Journal of Information Systems Engineering and Management
2025, 10(48s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Physical Sciences Teachers' Experiences of Online Teaching During the Covid-19 Pandemic

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ARTICLE INFO

Received: 10 Apr 2025

Revised: 30 Apr 2025

Accepted: 17 May 2025

ABSTRACT

The inspiration for this article came from the researchers' experiences during the COVID-19 pandemic. Determining how physical sciences are taught and learned in high schools in the Amajuba District of KwaZulu-Natal was the goal of the research. The study used mixed-method approaches, combining qualitative and quantitative techniques to explore the phenomenon. Learners and educators involved in teaching and studying physical sciences were the target demographic for this study. There were three stages to the data gathering, wherein the first stage, the quantitative data, was collected from one hundred and twenty (120) teachers through a structured closed-ended questionnaire. In the second stage, the qualitative data was collected from ten (10) physical sciences teachers through in-depth interviews. For the teachers/qualitative approach, the interview guide and open-ended questions were used, and a face-to-face in-depth interview was conducted. In stage three, a series of documents were reviewed and analysed. The study's findings showed that 40% of the participants performed online lessons during the COVID-19 era at their schools using social media platforms, and 35.5% of the respondents mentioned using Google learning platforms. 75.8% of the respondents noted that they face challenges associated with online learning and teaching, and only 24.2% of them stated that they are not facing any challenges related to online learning and teaching. This study recommended that South African high schools provide their employees with training programmes on online instruction. These programmes will give educators a chance to learn the necessary e-teaching skills.

Keywords : COVID-19 **,** online teaching , physical sciences, teachers' experiences, Curriculum Assessment Policy Statement, Information Communication Technology

INTRODUCTION

A modern educational technique is online learning, where students and teachers adhere to guidelines that define curriculum programs delivered via the Internet using advanced information technology. Platforms such as virtual learning portals, apps, and social media are examples of modes of instruction. On-campus classes are optional for students, so as long as they have the requisite technology and software, they can engage in this learning style from a distance.

While the rest of the world was preparing for a Fourth Industrial Revolution (4IR) classroom by 2030, South Africa was still working on systemic balance following Apartheid, making it lag behind many countries worldwide. Despite the number of under-resourced rural schools, like those in Amajuba district in Kwazulu-Natal province, having remained constant over nearly three decades of democracy, the fight for educational equality continues. Efforts to update the curriculum are still underway. It began with the Curriculum 2005 (C2005) which was the first step towards eradicating the disparities in the apartheid education system Garfield de Waal (2004).

This was followed by the Revised National Curriculum Statement (RNCS), which were not a new curriculum but rather a simplification and strengthening of Curriculum 2005. Its objective is to build the groundwork for a unified national core curriculum by focusing on the structure and design of the curriculum, teacher orientation, training and development, learning support materials, provincial assistance for teachers in schools, and implementation timelines (Ramrathan, 2020).

Journal of Information Systems Engineering and Management
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Then Outcome-Based Education (OBE) where focus was on outcomes of educational process (Keswa,2020), in fact, the OBE model alleges that learners' success is solely the teacher's responsibility (Schmidt ,2017). The OBE was criticized for proposed outcomes. Many individuals oppose OBE reforms because they believe the criteria to be too simple, too difficult, or poorly constructed. As opposed to rejecting OBE itself, some so-called OBE critics criticize non-OBE measures that were offered as part of a comprehensive reform "package."

The Curriculum and Assessment Policy Statement (CAPS) was then implemented in 2012. Assessment, workload, and planning are the pillars of CAPS, which aimed to alleviate the burden on instructors by allowing for greater flexibility in assisting learners with their studies (DOE, 2012). In addition, teaching and learning subjects have distinct priorities, expertise, content emphasis, and content weighting (DOE,2012). However, the implementation of the CAPS document has resulted in numerous significant changes to our curriculum (Education.gov.2019), such as assisting and facilitating inclusive education, regardless of the socio-economic status of the learner, race, class, physical or mental ability, by providing them with the knowledge, skills, and values necessary for self-fulfilment and constructive participation in society as citizens of a free country. Again, ensuring that students acquire and utilize skills and experiences in ways that enrich their lives. In this way, while the program is responsive to global imperatives, it promotes the concept of localizing awareness. In addition, illustrate knowledge of reality as a collection of related instrumentality that integrates interrelated coherent entity by recognizing that there are no discrete requirements for critical thinking. (Department.gov. 2012).

With the coming of Corona Pandemic (COVID-19) in South Africa, just like all other countries in the world were obliged to adapt to a new teaching and learning approach which was online classes to prevent educational processes in country from being halted. Although, the first online classes began in the early 1980s, thanks to Murray Turoff's creation of computer conferencing in 1970 (Hiltz and Turoff,1978). Synchronous communication between separated individuals is possible using computer conferencing, often known as computer-mediated communication (CMC). Whereas all messages from all participants are preserved, categorised, and available on-demand centrally, the user can communicate at any time. Local computer networks, mainly limited to a single institution, were used in the early days of computer conferencing. The New Jersey Institute of Technology in the United States was one of the first to offer computer-assisted training. Using specially modified computer conferencing software termed "Virtual Classroom," Roxanne Hiltz and Murray Turoff built a "typical online classroom" between 1985 and 1987, giving various courses entirely or partially online. (Hiltz, 1990, p. 134).

Before COVID-19 the 4IR trends process, and in keeping with the rest of the world, a 10-year online education plan was developed. South Africa's plan was not exceptionally high. According to the Quarterly Labour Force Survey (QLFS) of Statistics South Africa (Stats SA), the aggregate rate of jobless graduates is 9.3 per cent in Quarter 1 of 2021: 40.3 per cent of graduates aged up to 24, 15.5 per cent of those aged 25 to 34, and 5.4 per cent of those aged 35 to 64, one must wonder: Is digital education South Africa's future? A pandemic that has wreaked havoc on global economies and affected people mentally and physically has proven to be the most effective catalyst for change in an educational system beset by problems. The task of returning things to "as they were" remains unsolved. Because practical and lab work is essential in Science, Technology, Engineering, and Mathematics (STEM) modules and programs, public higher education verifies that a hybrid approach is required.

According to Killian et al. (2021), many physical sciences educators never believed they would have to engage in distance learning because of the practical and philosophical difficulties inherent in teaching and learning movement-based curriculum through the computer. Despite this, the bulk of physical sciences teachers have been forced to use distance education methods due to the COVID-19 epidemic. There are various challenges regarding maintaining high-quality physical education in online teaching and learning setting that is largely unfamiliar. Physical Sciences teaching have never been the same again in the pandemic age because of the lack of access to labs.

The realities and limitations of an online curriculum are similar to the socioeconomic circumstances of learners in the majority. Learners lack digital technology access, library materials, and, most critically, internet connectivity. Learners who live in places where internet access infrastructure is lacking, as well as the likelihood of having to choose between buying a loaf of bread for R15 or 500MB of data, must be given significant consideration.

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The COVID-19 outbreak has exposed the repercussions of educational inequality in South Africa, according to the Department of Education Province of Kwazulu-Natal vote no. 5 Annual Report 2019/2020 financial year, and it could catalyse addressing some of education's disparities, particularly in a rural province like KwaZulu-Natal. Efforts to stop the COVID-19 from spreading expose many systemic flaws across the educational environment. Improper sanitation and water facilities, overcrowding in classrooms and a teacher shortage at certain stages and schools are just a few of the difficulties that the educational system is attempting to address.

The Department of Education in KwaZulu-Natal planned and implemented lessons broadcast on various radio stations, newspapers, and digital platforms because of the academic sabbatical due to the COVID-19 countrywide lockdown. Matric learners received essential support during Level 5 Lockdown thanks to relationships with relevant stakeholders. In the year 2020, broadcast revision programmes were organised to assist learners in staying on track with their studies while still allowing them to participate in extracurricular activities.

LITERATURE REVIEW

Transition from Traditional class vs. Virtual class

Teachers and learners face difficulty moving from a conventional classroom to an online course supported by sophisticated communication technologies. Successful online learning is possible if learners consider variables such as technological literacy, e-learning planning and experience, as well as the isolation of a classroom setting (Palmer, 2005).

However, instructors that actively include their learners in learning activities can make online learning a reality. According to (Aljawarneh,2020) knowledge acquisition, motivation, and evaluation are the three elements that will help instructors be successful with online learning.

Learners in middle school and high school study sciences. When learners can verify and assemble their knowledge, they are engaged in scientific learning. Consequently, learners must be capable of providing genuine experience activities, educating and promoting learners' learning, and encouraging learners to engage in hands-on /minds-on learning in order to help them build their knowledge.

Learners' interest and motivation in physical sciences may be stimulated through practical work or hands-on experience. This can help learners improves their scientific knowledge and understanding of research (Lee & Boo 2022).

According to OECD (2020), teachers and learners are unprepared for online learning in the wake of the COVID-19 epidemic since it was not expected. Scientific teachers may have difficulties in this scenario since the job concentrates on adopting web-based learning and implements minds-on/hands activities in learning science. The study aimed to highlight the difficulties encountered by science instructors when teaching and learning online and to describe the efforts made by teachers to keep teaching online during the COVID-19 epidemic. After the COVID-19 epidemic ended, the study results were intended to offer reliable information regarding instructors' difficulties with effective online learning uptake.

Physical Sciences Teachers' Experiences in Online Teaching

Although such tragic incidents are viewed as unpleasant for humans, they can serve as a catalyst for change that propels education to the next level (Giovannella et al., 2020). Previous academics who have examined technological pedagogical content knowledge (TPACK) contend that K-12 teachers' adaption to technology in the new era has not yet achieved the necessary level (Mishra & Koehler, 2006; Poitras et al., 2017).
Nonetheless, this mandated move paved the way for teachers to utilize more technology in their online classes. Particularly, teachers of physical sciences should integrate technology into their physical sciences courses, use technology to assess their learners, create interactive learning environments, and perform experiments (Yildirim & Sensoy, 2018). Such an expanded usage of technology has been shown to increase learners' participation and achievement in physical sciences classes (Oktay & Cakir, 2013). Additionally, it is believed that digital technology can generate new chances for education and training (Chauhan, 2017).

According to recent research analyzing teachers' perspectives on physical sciences teaching during an emergency, teachers concur that their workload rose (Giovannella et. al.,2020; Marek, Chew, & Wu, 2021). In addition, teachers frequently consider that some subjects or themes are not suited to online teaching (Gratz & Looney, 2020; Joshi, Vinay, & Bhaskar, 2020a). These are typically procedural and

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e-ISSN: 2468-4376
https://www.jisem-journal.com/

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application-intensive disciplines. External distraction networking challenges (Joshi et al., 2020); lack of engagement, low participation rate (Arora & Srinivasan, 2020); and lack of training and technical support (Joshi et al., 2020). (Almaiah et al., 2020; Joshi et al., 2020; Sudevan, 2020). Managing learners during online instruction was cited as a further obstacle for educators. According to Punit and Qz.com (2020), many learners may disrupt online classes by creating noise, eating in front of the camera, playing music, or posting inappropriate comments from phony identities.

The research conducted by Trust and colleagues (2020) revealed that educators utilized Twitter hashtags to provide academic and emotional assistance. In this way, they were able to share their knowledge and teaching techniques with their peers. In such an out-of-the-ordinary setting, according to the researchers, teachers exhibited a cooperative and sharing attitude. On the other hand, Persico and colleagues (2020) discovered that teachers frequently avoid communicating with one another and sharing their experiences.

The mandatory online education brings emphasis to web-based teaching and learning resources. During the COVID-19 pandemic, researchers discovered that teachers had begun to view web-based resources as supplementary materials for online physical sciences teaching (al Darayseh, 2020; Radha et al., 2020). In addition to web-based tools, teachers reported accessing media like YouTube (Almurashi, 2016).

Teachers have also incorporated strategies such as classroom discussions (Townsend et al., 2002; Twigg, 2005), conducting collaborative activities (Niess & Gillow-Wiles, 2013), asking challenging questions during synchronous classes (Smith & Diaz, 2004), and speaking gently to learners (Bao, 2020; Mahmood, 2021). In addition, teachers are advised to be more patient and flexible with their learners' work because learners may meet infrastructure issues (Waqar, 2020). As in traditional classroom settings, Joshi, Vinay, and Bhaskar (2020b) assert that external encouragement, such as a "best online teaching award," is necessary for effective online teaching. Their exceptional efforts to improve their skills in order to assist learners' learning should not be disregarded.

A report published by UNESCO (2020) stated that as of April 2020, the COVID-19 had affected 92% of the educational lives of students globally. Considering that the procedure has taken longer than anticipated, this is a serious issue. Therefore, educators and stakeholders around the world seek to make the process of distant teaching and learning more efficient and streamlined. In addition, it is still being explored what measures should be implemented to prevent s from escaping school and classes, as well as what pedagogical approach and instructional tactics should be utilized. In light of these developments, we believe it is vital to investigate what methods and strategies teachers believe positively influence the engagement and motivation of students, as well as how they perceive online education to be more effective.

Online learning experience: South Africa case of COVID-19

Since the commencement of education, from colonization to decolonization, South African universities, colleges, and schools have relied on face-to-face learning (Mgqwashu', 2017).

Face-to-face education is a type of instruction that takes place in person and ignores the perspectives of learners; according to Morales (2022), this education happens in the presence of a tutor/teacher imparting information to learners in a delineated conventional method (teacher-centred) in the classroom and materials used in the past such as textbooks, chats, chalkboards, and others. However, these defined classrooms that are physically present remain unavailable in the face of difficulties ranging from learner demonstrations to eruptions of a pandemic like COVID-19.

The importance of online education vs. conventional teaching is a constant source of concern (Panyajamorn et al., 2018). According to UK research, even computer-literate learners preferred face-to-face instruction and learning (Orton-Johnson, 2009). Malaysian research showed that learners' readiness for online learning was influenced by their computer and internet skills and individual characteristics, including gender, race, year of study, and access to monetary help (Lau and Shaikh, 2012).

While this affected informal learning, learners found that online learning was the best way to continue their education after the school closure and travel restriction order. For all students in South Africa, both tertiary and high school, the government enforced that they return to their home cities in April 2020 to complete their education, which they must do entirely online. Giving an online allowance, data, laptops and students in South Africa have significant impacts in helping the family and learners stay

connected to online learning. Students also received free internet for online study using this data from their network provider.

Learners and teachers may benefit from online learning, but there are a few drawbacks to keep in mind, such as limited internet connection. Only 10 per cent of households in South Africa are connected to the internet. Other emerging countries have an average access rate of 50 per cent. The equipment cost is the fundamental cause of an access barrier. Because of poverty, 35 per cent thought there was no need for South African homes to access the internet. People who cannot afford technology believe they do not need an internet connection (Kargol, 2021). Learners in South Africa's more remote and rural areas have particular difficulties with online learning owing to the absence of appropriate online learning infrastructure and an inadequate internet connection (Lee, 2020). Learners also have difficulty connecting with their instructors, friends, and laboratories, impacting their academics.

Physical sciences differ from other academic disciplines because they emphasise practical activities instead of general information. Organising and operating physical sciences programmes online is necessary to communicate and practice physically successfully. Given the prevalence of in-person attending school and distance learning, we must investigate whether physical sciences courses delivered through online platforms successfully convey practical information. However, few studies have examined the efficacy and promise of service over internet education classes (Kim, 2007).

Physical sciences textbooks written by the University of Pennsylvania at Greensboro were examined, and it was discovered that experiential learning should be included with physical activity. Controlling engagement and motivation in physical education courses provided a teaching approach that combined learner-centred classrooms with a mixed learning approach (Lyu, 2011).

Only a few studies have looked into the efficacy of college courses in a limited number of topics, and none have examined the difficulties (see for example, Wernersbach,et al 2014; Jaggars & Bailey ,2010) .Consequently, identifying existing practices and the best methods in web-based physical sciences lessons is essential during the pandemic. New research identifies and suggests strategies for managing web-based physical training sessions for middle and high school learners.

According to Hall (2019), there were 11,252 schools in South Africa's rural areas. A total of 8192 primary schools and 3060 secondary schools were counted. More than half of these institutions can be found in the provinces of Eastern Cape, KwaZulu-Natal, and Limpopo, all of which are primarily rural. Around 72% of South Africa's rural children live in just these three provinces. Around 2.6 million children, or 62% of the total kid population in KwaZulu-Natal, live in rural areas (Hall, 2019). There may be as much as a third of South Africa's population living in rural areas, according to the World Bank (2018). The quality of education in rural parts of South Africa is lower for a number of reasons, including the difficulty for governments to provide these services there (Du Plessis & Mestry, 2019). Many of these factors contributed to the difficulties experienced by the majority of South Africans during the 2009 COVID-19 pandemic.

Teaching and Learning through Online Learning Platforms

During the COVID-19 pandemic-related school lockdown, online learning technologies have helped to preserve the continuity of teaching and learning. An online learning platform is a set of interactive online facilities that give teachers, learners, and others with information, tools, and resources to enhance educational delivery and administration (SAP Litmos, 2021). Different institutions of higher education have implemented various online learning platforms; the accepted platform influences the available teaching activities and the level of interaction and engagement between instructors and students.

Prior to COVID-19, online platforms were used to supplement traditional face-to-face learning. Recently, however, the majority of learning in higher education institutions has been conducted through online platforms. It is crucial to determine whether the true aim of teaching and learning is fulfilled through online instruction. Anwar and Adnan (2020) and Marinoni, Van't Land, and Jensen (2020) have identified a variety of advantages of teaching via online platforms, including the ability to deliver synchronous and asynchronous learning through emails, discussion forums, videos, and live sessions. The advantages of online learning have been cited by numerous authors, including Parlakkiliç (2017), Mwapwele et al. (2019), Torres and Giddie (2020), and many more. These advantages include the ability to teach and learn remotely, to reach a more diverse audience, to save money, to gain access to more

Journal of Information Systems Engineering and Management
2025, 10(48s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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information, to evaluate the effectiveness of instruction, to work together more effectively, and to improve student achievement.

Van de Heyde and Siebrits (2019, 2) state that "emerging learning technologies within the learning and teaching environments are generally underutilised in South Africa, and the need for, and use of the e-tools is of utmost importance as national higher education institutions are working towards a common goal within the context of a global education transformation. However, Bagarukayo and Kalema (2015) found that just a minority of South African public universities (38% to be exact) used online learning management systems as part of their classroom technology arsenal.

When it comes to online learning management systems like Moodle, the University of KwaZulu-Natal (UKZN) is one of the few universities that offers it. But, many lecturers still do not make full use of it. Innumerable students attend UKZN despite having insufficient levels of computer literacy because they came from underprivileged schools and low-income households. Because the institution only provides Moodle training for faculty, students are left to self-teach without any preparation to utilize or navigate the Moodle system. Bagarukayo and Kalema's (2015) evaluation of e-learning in South African institutions revealed that lack of adequate ICT skills was a major factor in both students' and teachers' struggles with the learning management system. In spite of widespread belief that studying Information Technology and System will improve students' fluency with computers, such courses typically do not incorporate any sort of online instruction. Improving classroom instruction and student learning requires that cutting-edge educational tools be made available to teachers and students alike (Van de Heyde and Siebrits, 2019).This research, however, aimed to go deeper into the methods educators use in order to reap the advantages of online education.

COVID-19 and the Digital Transformation of Education: What we are learning on 4IR in South Africa.

Mhlanga and Moloi (2020) researched to ascertain the results of the COVID-19 pandemic on education in South Africa regarding the use of 4IR (Fourth Industrial Revolution) tools. The research was done using secondary sources, however, and not primary. They use the phrases “remote learning” and “online learning” interchangeably. Over 160 countries were forced to shut down schools in response to the pandemic (World Bank, 2020). Educational institutions and government would have to initiate plans to help learners and students cope with the shutdown and continue their academic journeys with as little disruption as possible. COVID-19 is new, and the adoption of online learning platforms would need to be investigated to ascertain the pandemic's effect in speeding up digital education in a 4IR context. Many institutions had, really, only two choices: shut down or make use of 4IR tools.

Many universities and schools would have shut down due to being entirely unprepared for such a crisis. Factors contributing to this shutdown could be poor infrastructure, lack of internet connectivity, and data cost for mobile devices. Some universities, such as the University of Cape Town, addressed this challenge by providing 30 to 40GB of cellular data, printed learning materials and USB drives with copied material to students who did not have internet access (Peterson, 2020). A nationwide lockdown saw many educational institutions moving their courses online. For schools, they had to adapt. Some NGO’s (Non-Governmental Organizations) assisted the Department of Basic Education by making learning materials available online. Nevertheless, any online learning framework could experience challenges that were yet to be faced, such as inadequate hardware or devices, poor internet connections, lack of teacher expertise, and insufficient orientation for learners (Keengwe & Kidd, 2010).

Being caught by the sudden spread of the pandemic and lockdown of schools, the education sector in South Africa would have to change how they did schooling, social distancing, room capacity and ventilation, for example. Online learning was a valid option and going online meant using various tools. From Mhlanga and Moloi (2020), Table 2.1 is a non-exhaustive table illustrating the tools used to maintain online teaching during school and universityshutdowns.

Table 1: Tools Used for Online Teaching (Source: Mhlanga et al., 2020)

VIRTUAL LEARNING TOOLS DURING LOCKDOWN					
Tools Used	**Description**	**Connectivity**	**Platform**	**Conditions of Use**	**Target Group**
Television (SABC,	Teachers delivering	Offline	Television desktop	Free (lockdown)	Primary Secondary

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e-ISSN: 2468-4376
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DSTV, E.tv,)	lessons live to learners on TV				
Radio (SABC)	Teachers deliver lessons live to learners	Offline	Television desktop	Free (lockdown)	Primary Secondary
Use of free zero-rated applications and educational websites					
Mobile Platforms and Applications (Vodacom, Cell C, MTN)	Learners access learning material from educational and informational (reference) websites	Online	Desktop laptop mobile	Free (lockdown)	Primary Secondary
STEM lockdown digital school (Sasol Foundation (SF), Africa Teen Geeks)					
Internet (website), (Ms Zora, SF, Siyavula, DBE)	Teachers in public and private schools offer classes through a live stream	Online	Desktop laptop mobile	Free (lockdown)	Primary Secondary
Facebook (Ms Zora)	Teachers in public and private schools offer classes through a live stream	Online	Desktop laptop mobile	Free (lockdown)	Primary Secondary
Twitter (Ms Zora)	Teachers in public and private schools offer classes through a live stream	Online	Desktop laptop mobile	Free (lockdown)	Primary Secondary
Remote Learning (Online learning)					
Internet (Websites) YouTube Primary Secondary (Mostly all universities)	Learners learn on their own at home	Online	Desktop laptop mobile	All rights reserved	Primary Secondary Tertiary
Microsoft Teams (University of Johannesburg)	Used mainly by staff and learners in tertiary institutions to	Online	Desktop laptop mobile	Freemium	Tertiary

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e-ISSN: 2468-4376
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	hold discussions				
Skype	Used mainly by staff and learners in tertiary institutions to hold discussions	Online	Desktop laptop mobile	All rights Reserved	Tertiary
WhatsApp groups	Used mainly by staff and learners in tertiary institutions to hold discussions	Online	Desktop laptop mobile	All rights reserved	Tertiary
Zoom	Group Discussions	Online	Desktop laptop mobile	Freemium	Tertiary

Physical learning turned to virtual during the lockdown as various media providers helped by joining forces with the Department of Basic Education (DBE). The country had not been prepared for the lockdown, and virtual classes would enable schools and teachers to find the best ways, using technology, to continue education online. The SABC, DSTV, eTV, and other platforms such as radio created online spaces for lessons and teaching to continue. Many websites became zero-rated, meaning the data would not be deducted from a student's account should he/she access that site or resources from that site. Cellular data traffic increased between 35% and 60% on most of the local networks. Even prices of data packages came down to assist learners needing access to online sources. Using cellular data with these advantages could indicate why basic software, such as WhatsApp, was used. See section 2.7.

Services such as Siyavula sponsored free Maths and Science materials online, and the Department of Basic Education launched a non-profit online STEM school in partnership with Africa Teen Geeks. The Sasol Foundation also provided free access to Science, Technology, Engineering and Maths resources. Many platforms were utilised to ensure full access to as many resources, live stream teaching and other materials as possible. It also became clear that targeting learners in rural areas proved to be a considerable challenge.
Educational institutions such as University of Johannesburg, University of Cape Town and Tshwane University of Technology have chosen to continue many online courses during the lockdown and beyond. The Department of Basic Education has also provided textbooks, worksheets and revision materials on their website. Teaching has changed, and learning has changed. COVID-19 has had a significant impact on schools and tertiary institutions in South Africa. Many 4IR tools were adopted and adapted for utilization for online learning/remote learning.

METHODOLOGY

Research Design and Approach

The study adopted mixed method approaches which combine qualitative and quantitative techniques to explore the phenomenon (Timans, Wouters, and Heilbron, 2019). The mixed method describes, draws the inference, and provides an in-depth analysis of the subject matter in every aspect. The nature

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e-ISSN: 2468-4376
https://www.jisem-journal.com/

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of the research is an explanatory sequential mixed approach (Terrell,2012).

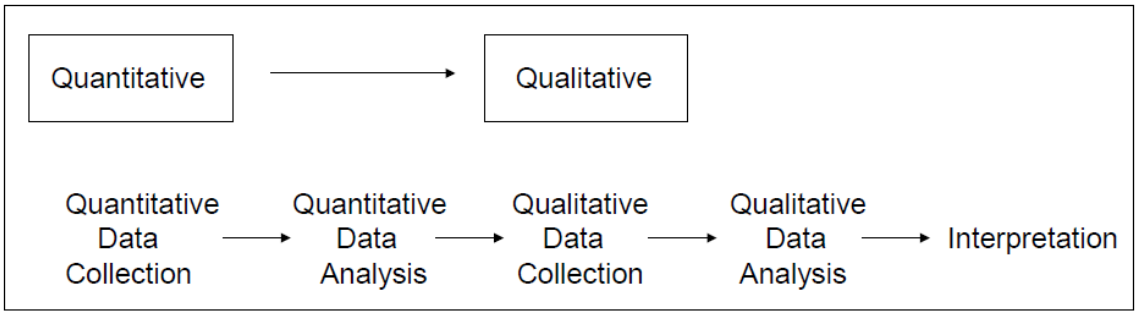

Figure 1: An Explanatory Sequential mixed approach (Terrell, 2012)

Therefore, this study's design is a sequential explanatory mixed methods approach in which the quantitative data was collected and analysed, and the findings were used to collect qualitative data (Terrell,2012). A sequential explanatory mixed method is depicted in Figure 1. This design consists of five distinct but linked stages, that is to say: quantitative data collection, quantitative data analysis, qualitative data collection, qualitative data analysis and then the interpretation stage, which reflects the appropriateness of online education to support how physical sciences are taught and learned in high schools in Amajuba District in Kwazulu-Natal, South Africa. Moreover, descriptive design focusing on describing details based on observation will restrict the research scope for identifying feasible solutions for the problems that learners encounter in physical sciences during online classes (Walliman, 2017). Hence, the explanatory design supports this study to examine this contemporary issue related to online education. Besides, it is essential to identify solutions by explaining the facts and facets rather than only focusing on exploring the nature of the research problem followed in exploratory research design (Sekaran & Bougie, 2016). The mixed method included document analysis, questionnaires, in-depth interviews with respondents, and applying descriptive, inferential, and thematic analysis of the results.

Regarding this sudden outbreak of COVID-19 and the related worldwide public health emergency, the health and safety of people are the prime concern. Therefore, an explanatory research design supports explaining the different aspects of online teaching and learning methods that apply to physical sciences. It can elevate the chances of examining and explaining the reasons for this contemporary issue, which had yet to be studied earlier for developing operational definitions and research solutions (Bryman, 2016). Furthermore, the application of this research design explains the process of implementing online teaching and learning methods for physical sciences for high-school learners in the selected high schools.

This study used a deductive approach between inductive and deductive research to address the three research questions and test the research hypotheses. Bryman (2016) contends that the inductive research approach helps to utilise known premises for generating untested conclusions, while the deductive approach aims at deducting tested conclusions to enhance the opportunity to test the research hypothesis. The selection of this research approach is beneficial for testing interrelationships between research variables based on pre-existing theories and the existing bodies of knowledge. Inductive reasoning emphasises that developing new theories by exploring a specific phenomenon develops a conceptual framework for addressing a particular issue (Sekaran & Bougie, 2016). Thus, the inductive approach was discarded in this study, and the deductive technique was included in the current research study.

Along with this, the inclusion of the deductive approach supports this research to evaluate the existing theories and concepts of online teaching and learning processes while commenting on the acceptability of those approaches and defining and explaining the concepts according to the existing research and concepts (Bal-Taştan et al., 2018). This, in turn, was catered to the requirements for addressing the teaching experiences of physical sciences teachers in selected high schools from the Amajuba District.

Research Methods

In contrast to research techniques, how a study's information is gathered is referred to as research methods. In this study, mixed methods were employed. Mixed methods are composed of both qualitative and quantitative research methods. Mixed methods studies are products of the pragmatist

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2025, 10(48s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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paradigm and combine the qualitative and quantitative approaches within different phases of the research process. (Tashakkori and Teddie,2008).

The collection of data in this study was done in three phases.

Phase one involved using a questionnaire as a data collection instrument where one hundred and twenty (120) physical sciences teachers were respondents. One hundred twenty physical sciences teachers were selected to be respondents in the questionnaire because there are 75 high schools in the Amajuba district, and only 67 of them offer physical sciences as a subject. At least one teacher was selected in each school, and schools with a high enrolment of learners in the subject had two teachers selected in other to have the 120 respondents for this study. Teachers were polled using questionnaires because of their efficiency and low cost. They also allowed respondent to express their views freely. The questionnaire was divided into four sections (Section A - Section D) to address this study's research questions and objectives.

Section A entails demographics of respondents who are physical sciences teachers, while section B deals with conducting physical sciences lessons during the COVID-19 era. Section C addresses reasons for conducting online lessons in a specific manner, and the last section, D, discusses the technology that informs teaching approaches during the COVID-19 era.

In stage one, questionnaires were conducted to gather quantitative data from respondents. Structured questionnaires, which included open-ended and closed-ended questions, were administered to explore the online teaching and learning experiences of physical sciences teachers during the COVID-19 pandemic.

Phase two involved an in-depth interview, where ten physical sciences teachers were participants. The ten participants were chosen based on specific interviewee selection criteria, such as: Who has pertinent information? Who is available? Who is willing to provide pertinent details? Who is the best source of information? Oral questions with brief explanations were included in the interview guide. Each teacher was interviewed for approximately 30 to 35 minutes during one-on-one interviews. Interviews were employed to validate responses given through questionnaires. Because of this, different educators could share their thoughts and opinions without worrying about what others might think (Bryman, 2004). The researcher could elicit additional information on teachers' experiences through semi-structured interviews. Probing helps the researcher to explore new routes that the participants initially needed to consider (Gray, 2009; Lodico et al., 2010). Using an interview guide allowed me to remain focused and organised and prevent repetition during the interview. According to Walliman (2006), asking repetitive questions throughout the interview is discouraged since it negatively affects the respondent's desire to answer questions. Interviews were done in the schools with the teachers after class hours and were done once individually.

In phase three, documents were reviewed to examine various documents that talk about physical sciences teachers' experiences. Documents like reports, newspapers, Journals, Articles, national policy documents such as Curriculum and Assessment Policy Statements (CAPS), school subject (in this case Physical Sciences) policy, Physical Sciences textbooks and many materials were reviewed in this study.

As mentioned by Bryman and Buchanan (2018), the primary research methods (first and second) help to collect information from research participants for gathering first-hand information based on their real-life experiences and the current state of their livelihood. Alternatively, the third method is used to carry out verified data from published sources, such as scholarly journals, peer-reviewed articles, newspapers, books, industry reports, and other credible sources containing information backed up with relevant evidence (Walliman, 2017). Finally, a document review of some secondary data related to the research topic was done. These secondary sources comprised published reports by the Government, non-governmental organisations, and research papers. Moreover, the policy documents were reviewed in the secondary data collection method in phase three.

The data for this study was obtained in three stages using a mixed-methods technique. The first stage entailed collecting quantitative data through a questionnaire, and the second and third stages were qualitative data, in-depth interviews and document analysis, respectively.

Here, mixed-method combining both primary and secondary methods is deemed adequate for gathering required data to achieve the research aim and objectives, hence commenting on the acceptability of online Physical sciences teaching and learning in chosen high schools.

Journal of Information Systems Engineering and Management
2025, 10(48s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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For this purpose, questionnaires, documents reviewed, interview schedules or interview guides were utilised as data collection tools. Primary sources entailed interviews and questionnaires, which can be collected through structured questionnaires and interview guides, whiles secondary sources entailed document analysis.

Data Analysis and Interpretation

The practice of studying data using analytical and statistical approaches to reveal important information is known as data analysis (Jay, 2018). The data analysis means analysing the qualitative and quantitative data from the respondents.

The data analysis in this study was done in two stages or parts. In Stage 1, an analysis of quantitative was done, and in stage 2, qualitative analysis was used. In the first stage, the quantitative data analysis approach was applied, where data was divided into descriptive analysis and inferential analysis reference of the data (Mishra et al., 2019).

In the second stage, themes were created based on in-depth interviews, and then the thematic analysis was done in the context of qualitative data (Driscoll et al., 2007). Interviews and Documents were analysed in the second stage.

For the current research, the researcher used different methods and techniques of data analysis for quantitative data, descriptive (percentages, frequencies and graphs, and charts) and inferential statistics (testing of hypothesis through the different tests). This technique helped identify the main features of the online teaching and learning process for supporting the educational requirements of learners studying in high schools in Amajuba District, KwaZulu-Natal, the selected high school (Roulston et al., 2017). Besides, this supported locating the significant themes in the educational process, especially in the case of high school. Furthermore, this study recorded and evaluated the primary qualitative data with the help of interview transcripts. The themes were generated for the qualitative aspect, and the thematic analysis was done to explain the in-depth interviews.

The Statistical Package for Social Science (SPSS) version 20 and MS Excel were employed to analyse the quantitative data. On the other hand, the qualitative data was divided into themes, and the thematic analysis was done and explained the results of qualitative data under the headings. The outcome of the data analysis procedure is displayed in the table below:

Table 2.: Summary of Data Analysis

Questions	Data Collection Tool	Data Analysis	Stages
1. How do Physical Sciences teachers in Amajuba District conduct online lessons during the COVID-19 era?	Questionnaire for the teachers teaching Physical sciences	SPSS Ver.20	1
2. Why do they conduct online lessons in the way they do?	Interview Schedules	Thematic formation of themes	2
3. What technology informs their teaching approach during the COVID-19 era?	Documents Review	Thematic formation of themes	2

RESULTS AND DISCUSSIONS

The online teaching and learning experience of physical sciences teachers in high schools

The researcher asked respondents to describe their difficulties with the teaching and learning process. The respondents' perception that it was challenging to communicate with educators and colleagues made this the most often mentioned problem. This shows that educators should have provided learners with feedback. Bakia, Shear, Toyama, and Lasseter (2012) contend that just as explanations, corrections, and suggestions are essential in conventional teaching, feedback is equally important in online learning. Learners learn from the feedback what they can do to develop and improve. Because it

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directs a learner's progress, providing excellent online feedback is a crucial skill for educators to achieve (Leibold, Schwarz, 2015).

The second and third factors are related to teaching methods because respondents claimed that teachers only provided notes and assignments and could not provide feedback, which suggests a one-sided approach. Sending messages to exceptionally high school learners is detrimental when teaching and learning online. It hinders learners' ability to conduct research and practise critical thinking. Providing topics to focus on, outlining objectives and the relevance of each topic, recommending relevant material, assisting learners in identifying relevant ideas and writing notes, promoting and moderating a discussion of ideas and theories, providing pertinent feedback and feed forward, validating and approving and encouraging learners to apply their new knowledge are all parts of the lecturer's role, according to Quiang (2018) and Anderson (2008b). The learners will receive new and accurate knowledge from these methods. The applicability of their learning will be attested to by learners, who will also grow more self-assured and motivated. This is essential for an online teaching and learning process to be successful.

The third consideration relates to tracking learners' development since respondents complained that the tests and homework were unclear. Uncertain assessments and assignments are only natural when ineffective teaching, learning, and communication exist. To prevent this, Amante and Oliveira (2019) recommend that assessment be carried out by a variety of parties, including the learner (self-assessment). In online learning, learners need to understand their test and assignment work to ensure they have the knowledge and problem-solving skills when they receive no pertinent feedback. This causes learners to fall short of the learning process goals.

Last but not least, the respondents said everything was plain repetitive, suggesting that teachers lacked the imagination to provide various learning experiences. To get around this difficulty, teachers are expected to offer and suggest multiple resources on the same subject in the form of texts, videos, voice notes, photos, etc. Learners must have access to many viewpoints and opinions on the subject. Additionally, it fosters critical thinking among learners. Overall, teachers were pleased with how they had adapted, but they encountered difficulties and needed assistance. They also expected problems in the future. It's also crucial to recognise that specific ideas appeared to converge across all of the subjects.

Teachers' responses were primarily influenced by technology, student participation, and meeting learners' needs. Teachers saw technology as a significant obstacle since many needed new skills to apply an online curriculum successfully. However, it was also noted that technology was a source of success because, once teachers could get past some obstacles, they could use it to connect successfully with learners and offer meaningful PS experiences. This was in line with other information gathered by SHAPE America simultaneously during the pandemic (SHAPE America, 2020).

Additionally, teachers expressed a need for ongoing professional development on how to effectively use technology in a virtual physical sciences classroom, which is in line with trends in the literature on how to effectively teach physical sciences (Rink, 2013). Additionally, learner engagement touched on the majority of the critical subjects. However, many teachers indicated that the learners participating in their classes were interested and passionate about the activities. Teachers discussed participation as a barrier because they could not order learners to participate. Meeting the needs of all learners was a topic that frequently appeared throughout the themes. It took a lot of work for teachers to meet their learners' needs, whether by connecting with them online or through a paper packet or by simply providing accommodations and modifications.

The online teaching and learning experience of physical sciences teachers in high schools

77.5% of the respondents used online learning and teaching platforms, and 22.5% stated they had never used them. From the findings, most (78%) of the respondents agreed that they used online learning and teaching platforms at their schools. Teachers most frequently mentioned their ability to overcome and learn technology (28%), engage students in e-learning (20%), and produce quality material for students (15%). One of the biggest triumphs for educators during the COVID-19 pandemic, according to more than 28% of them, was overcoming and embracing technology. 20% of teachers also cited learner participation in online learning as a success.

Receiving experiments and assignments from their learners showcasing activities and engaging in physical activity at home excited teachers. Having learners participate in synchronous video sessions

and everyday activities delighted many teachers. Finally, the teachers' capacity to produce high-quality content for learners was another significant achievement. On the other hand, the teachers also had a tale to talk about the drawbacks of adopting online instruction and teaching in physical sciences. The responses discussed the difficulties teachers encountered when instructing during the pandemic and the needs they have to aid in better preparing them for physical sciences in the future.

There were numerous requests for assistance from teachers regarding the best ways to deliver high-quality physical sciences teaching and learning throughout the COVID-19 pandemic and beyond. Given the circumstances and what was happening worldwide, teachers were pleased with the level of participation they saw from their learners who signed on and attended the class or submitted assignments. However, a sizable number of teachers expressed worry about the learners' lack of involvement. Teachers were frustrated and consumed by their fear of the unknown. Knowing their situation going into the New Year was the biggest worry for more than 35% of respondents. With a small range of 34% of mixed-level instructors to 37% of high school teachers, these sentiments of uncertainty were equally distributed among all levels of teachers.

The new technology related to learning and teaching system adopted by physical sciences teachers in high schools

The study's findings showed that 40% of the participants conducted online lessons during the COVID-19 era at their schools using social media platforms, and 35.5% of the respondents mentioned using Google learning platforms. About 23% of the respondents mentioned that they used nothing. From the findings, the majority (40%) of the respondents agreed that they used social media platforms to conduct online lessons and teachings during the COVID-19 era.

In order to hold live classes, many teachers also reported using video conferencing apps like Zoom, and they described mastering this new method of instruction as a success. The OPEN at-home lessons and connecting with learners via Zoom (their most significant achievement) have both given teachers and learners access to top-notch materials. The following five online learning tools are the new lifelines for both learners and educators; they truly aid in making courses come to life when educators and learners cannot present them in person. Learners and teachers can record short web films using the free Flip-grid online tool.

Teachers can easily create accounts and "classrooms" within such accounts. Learners enter classrooms with a code similar to Google Classroom. Teachers can then make short movies for learners to comment on in posts. It is possible to change the settings so that only teachers can see responses or learners can view and comment on each other's films. An excellent and user-friendly oral communication tool is Flip grid. It can be successfully adjusted to practically any age group or topic area. Another tool utilised in the teaching and learning process is Google Forms. This application is frequently employed to acquire data in various situations (surveys and quizzes). Users can disable the quiz feature to prevent them from opening other windows. For tests with multiple choices, auto-grading is also available. *Google Classroom* is a popular software that lets teachers create online communities where learners can upload assignments, get feedback, and discuss readings, events, or classes.

Even though no one in the education sector desired or anticipated the 2019–2020 academic year to end in this manner, distance learning at least allowed teachers to test out cutting-edge online resources that they can and will use to provide courses in any format in the future. Throughout the pandemic, WeVideo, a web-based video editor with free and premium accounts, has offered free upgrades to accounts for teachers and learners. Both educators and learners have seized this opportunity without delay. It is hoped that this programme will be extended if distant learning continues. Another programme that teachers and learners can access through a Google account is WeVideo. It also links to and uploads content directly to Google Drive, which is helpful for learner submissions. Additionally, teachers can create a "class" within the app and invite learners to join their classes using a unique code.

The overall effects of online teaching and learning on physical sciences during the pandemic

82.5% of the respondents mentioned that they face challenges associated with online learning and teaching, and only 17.5% stated that they are not facing any challenges associated with online learning and teaching. From the findings, the majority (82.5%) of the respondents mentioned facing challenges associated with online learning and teaching.

According to this study, there is some tension (both physical and mental) between learners and educators. However, much of this tension may be reduced by getting used to this style and planning classes comfortably for everyone. Regardless of their level of education, teachers and learners must cope with the severe problem of poor communication between them. The proper channels of communication between teachers and learners must be built in order for learners to explain their queries and participate in more excellent dialogue inside the online learning environment. Problems with network connectivity are a significant additional obstacle to effective communication.

In contrast to most learners who complained about losing out on extracurricular activities and eating outside, just 35.8% of learners claimed to exercise at home. They also mentioned more back problems, dry eyes, and eye strain. Regarding their mental health, they described higher stress levels, followed by concern, loneliness, and depression, but added that having more time to reflect during their absence from school was beneficial. The teachers had more time for physical activity, but the longer screen time made them more physically stressed from the computers. The teachers stated feeling stressed due to deadlines, unplanned interruptions, an increased workload, and worry about their careers, families, and selves, even though they claimed to have a better relationship with their families.

Interestingly, the reported depression prevalence was low. Due to the design and delivery of assessments online, half of the instructors were free to explore all of their options and be inventive and creative. However, they battled to maintain appropriate questions and impartial evaluations for the learners. Teachers claim that they have learned new teaching strategies and enhanced their capacity for creative thought due to their experience teaching online. However, educators thought they did not influence learner attendance, which may have impacted those learners' laboratory skills. They also have concerns about the learners' academic development.

CONCLUSION

The concepts of technology, interactions between learners, and satisfying learners' needs had a significant impact on teachers' reactions. Given that many required acquiring new skills to implement an online curriculum successfully, technology was seen by teachers as a substantial barrier. The use of technology to engage with learners and provide worthwhile Physical sciences experience was acknowledged as a basis of success, though some educators were able to overcome most challenges. According to the study, some obstacles to online learning were related to the challenging social and economic situations that educators and learners faced. The interviewees' poverty frequently challenged them to purchase a laptop or desktop computer to teach learners.

The researcher asked the respondents why they could not just teach their learners online using their cell phones rather than computers. Access to essential learning resources, such as computers and a suitable learning environment, exacerbates issues with online teaching. Another area for improvement with online instruction is the challenge of getting learners to participate. The learners must be prepared and eager to engage in online learning. From the review, it can be concluded that a large number of faculty members failed in online education in part because institutions and schools just made technology and various tools (Moodle, Zoom, Microsoft Teams) available without providing advice on which tools, strategies, and activities achieve the highest levels of learner retention.

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https://www.jisem-journal.com/

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