International Journal of Learning, Teaching and Educational Research
Vol. 23, No. 10, pp. 27-44, October 2024
https://doi.org/10.26803/ijlter.23.10.2
Received May 20, 2024; Revised Sep 20, 2024; Accepted Sep 26, 2024

Mathematics Teachers 'Experiences of Using Online Teaching Resources for Professional Learning in a Context of Disadvantage

Siphelele Mhlongo, Mdutshekelwa Ndlovu and Brantina Chirinda
University of Johannesburg
South Africa

Abstract. This interpretative phenomenological study adopted the Community of Inquiry framework to explore 30 South African teachers ' experiences of the effectiveness of Grade 9 online mathematics teaching resources. A survey questionnaire with open-ended questions and a semi-structured interview guide were used to obtain data on the teachers' experiences. Data were analysed using an inductive thematic coding approach. The findings were that the teachers positively experienced the efficacy of online teaching materials for their professional development in terms of cognitive, social, teaching and learning presences. Using WhatsApp groups to share and discuss the online materials enhanced a common identity (social presence), deep engagement with the mathematical and pedagogical content knowledge of the materials (cognitive presence), (peer) teaching and (peer) learning from one another via WhatsApp (social media) chat groups (teaching and cognitive presences) that collectively eased curriculum implementation and enhanced student learning. However, limited facilitator teaching presence and limited internet access for both teachers and learners constrained the platform's benefits. Participating teachers reported spending at least three hours per week searching for online teaching resources, sometimes fruitlessly, indicating a need for more digital literacy training. The study makes a valuable contribution to our understanding of the potential benefits of online resources for teaching complex mathematics topics such as fractions and familiarity with the obstacles that need to be overcome. The more teachers and students turn to online resources, the more the findings of this study can inform the development of such resources to improve mathematics learning outcomes for schools in contexts of disadvantage.

Keywords: mathematics teachers' experiences; professional learning; Mathematics teaching; online resources; fractions

1. Introduction

The digital revolution has had a tremendous influence not just on our daily lives but also on education globally, including the teaching and learning of mathematics, in which fractions are a significant challenge to many lower high school students. Amo-Asante and Bonyah (2023) assert that fractions are the building block of algebra and other topics in mathematics. As a result of the affordances of new digital technologies, our day-to-day life has become more interactive: we seek information on the Internet; we talk/chat via email and social media platforms on the Internet; and we learn and teach on numerous online platforms. These daily actions have an indelible impact on the teaching and learning environment, including mathematics education. Wu and Wang (2015) suggest that educators must continually adapt their pedagogy throughout their careers in response to rapid changes in technology. This implies that a mathematics teacher's pedagogical strategies must become more innovative and embrace the frequent use of online teaching and learning resources, such as Khan Academy, edX, or other similar platforms. For example, Jarrah et al. (2022) used digital-game-based ABACUS software to teach fractions in a quasi-experimental study. Students in the quasi-experimental group outperformed those in the control group of almost the same size.

The South African Department of Basic Education (DBE) created websites in 2009 with diverse online teaching resources. The resources allow teachers to engage quickly in professional learning. Since these online teaching resources are self-paced, teachers may devote more time to ideas requiring assistance and less time on topics they can learn quickly (Unwin, 2017). These technological resources enable teachers to work at a time, pace and location most suitable for their learners' learning requirements. In South Africa, Umugiraneza et al. (2018) showed that teachers with access to internet instructional resources have higher confidence levels in teaching mathematics, leading to students' better understanding of the subject. The Mathematics Senior Phase JC D14 website in Figure 1 was the focus of this study. It includes open-source mathematics subject content and workshop materials for professional development. Figure 1 shows a screenshot of the webpage; the web address is https://mathsjcd14.co.za.

Samples of official assignments and class activities are available on the website to help teachers learn new content and gain knowledge of new pedagogical strategies. This suggests that teachers are expected to develop expertise and experience using these online teaching materials for grade 9 Mathematics as part of their professional development. The resources also help to ensure that Mathematics teachers from various schools in the same district teach the same content to their learners. Teachers can upload and share samples of lesson plans and formal assessments and file index papers on the platform. The website provides senior phase Mathematics teachers with valuable tools for teaching and assessing students.

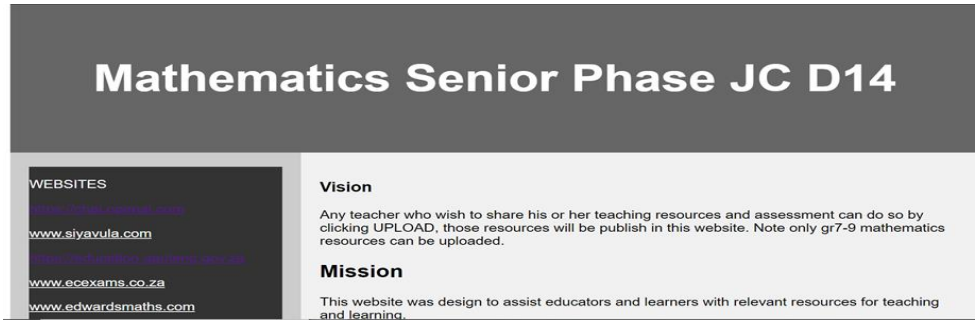

Figure 1: Senior Phase Mathematics website for District 14 in Gauteng

These materials are designed to provide teachers access to various resources that can contribute to a greater comprehension of mathematical ideas. Digital classes and e-books are other examples of resources available on the platform. This study explored the experiences of Grade 9 Mathematics teachers in Soweto public high schools using online teaching and learning materials. The study sought to contribute to the ongoing conversation on the role of technology in mathematics education and how it can be effectively integrated to enhance teaching and learning outcomes.

2. The Purpose of the Study

The study's primary purpose was to explore Grade 9 mathematics teachers ' experiences of the efficacy of online teaching and learning resources in Soweto public high schools through the lens of the Community of Inquiry (CoI) framework (Garrison et al., 2010). Grade 9 mathematics teachers were used as participants because they used the online teaching materials from the website. The study focused on teachers at public high schools in Soweto, South Africa, since learners underperform in secondary school mathematics at these schools, which is a national concern (Tseng & Kuo, 2014). The public high schools were located in a disadvantaged context with limited digital teaching and learning resources. The study has important implications for the future of mathematics education in contexts of disadvantage, especially considering the ongoing shift towards online learning post the COVID-19 pandemic. Using online resources can assist teachers in providing learners with personalised learning experiences and help them build a deeper understanding of mathematics concepts. Additionally, online resources can be accessed from anywhere and anytime, making them a valuable tool for teachers and learners who may not have access to traditional classroom instruction.

3. Research Questions

The following research questions were formulated to guide the study:

- How do Grade 9 mathematics teachers experience the efficacy of GDE's District 14 online mathematics teaching materials for their professional development regarding cognitive presence?
- What are the teachers 'experiences regarding the efficacy of online materials for their professional development in terms of teaching presence?
- How do the teachers experience the efficacy of the materials for their professional development in terms of learning presence?

- What are teachers 'experiences of the efficacy of the materials for their professional development regarding social presence?

4. Literature Review

Digital teaching materials have become indispensable for educators seeking to enrich online education (Holmes, 2013). The abundance of online teaching and learning resources provides learners with many options, enabling them to curate a personalised learning experience that caters to their unique learning needs and preferences (Cho et al., 2023). These resources, also known as e-learning materials, are diverse tools and technologies designed for digital dissemination, allowing learners to access them easily through online platforms, educational websites, or learning management systems. According to Ndlovu and Mostert (2018), online teaching materials can include multimedia components, interactive activities, and other digital resources that promote successful teaching and learning experiences. The website this study focused on was intended to provide senior-phase South African Mathematics teachers with appropriate teaching and assessment materials.

In today's digital age, access to technology and internet connectivity has become a prerequisite for teachers and learners. With the advent of online learning and the digitalisation of educational resources, educators and students must be equipped with the latest technological tools and fast internet connections to make the most of their learning experiences. Whether accessing online resources, participating in online classes or collaborating with peers, having a reliable internet connection and access to technology has become an integral part of the learning process. It facilitates faster and more efficient learning and opens up new avenues for creativity and innovation in teaching and learning. Therefore, it is imperative that both teachers and learners have access to these resources to stay abreast with the changing landscape of education. In South Africa, some schools need more access to technology. Kivunja (2018) notes that a lack of access to technology among teachers and learners may contribute to longstanding inequalities in South African society. Schools in South Africa are divided into five quintiles based on their socioeconomic status. Quintile 1 is the least affluent, and Quintile 5 is the wealthiest (Ogbonnaya & Awuah, 2019). Most rural and township schools fall into quintiles 1 to 3, meaning they face limited access to technology and the internet (Ogbonnaya & Awuah, 2019). As a result, implementing online teaching and learning in these schools is particularly challenging due to the need for more devices and internet connectivity, as highlighted by Chirinda et al. (2022).

Teaching has been transformed in today's digital age using numerous online teaching tools and platforms. Teachers now have access to many resources, such as video lessons, digital textbooks, and other multimedia components that can significantly enhance students' learning experience. These resources can be customised to suit the teaching style of the teacher and their students' requirements, as Ndlovu and Mostert (2018) pointed out. The benefits of online teaching resources are not limited to teachers only; they can also benefit students by tailoring materials to match the level and pace of their classes, providing extra practice, or modifying information to match the requirements of particular

students (Ndlovu & Ndlovu, 2020). In addition, Chirinda et al. (2021) argue that online teaching resources frequently allow for customisation, which is beneficial to teachers. Teachers who employ multimedia components and interactive features in online materials can increase student engagement, as Mahlaba (2020) attests. Thus, online teaching tools and platforms are crucial in today's classrooms as they provide teachers and students with the flexibility and customisation required to enhance learning.

5. Theoretical Framework

This study is based on the Community of Inquiry (CoI) framework, a useful theoretical model for designing and studying online teaching and learning experiences (Garrison et al., 2010). The CoI framework is a reputable and established model that facilitates comprehension and enhancement of online learning experiences. It identifies four critical components, namely social presence, teaching presence, cognitive presence, and learning presence, which are indispensable for successful online learning experiences (Shea & Bidjerano, 2010). The framework was chosen for the study because by prioritising these four components, the CoI framework offers a practical approach to assess and enhance online learning experiences.

5.1 Cognitive Presence

Cognitive presence is exploring, constructing, resolving, and confirming understanding through collaboration and reflection in a community of inquiry (Holmes, 2013). This involves exploring relevant information, making sense of and integrating ideas, and testing reasonable solutions. In this study, cognitive presence refers to the extent to which teachers can construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry (Garrison & Akyol, 2013). The study aimed to explore the level of cognitive presence exhibited by Grade 9 teachers as they engaged with online teaching materials and integrated ideas on WhatsApp while teaching. The aim was to create an educational community of inquiry that would establish an intellectual environment that facilitates critical discourse and the acquisition and application of higher-order knowledge. The study sought to identify the extent to which the teachers' cognitive presence contributed to the advancement of online learning pedagogy and the overall efficacy of the educational community of inquiry. The study's findings could ultimately inform the development of improved teaching strategies and more effective online learning environments.

5.2 Teaching Presence

The teaching presence involves the teachers' actions in designing and facilitating the learning process (Chigona, 2017). It encompasses the deliberate planning, guidance, and coordination of cognitive and social processes to achieve meaningful and valuable learning outcomes (Garrison & Akyol, 2013). The study explored how teachers chose learning activities from the website to support their teaching presence. Another important aspect of teaching presence is facilitating productive collaboration and reflection among learners, which was explored in this study. Lastly, teaching presence requires assessing the community's needs and providing relevant information and guidance to meet the desired learning outcomes (Garrison et al., 2011).

5.3 Social Presence

Social presence refers to the ability to project oneself and establish meaningful relationships with others (Garrison & Akyol, 2013). According to Garrison et al. (2011), effective communication, open communication, and group cohesion are the three main aspects that contribute to social presence. The study examined how participant teachers interacted with one another and established a sense of community in the online forum. In addition, the study explored the extent to which the social presence of the teachers influenced their interactions and communication within the online groups. Furthermore, the study explored the factors contributing to developing a strong sense of community among the participants.

5.4 Learning Presence

According to the CoI framework, collaborating to build understanding and engaging in critical reflection is crucial in achieving higher-order learning (Shea & Biderjano, 2010). Blended learning can create a sense of community through face-to-face interaction, but it is crucial to maintain this community during the online portion of the course. Given the self-directed nature of online learning, Grade 9 teachers in the study were projected to have self-regulated learning skills. Self-regulation is turning mental abilities into academic skills (Bazeley, 2013). By fostering a community of teachers and promoting self-regulated learning, the quality of blended learning and encouraging higher-order learning for students can be improved.

6. Materials and Methods

An interpretative phenomenological research design was adopted to explore Grade 9 teachers' experiences using online mathematics teaching and learning materials in Soweto public high schools. Phenomenology seeks to understand the lived experiences of individuals involved in the researched issue (Groenewald, 2004). Rooted in the philosophy of Edmund Husserl (1859–1938), phenomenology seeks to uncover the underlying meanings, structures, and essences that shape our understanding of the world around us (Behnke, 1989). It emphasises the importance of describing and interpreting participant experiences in their terms rather than imposing preconceived categories. For this study, the researchers considered participant teachers to be the primary knowledge source. They sought to gain a deeper understanding of their lived experiences using online mathematics teaching and learning materials in Soweto public high schools. By doing so, phenomenology provided a rich and nuanced account of the subjective realities of the participant teachers in the study (Groenewald, 2004).

Thirty Grade 9 mathematics teachers (15 male, 15 female) at various public urban secondary schools in Gauteng, South Africa, were purposely selected to participate in the study. The participants' ages ranged between 21 and 55. Table 1 provides demographic information about the participants' educational qualifications and mathematics teaching experience.

Table 1: Demographic information

Category	Frequency
Qualifications (Junior degree in mathematics education)	21
Qualifications (Honors degree in mathematics education)	9
Teachers' experience of teaching mathematics (1-5 years)	21
Teachers' experience of teaching mathematics (6-10 years)	6
Teachers' experience of teaching mathematics (11 or more years)	3

Teachers were purposively selected because they were teaching Grade 9 learners at public secondary schools in townships and informal settlements, could be conveniently accessed by the researchers, and were available to participate in the study. In addition, Grade 9 mathematics teachers were chosen to participate in the study because they used the website's online mathematics teaching and learning materials. Data were gathered using a questionnaire with open-ended questions (see Appendix 1) and online semi-structured interviews. The researchers opted for a questionnaire because it was easy to construct and analyse, saving time and resources. The researchers designed the questionnaire items using information from the literature and their experiences as mathematics educators. The questionnaires were emailed to the participants, who could complete them at their convenience. Participant teachers were given a three-week timeframe to e-mail back the completed questionnaires. Research reveals that questionnaires may not fully clarify participants' experiences. In this regard, the researchers used online semi-structured interviews, which took place via Zoom, as another data collection method. Face-to-face interviews were impossible due to the COVID-19 pandemic regulations. The online semi-structured interviews, audio-recorded with the participant's consent, were conducted individually with the teachers, depending on their availability. The online semi-structured interviews explored the participants' responses to the questionnaire. Field notes were made regarding participants' responses and non-verbal cues. Body language and facial expressions are sometimes more revealing than spoken words. The online semi-structured interviews helped researchers to have a detailed understanding of participants' feelings, beliefs, and experiences while using the online teaching and learning materials. Nonetheless, online semi-structured interviews were challenging for the participants since they struggled with high data costs and internet connectivity, highlighting the digital divide in contexts of disadvantage (Chirinda et al., 2021).

Trustworthiness in this research was established to ensure the findings were credible, reliable, and relevant. Multiple data sources and researchers were used to cross-check findings. The researchers returned to participants to verify the accuracy of the data and interpretations. To uphold the dependability of the findings, the researchers kept detailed records of the research process, including

decisions made, data collection methods, and analysis procedures. The researchers provided detailed descriptions of the research context and participants to help readers determine whether the findings are transferable to other situations.

7. Data Analysis

Interpretative phenomenological data analysis involves systematically exploring, describing, and interpreting the participants' experiences (Groenewald, 2004). The researchers started by bracketing, temporarily setting aside their assumptions and preconceptions to approach the data with an open mind. The interviews were transcribed and analysed thematically with the teachers' responses to the open-ended items in the questionnaire. The data analysis was categorised into five steps. The researchers started by browsing transcripts and participants' responses to items on the questionnaire to get a first impression. After noting the initial impression, they read the transcripts individually to ensure acquaintance with the data. During the second step of the data analysis, the team conducted open coding, meticulously labelling relevant words, phrases, and sentences in the transcripts and participants' responses to the questionnaire. In the third step, the researchers reviewed and analysed the codes, occasionally combining them to create new ones and discarding those deemed insignificant. Remaining impartial and objective, the team determined which codes were necessary and categorised them into themes. In the fourth step, the researchers thoroughly inspected the emerging themes, selecting the most pertinent and discarding any irrelevant ones. In the final step of data analysis, the researchers scrutinised the selected themes, identifying their connections and deciding if a hierarchy existed among them or if one theme was more important than others. Ultimately, the themes the researchers felt answered the research questions were classified under the COI framework's learning, cognitive, teaching, and social presence elements.

8. Results

This study aimed to examine the experiences of Grade 9 mathematics teachers while using online teaching and learning materials in public high schools in Soweto. The findings from the data analysis of the questionnaire and semi-structured online interviews are presented in the following sections.

8.1 Teachers' experiences of the efficacy of materials for their professional development in terms of cognitive presence

Cognitive presence involves teachers engaging in professional learning communities to solve problems and participate in collaborative learning (Garrison & Akyol, 2013). Collaborative learning helps teachers stay involved in professional learning activities for longer and feel more confident about teaching than learning in isolation. To establish the efficacy of materials for teachers' professional development in terms of cognitive presence, teachers were asked on the questionnaire and interviews if they found the online resources on the website explorative. During the study, teachers were supposed to determine if the website was explorative by visiting and assessing its content and features, looking for elements that encourage them to explore and engage with the materials, such as interactive lessons, resources, quizzes, forums, or other features that facilitate

learning and discovery. All teachers responded that they had not completed the activity because they lacked internet access.

Participant teachers were asked if the online teaching materials assisted them with their annual teaching plan (ATP). All 30 participant teachers responded that the materials assisted them in being in line with the ATP. For example, Teacher M said: *The materials save me time and allow me to adapt my instructional plans.*

Furthermore, participant teachers were asked on the questionnaire and interviews if the selected learning activities from the website helped them make connections between ideas. The study's findings were that the selected learning activities encouraged teachers to think critically about the content they teach and provided teachers with opportunities to build their understanding and mathematical ideas.

8.2 Teachers' experiences of the efficacy of materials for their professional development in terms of teaching presence

In online teaching and learning, a robust teaching presence is essential to ensuring a genuinely beneficial community of inquiry (Garrison & Akyol, 2013). To support the teaching presence, online platforms should include discussion forums, chat rooms, and collaborative tools to encourage discourse and interaction among participants. Findings from the study revealed that these resources enabled participant teachers to share their insights, experiences, and ideas, which was a valuable aspect of their professional development. The Website offers adaptive learning resources that tailor content and activities to an individual teacher's needs and progress, enhancing the personalised aspect of professional development. The online teaching resources facilitated connections and networking among teachers. In addition, the online teaching resources played a vital role in facilitating discourse among teachers by offering well-structured content, clear guidance, interactive tools, and opportunities for interaction and reflection.

Teachers were asked on the questionnaire: How do you find materials on the website valuable for your teaching presence? 27 of 30 participants gave positive responses. For example, "*The website has relevant topics and questions*" (Teacher A). Teacher B responded: "*The website has important mathematics worksheets.*" Teachers' responses indicated that the website offers relevant educational resources, tips, and recommendations that can add value to their conversations and demonstrate a commitment to supporting teachers in their professional development.

The study explored how online teaching resources improved the participant teachers' curriculum content knowledge. All the participants indicated in their responses to the questionnaire and semi-structured interviews that the online teaching resources improved their knowledge of curriculum content. Teacher L indicated:

The website's material provides ways to review the basic operations of fractions, such as addition, subtraction, multiplication, and division. I used the materials to ensure my students understood these fundamental concepts well before moving on to more advanced curriculum concepts.

8.3. Teachers' experiences of the efficacy of materials for their professional development in terms of learning presence

Teachers' abilities to develop higher-order thinking in learners are similar to having a roadmap for mathematics education. Teachers with this ability can guide learners beyond memorisation and repetition, fostering skills like critical thinking, problem-solving, and creativity. These characteristics are like the building blocks of a more engaged and adaptable mind, preparing students for the challenges they will face in the real world. So, when mathematical teachers are familiar with these aspects, they are essentially equipping learners with the tools they need to navigate the complex landscape of mathematical learning. Participant teachers were asked how online teaching materials supported them to develop higher-order thinking in learners. Teachers responded to the questionnaire that they felt the materials supported them in developing higher-order learning in their learners. Teacher Z articulated this:

"*The online materials help me define and differentiate my students' learning levels and develop higher-order learning in them."*

The South African Grade 9 Curriculum and Assessment Policy Statement for Mathematics requires that students' cognitive levels are assessed in terms of remembering, understanding, applying, analysing, evaluating, and creating. Teachers indicated that the materials assisted them in progressively developing students' cognitive abilities, moving from basic understanding to more complex applications and critical thinking.

The study explored whether the online teaching materials guided teachers in developing comprehensive examinations for their students. 27 of the 30 participants indicated in the responses on the questionnaire and during semi-structured interviews that the materials on the website improved their professional skills in assessing learners. Teachers indicated drawing inspiration from online teaching materials to create daily activities and exams aligned with learning objectives. As a result, they effectively assessed learners' mathematical knowledge and skills and fostered a sense of learning presence in assessments. Teachers indicated that the online resources helped them design assessments that promoted deeper engagement and understanding among their learners.

The study also explored if participant teachers found the materials on the website valuable for teaching. Twenty-seven participating teachers responded to the questionnaire and during semi-structured interviews that they, found the materials on the website helpful for teaching. The participants expressed that:

"*The materials on the website explain the concepts better"* (Teacher M).

"*They provide multiple strategies to present a topic*" (Teacher S).

The study's findings were that by offering a rich array of resources, interactive tools, and opportunities for collaboration, the online materials on the website created a dynamic learning environment that promoted active engagement, deep understanding, and a strong sense of learning presence in participant teachers. These materials were instrumental in enhancing the overall learning experience of the teachers who were motivated to work together. Nonetheless, three participant teachers responded that they found the materials on the website

outdated. It could be that the three teachers also had access to international secondary mathematics websites that offer advanced materials.

8.4. Teachers' experiences of the efficacy of the materials for their professional learning in terms of social presence.

According to the findings, most teachers expressed satisfaction with the materials available on the website for their professional learning and social presence. Teachers' responses revealed that the website was a valuable resource for educators to enhance their knowledge and skills and to connect with other professionals in their field. The teachers appreciated how the website provided them with relevant and up-to-date information, which helped them stay current with the latest trends and best practices in their profession. Overall, the feedback from the teachers suggests that the website is a highly effective tool for supporting their professional development and fostering a sense of community among educators. When asked how effective teachers communicated with their colleagues on the website, 24 of 30 participants indicated on the questionnaire that the website was very effective when they shared materials. For example, Teacher S responded: "*We are sharing activities; now, we are more self-motivated to interact and discuss fractions, which learners find difficult.*"

While primarily text-based, the websites integrate additional features such as video conferencing, forums, or chat rooms to enhance social presence and allow teachers to be more self-motivated and interactive in their discussions. The study's findings displayed that the website provided prompt and accurate responses to problems, contributing to teachers' sense of engagement and social presence.

The study revealed that teachers valued the materials on the website homepage for professional learning and maintained open communication with subject advisers. Regular subject adviser communication via emails, announcements, and posts helped teachers feel connected with others from different schools, thus easing curriculum implementation challenges and improving learning and teaching. In South Africa, subject advisers offer guidance and mentorship to teachers in their specialisations, particularly regarding technology integration in the curriculum. Teachers in the study often communicated with subject advisers for effective teaching using new tools, demonstrating a solid social presence. This agrees with (Chigona, 2017), who states that teachers must be digitally literate and fluent in integrating technologies. WhatsApp supplemented the online platform (website). The WhatsApp group fostered cohesion among participants. However, most schools need adequate internet access due to financial constraints and cable theft. The study found that teachers who spend a maximum of three hours per week searching for online teaching materials have higher self-confidence in teaching mathematics and have comprehensive beliefs about the nature of mathematics.

9. Discussion

Teachers are required to constantly change their pedagogy throughout their careers in response to technological innovations (Wu & Wang, 2015). This means that a mathematics teacher's teaching has to evolve with the digital revolution, be more innovative, and adapt to the regular use of online teaching and learning

resources. This study found that teachers valued the materials on the website homepage for professional learning. There was open communication between teachers and the subject advisers. Teachers responded that the materials had relevant topics and summary questions. Nonetheless, the findings from the responses to the questionnaire and semi-structured interviews revealed that the platform had limited interactivity, leading teachers to use WhatsApp to share materials and experiences and Siyavula materials to supplement teaching materials. This suggests to curriculum developers that the website might need specific features for effective communication or collaboration among mathematics teachers at Soweto Public Schools.

The collected data showed evidence of learning presence in how teachers shared online teaching material for mathematics and took responsibility for their learning. This included exploring new mathematics activities with learners. The participant teachers expressed that the website helped them teach the topic of fractions, which many of their students considered one of the most challenging sections of the mathematics curriculum. This agrees with Moyo and Machaba (2021), who reported in their study that many teachers highlighted that their students face significant difficulties while learning fractions. Fractions are taught from primary to high school, but many high school and college students cannot solve simple fractional problems, while fractions are closely related to everyday life (Barber & King, 2016). Learners must grasp the concept of fractions as this skill holds significant importance across a plethora of disciplines and in human life as a whole. To succeed academically and professionally, having a solid foundation in mathematics is crucial, including a thorough understanding of fractions. Neglecting to do so could hinder one's progress and limit their opportunities for careers in STEM. This implies that the website needs to add comprehensive activities for fractions.

Cognitive presence is associated with higher-order learning, time management and self-discipline. It is best supported in a community of teachers involved in building understanding and critical reflection (Pool et al., 2017). This study demonstrated cognitive presence when teachers could rename and organise their learning activities into different folders. Similar concepts for cognitive presence emerged during the selection of learners' activities. Only four of the participant teachers selected activities that matched learners' levels of understanding. For teachers to select such activities, they must understand such learning levels. The findings revealed that eleven participant teachers overlooked the different ability levels when selecting learners' activities. However, by keeping track of each other's work, they could recall the various levels of learning. Additionally, the data indicated that some teachers perceive the teaching materials on the website as explorative.

Social presence was evident through regular subject adviser communication through emails, announcements, and posts, fostering a sense of connection among teachers from different schools. Teachers also shared online teaching materials through emails and sent announcements on when to moderate and guide each other when setting exam papers. After participants shared materials, they

discussed and reflected on the content, thereby experiencing professional development at the school level. Teachers who learn collaboratively stay involved in professional learning activities longer and feel more confident than those who learn mainly in isolation (Feldman, 2020). Teachers valued the materials on the website homepage for professional learning. However, limited access to the Internet negatively affected teachers' collaborative learning.

The teaching presence was distributed among participants, with more knowledgeable others supporting those who needed assistance. Teaching presence in this study was demonstrated in the professional and instructional relationship subject advisers had with the participant teachers. The study revealed that subject advisers shared online teaching materials with teachers and moderated their exam question papers. This teaching presence distribution allowed more knowledgeable individuals to support teachers in the study. Research demonstrates that teaching presence is a crucial factor that enhances student motivation, satisfaction, and learning outcomes (Swan & Shih, 2005). The study's findings align with Swan's (2001) conclusion that interaction with instructors results in greater student satisfaction and perceived learning than interaction with peers.

10. Conclusion

The study explored teachers' experiences regarding the efficacy of materials for their professional development in terms of learning, social, cognitive, and teaching presence. Regarding social presence, participants reported feeling connected with teachers from different schools through regular communication via emails, announcements, and posts. Using WhatsApp groups to share and discuss teaching materials enhanced cohesion and improved curriculum implementation. However, limited internet access posed a challenge, and teachers spent a maximum of three hours per week searching for online teaching materials, indicating a need for more digital literacy training. Digital literacy training is necessary because individuals with high efficacy expectations of utilising the Internet are likelier to succeed in Internet-based tasks (Barber & King, 2016). Concerning cognitive presence, collaborative learning with other teachers improved their professional development and confidence, but internet connectivity issues affected online research time. The study demonstrated teachers' learning presence regarding how they communicated and took responsibility for their learning. This included exploring new activities and learning from others. Teachers could organise and rename their learning activities associated with higher-order learning, time management, and self-discipline. Learning presence is best supported in a community of teachers involved in building understanding and critical reflection.

11. Limitations

The study had limitations since only 30 teachers participated in the study. This could have impacted the generalisability of findings, as the sample size was relatively small. It is essential to consider the representativeness of the respondents and potential biases. The COVID-19 restrictions meant interviews could only be conducted online. This influenced the interactions between the

researchers and participants since some teachers faced challenges with high data costs and internet connectivity. This could have impacted the quality of the data collected for the study and the feasibility of online interviews for all participants.

12. Recommendations

From this study, it is recommended that policymakers and school administrators ensure that all public high schools in disadvantaged contexts have the necessary infrastructure and resources to support online teaching. This includes reliable internet connectivity, functional devices (computers or tablets), and technical support. The Department of Education should provide comprehensive training and professional development for Grade 9 Mathematics teachers in the context of the disadvantage in effectively integrating online teaching materials into their instruction. This should cover both technical skills and pedagogical strategies. The department ensures that the online teaching materials are aligned with the national or regional Mathematics curriculum. Teachers should be able to quickly locate and use resources that match what they are required to teach.

It is recommended that the Department of Education should establish a review process to evaluate the quality of online teaching materials. This can involve a committee of experienced mathematics teachers who can assess these materials 'relevance, accuracy, and effectiveness. In addition, teachers must be allowed some flexibility to adapt and customise online materials to meet the specific needs of their students and address local contexts and challenges. A system should be created for teachers to provide feedback on the online mathematics materials, including reporting technical issues and suggesting improvements. This can help continuously improve the resources. The relevant stakeholders should ensure that online teaching materials are accessible to all students, including those with disabilities. Various formats, such as audio or video options, should be considered to accommodate different learning styles.

13. References

Amo-Asante, K., & Bonyah, E. (2023). Building students' conceptual understanding of operations on fractions using manipulatives: A junior high school perspective. *Mediterranean Journal of Social & Behavioral Research, 7*(3), 151-159. https://doi.org/10.30935/mjosbr/13381

Bazeley, P. (2013). *Qualitative data analysis*. Sage.

Barber, W., & King, S. (2016). Teacher-Student Perspectives of Invisible Pedagogy: New Directions in Online Problem-Based Learning Environments. *The Electronic Journal of e-Learning*, *4*, pp. 235–243.

Behnke, E. A. (1989). *Edmund Husserl's Contribution to Phenomenology of the Body in Ideas II.* Kluwer Academic Publisher.

Chauraya, M., & Brodie, K. (2017). Learning in Professional Learning Communities: Shifts in Mathematics Teachers' Practices. *African Journal of Research in Mathematics, Science and Technology Education*, *21*(3), 223-233. https://doi.org/10.1080/0035919X.2017.1350531

Chigona, A. (2017). Western Cape Subject Advisors' Perception of Their Preparedness for Connected Classrooms. *The Electronic Journal of e-Learning, 15*(5), 444–454. Available online at www.ejel.org

Chirinda, B., Ndlovu, M., & Spangenberg, E. (2021). Teaching Mathematics during the COVID-19 Lockdown in a Context of Historical Disadvantage. *Education Sciences, 11*(4), 177. https://doi.org/10.3390/educsci11040177

Chirinda, B., Ndlovu, M., & Spangenberg, E. (2022). Mathematics Learners' Perceptions of Emergency Remote Teaching and Learning during the COVID-19 Lockdown in a Disadvantaged Context. *International Journal of Learning, Teaching and Educational Research*. *21*(1), 179-194. https://doi.org/10.1007/s42087-023-00353-7

Cho, M. E., Lee, J. H., & Kim, M. J. (2023). Identifying online learning experience of architecture students for a smart education environment. *Journal of Asian Architecture and Building Engineering, 22*(4), 1903–1914. https://doi.org/10.1080/13467581.2022.2145216

Feldman, J. (2020). The role of professional learning communities to support teacher development: A social practice theory perspective. *South African Journal of Education, 40*(1), 1–6. https://doi.org/10.15700/saje.v40n1a1668

Garrison, D. R., Anderson, T., & Archer, W. (2010). The first decade of the community of inquiry framework: A retrospective. *The Internet and Higher Education, 13*, (1–2), pp. 5–9. https://doi.org/10.1016/j.iheduc.2009.10.003

Garrison, D. R., & Akyol, Z. (2013). The Community of Inquiry Theoretical Framework. In *Handbook of distance education* (pp. 122–138). Routledge. The Community of Inquiry Theoretical Framework. In *Handbook of distance education* (pp. 122–138). Routledge.

Groenewald, T. (2004). A Phenomenological Research Design Illustrated. International Journal of Qualitative Methods, 3(1), 42-55. https://doi.org/10.1177/160940690400300104

Holmes, B. (2013). School Teachers' Continuous Professional Development in an Online Learning Community: Lessons from a Case Study of an eTwinning Learning Event. *Journal of European Journal of Education*, *48*(1), 97–112. https://doi.org/10.1111/ejed.12015

Jarrah, A. M., Haneen, A., Jason D. Johnson, J. D. & Wardat, Y. (2022). Assessing the impact of digital games-based learning on students' performance in learning fractions using (ABACUS) software application, *EURASIA J Math Sci Tech Ed, 18*, 1–10. https://doi.org/10.29333/ejmste/12421

Kivunja, C. (2018). Distinguishing between Theory, Theoretical Framework, and Conceptual Framework: A Systematic Review of Lessons from the Field. *International Journal of Higher Education, 7*(6). https://doi.org/10.5430/ijhe.v7n6p44

Mahlaba, S. C. (2020). The State of South African Mathematics Education: Situating the Hidden Promise of Multiple-Solution Tasks. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(12), em1921. https://doi.org/10.29333/ejmste/9279

Moyo, M., & Machaba, F.M. (2021). Grade 9 learners' understanding of fraction concepts: Equality of fractions, numerator and denominator. *Pythagoras, 42*(1), a602. https://doi.org/10.4102/pythagoras.v42i1.602

Ndlovu, L., & Ndlovu, M. (2020). The effect of graphing calculator use on learners' achievement and strategies in quadratic inequality problem solving. *Pythagoras, 41*(1), a552. https://doi. org/10.4102/pythagoras. v41i1.552

Ndlovu, M. C., & Mostert, I. (2018). Teacher Perceptions of Moodle and Throughput in a Blended Learning Programme for In-Service Secondary School Mathematics Teachers, *Journal of Africa Education* Review, *15*(2), 131–151. https://doi: 10.1080/18146627.2016.1241667

Ogbonnaya, U. I., & Awuah, F. K. (2019). Quintile ranking of schools in South Africa and learners' achievement in probability. *Journal of Stars Education, 18*(1), 106–11. https://doi.org/10.52041/serj.v18i1.153

Pool, J., Reitsma, G., & van den Berg, D. (2017). Revised community of inquiry framework: Examining learning presence in a blended mode of delivery. *Online Learning, 21*(3), 153-165. https://doi.org/10.24059/olj.v%vi%i.866

Shea, P., & Bidjerano, T. (2010). Learning presence: Towards a theory of self-efficacy, self-regulation, and the development of a community of inquiry in online and blended learning environments. *Computers & Education, 55*(4), 1721-1731. https://doi.org/10.1016/j.compedu.2010.07.017.

Swan, K. (2001). Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses. *Distance Education, 22*(2), 306–331. https://doi.org/10.1080/0158791010220208

Swan, K., & Shih, L.F. (2005). On the Nature and Development of Social Presence in Online Course Discussions. *Journal of Asynchronous Learning Networks, 9*(3), 115-136. https://doi.org/10.24059/olj.v9i3.1788

Tseng, F., & Kuo, F. (2014). A study of social participation and knowledge sharing in the teachers' online professional community of practice. *Computers & Education, 72* 37-47. Retrieved from http://dx.doi.org/10.1016/j.compedu.2013.10.005

Umugiraneza, O., Bansilal, S, & North, D. (2016). Exploring teachers' use of technology in teaching and learning mathematics in KwaZulu-Natal schools. *Pythagoras 9*(1), a342. https://doi.org/10.4102/pythagoras.v39i1.342.

Unwin, A. (2017). Community of practice or practice communities: online teacher development. *International Journal for e-Learning Security, 7*(1). https://doi.org/10.20533/ijels.2046.4568.2017.0067

Wu, Y. T., & Wang, L.J. (2015). The exploration of elementary school teachers' internet self-efficacy and information commitments: A Study in Taiwan. *Educational Technology & Society, 18*(1), 211-222. https://doi.org/10.2307/jeductechsoci.18.1.211

Appendix 1: Questionnaire for the study

Mathematics Teachers' Experiences of Using Online Teaching Resources for Professional Learning in a Context of Disadvantage
Section A: Participants' demographic data 1. Gender 2. Age group 3. Qualifications 4. Position 5. Years of work experience 6. Current Grade Teaching
Section B: What are teachers' experiences of the efficacy of the materials for their professional learning in terms of social presence? 1. Is there a reason why your school has or has no access to the internet? 2. How much time do you spend searching the online teaching materials? 3. By what means are materials you find on the website homepage valuable for professional learning? 4. By what means are materials you find on the website homepage valuable for teaching? 5. How effective you are when communicating with other teachers on website?
Section C: What are teachers' experiences of the efficacy of materials for their professional development in terms of cognitive presence? 1. Is the senior phase Math's teachers' online resources website explorative when you visit it? 2. How are online teaching materials assisting you to be in line with your annual teaching plan (ATP)? 3. Are selected learning activities from the site assist with the connection of ideas?
Section D: What are teachers' experiences of the efficacy of materials for their professional development in terms of teaching presence? 1. In what way are online teaching resources facilitating discourse with teachers? 2. How do the online teaching resources improve your current teaching and learning practice? 3. In what manner do online teaching resources improve the curriculum content knowledge? 4. Exactly how do you share online teaching resources with teachers?

Section E: What are teachers′ experiences of the use of online materials in mathematics teaching and learning in terms of learning presence?

1. How do the online teaching materials provide higher-order learning?
2. By what method do the online teaching materials transform teachers' mental abilities into academic skills?
3. How are online teaching materials direct when setting the question paper?