findings' credibility as more evidence increases reliability. Simply re-examining original data adds less than new data, demonstrating sample variability's limited impact and reducing chance findings (Munafò et al., 2017; Hüffmeier et al., 2016). Caveats exist - data from different periods may not be comparable, limiting the impact on conclusions (Cesario, 2021). Successful conceptual replication using modified approaches enhances credibility by showing that methods do not drive results (Romero, 2019). No set number exists, but Schimmack (2020) argues that successful replications build strong cumulative evidence. Conceptual replications boost credibility by reducing chance findings and validating accuracy (Romero, 2019; Nosek & Errington, 2020). However, clarity is needed on what constitutes accurate replication versus new, related research (Hüffmeier et al., 2016).

An exemplary demonstration of this principle is the celebrated Marshmallow experiment by Shoda, Mischel, and Peake in 1990. There is a widely held belief that important connections exist between a child's ability to delay gratification before beginning school and their later accomplishments and socioemotional conduct during adolescence. A good conceptual replication improves the trustworthiness of the significant findings, but only if it is clear that it qualifies as a replication rather than a new research focusing on a comparable but different research subject. Watts, Duncan, and Quan (2018) tried to replicate the notion; however, their results showed a bivariate correlation that was only half the magnitude of the one described in the original work. Indeed, it reduced by 66.67% after accounting for variables such as family background, early cognitive aptitude, and home environment. On the contrary, some individuals have contended that the original conclusions remain valid, considering the variations in research methodology and data interpretation, as exemplified by (Dolfini & Collins, 2018).

5.12.2. Trustworthiness and Unintentional Replication

Replications are usually intentional. Replication studies are deliberately crafted to replicate primary research systematically. However, it is essential to recognise that replications do not always have to be intentional. During the literature review stage, it is feasible that primary research may be unintentionally disregarded, mainly due to language hurdles or publication in a non-indexed journal. It is plausible that the primary research's results have not been published or made available as a preprint when the unintentional replication research is planned. The concept of 'multiple independent discoveries' has garnered significant interest in sociology and philosophy of science, particularly in the scholarly contributions of (Merton, 1963). Several of these findings may potentially be classified as inadvertent duplications.

Unintentional replications are typically conceptual, meaning they employ a slightly modified research technique to address the same research topic using new data. If the variations in research techniques are significant, it does not qualify as replication but rather as another original investigation into the same research subject. A more appropriate phrase would be triangulation, which signifies using many approaches to investigate the same research subject. Alternatively, inadvertently employing the same research methodology with fresh data, known as a direct replication, is possible. This is especially relevant when examining a relatively straightforward research question, such as comparing the death rates of a new pharmaceutical drug versus a placebo. What is the connection between the presence or absence of intentionality in replication and the level of trustworthiness? An unintended replication holds equal value to an intentional replication in terms of contributing to the credibility of the initial findings, provided that it is successful. Assuming all other factors remain constant, an unintentionally successful publication is equally valuable as it provides more evidence for the same research issue, especially when it is established with strict methodology and considers potential biases.

5.12.3. How to Assess Trustworthiness

Replication is becoming recognised and embraced as an integral component of academic research, as demonstrated by (Lakens, 2020; Zwaan et al., 2018). However, limited focus has been on the correlation between replication and trustworthiness. Ultimately, we suggest that the assessment of research findings' dependability should be broadened to include not just widely recognised characteristics, such as the likelihood of the findings before conducting the primary research. This is frequently referred to as the prior probability of the observations. Secondly, what was the primary research's sample size and methodological rigour level? In essence, was the initial research valid and precise enough? Thirdly, what was the cumulative number of reproductions, direct replications, and conceptual replications conducted? What was the scope of their investigation and the rigour of their methodology? What was the success rate among them? Fourthly, what matters of importance are being discussed? In simpler terms, should another replication research be conducted before taking action based on the combined results?

Undoubtedly, additional effort is required to implement or establish more accurate definitions for some of these ideas. What are the effective ways to evaluate the methodological quality of research, and how can this be used across various academic disciplines and types of studies? Similarly, this applies to concepts like prior probability, stakes, and other associated terminology. Systematic reviews, meta-analyses, Bayesian inferences, and decision theory are valuable methodologies for answering these four issues. A compelling approach entails assessing the degree of "acceptable regret," which pertains to the likelihood of mistakenly assessing the research hypothesis that we find tolerable (Djulbegovic & Hozo, 2007). However, this would exceed the scope of the current paper. The main objective is to emphasise the need to consider these factors when evaluating the reliability of a research's results. Additionally, examining and implementing these factors is crucial to ensure accurate assessments thoroughly.

5.13. Limitations

Both convenience and purposeful sampling have several drawbacks, such as non-random participant selection, which means the researcher's scanty and prejudice are present when selecting the research's subjects. This makes it more difficult for researchers to deduce information about a population (Etikan et al., 2016). Purposive and convenience sampling was the approach utilised in this research. The researcher ensured at all times that my involvement did not affect the learners' responses, even though the researcher was the participants' math teacher, which may have led to prejudice and subjectivity. At all stages, the data collection and analysis for this research project were conducted independently from me and without regard to my ideas, viewpoints, or beliefs.

The inability of participants to respond to the semi-structured interview was one of the constraints predicted before the research started. That would have had a detrimental effect on producing information-rich and valuable data for the project. The participants in the semi-structured interview first displayed signs of anxiety and reluctance to engage in talks prompted by the interview questions, as outlined in the interview schedule. The participants seemed to seek the researcher's validation to accept their replies or instructions. The researcher consistently reassured them that there were no objectively correct or incorrect answers and that all their responses were deemed acceptable. The participants were a little as a result, andation was quickly replaced by animated explanations that could be heard. The tiny sample size in this research is another drawback. The researcher used a thorough investigation as part of my approach to get around this to gather information-rich, comprehensive data.

5.14. Summary

This chapter explored the research's design and methodology, addressing the research's setting, sample selection, and data collection methods. It highlights the notion proposed by Christensen and James (2017) that researchers should tailor their approaches to align with learners' communication styles, address their concerns, and accommodate their schedules. Following the data collection process, semi-structured interviews were transcribed, extracting relevant information. A detailed explanation of the methods and strategies employed to explore Grade 10 learners' perceptions regarding using Microsoft Teams for trigonometry studies is provided, grounding these choices within the interpretative paradigm. This establishes a robust and flexible framework for comprehensive investigation, laying the groundwork for the subsequent chapter's presentation and discussion of the investigation's results. The insights gained from this methodology extend beyond the current research, contributing to broader discussions on integrating technology into education. The enduring relevance of the approaches and paradigms discussed underscores the importance of meticulous research design in academic inquiry. The forthcoming chapter, Chapter Six, will provide a detailed analysis of the data generated in this research.

Chapter Six: Presentation and Analysis of Findings

6.1. Introduction

The research methodology, encompassing the design and data-gathering procedures, was discussed in chapter four. This chapter aims to systematically present, assess, and organise the findings and results of the four data-collection tools. This chapter examines the data gathered from the 23 individuals who participated post-task. A summary of the background for the interviews is provided, followed by an analysis of the impact of the Microsoft Teams platform on the acquisition of trigonometric functions and the results obtained from the interviews. Chapter Five is a crucial turning point in this research, shifting from the techniques and theoretical foundations explained in Chapter Four to the practical implementation of these ideas through data presentation and examination. This chapter is essential for comprehending the impact of integrating the Microsoft Teams platform on acquiring trigonometric functions by Grade 10 learners. This statement summarises the essence of the research by carefully examining, analysing, and combining the results obtained from several data-collection methods used in the research.

The chapter begins by revisiting the replies obtained from the 23 participants, both pre- and post-task. After engaging with the Microsoft Teams platform, this introductory segment aims to establish a solid foundation for thoroughly comprehending the alterations and advancements in the learners' comprehension of trigonometric functions. The responses are more than just numerical data; they reflect the degree and scope of the educational intervention's influence on the learners' academic advancement.

Subsequently, the chapter summarises the interview situation, providing valuable information about the qualitative components of the research. The interviews, which are crucial for capturing the intricate experiences and perceptions of the learners, are thoroughly examined. This part explores the impact of the Microsoft Teams platform as both a technological and pedagogical instrument on the learners' cognitive comprehension of trigonometric functions and their overall learning experience. The debate here extends beyond the platform's usefulness in imparting mathematical concepts. It also includes the broader implications for learner engagement, motivation, and interaction in a digitally enhanced educational environment.

Following that, the chapter conducts an in-depth examination of the frameworks that formed the foundation of this research. The socio-constructivist theory, Connectivism, the Zone of Proximal Development (ZPD), scaffolding, and the theory of collaborative learning are examined again, not only as abstract concepts but as active and integral components of the educational process encountered by the learners. This part seeks to integrate these theories with the tangible results of the research, demonstrating how they materialised in implementing the Microsoft Teams platform for teaching trigonometric functions. Every hypothesis offers a distinct perspective through which the data is analysed, enhancing a comprehensive comprehension of the research's results.

The chapter thereafter shifts to a comprehensive qualitative examination using the procedures prescribed by renowned researchers. This research is not a simple data gathering; it is an analytical process that aims to create significance and extract valuable observations from the gathered material. The methodology utilised in this research encompasses various techniques, including confirmation and inquiry. It involves analysing textual, visual, and aural material to uncover the fundamental patterns, themes, and narratives. This chapter provides a detailed portrayal of the participants' responses, illustrating the learners' progression throughout the research process. This document outlines the first introduction of learners to trigonometric functions, their involvement with the topic, and the changes in their comprehension and perspective as they progressed through several phases of the research. This presentation is more than just a compilation of answers; it is a story that captures the learners' intellectual and personal development within the research framework.

This chapter thoroughly presents the research findings. It combines theoretical frameworks with actual observations, quantitative data with qualitative insights, and educational tactics with technology interventions. The chapter aims to provide a comprehensive and detailed examination of how the Microsoft Teams platform affects the learning of trigonometric functions. This will lay the foundation for a comprehensive analysis and interpretation of these results in the following chapter.

6.2. Analysis of the Frameworks Used in the Research

This research was based on the socio-constructivist theory, the theory of Connectivism, the zone of proximal development (ZPD), scaffolding, and collaborative learning theory. In the socio-constructivist approach, Towers et al. (2018) suggested that the constructivist approach, social contact helps knowledge acquisition to become a reality, further suggesting that learning is a shared experience rather than an isolated one. The anchored instruction approach uses the Microsoft Teams platform to improve learners' problem-solving abilities. According to Braem and Egner (2018), in Connectivism, learners should embrace various strategies while encountering new learning information for learning to occur effectively. ZPD emphasises the social component of learning by arguing that what learners can accomplish with help and support is more significant than what they can do independently (Charles, 2018).

The core premise of scaffolding states that providing learners with temporary help provides them the self-assurance necessary to use that support while participating in self-directed learning (West et al., 2017). Communication between learners occurs when they work in groups on projects, allowing for the sharing of ideas and the encouragement of higher-order thinking. These theories were used in this research to find answers to the primary research issues. The scaffolding and collaborative learning theories formed the foundation for social interactions while learners worked in groups.

The theory of anchored instruction, which views technology as an anchor for learning, is well-suited to using the Microsoft Teams platform in trigonometric functions education (Mattar, 2018). With the introduction of various teaching and learning techniques, including exercises, visual manipulatives, and the Microsoft Teams platform, Connectivism came to the fore. Moreover, the Zone of Proximal Development (ZPD) and scaffolding are intricately linked to the assistance learners receive from their teachers, peers, and educational resources. The researcher utilised these interconnected ideas to obtain data that was abundant in information for the investigation. The principles of scaffolding and collaborative learning theories guided the learners' social interactions during group work. The use of the Microsoft Teams platform for teaching trigonometric functions is in keeping with the anchored instruction paradigm, which acknowledges the use of online technology as a basis for supporting learning. The Connectivism theory became prominent through many educational methods, including worksheets, visual manipulatives, and technology.

Furthermore, learners' support from their peers, learning resources, and teachers is intricately linked to the Zone of Proximal Development (ZPD) and scaffolding practice. These interconnected ideas converged to furnish the researcher with data that was abundant in information for the research. This research expands on the theoretical frameworks previously described by exploring the ramifications and real-world applications of these ideas in the context of teaching trigonometric functions using Microsoft Teams. A comprehensive lens for viewing and analysing the educational process was made possible by the merger of socio-constructivist theory, connectivism, the Zone of Proximal Development (ZPD), scaffolding, and collaborative learning theories. The research discovered that Microsoft Teams-enabled social interactions significantly improved learning, consistent with the socio-constructivist hypothesis. Through their interactions with classmates and teachers on the platform, learners actively built knowledge rather than only being passive recipients of it. This is consistent with Vygotsky's theories, which highlight the value of social interaction in learning. The traditional dynamics of teacher-led education were challenged by the digital environment of Microsoft Teams, which established a virtual community of learners where knowledge was co-constructed.

The research also emphasised the significance of connectivism in the acquisition of trigonometric functions. Microsoft Teams' many features, such as its chat capabilities, file sharing capabilities, and video conferencing, encouraged learners' connectivism by enabling them to approach challenges from multiple perspectives. According to the research, learners' connectivism could be increased by using technology in mathematics classes to give them different approaches to comprehend and solve issues. It was clear how ZPD and scaffolding contributed to learners using Microsoft Teams to ask for and get help. The platform functioned as an instrument for educators to deliver prompt support, conforming to the scaffolding theory by Gonulal et al. (2018). This digital scaffolding expanded the ZPD beyond the traditional teacher-learner interaction, which went beyond teacher help to incorporate peer guidance from more experienced learners.

The collaborative learning hypothesis was especially relevant in this research. Learners used Microsoft Teams to participate in group discussions and cooperative problem-solving exercises that adhered to the collaborative learning guidelines provided by Kali et al. (2009). In addition to making knowledge production easier, this collaborative method helped learners develop a feeling of community and support one another, which is important in a digital learning environment.

6.3. Qualitative Analysis

The research utilises a qualitative analysis methodology, which involves examining textual, visual, or aural data and covers various examinations from verification to exploration (Mihas, 2019). Bhattacharya (2017) asserts that numerous approaches exist to manage and analyse qualitative research data. Data management encompasses the systematic and efficient handling and organisation of a significant amount of data by a researcher. Frequently, this procedure entails extracting smaller analytical components from the broader pool of unprocessed data for meticulous scrutiny. Inductive analysis in qualitative research involves starting at a certain level and systematically advancing upward based on the available evidence.

An essential aspect of qualitative research interpretation involves constructing narratives that illustrate the collaborative process through which the researcher and her participants jointly generate meaning. This often involves conducting data analysis, examining various data segments, uncovering analytical insights, and providing commentary on the insights found using a narrative approach. This research project utilised observation, pre and post-task, audio data, and learner replies to interview questions to assess and extract data that contains valuable information. In line with Braun & Clarke (2021), familiarisation involves recognising and understanding the data as information. This necessitates the researcher to shift their focus from data collection (including transcription) to analysis. Engaging in a focused and calm manner, jotting down informal notes while maintaining a serious and interested attitude towards the material, and actively engaging with the information in various ways are all integral components of the process. It is not about giving the data official labels; instead, it is about noticing what is intriguing about the data and any links you detect between people, data, and previously published research. It makes the remainder of the research much more pleasurable by giving a strong basis for probing and afterwards knowing facts.

Qualitative research encounters challenges due to the unstructured character of data, which differs from data that is exclusively numerical. Qualitative data encompasses several forms, such as interview transcripts, published materials, questionnaire responses, personal journals, films, photographs, and field observations. Analysing and detecting patterns in textual data can be more complex than numerical data (Castleberry & Nolen, 2018). The data analysis approach utilised in this work follows the guidelines set forth by Braun & Clarke (2018), which state that familiarisation is actively engaging with audio data by listening to text data by reading and rereading it several times. This process entails identifying noteworthy characteristics and making comprehensive observations about individual data points and the dataset.

The feedback should be guided by the research question(s) and any broader inquiries regarding the patterns and trends observed in the data. The research utilised interview scripts, field notes, and observations to provide a descriptive narrative for data analysis. The data obtained from this research were examined about the research inquiries, employing the socio-constructivist theory as the underlying conceptual framework. The data collection for this research involved pre- and post-task, observations, and interviews conducted according to a predetermined interview schedule. Every learner completed the first pre-task before using the Microsoft Teams platform in the session. After watching a PowerPoint presentation through Microsoft Teams that covered a variety of trigonometric function-related content from the required mathematics curriculum, learners completed the post-task.

6.4. Presenting the Participant Responses

The important topics and subtopics about trigonometric functions were taught and explained to the Grade 10 learners during the initial phase of the research project. By participating in conversations, asking questions, and interacting with one another about trigonometric function issues, learners at this stage are actively involved in inquiry-based learning. The next step was to do a written exercise requiring trigonometric function calculations. The researcher summarises the participants and the procedures followed during the data collecting procedures before presenting and discussing the responses generated by the participants in this research. This is an important part of the chapter because it places the findings in the larger context of the research. Twenty-three learners enrolled in the Grade 10 class were chosen for this research project. As a result, 23 learners were interviewed for this research. Examining the pre and post-task responses reveals that learners had difficulties responding to questions on trigonometric functions in the pre-task, which was completed before using the Microsoft Teams Platform in the session. Some of the learners appeared to have a higher understanding of the questions about trigonometric functions in the post-task after the use of the Microsoft Teams platform in the form of a PowerPoint presentation using Microsoft Teams platform.

Compared to the pre-task, learners made fewer mistakes in the post-task, according to an analysis of their answers to the questions. Even though several strategies were employed to dispel the misunderstandings learners had while working with trigonometric functions in mathematics, some learners were still unable to answer trigonometric function problems. The purpose of displaying the learners' responses to the pre and post-task questions was to compare the responses from the pre and post-task. The responses to the identical questions that the same learners answered on both interventions are included in the excerpts so that a sound conclusion may be drawn from the observations. According to the replies from learners, using the Microsoft Teams platform increased their comprehension of the material they were researching about trigonometric functions. The researcher had to choose just the learners who satisfied the requirements for this comparison: learners had to finish both the pre-and post-task and give written consent to participate in the research. As a result, none of the learners missed class and failed to complete the pre-task in groups. All 23 learners met all the requirements, 13 of whom were females and 10 of whom were boys.

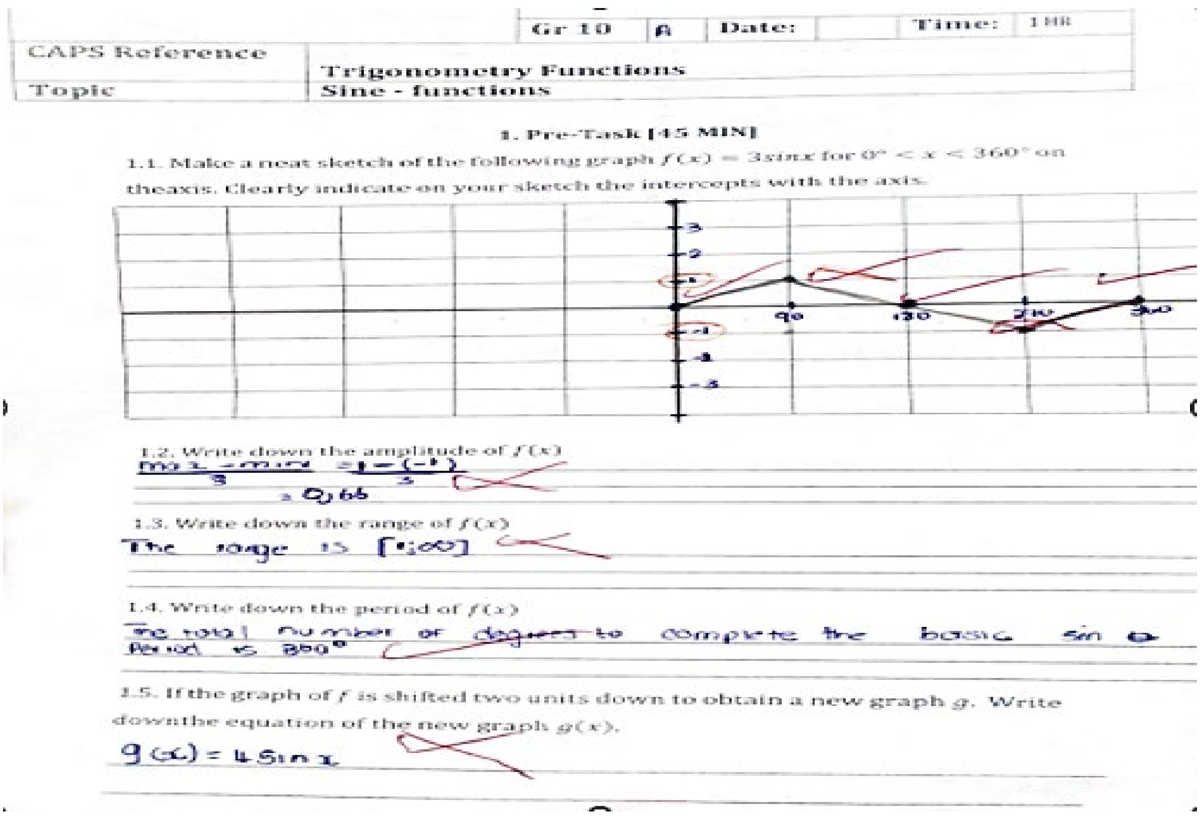
The findings suggest that utilising Microsoft Teams positively impacts learners' understanding of trigonometric concepts. This aligns with previous research highlighting the potential of technology-integrated learning environments to enhance learner engagement and knowledge acquisition (Amelia & Yosintha 2022; Ebner, 2023). The pre-task assessment revealed that learners initially struggled with trigonometric function problems. This aligns with observations made by Stanfield (2024) regarding the challenges learners face in grasping mathematical concepts traditionally. However, the post-task results, showcasing fewer mistakes and a deeper understanding of trigonometric functions after utilising Microsoft Teams presentations, paint a promising picture. One plausible explanation for this improvement lies in the interactive and collaborative nature of online learning platforms like Microsoft Teams. Amelia & Yosintha (2022) emphasises the effectiveness of online breakout rooms in fostering peer-to-peer learning and discussions. With its chat functionalities and potential for screen sharing, Microsoft Teams could have facilitated similar interactions, allowing learners to clarify doubts and learn from each other. Using PowerPoint presentations within Microsoft Teams also aligns with the notion that multimedia elements can enhance learner learning (Ebner, 2023). The visual representations and explanations embedded within the presentations could have provided a clearer understanding of trigonometric concepts than traditional textbook-based methods.

6.4.1.1. Responses of learners from the Pre-task on trigonometric Functions

During the data-collecting process, learners could use drawings and diagrams to complete the pre-task. According to the socio-constructivist theory's principles, the worksheet was initially filled out by each group of five or six learners before the entire class Firat et al. (2021). The researcher retrieved the pre-task for evaluation and additional analysis. While responses were analysed, it became clear that the learners had difficulties solving issues using trigonometric functions. Trigonometric function problems appeared to be challenging for learners to answer. Figures 11, 12, 13, and 14 show the answers to the pre-task questions.

FIGURE 11

NOMVULA'S RESPONSE TO THE QUESTION ABOUT $\boldsymbol{f(x) = 3\,Sinx\,for}$ *$0^0 < X < 360^0$*



	Gr 10	A	Date:		Time:	1 HR
CAPS Reference	Trigonometry Functions					
Topic	Sine - functions					

1. Pre-Task [45 MIN]

1.1. Make a neat sketch of the following graph $f(x) = 3sinx$ for $0° < x < 360°$ on theaxis. Clearly indicate on your sketch the intercepts with the axis.

1.2. Write down the amplitude of $f(x)$

1.3. Write down the range of $f(x)$

The range is [1;∞]

1.4. Write down the period of $f(x)$

The total number of degrees to complete the basic sin graph period is 360°

1.5. If the graph of f is shifted two units down to obtain a new graph g. Write downthe equation of the new graph $g(x)$.

$g(x) = 4 \sin x$

(Taken from participant responses)

Nomvula's response to the trigonometric functions-related question is demonstrated in Figure 11. This response was selected because she approached this topic with great difficulty and misunderstanding. In section 1.2, she was expected to record the magnitude of the recurring function. It represents the midpoint between a periodic function's highest and lowest values. If a function exhibits many local peaks and minima, the amplitude equals half the difference between the highest maximum and the lowest minimum. The correct answer to this question is 3-(-3) = 6 x ½ = 3**.** In 1.3. the range was supposed to be y ∈ [-3;3]. And 1.4. The period of this

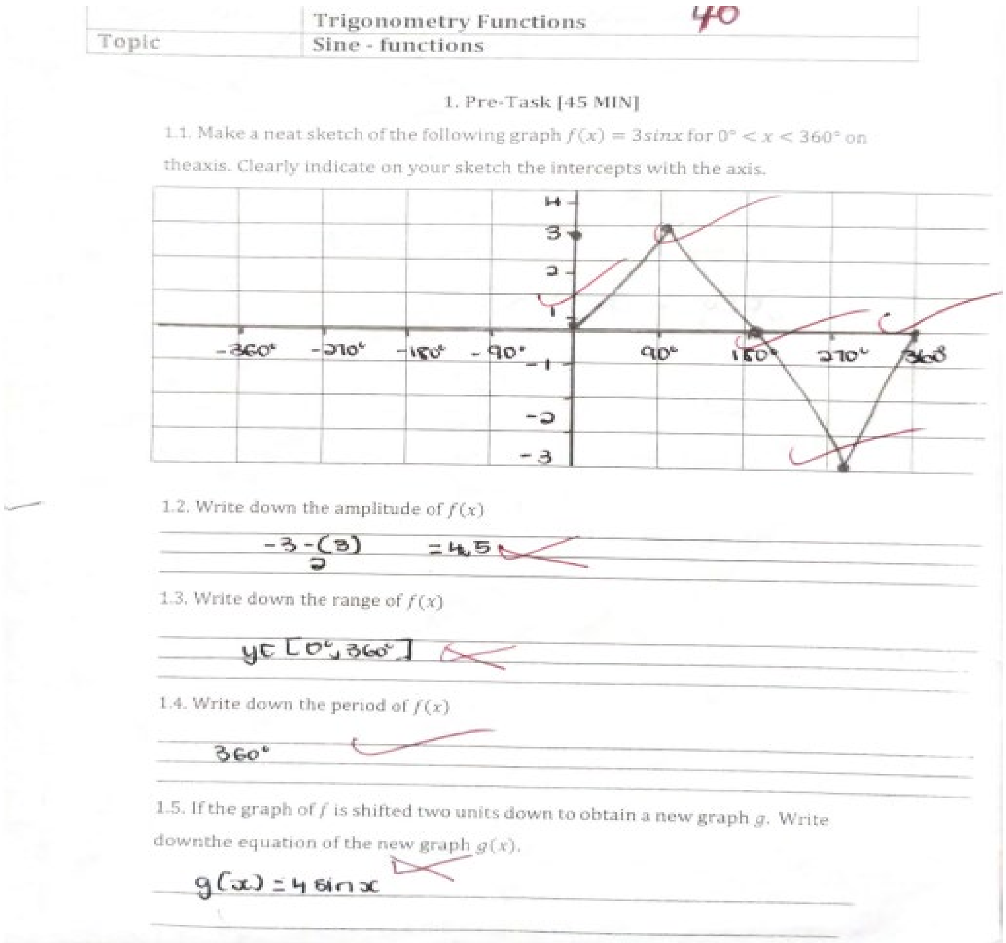
Sin function is 360^0 in 1.5. The graph is shifted two units down; the new graph must be g(x)= 3sin x-2.

Examining learner responses from the pre-task phase of this research sheds light on the specific challenges learners faced with trigonometric functions. This analysis aligns with the socio-constructivist learning theory, where collaborative learning through group work (Firat et al., 2021) can be instrumental in overcoming these difficulties. Figure 11 showcases Nomvula's response, which exemplifies the common misconceptions observed amongst learners. Her struggle with calculating amplitude (section 1.2) highlights frequent confusion. Amplitude represents half the difference between the maximum and minimum values, not the midpoint (Garnett et al., 2022). Similarly, her response regarding the range (section 1.3) suggests a misunderstanding of how the range is determined by the function's minimum and maximum y-values (Rohimah & Prabawanto, 2021).

These findings resonate with previous research by Wong et al. (2020), which identified learner difficulties in visualising trigonometric functions and their graphical representations. Nomvula's response hints at a potential lack of understanding regarding the periodic nature of sine functions and how horizontal shifts impact the graph. The analysis of pre-task responses serves as a valuable baseline for evaluating the effectiveness of the intervention using Microsoft Teams. Educators can tailor their online learning strategies by identifying specific areas of difficulty to address these misconceptions and foster a deeper understanding of trigonometric concepts.

FIGURE 12

KHADIJAH'S RESPONSE TO THE QUESTION ABOUT $f(x) = 3\,Sinx\ for\ 0^0 < x < 360^0$



(TAKEN FROM PARTICIPANTS RESPONSES)

Figure 12 shows that Khadijah's attempt to respond to the trigonometric function question failed, much like Nomvula's response did. The only difference was that Khadijah's response to the graph was correct. When instructed to respond to the pre-task, learners appeared unsure of themselves. Figure 12. Khadijah's response to the question on the amplitude of f(x) and range f(x) was Similar to Nomvula's response. They were wrong. Figure 12 indicates that Khadijah, too, was unsuccessful in answering the question based on amplitude, range, and writing of the new equation after vertical shifts for the Sine function. Learners appeared to be uncertain when tasked with writing the equation of the new graph after a vertical movement of two units in question 1.5 of the initial pre-task. The answers to the questions regarding trigonometric functions on a number line can be linked to the research conducted by Widodo and Ikhwanudin (2018). Their research suggests that learners focus on the relationship between parts and wholes and struggle with understanding amplitude and period as integral components of trigonometric functions. The type of error learners make when they deal with trigonometric function equations after the vertical shift of the function. Response to the question on trigonometry functions $f(x) = \frac{1}{2}\text{Sinx}$ for $0 < x < 360$

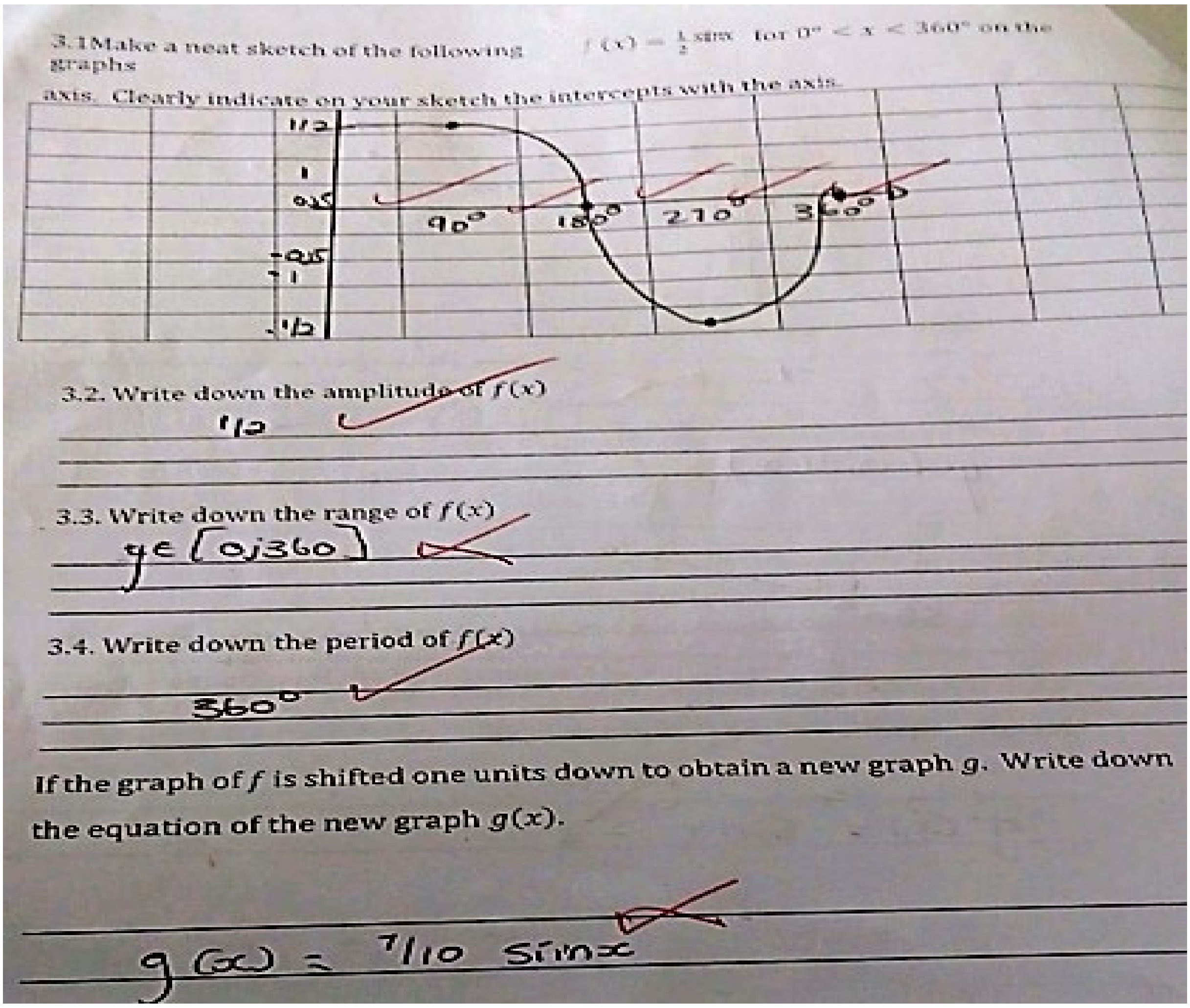
While both Nomvula and Khadijah faced challenges with the pre-task questions on trigonometric functions, Khadijah's case offers additional insights. While she correctly depicted the graph (Figure 12), her difficulties with amplitude, range, and equation adjustments highlight common learner misconceptions. This echoes the findings of Widodo and Ikhwanudin (2018), who identified a tendency for learners to prioritise memorisation of parts over understanding the holistic concepts of amplitude and period within trigonometric functions. Khadijah's struggle aligns with this notion, suggesting a focus on individual aspects like the graph itself rather than a grasp of the underlying principles that govern it.

Furthermore, Khadijah's uncertainty regarding the equation after a vertical shift (question 1.5) resonates with research by Karakose et al. (2021). Their research identified learner difficulties applying transformations like vertical shifts to trigonometric equations. This highlights the need for interventions that bridge the gap between theoretical understanding and the practical application of concepts. Building upon these observations, educators utilising Microsoft Teams can employ targeted strategies to address these misconceptions. Interactive features like polls and quizzes within Teams can be used to assess learners' understanding of critical concepts like amplitude and period (Amelia & Yosintha, 2022). This real-time feedback can inform educators where to focus their explanations and identify areas requiring further clarification.

Additionally, the platform's screen-sharing capabilities can be leveraged for step-by-step demonstrations of how vertical shifts impact trigonometric equations. Educators can visually showcase the adjustments required to the original equation and how these translate to the shifted graph. This approach aligns with recommendations by Kaya and Geban (2023), who emphasise the value of visual representations in promoting learners' understanding of trigonometric transformations.

FIGURE 13

Nomvula's response to the question on trigonometric functions $f(x) = \frac{1}{2}$ Sinx for $0^0 < x < 360^0$

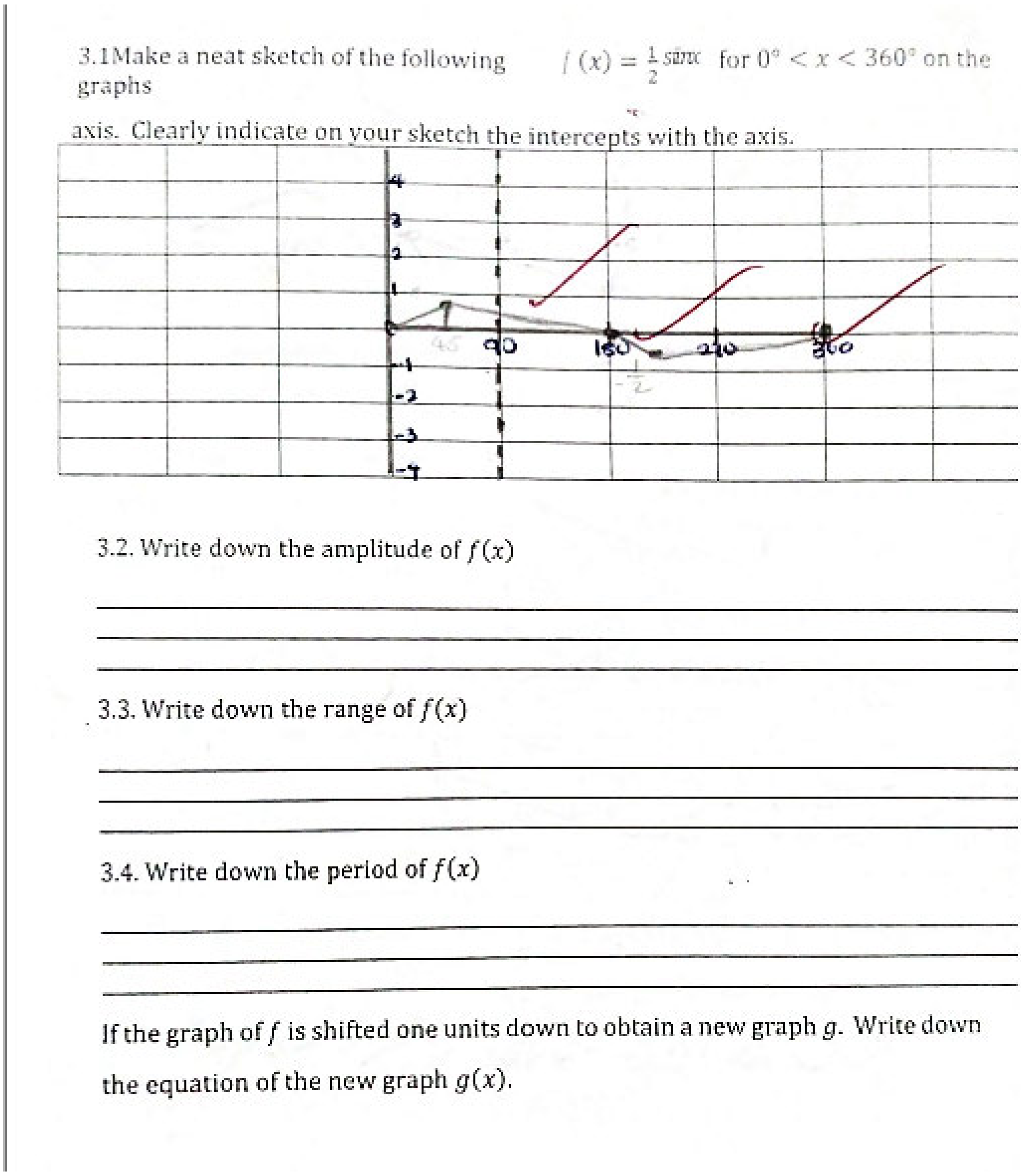


(Taken from participants responses)

Nomvula's response to the trigonometric functions-related question is demonstrated in Figure 13. This response was selected because she approached this topic with great difficulty and misunderstanding, like the question in Figure 11. The only difference in Figure 10 was that the graph and the amplitude were correct. In 1.3. the range was supposed to be $y \in [-\frac{1}{2}; \frac{1}{2}]$. And 1.4. The period of this Sin function is 360^0. In 1.5. The graph is shifted two units down; the new graph must be $g(x)= \frac{1}{2} \sin x - 1$

FIGURE 14

Khadijah's response to the question on trigonometric functions $f(x) = \frac{1}{2} Sin\ 0^0 < x < 360^0$


3.1Make a neat sketch of the following graphs $f(x) = \frac{1}{2} \sin x$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

3.2. Write down the amplitude of $f(x)$

3.3. Write down the range of $f(x)$

3.4. Write down the period of $f(x)$

If the graph of f is shifted one units down to obtain a new graph g. Write down the equation of the new graph $g(x)$.

(Taken from participant responses)

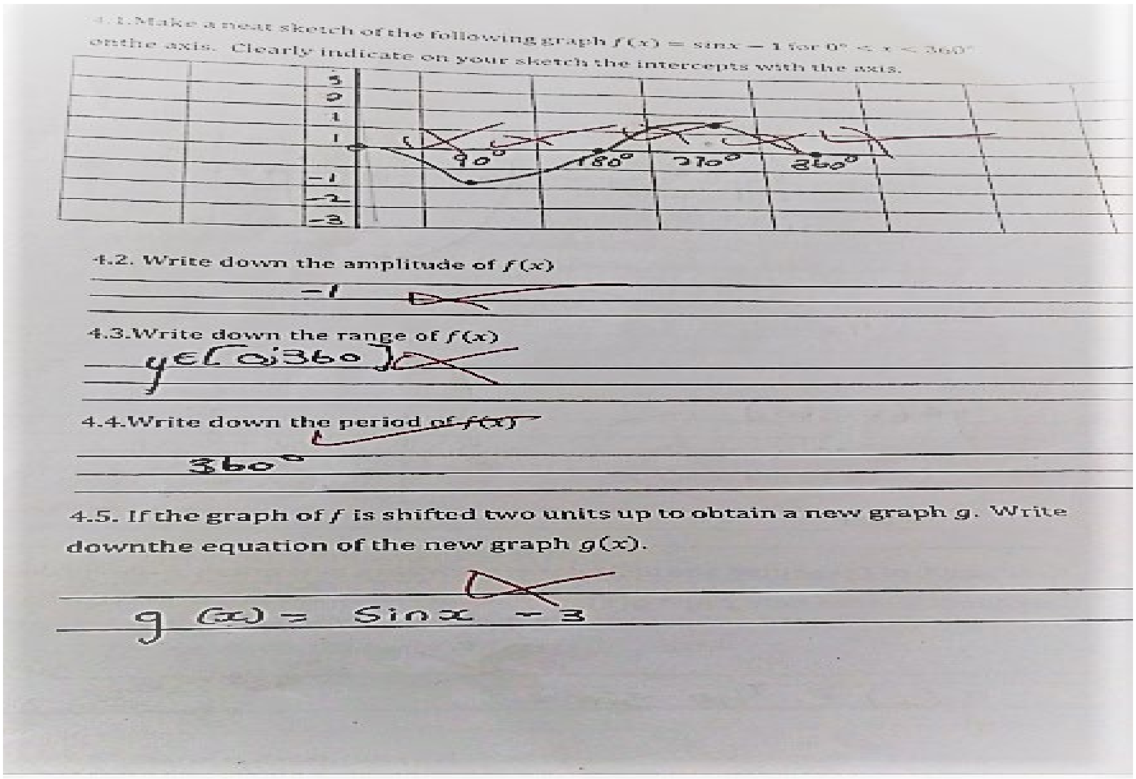
Khadijah's response to the trigonometric functions-related question is demonstrated in Figure 11. This response was selected because she approached this topic with great difficulty and misunderstanding; the only difference in Figure 11 was that the graph was correct, and all other questions and the amplitude were not attempted. In section 3.2, she was expected to indicate the magnitude of the periodic function. It represents the midpoint between a periodic function's highest and lowest values. If a function exhibits many local peaks and minima, the amplitude equals half the difference between the highest maximum and the lowest minimum. The correct answer to this question is $\frac{1}{2} - (-\frac{1}{2})$= 1 x $\frac{1}{2} = \frac{1}{2}$ **in** 3.3. The range was supposed to be an $\in [-\frac{1}{2};$

$\frac{1}{2}$]. Moreover, .4. The period of this Sin function is 360^0 . In 1.5. The graph is shifted two units down,; the new graph must be g(x)= $\frac{1}{2}$ sin x – 1

Data in Figures 13 and 14 led this researcher to conclude that the questions on trigonometric functions of f(x) $= \frac{1}{2}$ Sin $0^0 < x < 360^0$ proved to be a challenge for Khadijah and Nomvula, who were unable to calculate the $\frac{1}{2}$ Of Sin x with a restricted interval. There seemed to be confusion and lack of understanding when answering questions based on trigonometric functions where the period is halved and there is restriction. The data reveals that learners found this question challenging, as only a few learners answered the question correctly in the pre-task intervention.

FIGURE 15

MNDENI'S RESPONSE TO THE QUESTION ON TRIGONOMETRIC FUNCTIONS OF $f(x) = Sinx - 1$ for $0^0 < x < 360^0$



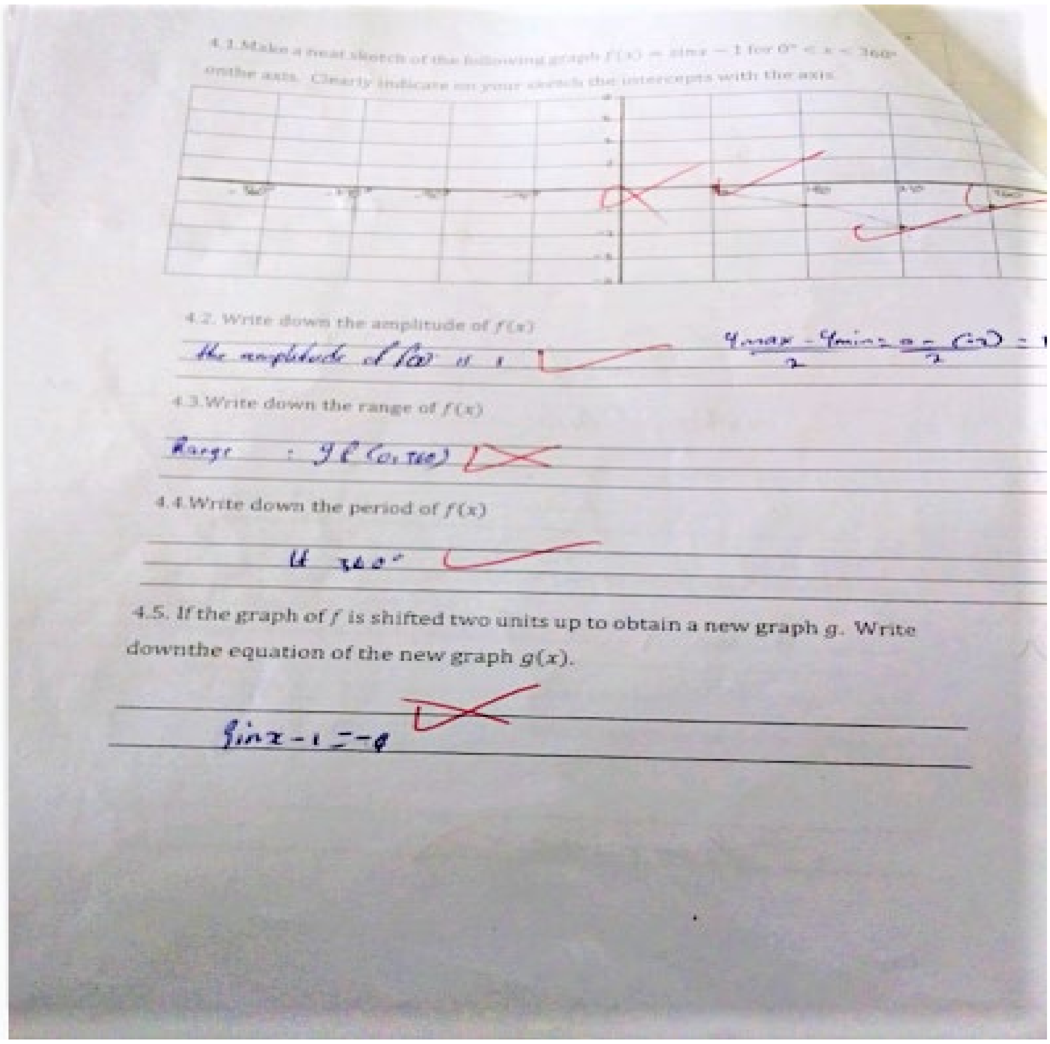
(Taken from participants responses)

Mndeni's response to the trigonometric functions-related question is demonstrated in Figure 15. This response was selected because she approached this topic with great difficulty and misunderstanding. In 4.2. she was supposed to write that the amplitude of the periodic function is half the distance between a periodic function's maximum and minimum; if the function has several local maxima and minima, the amplitude is half the distance between the grand maximum and the least minimum. The correct answer to this question is 0-(-2) = 2 x $\frac{1}{2}$ = 1**.** In 4.3. the range was supposed to be y ∈ [-2;0]. And 4.4. The period of this Sin function is 360^0 in 4.5. The graph is shifted two units down; the new graph must be g(x)= sin x

FIGURE 16

KHADIJAH'S RESPONSE TO THE QUESTION ON TRIGONOMETRIC FUNCTIONS

$f(x) = Sinx - 1\ for\ 0^0 < x < 360^0$



(Taken from participant responses)

Khadijah's response to the trigonometric functions-related question is demonstrated in Figure 16. This response was selected because she approached this topic with difficulty and misunderstanding. In 4.2. where she was supposed to write the amplitude of the periodic function, which is half the distance between a periodic function's maximum and minimum; if the function has several local maxima and minima, the amplitude is half of the distance between the grand maximum and the least minimum. The correct answer to this question is 0-(-2) = 2 x $\frac{1}{2}$ = 1. In 4.3. the range was supposed to be y ∈ [-2;0]. And 4.4. The period of this Sin function is 360^0 in 4.5. The graph is shifted two units down; the new graph must be g(x)= sin x

According to the answers given to the questions in the pre-task, learners had trouble figuring out how to answer questions about the many facets of trigonometric functions. While some learners could answer the questions correctly, others struggled to solve the trigonometric function-related difficulties. This suggests that there were still questions to be answered and any misunderstandings to be clarified about trigonometric functions. Since this research aims to examine how the Microsoft Teams platform may help learners understand trigonometric functions in mathematics, the researcher used PowerPoint presentations to assist learners in learning trigonometric functions.

The pre-task summary of findings shows that learners struggled to respond to questions based on many of the mathematical concepts linked to trigonometric functions. The part on the trigonometric function of $\mathrm{f(x) = Sinx - 1}$ for $0 < x < 360$ It proved to be the most difficult for learners to understand, with only 8% correctly answering question 4.3. The two questions on trigonometric functions were difficult to answer correctly in 78% and 76% of cases. The pre-task findings in this research paint a clear picture: learners grappled with various aspects of trigonometric functions. While some learners demonstrated understanding, a significant portion struggled with specific concepts, highlighting the need for targeted interventions. This aligns with previous research by Demir and Olgar (2022), who identified widespread learner difficulties in comprehending trigonometric concepts.

The analysis reveals a particularly challenging area - questions about the concept represented by the notation " " (presumably amplitude or period). Only 8% of learners answered question 4.3 correctly, suggesting a fundamental misunderstanding of this crucial aspect of trigonometric functions. This echoes the findings of Gökçe and Baloğlu (2021), who reported learner difficulties in grasping amplitude and period, often confusing them with other trigonometric properties. Furthermore, the high percentage of incorrect responses—78 % for other trigonometric function questions and 76% for other questions — indicates a need for a broader approach to address prevalent misconceptions. This aligns with Sianturi & Astrilia (2021) research, which identified diverse learner challenges with trigonometric concepts, ranging from graphical representations to equation manipulations. Addressing these knowledge gaps necessitates a well-designed intervention strategy. The choice of Microsoft Teams as the platform for this research holds promise. Its features, such as PowerPoint presentations, can be leveraged to enhance learner understanding. According to Kaya and Geban (2023), animations and visuals within these presentations can effectively illustrate complex concepts like amplitude and period. Additionally, Microsoft Teams' interactive capabilities can be utilised to foster deeper engagement. Tools like polls and quizzes can assess learner comprehension in real time, allowing educators to tailor their explanations and address specific areas of difficulty (Amelia & Yosintha, 2022).

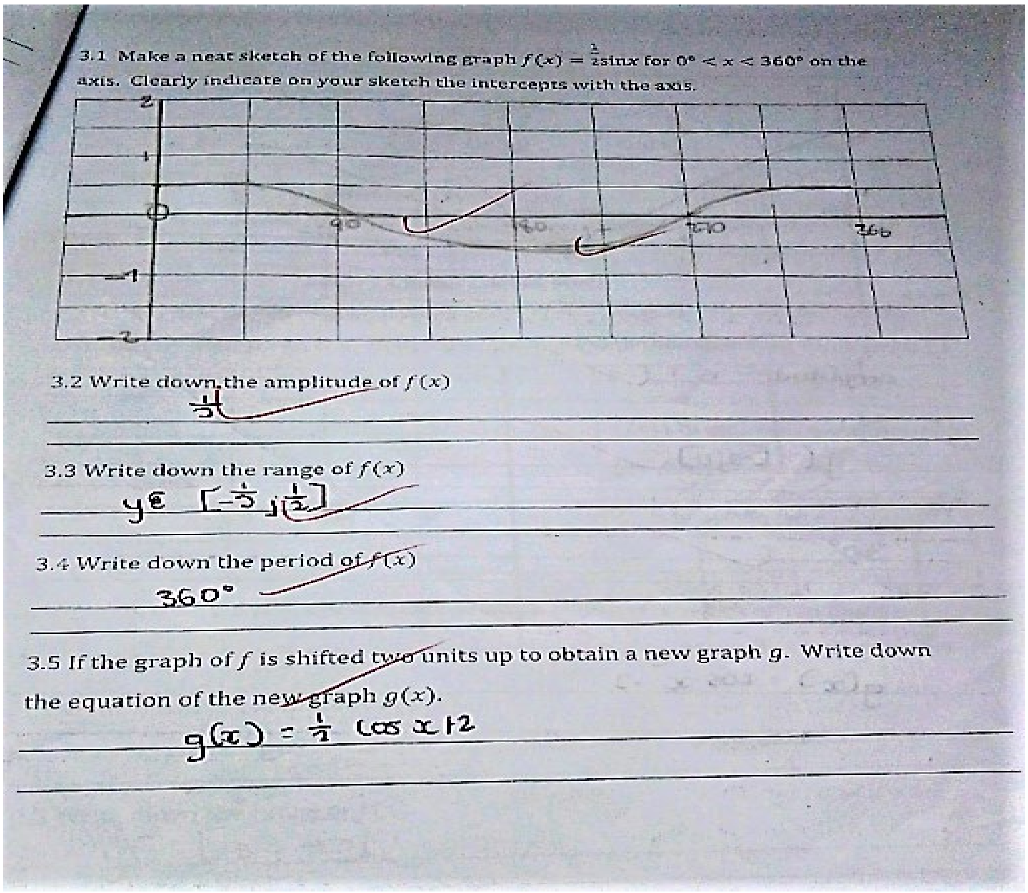
6.4.1.2. Responses of Learners from the Post-task on Trigonometric Functions

During the third step of the data collection process, the Microsoft Teams platform was utilised in the teaching and learning process to supplement the previously taught material. A PowerPoint presentation was used to teach learners about the trigonometric function parts of the mathematics curriculum. The post-task, which included the material covered in the PowerPoint presentation and the material covered during the classroom activities, was then completed by the learners.

After going through the Microsoft Teams platform-enhanced session, learners may have discovered that their preconceptions about the ideas and methods associated with trigonometric functions had become more transparent and more understandable. After introducing the Microsoft Teams Platform into the math lesson, a few learners discovered that they had fewer misconceptions about the concepts and procedures related to trigonometric functions. However, some learners still found it difficult to answer questions about trigonometric functions post-task. This may be explained by the fact that the participants in this research had a range of learning abilities. Figures 14, 15, 16, and 17 show the learners' answers in response to the questions on the post-task trigonometric functions.

FIGURE 17

NOMZAMO'S RESPONSE TO THE QUESTION ON TRIGONOMETRIC FUNCTIONS $f(x) = \frac{1}{2}Sinx\ for\ 0^0 < x < 360^0$


3.1 Make a neat sketch of the following graph $f(x) = \frac{1}{2}\sin x$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

3.2 Write down the amplitude of $f(x)$

$\frac{1}{2}$

3.3 Write down the range of $f(x)$

$y \in [-\frac{1}{2}; \frac{1}{2}]$

3.4 Write down the period of $f(x)$

$360°$

3.5 If the graph of f is shifted two units up to obtain a new graph g. Write down the equation of the new graph $g(x)$.

$g(x) = \frac{1}{2}\cos x + 2$

(Taken from participant responses)

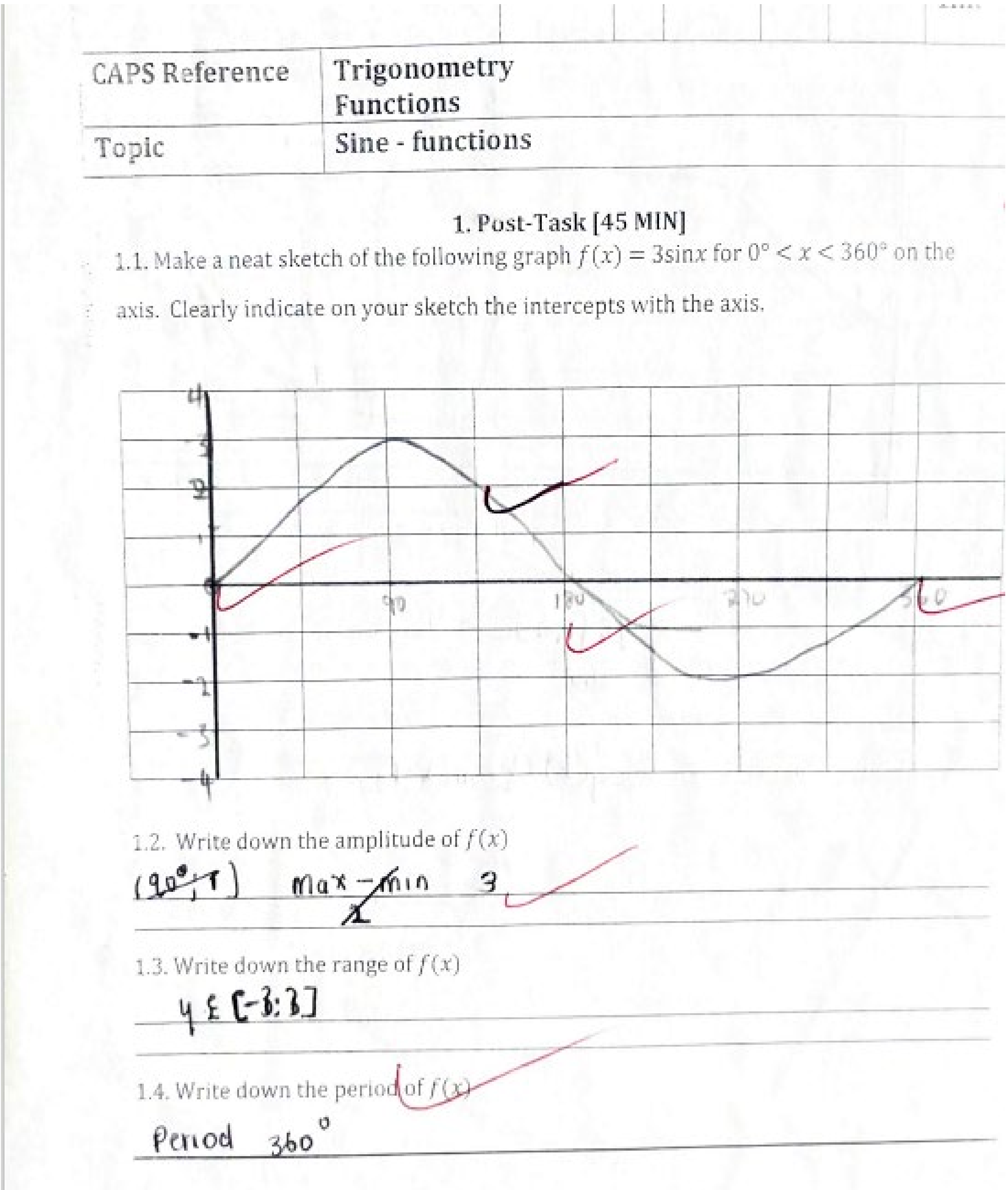
Nomzamo's response to the trigonometric functions-related question is demonstrated in Figure 17. This response was selected because she approached this topic quickly and accurately drew the graph in 3.1. In 3.2. where she accurately wrote the amplitude of the periodic function. It is half the distance between a periodic function's maximum and minimum. If the function has several local maxima and minima, the amplitude is half of the distance between the grand maximum and the least minimum. The correct answer to this question is $\frac{1}{2} - (-\frac{1}{2})$= 1 x $\frac{1}{2} = \frac{1}{2}$ **.** In 3.3. the range was also correctly written to be $y \in [-\frac{1}{2}; \frac{1}{2}]$. Moreover, .4. The period of this Sin function is 360^0. In 1.5. The graph is shifted two units down; the new graph is also correctly written g(x)= $\frac{1}{2}$ sin x – 1

The post-task analysis in this research reveals encouraging signs of progress in learner understanding of trigonometric functions after utilising Microsoft Teams. This aligns with previous research highlighting the potential of technology-integrated learning platforms to enhance learner learning (Ebner, 2023). Nomzamo's response (Figure 17) exemplifies this progress. Her accurate graph representation (section 3.1) and calculations for amplitude (section 3.2), range (section 3.3), period (section 3.4), and equation after a vertical shift (section 1.5) demonstrate a grasp of key trigonometric concepts. This suggests that the Microsoft Teams intervention, potentially through PowerPoint presentations, animations, or interactive elements, may have successfully clarified her understanding.

These findings align with Alacar and Olgar (2023), who investigated the effectiveness of dynamic mathematics software for learning trigonometry. They found that visual representations significantly improved learner comprehension, particularly for challenging concepts like amplitude and period. The multimedia capabilities of Microsoft Teams could have provided similar benefits for Nomzamo and potentially other learners. However, the observation that some learners still struggled with post-task questions underscores the importance of differentiated instruction (Mukhtar et al., 2020). The participants' diverse learning styles and prior knowledge likely influenced their responses to the intervention. Here, Microsoft Teams' features can be further exploited. Educators can leverage breakout rooms for targeted support, allowing learners with similar challenges to collaborate and clarify misconceptions (Amelia & Yosintha, 2022). Additionally, the platform's analytics can provide insights into individual learner performance, enabling educators to tailor future interventions to address specific learning gaps.

Figure 18

Nomvula's response to the question about $f(x) = 3\,Sinx \text{ for } 0^0 < x < 360^0$



CAPS Reference	Trigonometry Functions
Topic	Sine - functions

1. Post-Task [45 MIN]

1.1. Make a neat sketch of the following graph $f(x) = 3\sin x$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

1.2. Write down the amplitude of $f(x)$

(90°; 1) Max − min 3
2

1.3. Write down the range of $f(x)$

y ∈ [-3;3]

1.4. Write down the period of $f(x)$

Period 360°

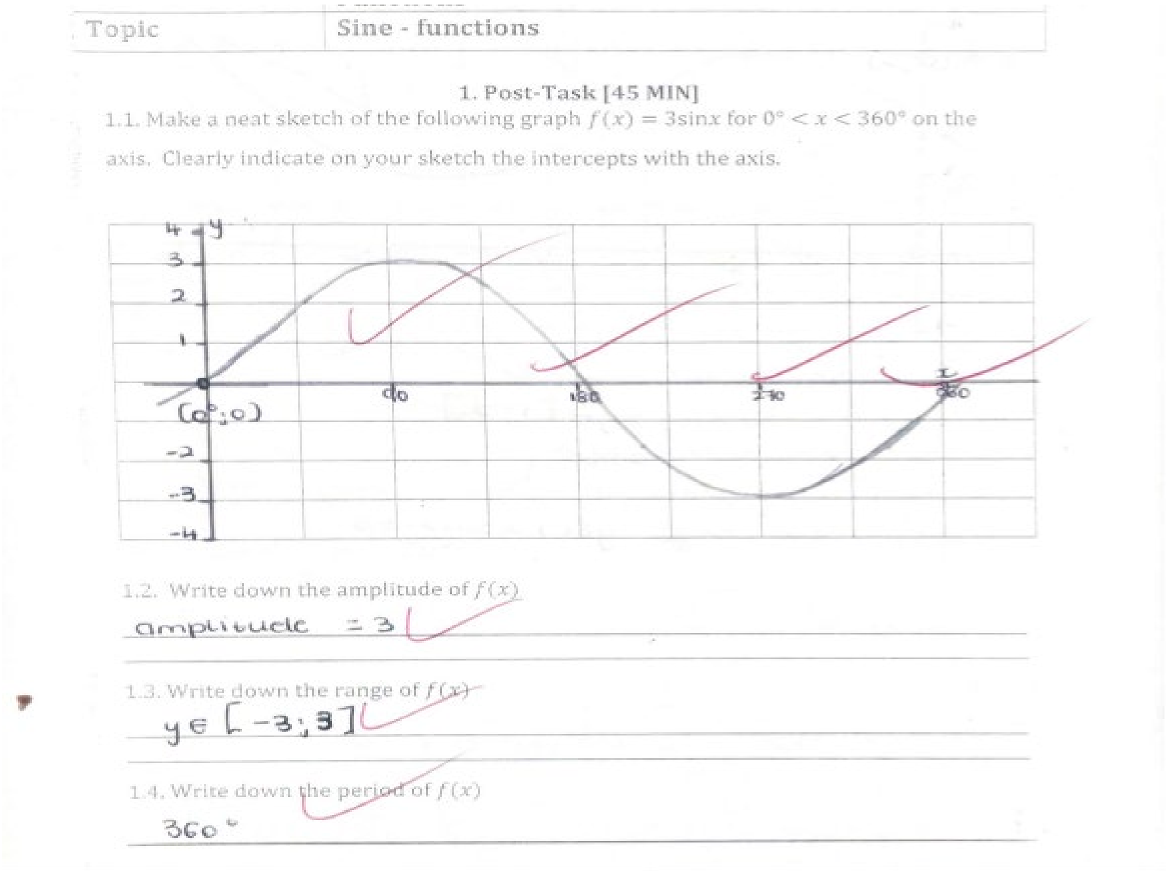
(Taken from participant responses)

Nomvula's response to the trigonometric functions-related question is demonstrated in Figure 18. This response was selected because she approached this topic accurately from 1.1. drawing of the graph accurately in 1.2. where she was supposed to write the amplitude of the periodic function, which is half the distance between a periodic function's maximum and minimum, if the function has several local maxima and minima, the amplitude is half of the distance between the great maximum and the least minimum. The correct answer to this question is 3-(-3) = 6 x ½ = 3**.** In 1.3. the range was supposed to be $y \in [-3;3]$. And 1.4. The period of this Sin function is 360^0 in 1.5. The graph is shifted two units down. The new graph must be g(x)= 3sin x-2

In the post-task assessment, Nomvula's response (Figure 18) offers a compelling illustration of the potential benefits of using Microsoft Teams for teaching trigonometric functions. Her accurate performance across all sections (graph drawing, amplitude calculation, range determination, period identification, and equation adjustment) suggests a significant improvement from her pre-task struggles (refer to the previous discussion). This positive change aligns with research by Liu et al. (2023), who explored the effectiveness of online learning platforms in promoting learner achievement in mathematics. The observed improvement in Nomvula's understanding can be attributed to several factors potentially linked to Microsoft Teams' affordances. The platform's capacity for multimedia presentations might have played a crucial role. Educators could have utilised animations or interactive elements within PowerPoint slides to visually represent trigonometric concepts like amplitude and period. Research by Pulak & Tomaszewska (2014) highlights the effectiveness of such visual aids in fostering learner comprehension of abstract mathematical concepts. Furthermore, the potential for real-time feedback within Microsoft Teams should not be overlooked. The platform's chat functionality or screen-sharing capabilities could have allowed educators to address Nomvula's misconceptions in real-time during the intervention, promoting a more profound understanding (Amelia & Yosintha, 2022).

FIGURE 19

KHADIJAH'S RESPONSE TO THE QUESTION ABOUT $f(x) = 3\ Sinx\ for\ 0^0 < x < 360^0$



(Taken from participant responses)

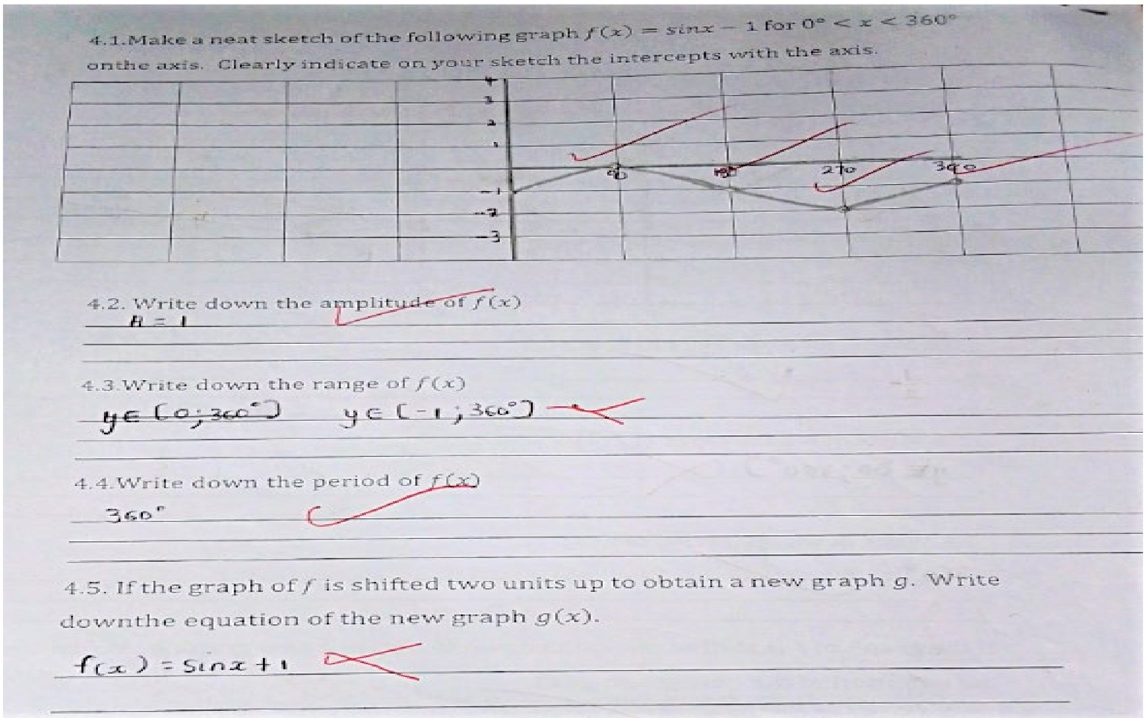
Khadijah's response to the trigonometric functions-related question is demonstrated in Figure 19. This response was selected because she approached this topic accurately from 1.1. drawing of the graph accurately in 1.2. where she was supposed to write the amplitude of the periodic function, which is half the distance between a periodic function's maximum and minimum; if the function has several local maxima and minima, the amplitude is half of the distance between the excellent intervention maximum and the least minimum. Khadijah's response was correct to this question is 3-(-3) = 6 x ½ = 3**.** In 1.3. the range was also correct to be y ∈ [-3;3]. And 1.4. The period of this Sin function is 360^0 . In 1.5. The graph is shifted two units down; the new graph must be g(x)= 3sin x-2

Khadijah's post-task response (Figure 19) adds another promising data point to the discussion. Her accurate performance in all sections (graph, amplitude, range, period, and equation adjustment) mirrors Nomvula's improvement and signifies a positive shift in understanding. This aligns with the work of Samritin et al., (2023), who investigated the effectiveness of blended learning approaches, combining online and face-to-face elements, in promoting learner achievement in mathematics. The Microsoft Teams intervention in this research can be considered a form of blended learning.

Khadijah's success likely stems from factors similar to those identified for Nomvula. Using multimedia presentations within Microsoft Teams (Ebner, 2023) could have provided her with explicit visual representations of trigonometric concepts, aiding her comprehension (Pulak & Tomaszewska, 2014). Additionally, the potential for real-time interaction and clarification within the platform (Amelia & Yosintha, 2022) might have addressed her lingering misconceptions.

FIGURE 20

MNDENI'S RESPONSE TO THE QUESTION ON TRIGONOMETRIC FUNCTIONS



(Taken from participants responses)

Mndeni's response to the trigonometric functions-related question is demonstrated in Figure 20. This response was selected because she approached this topic without difficulty and misunderstanding in 4.1. The graph was accurate, and 4.2. the amplitude of the periodic function was correct. It is half the distance between a periodic function's maximum and minimum. If the function has several local maxima and minima, the amplitude is half of the distance between the great maximum and the least minimum. The correct answer to this question is 0-(-2) = 2 x $\frac{1}{2}$ = 1. In 4.3. Unfortunately, the range was supposed to be y ∈ [-2;0] She got it wrong. In 4.4, the period of this Sin function is 3600, which is correct. In 4.5, the graph is shifted two units down; the new graph must be g(x)= sin x, which was also incorrect. This suggests that they also had less trouble responding to the questions post-task.

Mndeni's post-task response (Figure 20) offers a mixed picture. While she demonstrates a clear improvement compared to the pre-task (Figure 15), some misconceptions remain. Her accurate performance in calculating amplitude (section 4.2) and identifying the period (section 4.4) suggests a grasp of these concepts. However, errors in determining the range (section 4.3) and writing the equation after a shift (section 4.5) highlight the need for further targeted support. This finding aligns with the work of Khalid et al. (2023), who emphasised the importance of formative assessment in online learning environments. They argue that ongoing evaluation allows educators to identify knowledge gaps and tailor instruction accordingly. Mndeni's case exemplifies this point. While the Microsoft Teams intervention benefited her understanding, some areas require additional attention.

The potential causes of Mndeni's partial misconceptions can be explored. Limited exposure to the concept of range in the intervention materials or a lack of clarity during the presentation could explain her mistake in section 4.3. Similarly, her struggle with equation adjustment (section 4.5) might be due to difficulty visualising the impact of the vertical shift. Microsoft Teams' features can be leveraged to address these specific needs. Educators can utilise the platform's chat functionality to provide Mndeni with personalised feedback on her errors (Amelia & Yosintha, 2022). Additionally, screen sharing can be used to demonstrate the concept of range visually and revisit the steps involved in adjusting the equation after a vertical shift. Mndeni's case underscores the importance of a nuanced understanding of learner learning. While the Microsoft Teams intervention demonstrably improved her understanding of some trigonometric concepts, it is crucial to acknowledge the need for ongoing assessment and differentiated instruction to address any remaining knowledge gaps fully.

6.4.2. Responses from semi-structured interviews

Maher (2018) argues that understanding qualitative data necessitates thorough and insightful engagement with the data. Furthermore, the researcher must employ innovative cognition to analyse the data, formulate hypotheses, and comprehend the overall meaning. The interpretation of research findings is contingent upon the imaginative capacity of researchers. Researchers immerse themselves in data to streamline their jobs, utilising it as a repository of factual information and a wellspring of imaginative stimulation. Research methodology invariably entails engaging with the data. Erlingsson and Brysiewicz (2017) argue that there is a common point of departure. Transcribed interview materials are commonly utilised for qualitative content analysis.

Qualitative content analysis aims to condense substantial material into a concise and coherent presentation of the primary discoveries. Throughout the analysis process, from explicit and direct information to underlying implications, the unedited data obtained from word-for-word transcribed interviews are progressively condensed to generate distinct categories or themes. The interviews conducted with learners served as the concluding phase in the data collection process for this research project. The interviews were conducted according to an interview schedule that consisted of a set of open-ended questions.

Utilising the interview schedule as a tool, the researcher collected data that could be connected to the primary research questions and pursued a line of inquiry pertinent to the research issue. According to Roberts et al. (2019), interviews, which are used in this case research, are a feature of descriptive research that thoroughly explains occurrences in plain language and enables a complete evaluation of a particular episode. The objective is to comprehend objects through the interpretations assigned to them by people. Analysing this descriptive data enables the discovery of novel perspectives, ideas, and concepts. The researcher endeavours to gather a wide range of perspectives while avoiding any prejudice stemming from their worldview, even though their ontological and epistemological perspective may influence their investigation. Initially, the interview participants showed a slight unease and exhibited reluctance to provide open-ended responses to the questions. The participants were more at ease and started to respond to the questions with less inhibitions when the instructors informed the learners that there were no correct or incorrect answers and that probes and prompts would guide them. According to Castleberry and Nolen's (2018) opinions, the researcher in this research faithfully transcribed the data. The participants' genuine verbatim comments are quoted to support the data display and discussion. Given that this research falls under the category of qualitative research, the researcher tried to capture the participants' real experiences through their words and views.

In every interview conducted as part of this research, the participants said that using the Microsoft Teams Platform in the mathematics curriculum improved learners' understanding of trigonometric functions. Participants admitted that they encountered difficulties with the different subtopics comprising the syllabus's trigonometric function coverage. These difficulties included identifying the horizontal and vertical shifts and the change of amplitude and period. However, after watching the PowerPoint presentation on Trigonometric functions, the learners felt more comfortable confronting issues related to the research of trigonometric functions.

6.4.3. The Effect of the Microsoft Teams Platform on Learning TrigonometricFunctions

Microsoft Teams Platform transports learners to a multidimensional environment where mental, emotional, and perceptual processes are interwoven. As a result, their learning experiences and preferred learning approaches help to shape how they view learning (Cheng, 2018). In the 21st century, governments worldwide have made enormous investments in learning technology used in classrooms (Kearney et al., 2017). Additionally, Magdalene and Sridharan (2018) define learning technology as the area of technology that supports creating and using tools that support or promote education.

It can also be understood as the research and implementation of using, producing, or managing technological resources to streamline the educational process. Online learning may be defined as instruction that is given digitally and is designed to facilitate learning. Using the resources at hand and improving the remote learning experience streamlines the online learning process. This research uses the Microsoft Teams platform in the form of eLearning, as defined by Magdalene and Sridharan (2018), to encourage a better grasp of technological functions in mathematics, a subject many learners find difficult in the classroom.

The advantages of adopting technology in education are also no longer debatable, according to Agrawal (2019), as it permeates every aspect of our lives. The main advantages of the Microsoft Teams platform for education are that it allows for self-paced and customised learning, improves future readiness, fosters engagement and interaction, and makes learning more fun. Digital device use in teaching and learning is becoming increasingly common in educational institutions worldwide. This research will look into their perceptions to better understand how Grade 10 learners perceive using technology to learn trigonometric functions in mathematics. Thus, it is crucial to this research's findings that we draw attention to the rapidly expanding sector of the economy that supports technology in education.

6.4.4. Findings From Semi-Structured Interviews

Learners were asked to respond to a series of questions during an interview to understand more about how grade 10 learners perceive using the Microsoft Teams platform. The data findings that address the main research question are given in this part. It was clear from the interviews and observations that the Grade 10 learners who took part in this research learned trigonometric functions better due to using Microsoft Teams. All learners appeared to agree that using the Microsoft Teams platform to learn mathematics improved their comprehension of trigonometric functions, making them seem more approachable and straightforward.

Based on the answers given by learners to the pre-task questions, 55% of learners showed a lack of understanding in performing calculations that involved using trigonometric functions. However, the responses recorded after the Microsoft Teams platform intervention reveal that 72% of learners were more involved in the task and had deeper participation in the activities, which led to more precise answers to the questions.

The unanimous agreement among learners regarding improved comprehension (through interviews and observations) resonates with previous research by Zhou & Zhang (2023), who explored the benefits of online learning platforms in mathematics education. The learners acknowledge that Microsoft Teams made trigonometric functions seem "more approachable and simpler," suggesting a positive shift in their perception of the subject. This qualitative data complements the pre-task finding that 55% of learners struggled with trigonometric function calculations. The post-task increase to 72% of learners demonstrating deeper participation and providing more precise answers signifies a noteworthy improvement. This aligns with the work of Samritin et al., (2023), who investigated the effectiveness of blended learning approaches in promoting learner achievement. In this context, Microsoft Teams can be viewed as a form of blended learning, combining online elements with classroom instruction.

The positive learner perceptions can be attributed to several potential factors. The Microsoft Teams platform might have facilitated a more interactive learning experience than traditional methods (Amelia & Yosintha, 2022). Features like polls, quizzes, and breakout rooms could have fostered engagement and deeper understanding. Additionally, multimedia presentations within Teams (Ebner, 2023) could have provided learners with explicit visual representations of trigonometric concepts, enhancing their grasp of the subject matter (Pulak & Tomaszewska, 2014).

6.4.4.1.What are Grade 10 Learners' Perceptions of Using Microsoft Teams as an Online Learning Platform for Learning Trigonometry Functions in Mathematics?

In the interviews, learners were asked the following question in answer to the first important research question: How do you feel now that you have had to complete this activity using the Microsoft Teams online platform? Khadijah answered that she enjoyed viewing the explanations for all the trigonometric functions. It was distinct from how it was previously taught in class.

Khadijah: *"...I enjoyed viewing the explanations of all the trigonometric functions. It was distinct from how we had previously handled trigonometric functions in class."*

The learner interviews in this research offer a window into the positive impact of Microsoft Teams on learner perception and understanding of trigonometric functions. Khadijah's response to the prompt: "How do you feel now that you have had to complete this activity using the Microsoft Teams online platform?"

Khadijah: *"...I enjoyed viewing the explanations of all the trigonometric functions. It was distinct from how we had previously handled trigonometric functions in class."*

This sentiment highlights a crucial point – trigonometry can be a challenging topic for beginners Atilgan (2021). Khadijah's enthusiasm suggests that Microsoft Teams presents a refreshing alternative to traditional teaching methods. Further analysis strengthens this claim. All 23 participants reported that Microsoft Teams facilitated their comprehension of trigonometric functions. Several factors contributed to this positive perception. Learners specifically mentioned the PowerPoint presentations as a source of clarity. Mndeni, a first-time online learner, expressed,

Mndeni: *"It was the first time I used online learning, but the Microsoft Team's online platform learning made it easier for me."*

Similarly, Nomvula echoed this, highlighting the positive emotional experience and improved understanding gained through Microsoft Teams (Nomvula, as cited in the text). These experiences resonate with the work of Clark et al. (2003), who advocate using multimedia learning principles to enhance learner engagement and knowledge retention. The PowerPoint presentations within Microsoft Teams, incorporating visuals alongside explanations, likely contributed to the improved comprehension reported by the learners. Beyond clear explanations, the platform's use of manipulatives appears to have instilled confidence when tackling problems.

Ntando's comment exemplifies this,

Ntando: "*I feel great because I learned new things I was unaware of before using Microsoft Team's online platform*".

This aligns with research by Moyer-Packenham (2020), who highlights the value of manipulatives in promoting a deeper understanding of mathematical concepts. By allowing for the integration of such tools, Microsoft Teams fosters a more interactive learning experience. The positive impact of Microsoft Teams extends beyond individual learner experiences. By fostering active engagement and a deeper understanding of the material, the platform can promote meaningful learning construction (Wang et al., 2020). This highlights the importance of continued exploration and using Microsoft Teams as a valuable pedagogical tool.

As a mathematics educator, I uncommonly hear learners express satisfaction with their progress in understanding trigonometric functions. Trigonometric functions are the part of mathematics that beginners find difficult and perplexing. The learner's compliments in the clip above demonstrate the good effects of using Microsoft Teams as a teaching tool. In light of the excerpt above, more analysis found that participants generally agreed that using Microsoft Teams to research trigonometric functions in mathematics made it easier to comprehend them.

The learner's compliments demonstrate the benefits of using Microsoft Teams as a teaching tool. All 23 participants, it was discovered, concurred that seeing the PowerPoint presentations from Microsoft Teams made trigonometric functions more straightforward to comprehend. Participants found it more straightforward for a variety of reasons. Learners expressed optimism when they mentioned that the explanations given in the PowerPoint presentation enhanced their understanding of the material taught in class.

Mndeni: "… *It was the first time for me to use online learning, but the Microsoft team's online platform learning made it easier for me."*

Nomvula: "*... I feel so happy that I got to learn trigonometric functions at home. It was the best feeling ever. I had such a wonderful experience, and I understood many things I lacked.*"

Additionally, using manipulatives enabled them to tackle the trigonometric function problems on the worksheet with greater confidence. Mendoza and Mendoza (2018) corroborate the learners' assertions by stating that utilising suitable and innovative resources and strategies, such as integrating Microsoft Teams in mathematics activities, enhances learners' cognitive adaptability by fostering the exploration of multiple solutions to a given problem. Another learner seemed upbeat when she said that the explanations provided in the PowerPoint presentation added to the knowledge covered in class and, through manipulatives, allowed her to approach the trigonometric functions problems on the worksheet with more assurance.

Ntando: *"... I feel great because I learned new things I was unaware of before using Microsoft team's online platform."*

Additionally, it facilitates the processes of meaningful learning construction by allowing a more extensive deployment of learners' cognitive resources; for this reason, it is crucial to encourage using the Microsoft Teams platform as a teaching tool. Because the Microsoft Teams platform can provide an atmosphere where learners can learn successfully, it offers an alternative form of education in the classroom as ICT is more integrated into both learning and teaching. The research results support the idea that online learning is more efficient for gaining mathematical information when supplemented with traditional in-person instruction.

6.4.4.2. How Effective is Microsoft Teams as an Online Learning Platform In Helping Learners Improve their Knowledge of Trigonometric Concepts?

The next section of the research presents and analyses participants' responses to the second key research question: How effective is Microsoft Teams as an online learning platform in helping learners improve their knowledge of trigonometric concepts? To help learners comprehend the material, exercise critical thinking, and broaden their learning opportunities, the participants in this research used the Microsoft Teams platform as a learning tool to supplement their research of trigonometric functions. The PowerPoint presentation helped energise the learning process and inspire a more profound comprehension of mathematical trigonometric functions.

The participants reported improved knowledge of trigonometric concepts after using Microsoft Teams. Therefore, the research found that Microsoft Teams was an effective online platform for helping learners improve their knowledge of trigonometric concepts.

Wine: "*…I feel more knowledgeable and more informed…*"
Ntando: *"…Yes, I found that using the Microsoft Teams platform helped me learn about trigonometric functions. I understand the plotting of different trigonometric graphs. Moreover, I can interpret the graphs now easily. It helped me to learn concepts like amplitude and the period of different functions. All in all, it was great to use this platform for learning…*"
Nomzamo: *"…The Microsoft Teams platform helped me in learning about trigonometric functions. I learned things I did not know before, like the starting point of different functions, basic shapes of different trigonometric graphs, and the effects when it increases and decreases…*"

The word cloud below shows some standard trigonometric-related functions in which the participants improved. It also shows which concepts learners learned when using the Microsoft platform. All learners said they had improved their knowledge of trigonometric functions and related concepts, with some going further to explain the specific functions they had improved. As substantiated by the data presentation, learners improved in plotting and interpreting graphs. Some learners said they understood cosine, tan, a, and q functions more.

6.4.4.3. How Can Microsoft Teams as an Online Learning Platform Facilitate Learning, Collaboration, Self-Efficacy, and Engagement In Trigonometric Functions? Why?

The third main research question was: How can Microsoft Teams as an online learning platform facilitate learning, collaboration, self-efficacy, and engagement in trigonometric functions? Why? The research's participants were able to pinpoint reasons for debate. The educational institution where this research was conducted grants access to computers, email, and the Internet to all personnel, including teachers, administrators, and members of management. Learners in schools cannot access any other technological devices; they only have their smartphones. The projector and screen in the school's computer lab are accessible to teachers. High school learners regard trigonometric functions as a complex and tedious topic. Therefore, learners would welcome any departure from the dull, traditional techniques teachers typically use to teach trigonometric functions. Many participants mentioned how understanding trigonometric functions was enjoyable and engaging throughout the presentation. Learners appeared to uncover a more enjoyable aspect of learning, which can help ease their concern about mathematics.

Microsoft Teams proved an online learning platform that facilitates learning, collaboration, self-efficacy, and engagement in trigonometric functions. Interventionimonies of improvement knowledge demonstrate the extent of learning the learners were engaged in. One of the respondents said,

Mndeni: *"... I got to know the plotting of different trigonometric functions, especially about sine and cosine, because I understand those now and interpret all functions and be able to respond to different questions.*"

6.4.4.4. Collaboration

Internet connectivity due to load-shedding presented challenges to online learning for the learners in this research. Some learners had to move around their homesteads looking for spots with good internet connectivity, which meant they missed some sections of the teacher's teaching. However, the collaborative learning function of Microsoft Teams allowed learners to 'catch up' as they could get assistance from fellow learners with whom they had been placed into a group.

Nomzamo: "*...I only realised that the class had left me behind, but I did catch up because my other classmates helped me with their questions, and I will listen when the teacher repeats the aspect I missed."*

6.4.4.5. Self-efficacy

The research participants expressed improved confidence in solving trigonometric problems after using Microsoft Teams as an online learning platform. Learners expressed confusion and limited knowledge of trigonometric functions, which improved after online learning. They expressed being more confident, knowledgeable and informed so they could complete all assignments they were tasked to do.

The participants said,

Snenhlanhla: "…*I am feeling thrilled at the same time. I am so glad I have completed these activities easily using the Microsoft team's online platform, especially because doing Trigonometric functions was a trouble for me and posed a big challenge.*"

Another learner said she can now confidently say she understands the plotting of different trigonometric graphs and the effects of a and q in different graphs. I am in a better position to interpret them now.

Alwande: *"...I can now confidently say I understand the plotting of different trigonometric graphs and the effects of a and q in different graphs. I am in a better position to interpret them now."*

6.4.4.6.Engagement

Participants' responses show intensive engagement with the learning platform and the trigonometric functions. Some learners expressed difficulty in understanding before online learning via Microsoft Teams. However, their knowledge and understanding of trigonometric functions improved by actively engaging.

The participants' responses make it clear that enjoyable teaching and learning approaches are necessary to keep learners interested because it might be challenging to regain them after losing them. Furthermore, according to Lee and Chan (2019), learners will be more motivated to research mathematics if learning can be made more enjoyable and entertaining. Furthermore, developing future-proof qualities such as effective communication, reasoning ability, creativity, critical thinking, and problem-solving prowess will be facilitated. By allowing learners to create, exchange, and talk about games-based puzzles for others to solve, it is believed that they would be inspired to produce and share knowledge and, as a result, develop a more substantial respect for math and technology. Similarly, Rahayu, Putri, Zulkardi, and Hartono (2019) emphasise the significance of tailoring learning activities to advance the times and make learning enjoyable. According to the participants, using the Microsoft Microsoft Teams platform to research trigonometric functions helped them retain what they had learned. Seeing the illustrations and graphics made the learning material more approachable for them because they could use more than one sense.

Using the Microsoft Teams platform in the classroom helps learners acquire language, mathematics, problem-solving skills, and memorisation Rahayu et al. (2019). According to earlier studies, integrating Microsoft Teams in the classroom can broaden learners' experiences and encourage active learning. In computer-based contexts, popular mediums for aiding mathematics idea visualisation include animations and mathematics manipulatives. Some learners believed that this new approach to mathematics had improved their understanding of abstract mathematical ideas and, as a result, improved their memory (Fabian et al., 2018). Additionally, the research results by Dele-Ajayi et al. (2019) provide perspective on how the introduction of digital technology, particularly in environments where it had not been used before, alters the dynamics of the traditional classroom. Mathematical classrooms should include techniques for making learning fascinating and adventurous to make it a more engaging experience for learners. There has to be a change from the traditional teaching methods to ones that engage learners better by appealing to several senses. In their remarks about the employment of the Microsoft Teams platform as a novel means of sharing knowledge about trigonometric functions in mathematics, learners' learning experiences were expressed. The learners described it as an alternative learning experience that had captured their interest to the point that this Microsoft Teams platform-based education would have a lasting impact on them.

Khadijah: "*...I had never seen a math movie before... I learned a lot and truly loved it.*"

Nqubeko: " *...This was the first time a laptop had been used for arithmetic. Complete our other topics in this manner will be enjoyable."*

It is usual for learners to regard anything new as novel when they are first exposed to it. This was accomplished by introducing learners to various teaching methods that they could identify with, which helped the knowledge stick in their brains. Collins and Halverson (2010) contend that individuals employ emerging technologies to acquire knowledge in every conceivable location. For example, individuals are engaging in interactive simulations that present them with complex scenarios, learners are attending online high schools and colleges, and adults are utilising social media platforms. The emergence of technological innovations such as the Microsoft Teams platform presents educational institutions and colleges with novel challenges in terms of learning opportunities. As a result of technological advancements, learners and teachers are transformed from being sources and providers of knowledge to facilitators and partners in learning. Using technology-based media like Microsoft Teams is one of the tasks of the teacher in enhancing the efficacy of learning in the classroom (Rahayu et al., 2019).

All ages are now able to engage in learning on their own terms, as a result of these emerging learning niches. Almost unanimously, the Microsoft Teams platform has had a transformative impact on society. It presently influences individuals' capacities to read, write, compute, and reason; these are the fundamental challenges in education. Nevertheless, the Microsoft Teams platform has been maintained at a distance from schools, typically only being used in particular programs (Collins & Halverson, 2010). Mendoza and Mendoza (2018) emphasize that technology like the Microsoft Teams platform is a different innovation resource that aids learners in enhancing their learning by effectively comprehending knowledge. Learners reported feeling more at ease and less worried about learning trigonometric functions after the Microsoft Teams platform-based lesson's intervention. There was a sense of confidence among some of the learners, as seen by their remarks, that they would be able to remember the knowledge they had learned.

The Grade 10 learners in this research have had a favorable learning experience as a result of the usage of the Microsoft Teams platform in teaching trigonometric functions. When the novelty and entertaining components of the lesson are combined, it will undoubtedly be an event that learners will remember. The use of the Microsoft Teams platform in the class has altered the learners' mindset, resulting in a sense of self-assurance that stems from an awareness of their capacities for memory retention. The following comment demonstrates this shift in attitude toward learning.

Sandiso: *"…Microsoft Teams made me to love mathematics so much that I don't have to worry about drawing the graphs…"*

Nomvula: *" … This is the section I was lost when it is taught but from now on, although there are some parts, I am struggling to understand but I am willing to spend more time in trying to understand them."*

The attitude of learners toward the subject at hand is one of the barriers to good mathematics learning, according to Segumpan and Tani (2018). Teachers are now faced with the problem of designing a learning environment that uses the Microsoft learning platform outside of the scheduled classroom instruction to cater to the interests of 21st-century learners. Microsoft Teams platform also lightens the mood while discussing mathematics and supports learners' expanding areas of interest. The optimistic view from Ann's aforementioned comment shows that learners have adopted a more self-assured attitude while they work on mastering trigonometric functions. In many schools, mathematics anxiety is a widespread issue.

Richardson and Suinn (1972) initially defined mathematics anxiety as a condition characterised by distress and apprehension that hinders an individual from engaging in numerical manipulation and solving mathematical puzzles across various academic and practical settings. Evangelopoulou et al. (2019) claims that mathematics anxiety still impacts our culture and young people's progress and achievement in the subject. Effective pedagogical strategies, including collaborative group work, mathematical discourse, inquiry-based learning, speculative writing, problem-solving instructional methodologies, content integration, and the Microsoft Teams platform, can potentially alleviate learners' apprehension towards mathematics. Likewise, according to Celik (2018), mathematics anxiety is a profound sense of powerlessness or frustration regarding one's mathematical aptitude.

Sandiso: *"…Microsoft Teams relieved me that I do not have to worry. It taught me more relaxed and less anxiety…"*

Mndeni: *"... I used to be anxious every time the Mathematics teacher calculated the amplitudes, determining periods of different functions, but Microsoft Teams make it easy for me because the graphs are drawn into scale…"*

Mathematical anxiety is the word used to describe the intense unease and feelings of worry that learners experience when thinking about or doing mathematics. How teachers present their lessons may impact how anxious learners are about mathematics. To overcome mathematics anxiety, we must look at the classroom setting and how mathematics is taught there. Addressing learners' fear and low self-esteem, boosting their confidence, and changing their attitudes about mathematics is vital. Learners who may be afraid of mathematics might develop a positive attitude toward learning the subject using the Microsoft Teams platform and new teaching and learning approaches.

One of the most effective ways to allay the worries of learners is to increase their appreciation of mathematical computation. As shown above, participants' responses highlight the necessity for the Microsoft Teams platform to be included in mathematics curricula to support effective teaching and learning. A common theme running across all of the comments is the notion that learning became more straightforward as a result of the usage of the Microsoft Teams platform. Similar ideas could be seen in the comments given by the research's participants, showing that the Microsoft Teams platform may be employed as a motivating tool in mathematics teaching and learning activities. It quickly became apparent that having the lesson presented as a PowerPoint had a good impact on engagement among learners, encouraging deep and active learning.

6.5. Summary

This chapter meticulously analysed findings from diverse data collection methods, comprehensively understanding the research's outcomes. It examined quantitative data from pre- and post-task stages, qualitative insights from interviews, and theoretical frameworks guiding the research's methodology. The synthesis of these findings aims to underscore their implications in educational technology and mathematics education. Theoretical concepts like socio-constructivism, connectivism, ZPD, scaffolding, and collaborative learning were integrated into learners' experiences. Utilising the Microsoft Teams platform created a dynamic learning environment where these theories influenced interactions among learners and with the content. This facilitated a blend of individual and collaborative learning experiences, aligning with pedagogical principles. Chapter six highlighted the significant potential of the Microsoft Teams platform in enhancing Grade 10 learners' understanding of trigonometric functions. It emphasises the platform's impact on fostering an engaging, collaborative, and confident learning environment, contributing valuable insights to educational technology and mathematics education. These findings pave the way for further exploration in Chapter Seven within the broader context of the educational landscape.

Chapter Seven: Discussion of Findings

7.1. Introduction

In chapter five, the findings were presented and analysed according to the data gathered for this research. The method of data analysis was covered, and the semi-structured interview extracts were analysed. This chapter builds on that analysis by discussing the key findings that emerged from the presentation and analysis of the data. This chapter presents the major themes that emerged from the research data. It highlights how the Microsoft Teams platform provides a more engaging and enjoyable learning environment, enhances knowledge retention, and offers a distinct educational setting. Additionally, the chapter discusses how collaboration fosters a positive attitude towards learning trigonometric functions and reinforces key trigonometry concepts and skills.

There will also be a discussion on how the Microsoft team's platform supports the learning process in situations where learners' languages may differ. The effective use of the Microsoft team's platform to encourage multimodal learning and expose learners to other approaches to learning is then looked at. Following that is more discussion on how the Microsoft Teams platform facilitates understanding trigonometric functions and the relationship between online-enhanced learning, scaffolding, and the ZPD. Studies using descriptive content analysis vary in techniques and are not based on a particular qualitative tradition. Reading and reviewing the data, looking for themes, emotions, and the unexpected while considering the big picture are the first steps in analysis to get a feel of the entire research. The primary objective of the content analysis is to find themes and connections between and within the data (Korsjens & Moser, 2018). According to Castleberry and Nolen (2018), a qualitative data analysis model may be broken down into five steps: compiling, deconstructing, reassembling, interpreting, and drawing conclusions.

According to Erlingsson and Brysiewicz (2017), content analysis is a qualitative analysis-related reflective procedure. Consequently, identifying and condensing meaning, classification, and categorisation units are continuous. Ongoing processes consist of coding and categorisation, followed by a review of the raw data in light of the initial analysis's findings. The analysis entails a dynamic and introspective procedure of manipulating data and reworking it to identify correlations and associations. After coding condensed meaning units, it becomes easier to identify trends, obtain a broader perspective, and classify codes.

According to Braun & Clarke (2021), the ultimate objective of the analysis is to present various answers concisely throughout the breadth of a project. The researcher's extensive analytical work to discover and comprehend structured meaning across the dataset led to the developing themes conceived as meaning-based patterns. Themes are generated, moulded, and endowed with significance through data, scientist subjectivity and experience, and research inquiries. This chapter will focus on the fundamental themes extracted from the data, which are essential for investigating the research aims and inquiries.

7.2. Emerging themes in how the Microsoft team's platform is used

This chapter examines the application of the Microsoft team's platform in facilitating the understanding of trigonometric functions among 10th graders. The analysis is based on thematic reflection and discourse of data collected through interviews, observation, pre-and post-task, and verbal expressions. Cormack et al. (2018) define thematic analysis as constructing themes from qualitative verbal expressions, codes, and patterns of recurrence, evaluation, or correlation within these themes. Thematic analysis can integrate various forms of data and is particularly advantageous when investigating experiences, perceptions, and comprehensions. This approach exhibits versatility as it can be applied across multiple theoretical frameworks and analyse a broad spectrum of qualitative data. Additionally, large, small, and medium-sized data sets can be analysed with this method. As a result, thematic analysis was a suitable approach for examining the data during this research inquiry.

It might be challenging to navigate the themes of qualitative analysis. Finding themes pertinent to the researched topic, the research question, the research setting, and the theoretical framework is a step in the process. The aforementioned approach enables data to be both described and meaningfully interpreted. The goal is to create conceptual categories to create concepts or themes for each category. The following themes discuss the learners' perceptions as they relate to my research objective: to explore how learners perceive using the Microsoft Teams platform while learning trigonometric functions.

7.2.1. Microsoft Teams Platform as a More Engaging and Enjoyable Learning Environment

It might be claimed that learner interaction is equally important for engaging learners in their engagement with the educational system in online learning. According to findings from research by Banna et al. (2015), learner-learner interactions and teacher-learner interactions should always be planned to expand the forum for communicating each activity in the teaching and learning process. Since it offers messaging, conference features, a discussion room, and a platform to share files and evaluate performance, it appears that the Microsoft Teams platform tends to agree with this online learning component.

Similarly, Xianfang (2019) notes that current online technology has been popularised and implemented in teaching with the development of scientific and related technology techniques, which has aided in the advancement of educational endeavours.The teaching idea in traditional instruction has been altered due to the implementation of the Microsoft Teams platform, and the teaching strategy has been developed. In this research, online-assisted learning was added to the standard teaching and learning process in order to include Microsoft Teams. The lesson on trigonometric functions in mathematics was delivered using a PowerPoint presentation by the research of Purwanti et al. (2021). Trigonometric functions are often a challenging portion of mathematics for learners, but they were eager to master them using the screen-shared PowerPoint presentation. Since the Microsoft Teams platform allowed them to visualise the topics being taught, learners who often perceive trigonometric functions to be a challenging area of mathematics were enthused about researching trigonometric functions.

It was clear from the interview replies that every learner who replied to question one mentioned how using the Microsoft Teams platform to teach trigonometric functions made the mathematics course more interesting and fun. The enjoyable learning component is consistent with Celik's (2018) current literature, which maintains that learners actively participate in the learning process as long as the subject's content and instructional strategy are enjoyable and engaging. As a result, making appropriate selections for teaching activities throughout classroom procedures is important for learning. Saylan et al. (2018) contend that a lack of technological advancements in the classroom impacts learners' attitudes, motives, and interests in the topic and their ability to participate in and enjoy the lesson. Learning will not stick if learners cannot learn while having fun. Online learning and technology are intertwined with mathematics research. Consequently, technological advancement in online blended learning should be present in every lesson. Khadijah and Mndeni were confident throughout the interview session for this research that adding the Microsoft team's platform to the mathematics class had altered their perspective on researching trigonometric functions to one of pleasure and enjoyment. Asanda expanded on this notion of appreciating the Microsoft team's platform-enhanced instruction, perceiving the platform as more engaging and enjoyable than using the board in a classroom.

Rarely do learners acknowledge enjoying themselves while researching mathematics. However, the Grade 10 learners in this research appeared to have appreciated the Microsoft Team's platform-enhanced lecture to the point where they highlighted the enjoyable nature of learning mathematics to communicate their delight. Mndeni acknowledged that learning using the Microsoft Team platform was fun. Learners must actively interact with the learning material and classroom activities for meaningful learning. The role of educators is to facilitate learners' realisation of their maximum learning capacity through utilising available resources and implementing innovative pedagogical approaches. The ability to hold learners' attention or interest continues to be a struggle for teachers, who face their learners' various and heterogeneous personalities daily.

The level of engagement of each learner in classroom-based instruction determines its success. An alternative to traditional, boring, and regular teaching is required to increase learners' attention and pique their curiosity. Making math lessons more approachable and appealing to learners will require taking new steps, such as having fun while learning. This research has highlighted that integrating Microsoft Teams into learning trigonometric functions has altered learners' attitudes about learning to one of delight and fun. Since learners learn most effectively when having fun, it fosters meaningful learning when the learning process is viewed as a fun activity.

7.2.2. Strengthens the Learned Knowledge

Remembering what has been learned emerges from considering the enjoyable part of learning. Learning that has been enhanced technologically makes it easier for learners to recollect what they have learned, which improves their performance in a topic. In this regard, learners believed that without Microsoft teams in the classroom, learning would be complex, they would revert to recitation, and their learning would not be long-lasting. Additionally, this circumstance may impact learners' learning motivation, attitudes toward the subject, engagement in the session, and ability to learn while having fun (Saylan et al., 2018).

The learners compared the usage of Microsoft Teams in delivering a mathematics lesson to their experience of watching a film, effectively capturing the heart of this theme, which concerns remembering what has been learned. Most of the time, learners are intrigued by the films they view, and they can recollect the most important details. They occasionally possess the rare capacity to recall their experiences in great detail and to recount the tale to others for a considerable amount of time. Nomzamo thought the trigonometric functions lesson given via Microsoft Teams screen sharing was akin to viewing a blockbuster film. This would indicate that the information from the trigonometric functions lesson will also be retained in memory and relied upon as needed.

Given that learners' progress is defined by their ability to complete formal assessment tasks, all stakeholders must consider this while developing learning strategies. Learning outcomes increase at school when learners do well on assessment interventions due to their improved memory and recall of essential material. One learner was confident she would remember what she had learned in the technology-infused trigonometric function session. Zaranis (2019) asserts that most learners in developed nations now possess electronic devices and mobile phones, immensely favoured by young learners irrespective of their ethnic or social heritage. This trend is rapidly broadening. As a result, learners may readily identify with and relate to implementing digital technology in the classroom.

Learners were mesmerised by the images on a screen. Since this research entailed teaching a mathematics lesson using the Microsoft Teams platform, learners accepted the Microsoft Teams-enhanced lesson as something they would remember since it resembled films they often watch on their televisions. This attitude of today's learners demonstrates that learning is most successful when learners are given the freedom to do so. Technological devices made learners more involved in the session, which, in turn, helped them remember the lesson's material.

7.2.2.1. Learning of Concepts Despite Learners' Linguistic Diversity

This research aimed to develop learning activities that consider the diversity of learners and individual differences. Bussi and Sun (2018) posit that linguistic variations extend beyond phonetics, lexicon, and syntax to encompass diverse speaking cultures. Language plays a common and crucial role in communicating mathematical concepts for learning, teaching, and the growth of mathematical thinking. The linguistic qualities of language can facilitate understanding in learning discourse and make numerical ideas more transparent. Therefore, by conducting a cross-cultural analysis of languages, we can understand the linguistic constraints and support that may facilitate or impede the acquisition of mathematics by learners and the instruction of it by teachers.

Most participants in this research were non-native English speakers from their childhood. However, at Hope High School (the research site), where all mathematics classes are taught, English is the language of instruction and learning. This might be a contextual issue that hinders the learning process and keeps the research participants from learning well (Bussi & Sun, 2018). The mathematical notion of trigonometric functions, which is already tricky for learners to grasp, is accompanied by many new terms, concepts, and terminology that some learners may find difficult to comprehend and interpret. Learners encountering unfamiliar terminology might not completely comprehend what is being taught. Learners frequently tend to become disinterested in the class when they do not entirely grasp what is being taught. Losing interest or engagement in any learning component might hinder the learners' ability to advance in the future.

English throughout the Curriculum (EAC) is one of the cornerstones of the teaching principles outlined by the CAPS curriculum. Even if the language is presented to the learners, not every learner may fully grasp the principles. The learner can better comprehend the concepts associated with the trigonometric function learning material since it is presented graphically, making it possible for them to perceive precisely what the words imply. The comments of some of the learners, who claimed that they only comprehended the words after watching the PowerPoint presentation, reveal the ambiguity around the use of terminology like "Amplitude" and "Period." Using graphics, learners gained knowledge of mathematical ideas and procedures thanks to using Microsoft Teams. Even though the PowerPoint presentation was in English, visuals helped learners who had trouble understanding the mathematics lessons when provided in English. Using images and other illustrations helped learners understand the full significance of what was being taught by demystifying and decoding any unclear notions. In a nutshell, the learners could grasp what was intended in the visuals if they did not understand what the teacher was saying.

Hughes et al. (2019) point out that educators encounter significant obstacles in fulfilling the learning demands of different learners in the classroom. This supports technology's good influence on the teaching and learning of trigonometric functions. Additional support and more aggressive treatments are needed to facilitate learning acquisition when learners encounter acute and long-term difficulties when researching mathematics. Technological advancements and accessibility have led to the growing usage of online learning in the form of Microsoft Teams to support the intensity of intervention for learners.

Unlike real-time training, online instruction may be edited for instructional accuracy, slowed for learner processing time, and replayed for consistent skill demonstration. This allows the intensity of the intervention to be modified for individual learning requirements. The PowerPoint presentation offers a permanent resource that can be used again to meet the requirements of numerous learners at once and repurposed to provide a clear review of abilities. This research has highlighted the conclusion that technology tools may be able to adapt individual variances in the learning process.

7.2.3. Offering a Different Learning Environment

According to research by Ben-Chaim et al. (2019), the human mind is naturally inquisitive and loves taking on solo and cooperative intellectual tasks. Additionally, Hastuti et al., (2020) acknowledge that educators are continuously looking for strategies to improve and inspire learners to participate in purposeful learning activities since the quality of learning outcomes is commonly connected with learner engagement.

The distribution of information and material, as well as the location, timing, and pace of learning, may all be tailored to the learner's preferences to a large extent with Microsoft Teams learning. Additionally, it improves learning in general and interactions between people and computers, which could enable learners to use higher-order thinking abilities. To further develop the concept of an alternative learning experience, Vajravelu (2018) points out how a traditional curriculum, which is the norm in many classrooms, actively discourages questioning and makes it difficult to establish clear standards that can direct us toward forming allies with currently available technologies. Adapting instructional strategies to combine classic and contemporary learning methods is crucial. The quick growth of technology has impacted the classroom's usage of teaching methods. Relying on traditional teaching methods and a consistent routine can readily lead to disengaged learners, tedious lessons, and diminished enthusiasm for the educational journey. Instructors consistently strive to incorporate strategies that foster learner engagement and participation in the course material. Utilising technology as a resource during the trigonometric function research allowed learners to engage in a unique learning process.

According to the research of Roman & Boling (2024), which emphasises that information consumers are not merely passive recipients but rather active learners, the notion that learning trigonometric functions through the Microsoft Teams platform provides an alternative learning experience is gaining traction. Consequently, learning becomes more engaging and long-lasting when learners have an optimal learning environment and the opportunity to investigate their surroundings. By employing this pedagogical approach, the traditional teacher-centric perspective on the learning process is inverted, and the learners are thrust into the centre of the learning journey.

According to the earlier chapters of this research, the research participants had limited access to Microsoft Teams for use in classroom instruction. Since it differed from the usual method of teaching and learning in the classroom, the use of the Microsoft Teams platform to give the lesson on trigonometric functions in mathematics was viewed as innovative by learners. Learners highlighted in their responses that this progressive and unusual learning environment helps to heighten their interest in the Trigonometric function lessons. The lesson's use of the Microsoft Teams platform appeared to spark an inner enthusiasm and drive the learners to master mathematics. They seemed to be fervently eager to take in all the information given to them. Some learners were keen to express their joy at gaining helpful knowledge from mathematics to aid their comprehension of trigonometric functions.

These results also support earlier research by Kitchenham (2006), which suggests that the shift in our society's increasing reliance on technology necessitates emphasising technological literacy in our learners' education. This will help learners who may or may not pursue careers in technology. Additionally, learners must take advantage of formal and informal learning options that will improve their 21st-century learning abilities.

7.2.3.1. Engaging Learners' Senses Through Multimodal Learning

According to the research participants, utilising the Microsoft Teams platform for online learning in education has several benefits. It enhances understanding of trigonometric functions, promotes long-lasting learning, effectively teaches abstract subjects, saves time, and stimulates learners' interest and curiosity by engaging multiple senses (Saylan et al., 2018). Brosseuk et al. (2019) argue that digital technologies should be utilised alongside traditional methods rather than being seen as a substitute or competitor. An additional discovery from this research reveals that participants perceived online learning through the Microsoft Teams platform in education as advantageous for comprehending trigonometric functions.

It promotes enduring knowledge, encompasses complex concepts, reduces time consumption, and stimulates learners' curiosity and interest by engaging multiple senses (Saylan et al., 2018). Brosseuk et al. (2019) argue that digital technologies are supplementary to, rather than substitutes for or competitors of, older methods. Emerging literacy is an essential skill that all learners must possess to succeed in their education. Multimodal learning environments can provide valuable support in developing this skill. Volta et al. (2018) assert that recent psychophysics and developmental psychology discoveries indicate that learners do not similarly employ and assimilate identical sensory modalities. Instead, they discern a selective sensory pathway through which they obtain specific concepts. Nevertheless, within educational institutions, the visual channel is often utilised only for instructional purposes, relegating the other channels to a secondary position. This research looks at the potential for developing and accessing innovative teaching approaches. The study specifically aims to gain an excellent knowledge of how Microsoft Teams is used to teach trigonometric functions. One of its main novelties is that this new technology is founded on the reaffirmed notion that particular sensory systems play particular roles in acquiring particular ideas.

The learners were exposed to an alternative approach to learning trigonometric functions by delivering a lecture that deviated from the traditional method of passively observing the instructor from a desk. A multimodal approach to learning in the classroom may be beneficial and a significant source of innovation for both instructors and learners. Implementing Microsoft Teams in mathematics education is regarded as a method to aid learners in conceptualising challenging and abstract mathematical concepts. This form of instruction has already been explored in chapter four. A mix of text, auditory, and visual elements is used in this learning approach to leverage more than one sense and encourage positive learning.

There is an apparent disconnect between traditional teaching approaches and what engages learners in the present-day context of schools. It is worth closing this gap and connecting with how learners prefer to research in the classroom since efficient teaching techniques will lead to satisfying educational outcomes. Nomzamo and Samu highlight the benefit of using more than one sense when learning trigonometric functions. When probed during the interview session, these learners highlighted that they prefer to see the effect of amplitude and turning points of the graphs on the screen and thereafter do it for themselves.

Teachers who design comprehensive interdisciplinary assignments and instructional materials integrating technology into their courses can effectively captivate learners in teaching-learning. Integrating traditional pedagogical approaches with cutting-edge technology tools has demonstrated a favourable influence on acquiring trigonometric functions in mathematics.

7.2.3.2. Application of Differentiated Styles of Teaching

According to Apriati (2019), it is beneficial for teachers and educators to invest time and effort during the early years of learning to assist learners in establishing a strong understanding of trigonometric functions. This is particularly important as it can guarantee success for learners in future mathematics, careers, and life. By doing this, teachers should be exposed to various tactics to enhance the initial training of trigonometric functions for early primary years and emphasise learners' approaches in visualising and resolving challenges related to trigonometric functions.

Mendoza and Mendoza (2018) suggest that including Microsoft Teams in mathematics exercises can enhance learners' thinking flexibility by encouraging the exploration of several solutions to a given problem. Moreover, it facilitates the broader utilisation of learners' cognitive abilities to improve the processes of constructing meaningful learning. Hence, promoting the use of the Microsoft Teams platform as an educational tool is imperative. Moreover, it can be a motivational tool in mathematics instruction and learning exercises. Every learner possesses a unique approach to the process of acquiring knowledge.

Learners commonly see mathematics as challenging and unattractive. Genlott & Grönlund (2018) reinforce this notion by asserting that there is widespread acceptance of mathematics as unpopular and uninteresting for elementary school learners. Their perspectives and dispositions towards mathematics span from deep admiration to complete dismissal. This study contends that the problem lies not in mathematics per se but in the pedagogical approach and proficiency employed in its instruction. Specific individuals engage in animated conversations, while others engage in anxious discussions.

Incorporating coding and robotics into the educational curriculum is being discussed urgently (Robinson, 2019). South African schools' Teaching and learning approaches must be adapted in response to societal advancements. For learners to be adequately equipped for the future in a technologically advanced setting, they need to be motivated and inspired to embrace the challenges of a dynamic society. Integrating online learning using the Microsoft team's platform into the traditional classroom setting during this research project can be considered a positive step in preparing learners for the fourth industrial revolution.

7.2.4. Theme 4: Collaboration Provokes A Positive Attitude In Learning Trigonometric Functions

The findings of research by Makhno et al. (2019), whose conclusions were directly relevant to the current research, showed that synchronous learning through the Microsoft team's platform encourages cooperation and engagement between learners and their teachers. Learners can record lessons presented on the Microsoft Teams platform and use them as a research tool to access all research materials without restriction. According to the present research, most learners feel that, unlike in the classroom, the Microsoft Teams platform allows them to connect freely with their classmates and teachers. On this platform, teachers may simultaneously instruct and offer straightforward assignments and learning activities that learners can easily interact with. Another research by Poston et al. (2020) supports the idea that the Microsoft team is helpful when managing group projects. Learners may use the Microsoft Office feature offered on the platform to collaborate on group work assignments while participating in the online course.

The present research was conducted among polytechnic learners, and these findings agree. The availability of learning tools made learners pleased. During the coronavirus disease 2019, learners used Microsoft Teams to participate in discussion forums, complete their assigned coursework, and engage in active learning. The researcher used traditional classroom teaching techniques, manipulatives, scaffolded learning, and integrated online learning into the Microsoft Teams platform to instil a deeper understanding of trigonometric functions and represent them in graphs. Using the learners' opinions about how they perceive learning trigonometric functions with the help of the Microsoft Teams platform, this research examined how using the Microsoft Teams platform can improve collaboration and, as a result, create a positive attitude toward learning trigonometric functions in mathematics.

To instil a deeper understanding of trigonometric functions and represent them in graphs, the researcher used traditional classroom teaching techniques, manipulatives, scaffolded learning, and the integration of online education through the Microsoft Teams platform. Using the learners' opinions about how they perceive learning trigonometric functions with the help of the Microsoft Teams platform, this research examined how using the Microsoft Teams platform can improve collaboration and, as a result, create a positive attitude toward learning trigonometric functions in mathematics.

This research looked into how learners' anxiety may be reduced and how to learn about trigonometric functions in mathematics with a positive attitude by using the Microsoft team's online learning platform. A step in developing a positive attitude about a subject is to create an environment that supports efficient teaching and learning. The motives and attitudes of learners affect their understanding of and performance on examinations in school courses, including mathematics (Michaelides et al., 2019). Mathematics learners who generally show higher levels of self-efficacy, curiosity, and value in the subject do better.

One of the challenges that learners face when learning mathematics is how they view the class and the things connected to it. Learners' attitudes are influenced by various factors, including course content, the course presenter, the learners' preparedness, presenting methods, and the learning and teaching environment. As a result of the learning environment, attitudes develop in learners and take the forms of cognition, affect, and behaviour (Celik, 2018). Similarly, Andamon and Tan (2018) contend that learners have trouble understanding mathematical ideas and procedures since mathematics is, by its very nature, an abstract field. Learners frequently acquire anxiety over failing the topic.

Because worry and anxiousness are easily formed in learners, math phobia is common. This research employed various intervention strategies: peer support, technology-enhanced lessons, teacher support, and manipulatives to assist learners in learning trigonometric functions while assuaging any anxiety or dread they might have been experiencing. This research returns to the idea that Microsoft Teams-enhanced learning has encouraged a favourable attitude toward learning trigonometric functions. This is clear from Nomvula and Alwande's comments, which they made about their experiences researching trigonometric functions via technology when they agree that the knowledge gained from this lesson will be used to grasp any trigonometric-related topics better because it was the finest mathematics lesson ever.

The participants in this research stated that using the Microsoft Teams platform to learn trigonometric functions increased their motivation for and attitude toward learning mathematics. The opinions of other learners are also exemplified through Nosipho's beliefs and perspectives. The innovative use of online learning to supplement traditional, passive learning enhanced the experience for learners and encouraged collaborative learning with efficient mathematical communication. The results of prior research by Makhno et al. (2019), whose conclusions were directly relevant to the current study, showed that synchronous learning through the Microsoft team's platform encourages cooperation and engagement between learners and their teachers. They can use the research tool to access all research materials without restriction.

On this platform, teachers may simultaneously instruct learners and offer straightforward assignments and learning activities that encourage complete participation and easy response. Another research by Poston et al. (2020) supports the idea that the Microsoft team is helpful when managing group projects. Learners may use the Microsoft Office feature offered on the platform to collaborate on group work assignments while participating in the online course. The present research was conducted among polytechnic learners, and these findings agree. The availability of learning tools made learners pleased. During the coronavirus disease 2019, learners can participate in discussion forums, complete their coursework, and engage in active learning using Microsoft Teams.

One of the challenges that learners face when learning mathematics is how they view the class and its connections. Learners' attitudes are influenced by various factors, including course content, the course presenter, the learners' preparedness, presenting methods, and the learning and teaching environment. As a result of the learning environment, attitudes develop in learners and take the forms of cognition, affect, and behaviour (Celik, 2018).

Similarly, Luttenberger et al. (2018) suggest that people may experience particular types of intervention and performance anxiety in educational contexts related to a knowledge area. The most prevalent of them is unquestionably math anxiety. Around the world, math anxiety is a common issue for people of all ages. Most teenagers report feeling anxious and stressed in math classrooms and while researching arithmetic in the international assessments of the Programme for International Learner Assessment (PISA) research. Self-efficacy and motivation in math are two factors that interact with mathematics anxiety and can either exacerbate or lessen it.

Andamon and Tan (2018) argue that mathematics is inherently abstract, making it challenging for learners to understand mathematical concepts and processes. Learners often experience apprehension regarding their ability to pass the topic successfully. Learners often experience feelings of fear and anxiousness, leading to the development of mathematics phobia. In order to mitigate the anxiety and apprehension of the participants, this research investigation employed a range of intervention tactics, including assistance from the instructor, peers, manipulatives, and technology-enhanced lessons to facilitate the learners' comprehension of trigonometric functions. An overarching theme that consistently arises in this research is that integrating Microsoft Teams has resulted in a positive disposition toward the acquisition of trigonometric functions.

7.2.4.1. Making Trigonometric Functions Learning Easier to Understand

Hastuti et al. (2020) assert that millennials are coming of age in a digital environment, indulging in a wide range of electronic devices and software to maintain connectivity. Technology's continuous and widespread progress has impacted every facet of human existence. Unquestionably, the educational realm is not exempted. Consequently, the teaching-learning environment has experienced a significant change in perspective due to these technical advancements and the swift growth of computer-assisted learning programs.

Furthermore, Collins and Halverson (2010) assert that everyone is cognizant of the profound impact that technology has had on society at large. It currently influences the ability to read, write, calculate, and think, which comprise the majority of academic labour. The primary concern pertains to the capacity of our current educational institutions to adapt and incorporate the emerging possibilities of technology-enabled learning in preparation for the forthcoming era of public education. According to Harper (2018), who agrees, technology encourages teacher-learner cooperation during learning activities, and instructors who utilise it make the most of the tactics they use to maximise learner learning and to promote their investigation of the subject matter.

Practically speaking, learning trigonometric functions puts learners in a position for success in the present and the future since trigonometric functions are essential to ordinary decision-making at home, in the real world, and at work. Aware of the cognitive conflict that learners encounter while learning about trigonometric functions, the current research looked at how learners' prior knowledge of trigonometric functions was revealed through their use of the Microsoft team's platform for online learning, as well as how pre- and post-task showed how changes to these tools helped learners develop flexible and generalisable trigonometric function knowledge. Learners agreed that Microsoft Teams significantly influences the learning of trigonometric functions in mathematics by making them easier to grasp. They highlight that Trigonometric graphs are simple to grasp when using the Microsoft Teams platform. The learners appreciated the effectiveness of the lesson presentation, which aided in comprehension and made passing the post-task possible.

The chance to reap the rewards and advantages provided by this cutting-edge learning method can be seen by the key stakeholders in the advent of online learning in the shape of Microsoft Teams in the educational arena. During this research, it became clear how much the Microsoft team's platform mediation in learning trigonometric functions has made trigonometric functions easier to grasp. The theme that emerged from the analysis of learner responses in the conducted interviews and the study of responses from the observation, pre-, and post-task is that learning trigonometric functions became more straightforward due to the Microsoft team's platform's intervention in the learning process.

7.2.5. The Reinforcement of Key Trigonometric Concepts

The benefit of sharing information is one advantage of Microsoft Teams. It integrates with other Microsoft applications like Word, Excel, and PowerPoint, making it simple to share files, manage them, and work together to create real-time content (Simon, 2021). Microsoft Teams offers a calendar, file storage, team spaces, and social networks that facilitate collaboration and make it simple for learners to retain their notes, share them with others, and revisit that material at their speed to solidify newly learned concepts.

According to recent studies, learners do poorly in trigonometric functions. The main goal of the research was to assess how well Microsoft Teams serves as an online learning environment that allows learners to improve their comprehension of trigonometric concepts. Various instructional techniques and resources were incorporated into the learning process to reinforce learning objectives, eliminate misconceptions, and foster a more profound knowledge of the complex mathematical ideas linked to trigonometric functions. Research conducted by Higgins et al. (2017) has demonstrated that utilising Microsoft Teams as an intervention tool in mathematics significantly impacts learner results, motivation to research, and attitude toward learning. Chapter four discusses the research conducted by Bidabadi et al. (2019), which examines the impact of Microsoft Teams on learner learning by exploring the changes in motivation and attitude.

The objective of teaching and learning mathematics is to ensure that the learners have learned the key mathematical ideas and problem-solving techniques, ensuring meaningful learning. Participants in the research who were learning stated their pleasure with how the Microsoft Teams platform intervention had improved their learning process. The answer to the question: Which features of the trigonometric function do you find easiest to understand? From the semi-interview schedule after attending the session using the platform developed by the Microsoft team to teach trigonometric functions, learners verified that their comprehension of several distinct concepts within the topic of trigonometric function in mathematics had been reinforced. The responses received from learners show that the Microsoft Teams-enhanced course clarified one component of trigonometric functions and emphasised the important parts. The learners appeared to agree that their comprehension and interpretation of trigonometric functions had become more lucid and approachable.

In this chapter of this research, the concepts of socio-constructivist theory were examined. These concepts encompassed the identification of learners' ZPD and the use of scaffolding to facilitate effective learning. The information discussed in chapter three is connected in this chapter, which also discusses how scaffolding and the ZPD relate to reinforcing the main ideas when researching trigonometric functions in grade 10 math class.

7.2.5.1. Scaffolding

According to Rahman et al. (2018), the fundamental implication of the socio-constructivist theory is to facilitate learning by providing a scaffolding process. This process involves the direction of more knowledgeable individuals, such as teachers and peers, to support learners. To help learners who struggle to become independent problem-solvers, teachers and more experienced peers scaffold their learning. In other words, scaffolding is a technique that assists in increasing the learning capacity of learners. Wright (2018) also defines scaffolding as a method that offers learners temporary assistance, assistance from peers in group settings, assistance from the learners through meta-cognitive self-scaffolding, and assistance in technologically mediated contexts.

Throughout the whole process of gathering data for this research project, scaffolding was used to support learners. The researcher began the research by introducing the idea of trigonometric functions and outlining the many facets of the learning content for trigonometric functions. On a whiteboard, the initial courses used various coloured pens to show different periods of functions and the derivation of each trigonometric function ratio. This research aims to make ideas more understandable and assist learners in completing prescribed tasks provided in their everyday class activities by curriculum standards. Learners completed the initial task-based worksheet in small groups of five or six, adhering to the scaffolding theory, which posits that this facilitates the provision of transient assistance to learners. Due to the random nature of the group composition, each group had learners with a range of learning abilities. To increase learners' involvement in the learning process, this procedure ensured learners had the chance to collaborate with and seek the help of their classmates.

As a result, learners who had more trouble than others completing specific problems could talk about their difficulties with their more experienced group members. The worksheets also included illustrations and diagrams that learners could use to answer questions based on trigonometric functions. The next day, this research adopted the usage of Microsoft Teams in the virtual classroom rather than sticking with the traditional teaching approaches. A PowerPoint presentation was employed as a technological mediation intervention approach to further scaffold or help the learners' efforts to master trigonometric functions in mathematics successfully. A learning environment was developed where learners may question how the Microsoft Team's platform was used to explain any misunderstandings about the course material and use the available knowledge to maximise their learning capacity.

This is consistent with the research by Prismana et al. (2018), who emphasised that education should place equal emphasis on developing 21st-century skills and knowledge of basic academic subjects. These abilities aid learners in preparing for life in college and the workplace. Developing 21st-century skills, including problem-solving, critical thinking, collaborative learning, integrating environments, and using digital technologies in the classroom, can be accomplished in various ways.

The second post-task provided learners with the opportunity to consider the numerous intervention strategies that had been employed to maximise their learning. It was more probable that learners could retain and recall what they had learned if their comprehension of trigonometric functions was improved using visual manipulatives from Microsoft Teams intervention. The outcomes show that learners engaged in various learning activities that encouraged interaction, involvement, and engagement. Various teaching techniques were used to capture and maintain learners' curiosity, promote active learner engagement, and maintain the lesson's pace.

Was using the Microsoft Teams platform helpful in learning about trigonometric functions? Was one of the questions learners were given throughout the interview process. If it helped you at all, how? It is clear from the replies provided by learners, which are shown below, that Ntando, Khadijah, and Nomzamo agreed that using the Microsoft team's platform to learn about trigonometric function made it easier to respond to questions in both the pre-and post-task Aphiwe even highlighted that It was an excellent PowerPoint presentation and very useful to respond to the questions in post-task.

According to Gonulal and Loewen (2018), the adaptive and temporal help offered by the teacher is described by the metaphor of scaffolding in teaching and learning. Applying different methods does not guarantee that scaffolding has been successfully provided. Because all learners do not react to scaffolded support in the same way, teachers may employ a range of ways to tap into various learning styles and tactics. This research revealed that the Microsoft Teams platform significantly facilitated learners and fostered increased participation and interaction within the educational setting. This finding suggests that there might be a correlation between interactions within the learning and teaching environment and the positive learning experiences that learners had while researching trigonometric functions in mathematics using the platform developed by the Microsoft team.

7.2.5.2. Zone of Proximal Development

There are a few samples of learner work, answers from the pre-task, and responses to questions from the post-task provided by the identical learners. Evidently, in the post-task, learners could correctly answer more questions. The learners took the post-task after the PowerPoint presentation intervention using the Microsoft team's platform. By the time learners started working on the post-task activities, they had already benefited from support for their understanding of trigonometric functions from the teacher's explanations, their peers' cooperation, the use of manipulatives, and technological aid. Consequently, there was a chance that the learners may grow more at this stage in the research.

Morgan and Skaggs (2016) state that each member possesses a distinct talent level within a collaborative group. This leads to a unique Zone of Proximal Development (ZPD) for each individual inside the project's framework. This is pertinent to collaborative tasks. Group work provides learners with the opportunity to synergise their strengths with those of those who lack the requisite knowledge and abilities. Consequently, peers can aid group members with varying knowledge and skills and supply the necessary support in a collaborative endeavour to strive towards a shared goal. Vygotsky perceives peer interaction as a potent method for augmenting and expanding knowledge acquisition.

Additionally, according to Vygotsky, ZPD is the gap between a learner's current level of development and the degree of development they must reach with help from an experienced adult or their peers. The ZPD approach is deeply anchored in the social theory of learning, which holds that people acquire new information and skills most effectively when working collaboratively and cooperatively (Taukeni, 2019). Through such collaborative activities with more experienced people, people learn new information and skills and internalise them.

The classroom environment allowed for flexible learning throughout the teaching and learning process and promoted creative thinking, aiding in issue resolution. The Zone of Proximal Development (ZPD) of the learners in this research refers to the discrepancy between their initial performance on the task-based worksheet and their ability to analyse the questions encountered in the post-task, with the assistance of the teacher, peers, and the Microsoft Teams platform. The proper scaffolding or assistance will help learners attain their maximum potential and effectively finish the activity while they are in their ZPD for that task.

In this research, the concluding task was for participants to complete the tasks outlined in the post-task. Following this, semi-structured interviews were conducted with the participants, who had completed the different stages of data collection. The researcher then allowed learners to engage in a PowerPoint presentation facilitated by the Microsoft Teams platform. This activity could be interpreted as the scaffolding the learners needed to accurately respond to the post-task questions. Learners' Responses made it evident that the Microsoft team's platform's assistance when researching trigonometric functions had a good influence on the learning process. The justifications given by participants Asande and Mndeni support the idea that delivering knowledge to learners through online learning substantially impacts their ability to acquire trigonometric functions.

Lopes and Soares (2018) found that in this research, the teacher's role shifted to that of a guide and facilitator. The teacher motivated them to construct their knowledge instead of leading or walking alongside the learners. The teacher provided support, closely monitored their learning outcomes, and only intervened in the learning process when necessary. Most class time was dedicated to open discussions, problem-solving exercises, clarification of underlying principles, and addressing application concerns. This was done to enhance learners' engagement in their learning process within a group setting.With the shift towards a technology-driven culture, online learning platforms like Microsoft Teams in education are emerging as a significant global issue. Consequently, there has been substantial worldwide investment and research in educational technologies. Extensive research, educational efforts, and policy-making have centred around identifying the most efficient methods of integrating Microsoft Teams into schools to enhance the quality of teaching and learning. Dynamic elements like learners, teachers, and administrators impact how Microsoft Teams is integrated into the educational process, directly or indirectly (Saylan et al., 2018).

7.3. Summary

The chapter underscores the neurological adaptations in the brains of today's learners, who comprise the intervention generation, shaped by constant exposure to visual media and gaming. These learners exhibit distinct knowledge acquisition patterns, heavily relying on visual stimuli for comprehension and retention. This underscores technology's pervasive influence on education, with traditional paper textbooks being gradually replaced by dynamic multimedia programs accessible on portable devices like tablets and smartphones. The research highlights Microsoft Teams' role in promoting active and collaborative learning, offering learners a dynamic, interactive environment for engagement with peers, teachers, and content. This fosters better comprehension of mathematical concepts and enhances analytical and problem-solving skills. Through collaborative learning on Microsoft Teams, learners experience a sense of belonging and mutual support, contributing to closing the digital divide in education and preparing them for a technology-driven world.

However, integrating technology into education requires addressing challenges such as equitable access to technology, of which it is a limitation to under-resourced schools, and bridging the digital literacy gap between learners and teachers. The research's findings will inform future educational policies and practices, advocating a systematic shift towards technology's integral role in learning. This transformation necessitates investment in infrastructure, teacher training, and curriculum development tailored for technology-rich classrooms. Technology should be viewed not as a supplementary tool but as an essential component of the learning process, requiring comprehensive changes in educational approaches and resource allocation. The forthcoming chapter discusses the concluding thoughts, limitations and recommendations.

Chapter Eight: Concluding Thoughts, Recommendations, and Limitations

8.1. Introduction

Chapter seven went into great length about the themes that emerged from the data collected for this research. This final chapter provides an overview of the key features that formed the foundation of the study. The chapter opens with a presentation of the research topic, including the main research questions. Next, the recently discovered data this work adds to the field is discussed. The opening of this chapter goes into additional detail about the research's implications and how they relate to how education is now conducted, especially regarding the use of technology in mathematics instruction. The thorough method used in the research to evaluate the efficiency and impact of the Microsoft Teams platform in teaching trigonometric functions offers new avenues for understanding how educational technologies might improve learner learning.

This chapter attempts to summarise the main findings of the research by combining the most important ideas and discussing their broader implications. It aims to demonstrate the revolutionary potential of technology in education—not simply as a means of knowledge transfer but also as a force for reinventing instructional techniques and improving learner comprehension and engagement. The study revealed a distinct story beginning to take shape as we discussed the research's objectives and the answers to the research questions on Microsoft Teams' beneficial contribution to a more in-depth, participatory, and engaging learning environment. Learners now have a more tangible grasp of the topic because of the platform's capacity to visually and interactively bring trigonometry's abstract notions to life.

The research also clarifies the broader effects of using technology in the classroom, such as Microsoft Teams. It highlights a move towards a more learner-centred approach, in which technology is integrated into instruction rather than used as an afterthought since it speaks to the digital natives of today's learners. This change involves more than just implementing new resources; it also entails adopting a new way of thinking about teaching and learning, recognising and using technology's potential to produce a more dynamic, engaging, and productive environment. This chapter will also examine the possible ramifications of the research's conclusions for upcoming educational practices and regulations. It seeks to add to the continuing conversation regarding the role of technology in education to help educators, administrators, and legislators make well-informed decisions about incorporating digital technologies into the teaching and learning process. This chapter's opening provides context for an in-depth and thoughtful analysis of the research's contributions to educational technology and mathematics education. The recommendations and limitations are next discussed, and then a compilation of the crucial topics is offered, interlaced with the researcher's thoughts and observations.

8.2. Focus of the Research

The main objective of this research was to explore how learners felt about using the platform developed by Microsoft Teams to learn trigonometric functions in mathematics. This research aimed to allow learners to voice their opinions on how the Microsoft Teams platform should be included in their study of trigonometric functions. This research aimed to work with individuals who represented the demographic the researcher was investigating. A group of 10-grade learners was selected from Hope High School in the King Cetshwayo region of KwaZulu-Natal, Africa. The researcher deliberately chose the research site due to its convenience and suitability, as it enabled the research to be conducted during school hours without disrupting instruction and learning by requiring the researcher to leave their place of employment. The research mainly focused on how Grade 10 learners perceived using the Microsoft Teams platform to teach trigonometric functions.

The researcher was able to collect information-rich data using a variety of data-producing instruments and methodologies. Data collection for the Pre-task, Post-task, and semi-structured interviews was based on a template derived from an initial set of open-ended questions outlined in the semi-structured interview schedule. The Pre-task was given after the teacher had covered all of the content in the Trigonometric Functions curriculum. Learners participated in small group cooperative learning and scaffolding with their classmates throughout this data generation phase. The worksheet was completed by groups of learners using visual manipulatives, screen sharing, diagrams, and drawings. The pre-task responses from learners were used to gather data useful in addressing the main research topics.

Microsoft intervention was used to augment the teaching and learning of trigonometric functions in mathematics using a PowerPoint presentation. All learners in the class finished the

Post-task that followed. The researcher determined the impact of the Microsoft Teams platform on the teaching and learning process by analysing learners' answers to the Post-task Questions. The learners were then interviewed, which was the most effective approach for gathering information-rich data. The participant collected qualitative data for this research, which provided the answers to the primary research questions and proved appropriate and successful. The audio-taped interviews produced much detailed information that was analysed to identify the major topics in this research. The final research tool was designed to provide a means of triangulating the data already produced.

The fact that participants actively participated in the research process and that the technique was in line with how the participants felt about their learning experiences helped validate the validity and reliability of this research. Before the primary research, a pilot study was carried out. To address the issue of an unbalanced power connection between the researcher and the participants, learner involvement was promoted in a collaborative rather than confrontational way.

8.2.1. What are Grade 10 Learners' Perceptions of Using Microsoft Teams as an Online Learning Platform for Learning Trigonometry Functions in Mathematics?

The first research question was to determine how learners perceived using the Microsoft Teams platform to learn trigonometric functions. As stated in chapter two of this research, earlier studies have shown learners had trouble grasping the language used to describe trigonometric functions, which made it difficult for them to comprehend and learn about trigonometric functions concepts and their application in mathematics. Thematic analysis was used to analyse the data from this research using a socio-constructivist perspective and connectivism. The results showed that learners had a great experience using the Microsoft Teams platform to research trigonometric functions. The data also showed that when the Microsoft Teams platform was included in the math class, learners could use the visuals to dispel misconceptions and confusion about trigonometric functions. Learners reported feeling less perplexed and more secure when approaching arithmetic problems using trigonometric functions.

Data from the observation schedule, Pre-task, and semi-structured interviews were analysed to determine how learners felt about using the Microsoft Teams platform to learn mathematics. The learner participants had detailed accounts of using the Microsoft Teams platform to learn trigonometric functions. The learners discussed how much they enjoyed learning math using the Microsoft Teams platform, how the enhanced lesson had made a lasting impression, and how their concerns about learning trigonometric functions had been allayed.

As previously stated, the learners enrolled at the educational institution where this research was conducted were not permitted to utilise any Microsoft Teams platform during instruction. The learners were engaged and excited by the math lesson given online via the Microsoft Teams platform with a PowerPoint. The lesson enhanced by the Microsoft Teams platform allowed learners to reconsider how they had previously thought about researching trigonometric functions in mathematics. The learners in this research focused on having fun and enjoying themselves while using the Microsoft Teams platform to learn. The learners clearly stated how much they valued using the Microsoft Teams platform to learn and how they wished it had been used in all of their other classes. Learners will get more actively interested in the learning process when they recognise a fun component in the learning process. This was evident in the research as learners developed strong connections to the trigonometric functions content for learning that was being presented to them via PowerPoint slides. They see several facets of the topic. They offer ongoing education because of this. Microsoft Teams platform helps learners to comprehend the subject more fully. Due to the usage of graph images, the subject becomes more captivating and appealing.

The participants in this research described their use of the Microsoft Teams platform to learn as an innovative method that stuck with them and imprinted itself on their memories. One of the teaching objectives is that learners should have the necessary knowledge and abilities at the end of a class. Examining the learners' replies shows that they grasped the content from the lesson augmented by the Microsoft Teams platform well and that their understanding of trigonometric functions had increased. After viewing the images and explanations in the PowerPoint presentation, participants in this research who were interested in their opinions stated that they felt less apprehensive about learning trigonometric functions. When learning mathematics, learners often lack confidence and worry that their answers may be incorrect, which can cause math anxiety. Creating a positive attitude toward the subject is crucial to overcoming the worries and uncertainties learners develop when learning mathematics. Including the Microsoft Teams platform in the learning process appears to have inspired learners to overcome the contextual factors that posed difficulties in understanding trigonometric functions and continuing their learning.

8.2.2. How Effective is Microsoft Teams as an Online Learning Platform in Helping Learners Improve Their Knowledge of Trigonometric Concepts?

In response to the second research question, using the Microsoft Teams platform as a learning tool optimised how well learners used their senses. Multimodal learning was identified as a potential subject in the preceding chapter. In this chapter, the researcher developed that concept by focusing on the finding that learners could visualise the mathematical concepts they were learning about trigonometric functions. The way learners use the Microsoft Teams platform to research trigonometric functions has improved due to the learning content's visualisation. Not all of the textbook information about trigonometric functions is supported by diagrams and images. Learners were more successful in solving problems involving trigonometric tasks than they would have been without introducing the Microsoft Teams platform as a tool to support learning. The fact that most learners responded correctly in the Post-task, compared to the Pre-task, shows the effectiveness of employing visuals from Microsoft Teams to clarify the questions in the class activities.

According to Krishnan (2019), scaffolding in educational settings encompasses a range of pedagogical approaches implemented to propel learners towards greater comprehension and autonomy throughout the learning journey. In such situations, the instructor's function is to aid and support the learners as they progress through the levels. The instructor encourages, motivates, and facilitates the growth of learners' abilities to greater degrees of comprehension. We can all agree that instructional scaffolding plays a role in all teaching in this way.

In this research, learners learning trigonometric functions expanded their knowledge and experience through the application of temporary scaffolding. The research's participants were given the chance to get scaffolding from their group members, the teacher, and the instructional materials and instruments employed in the teaching and learning process. This is consistent with socio-constructivism theory, which holds that learners socially construct knowledge by communicating its meaning to others. In the research, the teacher's explanations and the learners' comments served as additional scaffolding, enabling the learners to pursue autonomous learning.

Similarly, learners could build and integrate the knowledge and abilities necessary to solve trigonometric function problems in line with the concepts of Vygotsky's Zone of Proximal Development through their social interactions with their peers. The ZPD may be understood as the learner's capacity to attain greater levels of success while working through a challenge with the aid of a more experienced person. Scaffolding is a technique used to assist learners in achieving their ZPD.

This research promoted cooperative learning to increase the learners' self-esteem and confidence in their ability to solve mathematical problems. The Microsoft Teams platform was included as a learning tool to improve the learning process by allowing learners to explore and find solutions to trigonometric function-related challenges. The plain and straightforward explanations encouraged by the visual depiction of trigonometric functions were complex for learners to understand.

8.2.3. How Can Microsoft Teams as an Online Learning Platform Facilitate Learning, Collaboration, Self-Efficacy, and Engagement in Trigonometric Functions? Why?

The research examined how learners using the Microsoft Teams platform can facilitate learning, collaboration and self-efficacy in specific ways when learning trigonometric functions in mathematics. The learners who participated in this research had access to limited resources that might be used to support their mathematics learning, as the researcher mentioned earlier in this chapter. Classroom instruction is supplemented using the mathematics textbook, diagrams, charts, and the chalkboard. The learners in grade 10 are aware of the developments in the digital Microsoft Teams platform related to smartphones, laptops, PCs, and gaming consoles.

It was a pleasant departure from the usual routine of how lessons were given to include the Microsoft Teams platform in the learning process. Because it was a departure from the ordinary, the learners welcomed the change with open arms, which piqued their curiosity. The Microsoft Teams platform worked well as a learning tool since it kept learners' attention and allowed them to give thoughtful answers to the questions on the post-task.

The primary objective of this research was to highlight the problems that influence how learners approach using the Microsoft Teams platform to learn mathematics collaboratively. The researcher observed the world via the experiences and perspectives of the learner participants in this research, which tends toward an interpretative paradigm. The interpretative method is participant-oriented, allowing learners to voice their opinions without bias or restraints.

The Microsoft Teams platform has the potential to significantly influence education, making it a popular teaching and learning tool in classrooms. It is an effective tool for fostering learners' social and cognitive abilities and self-efficacy, and teachers and academics are very interested in it. The learners participating in this research appeared to view the shift from the traditional, boring style of lesson delivery to a progressive, innovative mode of teaching using the Microsoft Teams platform as a novelty and a welcome change. The learners were exposed to Microsoft Teams platform advancements like mobile phones, computers, laptops, and games in their homes, neighbourhoods, and among their parents, relatives, and classmates since they lived in a digital era. They embraced the Microsoft Teams platform's integration into their academic curriculum to stay up with the trends they had become used to. This teaching technique they could relate to and identify with piqued their attention and kept them focused on the lesson.

The learners were exposed to technological advancements, including mobile phones, computers, laptops, and games in their homes, towns, and among their parents, relatives, and classmates. They embraced integrating the Microsoft Teams platform into their educational programs to keep pace with the new content and increase their understanding and knowledge of trigonometric functions. They could relate to and identify with this teaching technique, which piqued their attention and helped them stay focused on their learning. It is essential to keep humans involved in an interactive environment that promotes in-depth and instinctive interaction between learners and the learning content to eventually activate all or a few of their senses and make a realistic experience possible. Using the Microsoft Teams platform as its technological component with multimodal stimulation, this engaging learning activity allowed the learners to be deeply involved in the learning process and improve their learning outcomes (Doumanis & Porter, 2019). In the analysis of the interviews for this research, the learners themselves expressed that the Microsoft Teams platform is one of the resources that they appreciated using to improve their understanding of the trigonometry functions and seeing complex or abstract mathematical ideas on a screen made the whole idea of using their brains become like a beautiful game.

According to the learners, the PowerPoint presentation from the Microsoft platform helped them clarify their questions and ambiguities about trigonometric functions in mathematics. The innovative use of the Microsoft Teams platform in the mathematics class transformed the traditional passive teaching approach into an engaging, activity-based lesson promoting efficient interaction and communication.

8.3. Bringing New Knowledge to The Field

This research revealed how grade 10 learners felt about using the Microsoft Teams platform to learn trigonometric functions in mathematics. The study established that using visual manipulatives through the Microsoft Teams platform improves the learning of trigonometric functions. It has been indicated in earlier chapters that learners have difficulties while attempting to solve issues using trigonometric functions. This research tried to leverage the Microsoft Teams platform to make it simpler for learners to solve problems using trigonometric functions. This research attempted to use the Microsoft Teams platform in a way that would make it easier for learners to learn trigonometric functions to solve problems. Microsoft Teams allowed learners to engage several senses and supported various learning modes. The learners were assisted in solving the issues given by the graphical presentation illustrating the part-whole idea, an essential component of learning trigonometric functions. Combining the Microsoft Teams platform with traditional teaching methods enabled learners to comprehend trigonometric functions in a way that promoted effective learning.

The Microsoft Teams platform was used in this research to support individual and group learning and promote learning by enabling learners to visualise mathematical trigonometric function concepts, assuring them to approach trigonometric function issues positively. The addition of the Microsoft Teams platform to learning trigonometric functions sparked the attention and enjoyment of the learners, who performed higher in the Post-task than in the Pre-task. The research findings highlight that using Microsoft Teams as a teaching and learning tool helps learners learn and recall trigonometric functions in mathematics more efficiently.

8.4. Recommendations

The use of Microsoft Teams platform-based tools to learn trigonometric functions in mathematics appears to have had a good effect on all research participants, according to a review of the research's data. Learners from a Grade 10 class that has participated in the study.

It is important to consider how the Microsoft Teams platform may be used to educate and learn about trigonometric functions in subsequent grades. When navigating visual representations of this concept, learners can significantly benefit from elucidating misconceptions regarding the part-whole concept, the foundation for mathematical trigonometric functions. According to the responses that emerged throughout the research, the Microsoft Teams platform may be implemented in teaching practices at any school with the appropriate resources. Combining instructional strategies can be employed in classes with a variety of learners and in classes where the language of instruction differs from the learners' native tongue. This research has demonstrated that various instructional strategies in courses with many learners may be successful.

Throughout this research , it became evident that the instructor assumed the role of a facilitator, with the learners engaging in active participation to facilitate the learning process. Learners benefit from this learner-centred approach to education because it encourages them to develop intrinsic motivation and accept responsibility for their learning. This research aims to assist curriculum designers and teachers determine the feasibility and methodology of incorporating the Microsoft Teams platform into their instructional practices and other educational initiatives.

8.5. Limitations

Thematic analysis was used in this research to draw forth new themes from the gathered data. The use of purposive sampling and its constrained scope is one of the limits of a theme analysis. Purposive convenience sampling was used in this research's sample design to make the data collecting location convenient for the researcher and enable information-rich data gathering. Since the interviewees had to be interested in the topic or the research itself, a truly random sample was unlikely to be possible in this research. This might have resulted in a slightly distorted interpretation of the data analysis findings (Roberts et al., 2019).

This research was restricted to one class with learners at one school. If the researcher had included learners from different schools in the study, there would have been a greater diversity of participants, skill levels, learning settings, and teaching methods. In deep rural parts of South Africa, where there are few essential utilities like power and running water, the Department of Basic Education is home to numerous schools. It is possible that research carried out at a school without power produced different findings.

Additionally, the choice of learners who participated in this research was restricted to only one grade and one class, i.e., the 10A class. To provide more in-depth data regarding learners' perspectives on using the Microsoft Teams platform when researching trigonometric functions in mathematics, this research should have been expanded to include learners from other grades and different phases. A more diverse sample would have given the research's findings more room to be generalised because learners perceive the learning content and instructional strategies differently depending on their stage of development (Hajaree, 2015).

8.6. Thoughts/Reflections of the Researcher

Microsoft Teams platform is widely acknowledged as a collaborative tool and an effective online teaching platform owing to its many remarkable attributes. Microsoft Teams satisfies the prerequisites for coordinating a virtual classroom, including the following functionalities: screen sharing, call and meeting recording, assignment management, and learner response. Utilising Microsoft Teams for online instruction is a provisional yet efficacious resolution that enables us to collaborate harmoniously to adhere to the government's anti-epidemic campaign regulations while maintaining the scheduled instructional sequence. The utilisation of Microsoft Teams as an instructional tool for foreign languages during the previous semester was met with early approval from the learners. While some universities and schools have reverted to traditional modes of instruction since the nation has recovered from the coronavirus disease 2019, it is recommended that we persist in advocating for the efficient utilisation of Microsoft Teams as an instructional tool by integrating virtual and traditional classrooms.

Microsoft Teams should be an auxiliary instrument for overseeing learners' independent learning. It assists instructors in managing learner affairs by facilitating task distribution and one-on-one communication. Educators have the authority to allocate homework to individuals or group initiatives. Using Microsoft Teams, learners can organise their studies, review lesson materials before class, and collaborate in groups to discuss and complete projects. It is recommended that teachers and learners maintain a continuous flow of information about the courses. Instructors employ Microsoft Teams to evaluate learners' learning outcomes. Furthermore, it is imperative to enhance communication between instructors and learners via Microsoft Teams forums and channels. This will enable instructors to receive valuable feedback regarding their instruction, enabling them to make necessary modifications to enhance the calibre of instruction and fulfil the subject's objectives.

Due to the conceptual and abstract nature of much of mathematics, it is an exceptional field of research. Effective mathematics instruction necessitates the deft integration of visual aids and images, establishing connections between the subject matter and tangible, real-life scenarios or occurrences that resonate with the learners. The medium of education must be interesting enough to maintain the learners' attention on the material being delivered to them because math learners commonly lose interest in the topic. The challenges that learners may have previously encountered with specific mathematical topics give them the impression that they cannot go past them.

It becomes difficult for the teacher to persuade the learners to abandon their pessimistic outlook and believe they can understand and resolve their concerns. One of the most common areas of mathematics that presents a barrier to learners is mastering trigonometric functions. Teachers frequently employ various techniques to help learners comprehend the many ideas and elements that make up the trigonometric functions curriculum. This finding justifies exploring the possibility of teaching trigonometric functions in mathematics using the Microsoft Teams platform.

Moreover, the South African Minister of Education emphasised that online learning, like the Microsoft Teams platform, is crucial to the developments happening throughout the world in White Paper 7 of 2004. Digital media have completely transformed the information society, and Microsoft Teams' advancements have fundamentally altered the teaching and learning processes. Microsoft Teams platform can guarantee that learners interact with the content meaningfully when it is correctly incorporated into teaching and learning. Microsoft Teams platform can improve higher-order cognitive abilities, including comprehension, logic, creativity, and problem-solving. Additionally, it is a motivating tool that raises output, and every learner will be prepared for full involvement in the knowledge society if online learning like Microsoft Teams platform integration into teaching and learning is successful.

As a result of the widespread perception that teaching is tedious and repetitive, many educators have lost interest in the profession. Firat et al. (2021) underscore the importance of incorporating activities into the teaching-learning environment that promote individual learning, enhance learners' critical thinking abilities, and enable them to examine various facets of a situation or event. They identify this as one approach to confronting and altering this mindset among educators.

8.7. Summary

The chapter highlights the significant impact of the Microsoft Teams platform on Grade 10 learners' understanding of trigonometric functions, emphasising its role in facilitating deeper comprehension and engagement with the subject. These findings have profound implications for education, particularly regarding digital literacy and technology integration in classrooms. The effective use of Microsoft Teams marks a shift towards more interactive and learner-centred approaches, catering to the needs of digitally immersed learners. Moreover, the research demonstrates technology's ability to bridge knowledge gaps in complex mathematical concepts, enhancing understanding through visual and engaging learning experiences. Learners' positive feedback underscores the importance of incorporating their perspectives in developing educational technologies, ensuring a comprehensive learning experience tailored to individual preferences.

Additionally, the research contributes to ongoing discussions on technology's impact on education, advocating for increased investment in educational technologies and educator training. It sets a precedent for further exploration of technology integration in education, encouraging innovation to enhance the educational experience for learners. Overall, this research highlights the transformative potential of technology in education, urging educators, administrators, and policymakers to embrace its role in revolutionising teaching and learning paradigms for the benefit of learners and society.

8.8. Recommendations for Future Research

The present study has been confined to learners in a particular school in the King Cetshwayo district; future research might focus on the perceptions of teachers and the working class, who use Microsoft Teams for meetings and communication. In addition, the current study only is centred on the qualitative findings; future research might use a mixed method or cross-sectional study to explore and determine the disadvantages and advantages of using Microsoft Teams, as well as to learn about additional difficulties or challenges encountered by the use.

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APPENDICES

APPENDIX A: Ethical Clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

10 March 2022

Sibusiso Thulebona Shandu (217079736)
School Of Education
Edgewood Campus

Dear ST Shandu,

Protocol reference number: HSSREC/00003833/2022
Project title: Exploring grade 10 learners' perceptions of using Microsoft teams as an online platform for learning Trigonometric functions
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 07 February 2022 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

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

This approval is valid until 10 March 2023.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

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

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

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

INSPIRING GREATNESS

APPENDIX B: Approval from Department of education (KZN)

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE HEAD OF DEPARTMENT

Private Bag X9137, PIETERMARITZBURG, 3200
Anton Lembede Building, 247 Burger Street, Pietermaritzburg, 3201
Tel: 033 392 1051

Email: buyi.ntuli@kzndoe.gov.za

Enquiries: Buyi Ntuli

Ref.:2/4/8/7240

Mr Sibusiso Thulebona Shandu
[redacted]
ESIKHAWINI
3887

Dear Mr Shandu

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"EXPLORING GRADE 10 LEARNERS' PERCEPTIONS OF USING MICROSOFT TEAMS AS AN ONLINE PLATFORM FOR LEARNING TRIGONOMETRIC FUNCTIONS",** in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from **28TH February to 31st March 2024.**
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

[redacted]

Dr M.J.B. Mthembu
Acting Head of Department: Education
Date: 28th February 2022

GROWING KWAZULU-NATAL TOGETHER

APPENDIX C: Consent and Assent forms

Consent for the Principal

School of Education, College of Humanities,

University of KwaZulu-Natal,

Edgewood Campus,

Dear Principal

Informed Consent Letter

My name is Sibusiso Thulebona Shandu. I am a PHD student researching at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am requesting to conduct a research research in an exploration of grade 10 learners' perceptions on using the Microsoft teams as a blended online learning platform for Trigonometric functions.

I can be contacted at:

Email: [redacted]m or 217079736@stu.ukzn.ac.za

Cell: 0[redacted]

My supervisor is Prof. Jayaluxmi Naidoo who is an Associate Professor at the School of Education, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: naidooj2@ukzn.ac.za Phone number: +27312601127.

Consent for Principal

CONSENT FORM FOR PRINCIPAL: Exploring grade 10 learners' perceptions on using Microsoft teams as a blended online platform for learning Trigonometric functions.

The researcher will first teach and assign Trigonometric functions tasks to learners without using the Microsoft platform, after which the responses will be analysed. When learners have returned to their respective homes the following day, re-teaching will take place, this time using the Microsoft Teams platform, and another task will be assigned to them, with responses compared.

Data will be generated by using both observation and semi-structured interviews. Learners will be expected to use their own devices, such as cell phones, tablets etc. If the learner/s do not have a device, the researcher will lend one from the school on behalf of that learner. Furthermore, the researcher will provide 1GB of data to each learner.

DECLARATION

I………………………………………………………………………… (Full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF PRINCIPAL DATE

…………………………………… ………………… ---------------------

Consent for the parents

School of Education, College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus,

Dear Participant

Informed Consent Letter

My name is Sibusiso Thulebona Shandu. I am a PHD student researching at the University of KwaZulu-Natal, Edgewood campus, South Africa. I am interested in an exploration of grade 10 learners' perceptions on using the Microsoft teams as a blended online learning platform for Trigonometric functions. To gather the information, I am interested in asking you some questions.

Please note that:

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- The interview may last for about 30 minutes to 1 hour.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalised for taking such an action.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

Equipment	**Willing**	**Not willing**
Audio equipment		
Photographic equipment		
Video equipment		

I can be contacted at:

Email: [redacted]

Cell: 0[redacted]

My supervisor is Prof. Jayaluxmi Naidoo who is an Associate Professor at the School of Education, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: naidooj2@ukzn.ac.za Phone number: +27312601127.

Consent for participants

CONSENT FORM FOR PARTICIPANTS: **Exploring grade 10 learners' perceptions on using Microsoft teams as a blended online platform for learning Trigonometric functions.**

The researcher will first teach and assign Trigonometric functions tasks to learners without using the Microsoft platform, after which the responses will be analysed. When learners have returned to their respective homes the following day, re-teaching will take place, this time using the Microsoft Teams platform, and another task will be assigned to them, with responses compared.
Data will be generated by using both observation and semi-structured interviews. Learners will be expected to use their own devices, such as cell phones, tablets etc. If the learner/s do not have a device, the researcher will lend one from the school on behalf of that learner. Furthermore, the researcher will provide 1GB of data to each learner.

DECLARATION

I………………………………………………………………………… (Full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF PARTICIPANT DATE

……………………………………… ………………… ---------------------

SIGNATURE OF PARENT (If participant is a minor) DATE

………………………………………… …………………..

Assent for the learners

TITLE OF THE RESEARCH PROJECT: Exploring Grade 10 Learners' Perceptions Of Using Microsoft Teams As An Online Platform For Learning Trigonometric Functions.

RESEARCHERS' NAME(S): Shandu Sibusiso Thulebona
RESEARCHER'S CONTACT NUMBER: [redacted]
What is RESEARCH?
Research is something we do find **NEW KNOWLEDGE** about the way things (and people) work. We use research projects or studies to help us find out more about learners and teenagers and the things that affect their lives, their schools, their families and their health. We do this to try and make the world a better place!

What is this research project all about?
My research is about exploring Grade 10 Learners' perceptions of using Microsoft Teams as an online platform for learning Trigonometric Functions.

Why have I been invited to take part in this research project?

You are invited to take part in this research because, the researcher wants to find out whether you can learn Trigonometric Functions using Microsoft Teams platform. The knowledge acquired in this research will go a long way in improving the teaching and learning Mathematics.

Who is doing the research?
My name is Sibusiso Thulebona Shandu I am a Mathematics teacher and PHD candidate researching at the University of KwaZulu-Natal. Edgewood campus, South Africa.I am interested in gathering data for research purposes. To gather the information. I am interested in asking you some questions.

What will happen to me in this research?
- You are expected to attended Mathematics class online using Microsoft Teams platform.
- There will be interviews that will be conduct by the research and you as a learner after the Mathematics lesson.
- The interview may last for about 30 minutes to 45 minutes
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.

Can anything bad happen to me?
- There is nothing bad that can happen to any learner, only teaching and learning will be taking place.

- Data will be stored in secure storage and destroyed after 5 years.

Can anything good happen to me?

- The good thing that will happen to all learners who will be participating in this research research is that, learners will be taught Trigonometric functions using online.
- Learners will learn at the comfort of their homes.
- Learners will have contributed a new knowledge in teaching fraternity

Will anyone know I am in the research?

- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.

Who can I talk to about the research?

My supervisor is Prof. J Naidoo who is located at the School of Education, Edgewood Campus University of KwaZulu-Natal(UKZN).
Contact details: Room CU 118, Main Tutorial Building, Edgdwood Campus, UKZN, email: naidooj2@ukzn.ac.za; Phone number: 0312601127

You may also contact the Research office

Tel. 031 260 8350 , email: HSSREC@ukzn.ac.za

What if I do not want to do this?

You have a choice to participate , not participate or stop participating in the research. You will not be personalised for taking such an action even if your parents have consented you to take part in the research.
Do you understand this research research and are you willing to take part in it?

YES NO

Has the researcher answered all your questions?

YES NO

Do you understand that you can STOP being in the research at any time?

YES NO

____________________ ____________________

Signature of Child Date

APPENDIX D : Observation Schedule

Observation schedule

This schedule will be used by the researcher to observe the learners whilst they are using *Microsoft teams* when learning Trigonometric functions. The learners' facial expressions and responses to the task given will be noted to dertemine purposive sampling.

Attitude towards Microsoft teams	Positive/Negative
Confidence	Comfortable/Uncomfortable
Competence	Competent/Incompetent
Measuring	Accurate/Inaccurate
Conjectures formulated	Correct/Incorrect
Challenges with the use of Microsoft teams platform	Encountered/Not encountered

APPENDIX E: Trigonometric functions lessons and activities

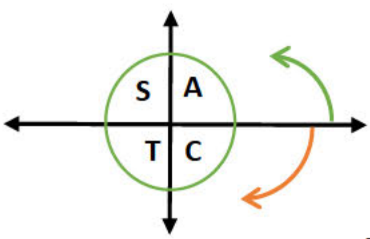
Trigonometric functions lessons and activities

<table>
<tr><td>SUBJECT & GRADE</td><td colspan="2">Mathematics Grade 10</td></tr>
<tr><td>TOPIC</td><td colspan="2">Trigonometric Functions</td></tr>
<tr><td>AIMS OF LESSON</td><td colspan="2">• Define the three basic functions
• Draw the 3 basic functions
• Explore the effect of a and q
• Sketch functions where the amplitude has changed, or a vertical shift has occurred</td></tr>
<tr><td>NB!! Can You?</td><td colspan="2">• Refers to activities learners will be doing independently and in Groups</td></tr>
<tr><td rowspan="2">RESOURCES</td><td>Paper based resources</td><td>Digital resources</td></tr>
<tr><td>Mathematics textbooks.</td><td>https://www.youtube.com/watch?v=moDktwnNqas
https://www.youtube.com/watch?v=z9mqGopdUQk</td></tr>
</table>

Lesson 1

INTRODUCTION

When the analyses of the Trigonometric ratios within the 4 quadrants was done in previous topic. We realised the following:

<table>
<tr><td>CAST Diagram +


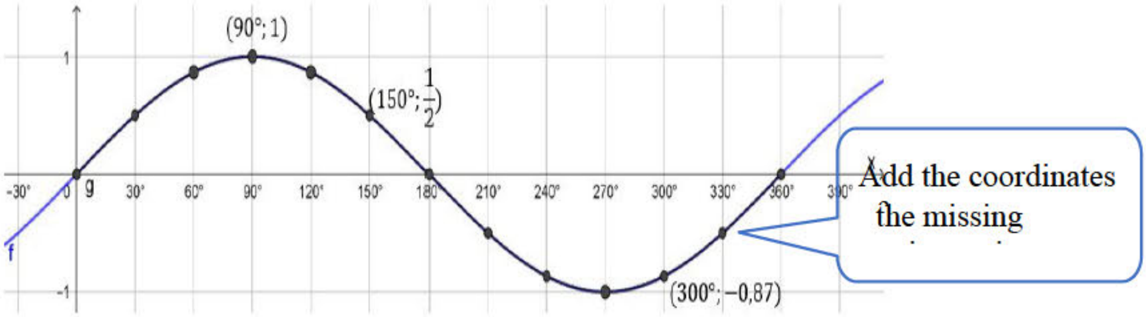
–</td><td>Important Facts:
1. We measure all angles anti-clockwise starting from 0°. Therefore 370° is in the first quadrant.
2. Negative angles are measured clock-wise from 0° Therefore −50° is in the fourth quadrant.</td><td>CAN You?
Use your calculator to Determine the following
sin 50° =
cos 70°=
tan 25° =
sin 89° =
sin 90°=</td></tr>
</table>

CONCEPTS AND SKILLS

1. Complete the table: [Use the method described above]

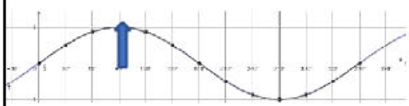
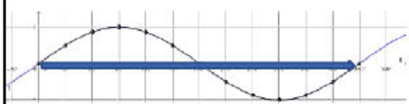
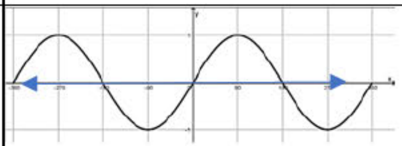
x	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°
$y = \sin x$	0	0,5	0,87			0,5				-1	

2. The graph of $y = \sin x$ for $x \in [0°; 360°]$ is drawn below. Write the coordinates of the point o

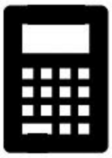


Let'look at the main features of this

[redacted]

	Solution	Meaning	Example
Amplitude	1	Max height from the $x - axis$. Amplitude is always positive	
Period	360°	One complete cycle Starts at 0° and ends at 360°	
Range	$y \in$ [-1;1]	All possible y- values	
Domain	$x \in [-360°; 360°]$	All x-values for which the graph was sketched.	

Calculator Tips: It is very handy to use the Table option on the calculator if we need to complete a table.



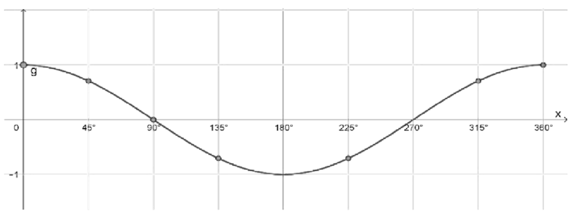
1. Click on **Mode**; Select 3: **Table**
2. $f(x) =$ is on the display **Type the function sin x;**
3. **Start?** 0 **End?** 360 **Step?** 30

In a similar way the graphs for $y = \cos\theta$ and $y = \tan\theta$ can be found.

$y = \cos\theta$

Table:

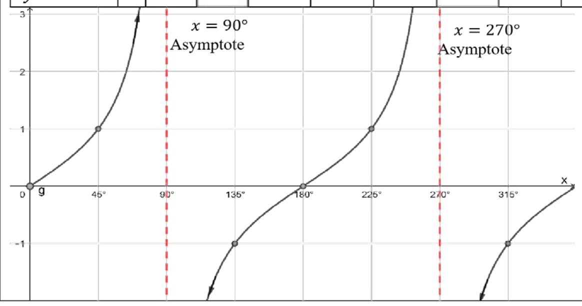
x	$0°$	$45°$	$90°$	$135°$	$180°$	$225°$	$270°$	$315°$	$360°$
$y = \cos x$									



$y = \tan\theta$

Table

x	$0°$	$45°$	$90°$	$135°$	$180°$	$225°$	$270°$	$315°$	$360°$
$y = \tan x$									



Complete the following for each of the graphs

	Solution
Amplitude	
Period	
Range	
Domain	

	Solution
Amplitude	
Period	
Range	
Domain	

Special facts regarding the $y = \tan x$

Asymptotes at $x = 90° + k.180°$ for k an integer

Remember the tan graph repeats every $180°$

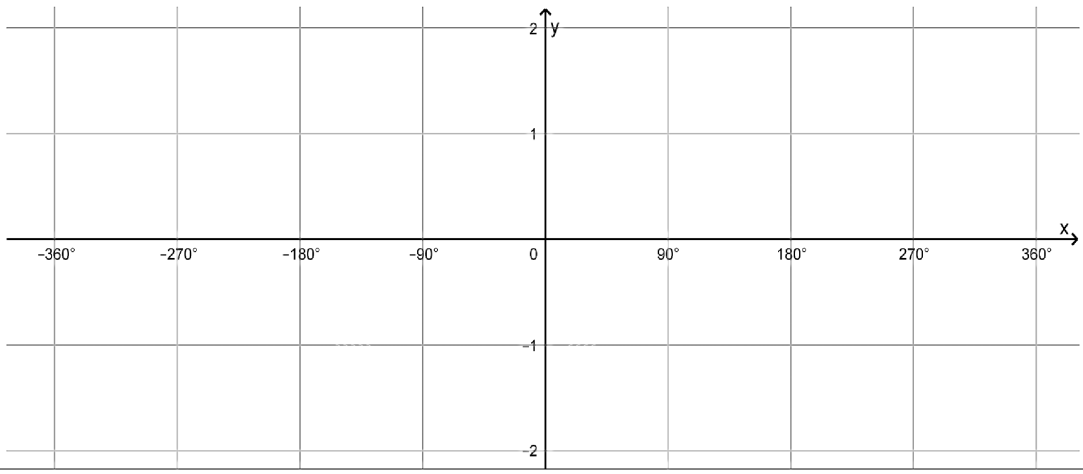
CAN YOU?

Draw sketch graphs of $f(x) = \sin x$; $g(x) = \cos x$ and $h(x) = \tan x$ for $x \in [-360°; 360°]$.

- Complete the table below.

x	$-360°$	$-270°$	$-180°$	$-90°$	$0°$	$90°$	$180°$	$270°$	$360°$
$f(x) = \sin x$									
$g(x) = \cos x$									
$h(x) = \tan x$									

- Draw neat sketch graphs of the above functions on the grid provided. Please show the asymptotes clearly on the graph.



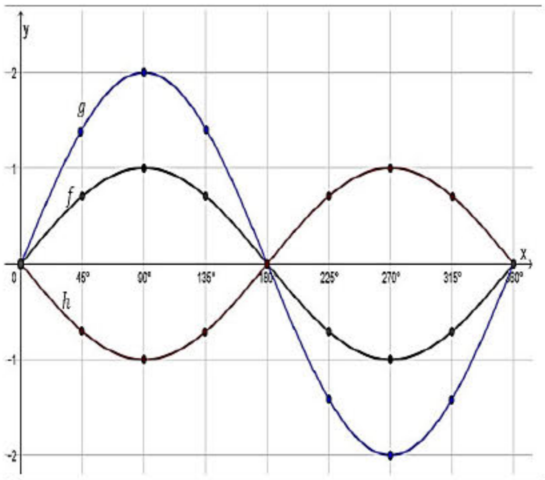
Lesson 2

The effect of $\boldsymbol{a}$ in the function $\boldsymbol{y = a \sin x}$.

Now that we have sketched the function $f(x) = \sin x$, let's explore how the function $y = a \sin x$ will look like.

Below are the graphs of

- $f(x) = \sin x$; $g(x) = 2\sin x$; $h(x) = -\sin x$



Can you?

1.Write down the value of a in each case.

2.How did this value affect the shape of the graph?

1. Complete the table below:

	$f(x)$	$g(x)$	$h(x)$
Amplitude			
Period			
Range			
Domain			

We can therefore say that a influences the ……………. of the graph.

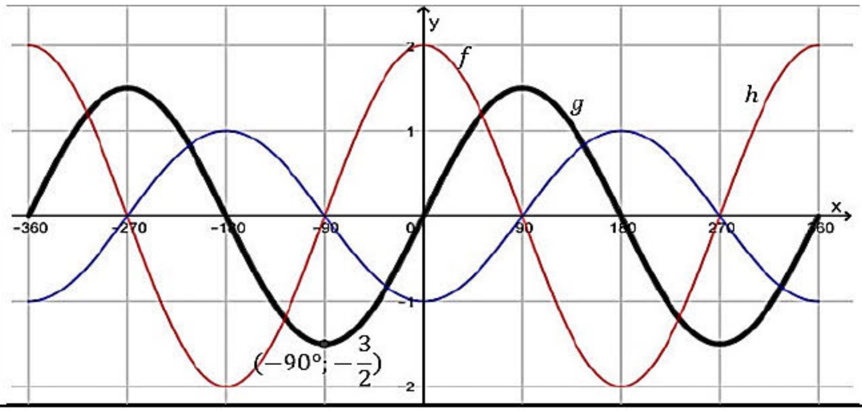
Example 1

Determine the values of a, b and c for the following graphs:

$f(x) = a\cos x$ $a=$

$g(x) = b\sin x$ $b=$

$h(x) = c\cos x$ $c=$



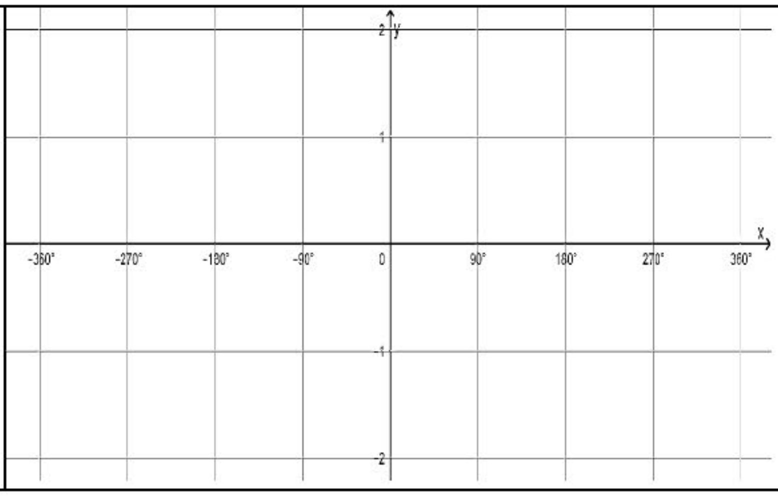
CAN YOU?

Sketch the following graphs for $x \in [-360°; 360°]$ on the accompanying grid.

$y = \cos x$

$y = 2\cos x$

$y = -2\cos x$



Lesson 3

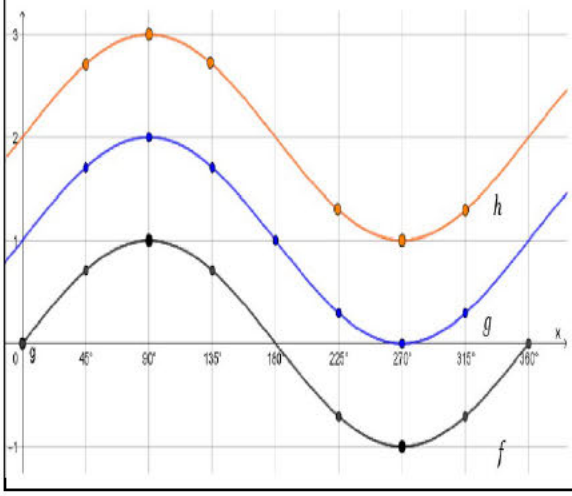
The effect of $\boldsymbol{q}$ in $\boldsymbol{y = \sin x + q}$

Research the three graphs below:

$f(x) = \sin x$

$g(x) = \sin x + 1$

$h(x) = \sin x + 2$



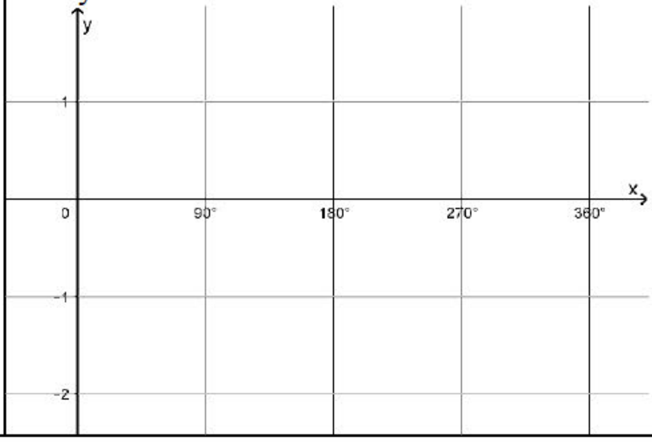
What transformation do you notice?

$\boldsymbol{y = \sin x}$ moved 1 unit up to give the graph of $\boldsymbol{y = \sin x + 1}$

$\boldsymbol{y = \sin x}$ moved 2 units up to give the graph of $\boldsymbol{y = \sin x + 2}$

Can you?

draw $y = \sin x - 1$



Example 2:

The graphs of $f(x) = a \sin x$ and $g(x) = \cos x + 1$ for $\in [0°; 360°]$

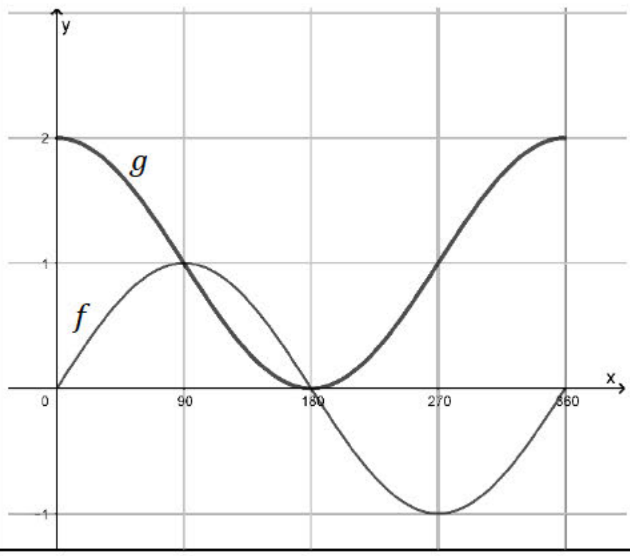
1. Write down the value of a.
2. What is the period of f?
3. What is the range of g?
4. For which value(s) of x will $f(x) > g(x)$?
5. The graph of f is reflected with respect to the x axis.
Write the equation of this new graph.

Solution:

1. $a = 1$ 2. $360°$

3. $y \in [0; 2]$ 4. $90° \leq x \leq 180°$

5. $y = -\sin x$



Solution: [Hints in brackets]

1. Amplitude= 1; Range: $y \in [0; 2]$

[Hint: starts at 1; $f(x)$ starts at 2]

Range: y −values between 0 and 2]

2. Amplitude: 2 [Ignore the sign]

Range: $y \in [-2; 2]$

3. $a = 1$; $q = 1$

[cos x moved 1 unit upwards]

4. $m = -2$; $n = 0$

[sin x did not move]

Consolidation

Summary of the trigonometric functions

	y= a sin $x + q$ and y = a cos $x + q$	y= a tan $x + q$
A	• Vertical stretch • A is the amplitude (ignore signs) • If a is negative, then there is a reflection in x -axis.	• Vertical stretch from the x-axis (ignore signs) the critical points are (45^0 ;a); (135^0 ;-a) ;(225^0 ;a) and (315^0;-a) • If a is negative, then there is a reflection in the x-axis. • The equations of the asymptotes are $x=90^0 + k.180^0$ where k represents integer values.
Q	Vertical shift	Vertical shift
Period	360^0	180^0

Learners are expected to acquire following skills after this lesson:

- Know the basics of graphs i.e., y = sin x, y = cos x and y =tan x.
- The period of the tan is 180^0, This graph has asymptotes.
- Learners need to start with the basic functions and apply the changes as mentioned in the question.
- It is also expected that learners are able to sketch a trigonometric graph without the use of the table.

APPENDIX F: Pre and Post Worksheet

<table>
<tr><td rowspan="2"></td><td colspan="6">Name:</td></tr>
<tr><td>Gr 10</td><td></td><td>Date:</td><td></td><td>Time:</td><td>1HR</td></tr>
<tr><td>CAPS Reference</td><td colspan="6">Trigonometry Functions</td></tr>
<tr><td>Topic</td><td colspan="6">Sine, Cosine, Tan - functions</td></tr>
</table>

1. **Pre-task & Post- task [45 MIN]**

1.1. Make a neat sketch of the following graph $f(x) = 3sinx$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

1.1 Write down the amplitude of $f(x)$

1.2 Write down the range of $f(x)$

1.3 Write down the period of $f(x)$

1.5 If the graph of f is shifted two units down to obtain a new graph g. Write down the equation of the new graph $g(x)$.

2.1 Make a neat sketch of the following graph $f(x) = \sin x + 2$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

2.2 Write down the amplitude of $f(x)$

2.3 Write down the range of $f(x)$

2.4 Write down the period of $f(x)$

2.5 If the graph of f is shifted three units up to obtain a new graph g. Write down the equation of the new graph $g(x)$.

3.1 Make a neat sketch of the following graphs $f(x) = \frac{1}{2} \sin x$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

3.2 Write down the amplitude of $f(x)$

3.3 Write down the range of $f(x)$

3.4 Write down the period of $f(x)$

3.5 If the graph of f is shifted one unit down to obtain a new graph g. Write down the equation of the new graph $g(x)$.

4.1 Make a neat sketch of the following graph $f(x) = \sin x - 1$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

4.2 Write down the amplitude of $f(x)$

4.3 Write down the range of $f(x)$

4.4 Write down the period of $f(x)$

4.5 If the graph of f is shifted two units up to obtain a new graph g. Write down the equation of the new graph $g(x)$.

2. Pre-task & Post- task [45 MIN]

1.1. Make a neat sketch of the following graph $f(x) = 4\cos x$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

1.2. Write down the amplitude of $f(x)$

1.3. Write down the range of $f(x)$

1.4. Write down the period of $f(x)$

1.5. If the graph of f is shifted two units down to obtain a new graph g. Write down the equation of the new graph $g(x)$.

2.1. Make a neat sketch of the following graph $f(x) = \cos x - 2$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

2.2. Write down the amplitude of $f(x)$

2.3. Write down the range of $f(x)$

2.4. Write down the period of $f(x)$

2.5. If the graph of f is shifted three units up to obtain a new graph g. Write down the equation of the new graph $g(x)$.

3.1. Make a neat sketch of the following graph $f(x) = \frac{1}{2} \cos x$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

3.2. Write down the amplitude of $f(x)$

3.3. Write down the range of $f(x)$

3.4. Write down the period of $f(x)$

3.5. If the graph of f is shifted two units up to obtain a new graph g. Write down the equation of the new graph $g(x)$.

4.1. Make a neat sketch of the following graph $f(x) = cos x + 1$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

4.2. Write down the amplitude of $f(x)$

4.3. Write down the range of $f(x)$

4.4. Write down the period of $f(x)$

4.5. If the graph of f is shifted three units down to obtain a new graph g. Write down the equation of the new graph $g(x)$.

3. Pre-task & Post- task [45 MIN]

1.1. Make a neat sketch of the following graph $f(x) = 5\tan x$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

1.2. Write down the amplitude of $f(x)$

1.3. Write down the range of $f(x)$

1.4. Write down the period of $f(x)$

1.5. If the graph of f is shifted one unit up to obtain a new graph g. Write down the equation of the new graph $g(x)$.

2.1. Make a neat sketch of the following graph $f(x) = \tan x + 1$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

2.2. Write down the amplitude of $f(x)$

2.3. Write down the range of $f(x)$

2.4. Write down the period of $f(x)$

2.5. If the graph of f is shifted four units down to obtain a new graph g. Write down the equation of the new graph $g(x)$.

3.1. Make a neat sketch of the following graph $f(x) = \frac{1}{2} \tan x$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

3.1. Write down the amplitude of $f(x)$

3.2. Write down the range of $f(x)$

3.3. Write down the period of $f(x)$

3.4. If the graph of f is shifted two units up to obtain a new graph g. Write down the equation of the new graph $g(x)$.

4.1. Make a neat sketch of the following graph $f(x) = \tan x - 2$ for $0° < x < 360°$ on the axis. Clearly indicate on your sketch the intercepts with the axis.

4.2. Write down the amplitude of $f(x)$

4.3. Write down the range of $f(x)$

4.4. Write down the period of $f(x)$

4.5. If the graph of f is shifted two units up to obtain a new graph g. Write down the equation of the new graph $g(x)$.

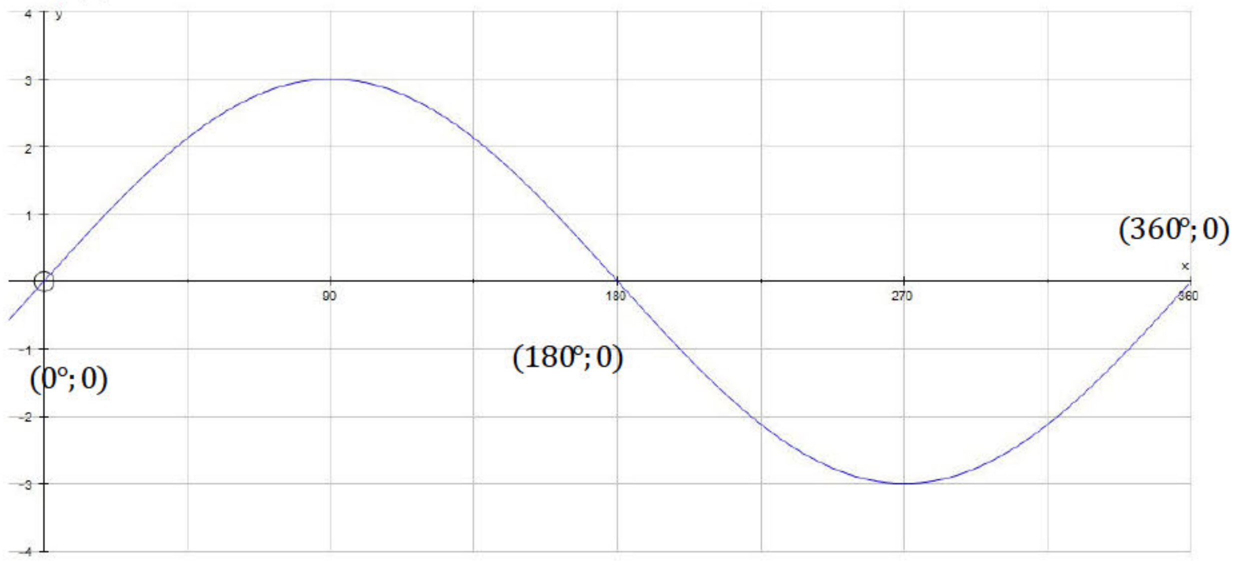
APPENDIX G: Pre and Post interverntion(Expected Responses)

	EXPECTED RESPONSES					
	Gr 10	A			**Time:**	**1HR**

CAPS Reference	**Trigonometry Functions**
Topic	**Sine, Cosine, Tan - functions**

1. Pre-task & Post- task [45 MIN]

1.1. $f(x) = 3\sin x$



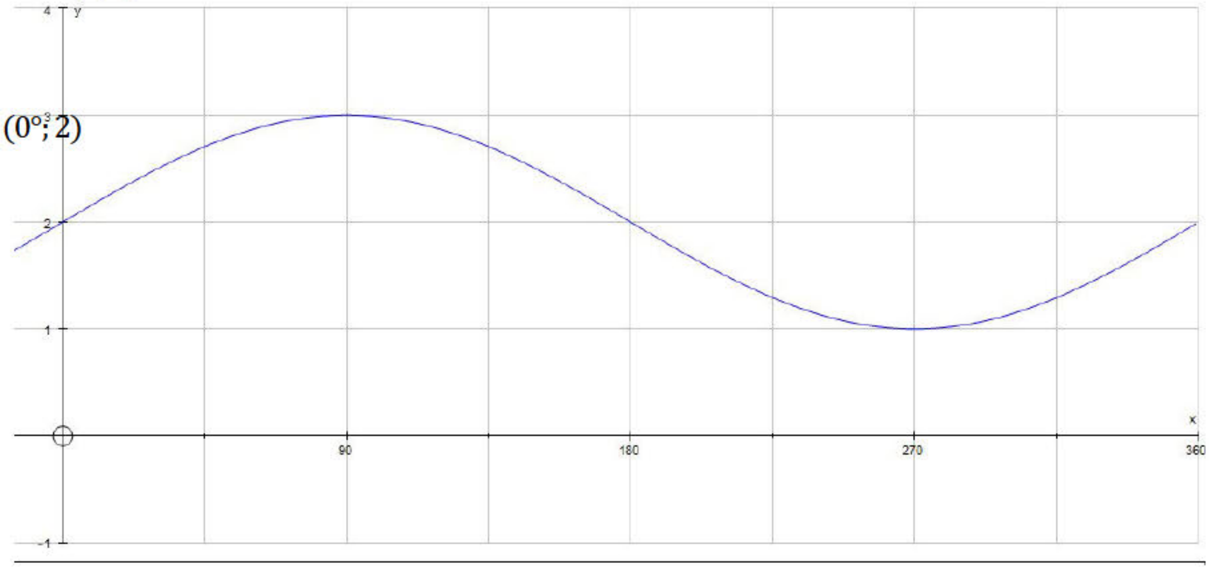
1.2. 3

1.3. $y \in [-3;3]$

1.4. $360°$

1.5. $g(x) = 3\sin x - 2$

2.1. $f(x) = \sin x + 2$



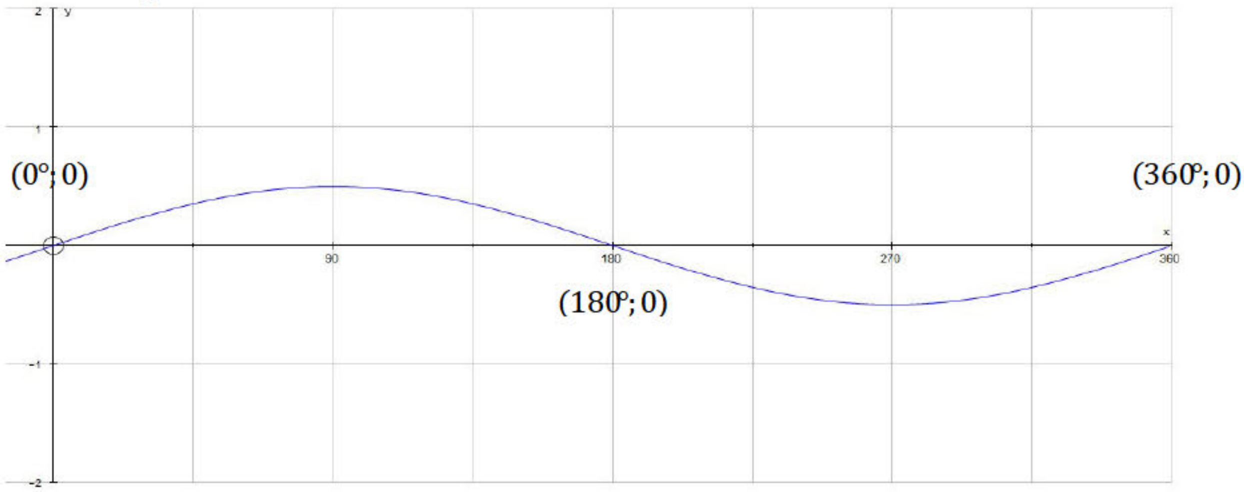
2.2. 1

2.3. $y \in [1; 2]$

2.4. 360°

2.5 $g(x) = \sin x + 5$

3.1. $f(x) = \frac{1}{2}\sin x$



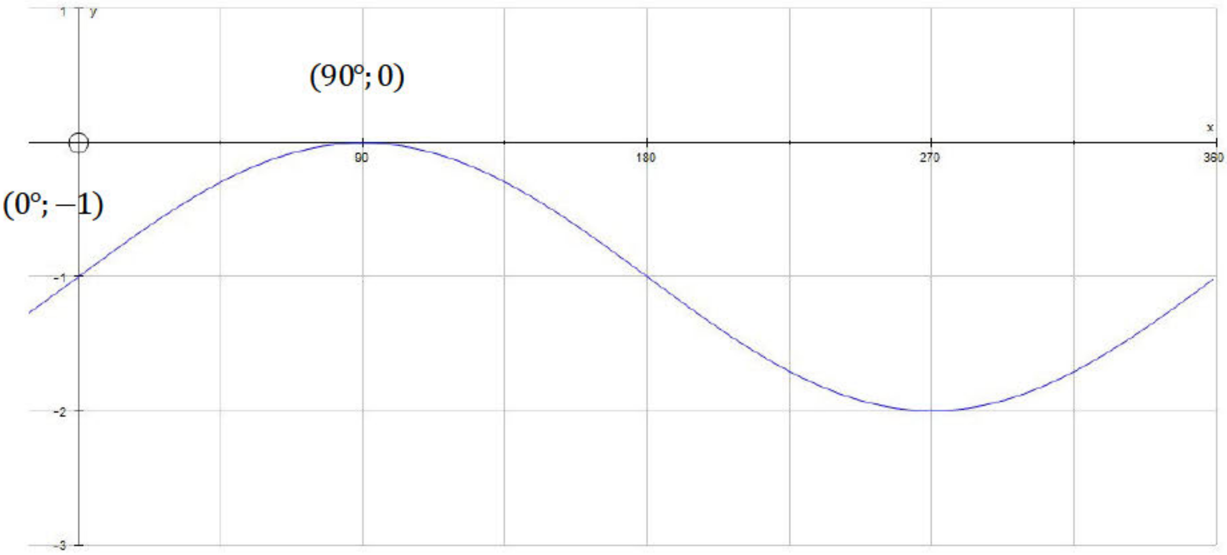
3.2 $\frac{1}{2}$

3.3 $y \in \left[-\frac{1}{2}; \frac{1}{2}\right]$

3.4. 360°

3.5. $g(x) = \frac{1}{2}\sin x - 1$

4.1. $f(x) = \sin x - 1$



4.2. 1

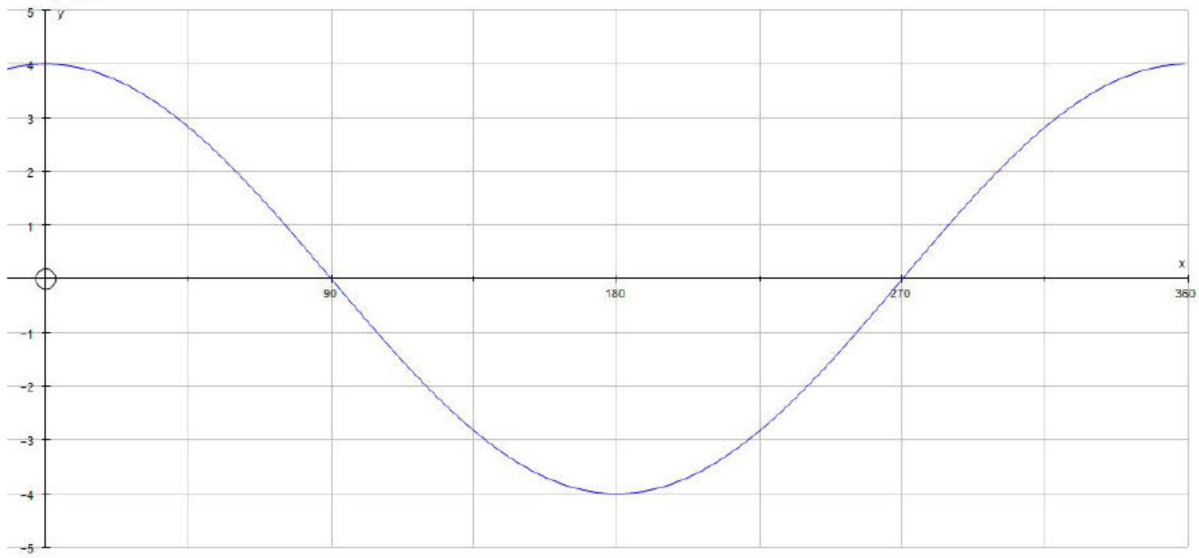
4.3. $y \in [-2;0]$

4.4. 360°

4.5 $g(x) = \sin x$

2. Pre-task & Post- task [45 MIN]

1.1. $f(x) = 4\cos x$



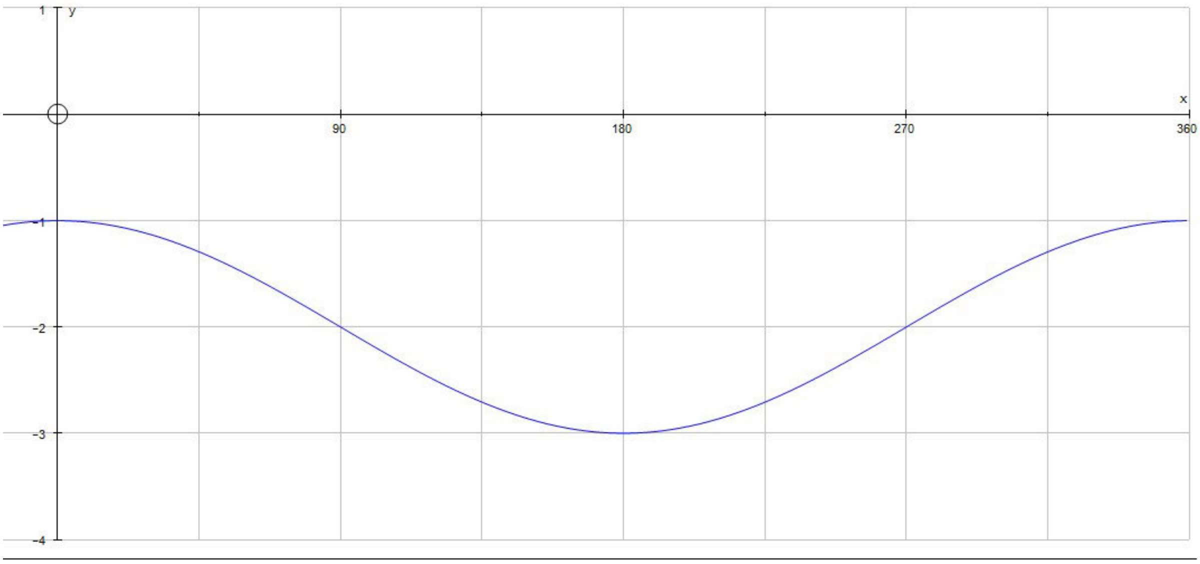
1.2. 4

1.3. $y \in [-4;4]$

1.4. 360°

1.5. $g(x) = 4\cos x - 2$

2.1 $f(x) = cosx - 2$



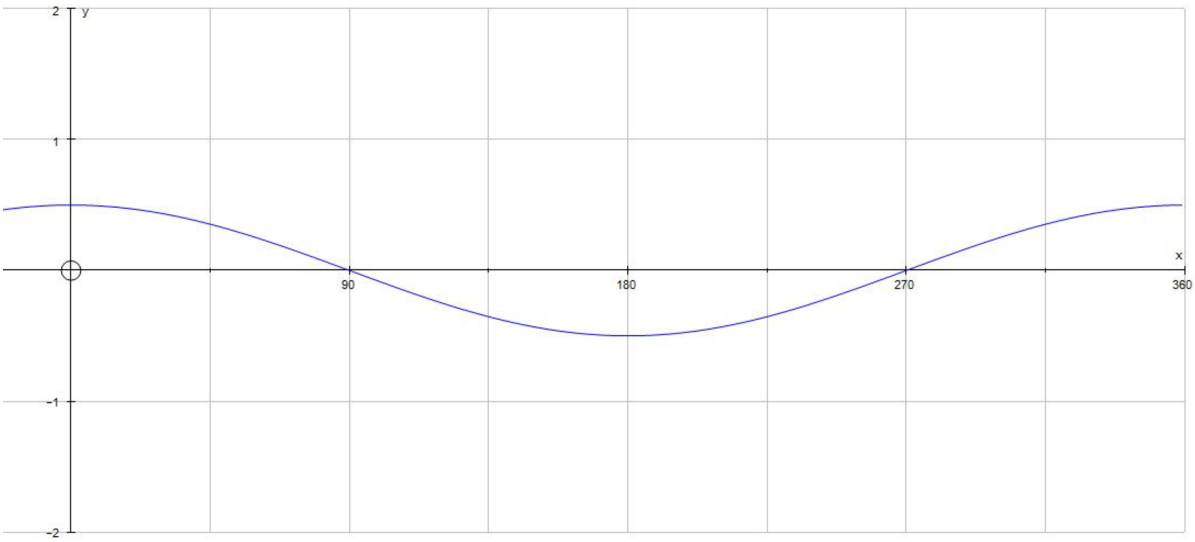
2.2. 1

2.3. $y \in [-3;-1]$

2.4. 360°

2.5. $g(x) = \cos x + 1$

3.1. f(x) = $\frac{1}{2}\cos x$



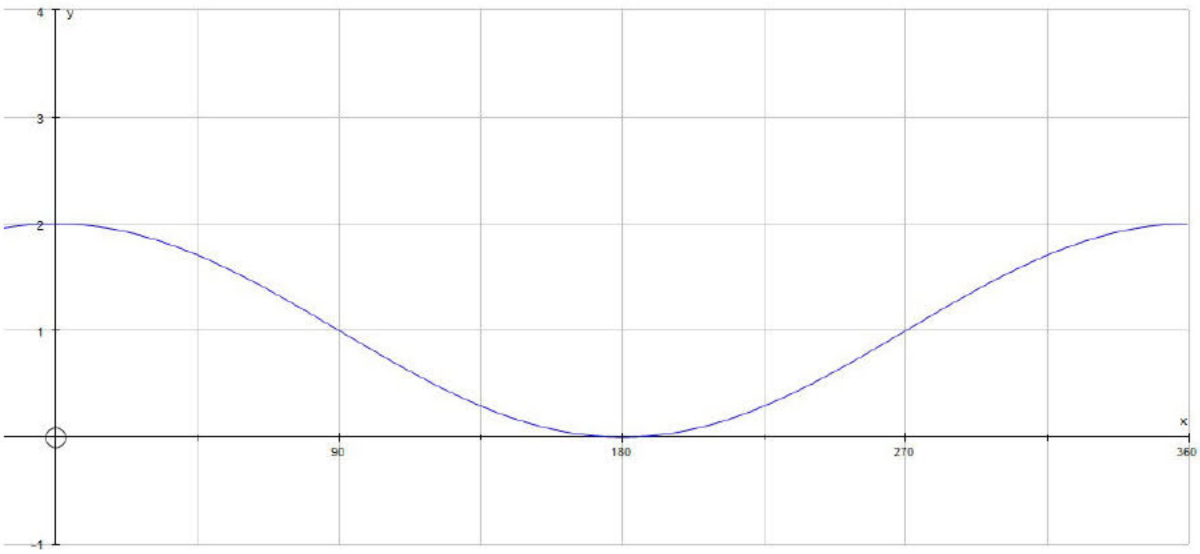
3.2 $\frac{1}{2}$

3.3 $y \in \left[-\frac{1}{2};\frac{1}{2}\right.$

3.4. 360°

3.5. $g(x) = \frac{1}{2}\cos x + 2$

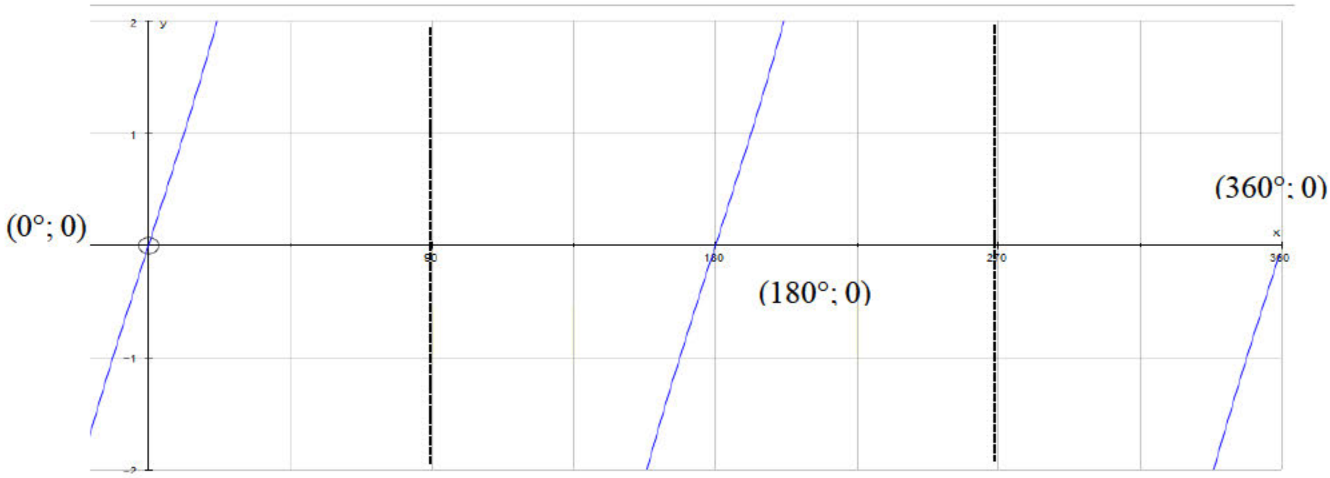
4.1. $\cos x + 1$



4.2. 1
4.3. $y \in [0; 2]$
4.4. 360°
4.5. $g(x) = \cos x - 2$

3. Pre-task & Post- task [45 MIN]

1.1 $f(x) = 5tanx$



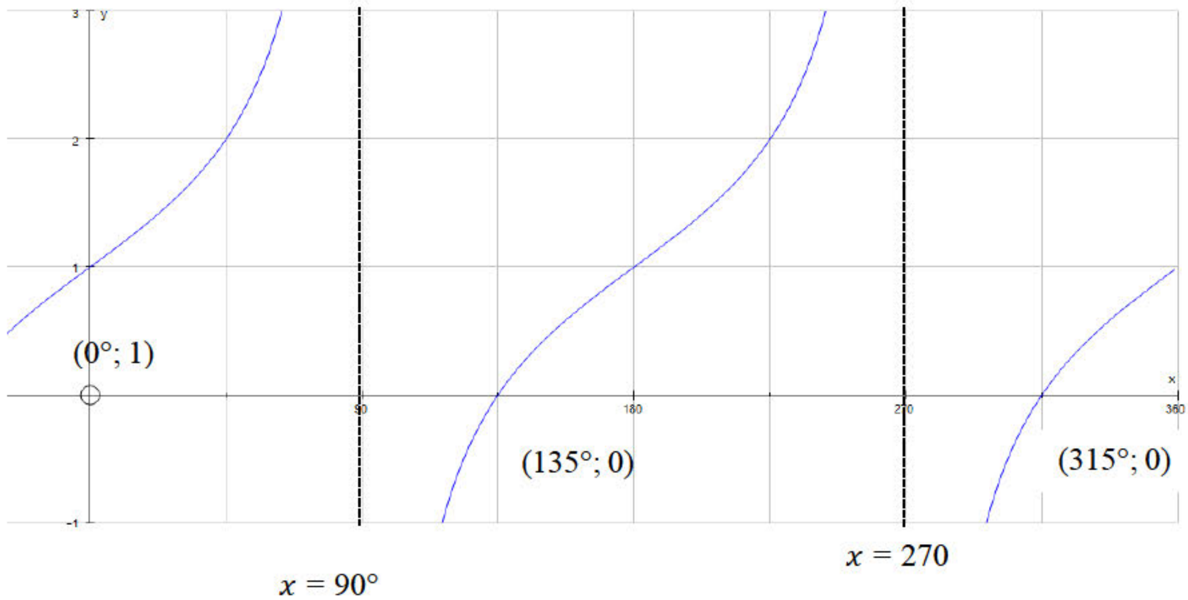
1.2 5

1.3 $y \in (-\infty; \infty)$

1.4 180°

1.5 $g(x) = 5tanx + 1$

2.1 $f(x) = tanx + 1$



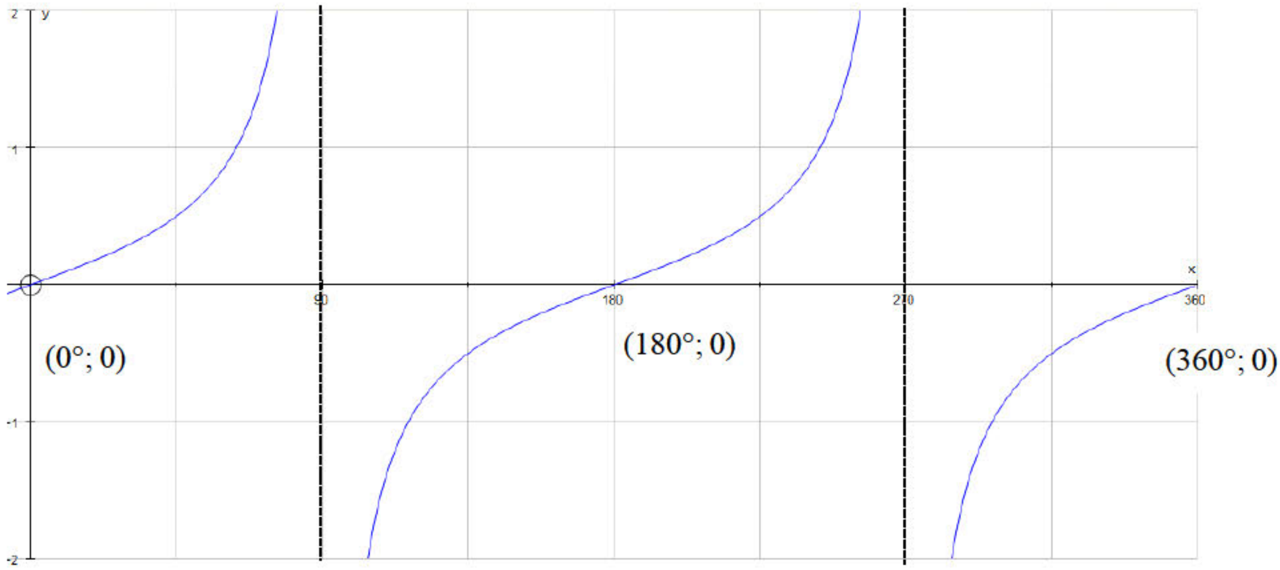
2.2 1

2.3 $y \in (-\infty; \infty)$

2.4 180°

2.5 $g(x) = tanx - 3$

3.1 $f(x) = \frac{1}{2}tanx$



$x = 90°$ $x = 270°$

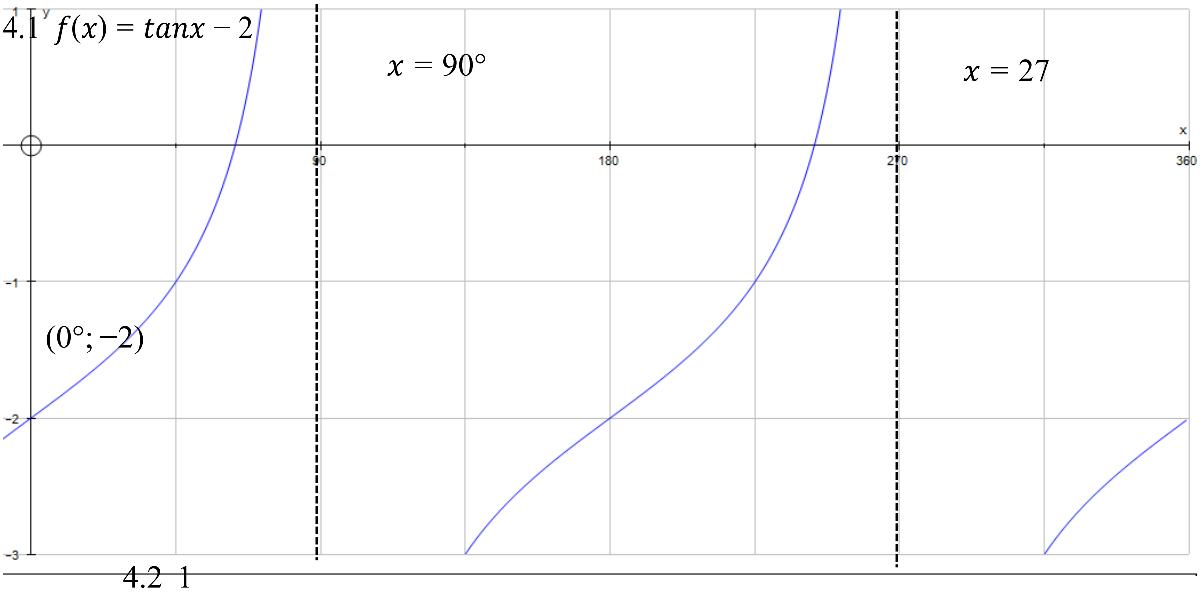
3.2. $\frac{1}{2}$

3.3 $y \in (-\infty; \infty)$

3.4 180°

3.5 $g(x) = \frac{1}{2}\ tanx + 2$

4.1 $f(x) = tanx - 2$



4.2 1

4.3 $y \in (-\infty; \infty)$

4.4 180°

4.5 $g(x) = tanx$

APPENDIX H: Interview Schedule

Interview schedule

Exploring grade 10 learners' perceptions on using Microsoft teams as a blended online platform for learning Trigonometric functions.

Semi - structured Interview schedule

Schedule for individual interview for all eighteen learners who participated in the research after they learn Trigonometric functions through the use of the Microsoft teams platform.

NB: Although a semi-structured questionnaire will be used, probing questions will be asked to obtain additional information.

Name: ....

NB: This interview requires your honest opinion and all details will remain confidential.

1. How do you feel now that you've had to complete this activity using the Microsoft teams online platform?

....
....
....
....

2. Which aspects of the activity made you feel this way?

....
....
....
....

3. Did you experience any problems while you were learning using the Microsoft teams online platform? Please explain your response.

....
....
....
....
....

4. Did you find that using the Microsoft Teams platform helped you in learning about Trigonometric functions? How did it assist you, if at all?

....
....

APPENDIX I: Editor's Letter

M&G
RESEARCH

The Hub Of Excellent Research

17 Lennox Road
Windermere
Durban
South Africa

Primary Email Address: [redacted]
Contact Number: [redacted]

17 December 2024

To Whom It May Concern,

Re: Editor's Letter

The letter serves to outline the scope of activities that were done during the re-editing of the thesis titled:

Exploring Grade 10 Learners' Perceptions of Using Microsoft Teams as An Online Platform for Learning Trigonometric Functions

The following activities were done:

- Grammar check
- Sentence construction
- Spelling check
- Punctuation
- Additional comments to be addressed by the author

As a professional editor, I pledge that the above aspects of the thesis were meticulously edited to the best of my knowledge when the work was sent to me. However, I am not responsible for any corrections that will be affected after the editing process.

Yours Sincerely,

[redacted]

Tigere P. Muringa (Ph.D.)

APPENDIX J: Turnitin Report

EXPLORING GRADE 10 LEARNERS' PERCEPTIONS OF USING MICROSOFT TEAMS AS AN ONLINE PLATFORM FOR LEARNING TRIGONOMETRIC FUNCTIONS

ORIGINALITY REPORT

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