

Enhancing educational practices in community learning centers: challenges and strategies for resource distribution and technology integration

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ABSTRACT

The primary goal of this study was to explore the challenges faced by teachers in community learning centers (CLCs) concerning resource distribution, technology integration, and their impact on teaching and learning outcomes, specifically in grade 12 mathematics. The study contributes to the literature by identifying key barriers in resource-constrained settings and proposing evidence-based strategies to enhance educational practices in CLCs. A multiple case study design was utilized, incorporating focus group discussions with six grade 12 mathematics teachers from different CLCs. The data was analyzed using thematic analysis, and the research was grounded in the dual theoretical frameworks of deliverology and implementation science. These frameworks provided a systematic approach to goal-setting, progress tracking, and addressing barriers to effective resource utilization. The results revealed significant challenges, including inconsistent resource distribution, limited technological infrastructure, and inequitable access to educational materials. The study concluded that these issues severely impact the quality of teaching and student outcomes in CLCs. Key recommendations included increasing institutional support, investing in technological infrastructure, implementing regular professional development workshops, and adopting deliverology and implementation science to overcome identified challenges. These findings have implications for policy-makers and educational practitioners, emphasizing the need for more equitable resource allocation and the strategic use of technology to improve educational outcomes. Further research is suggested to explore the scalability of these interventions in similar educational settings globally.

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1. INTRODUCTION

Community learning centers (CLCs) play an essential role in delivering education to diverse and often underserved populations, particularly in resource-constrained environments. These third-tier institutions serve as an alternative for students who could not access universities or technical vocational education and training (TVET) colleges, offering a pathway to further education and skills development (Department of Basic Education, 2015). Despite their crucial role, CLCs face persistent challenges that compromise the quality of education they provide. The two most pressing challenges were resource constraints and the effective integration of technology. Addressing these barriers was key to improving student success and the overall

learning experience in CLCs. The integration of technology in education is universally recognized as critical for equipping students with necessary digital literacy and access to a broader range of learning resources [1], [2]. Equitable distribution of resources ensure that all students, regardless of socio-economic background, had access to quality educational tools and materials. However, these objectives remain elusive in many CLCs, where disparities in resource availability and digital infrastructure affected both teachers and students. This study focused on understanding the complex challenges faced by teachers in CLCs related to resource distribution, technology integration, and equity. By investigating these issues, the study aimed to develop strategies that could enhance the teaching and learning environment in CLCs, with implications extending beyond local contexts to inform global educational practices in similar settings.

While prior research had explored the importance of technology integration and equitable resource distribution in education [1], [2], few studies had delved into the specific challenges that CLC teachers faced. The unique demands of resource-constrained environments often exacerbated these challenges, creating a gap in the literature that this study sought to address. The work of Zou *et al.* [2] highlighted the broad significance of technology in education but did not consider the specific context of CLCs. Similarly, Akkaya [1] emphasized the need for equitable resource distribution but lacked a detailed examination of the obstacles faced by teachers in these settings. This study filled this gap by focusing on the lived experiences of CLC teachers and examining how they navigated these challenges.

The study employed qualitative methods, conducting focus group discussions with teachers from various CLCs. The data collected was analyzed within the frameworks of deliverology and implementation science. Deliverology, developed by Sir Michael Barber, was a systematic approach to performance management, emphasizing goal-setting, progress monitoring, and targeted interventions [3]. This framework was complemented by implementation science, which focused on identifying and addressing barriers to putting research findings into practice [4]. Together, these frameworks provided a comprehensive approach to understanding and addressing the challenges faced by CLC teachers. The key research question guiding this study was: “How do teachers’ challenges and strategies with resources, technology integration, and equity affect grade 12 mathematics curriculum implementation and student outcomes in CLCs?” The study’s findings aimed to contribute to both local and international educational discourse by offering insights into the specific challenges of CLC teachers and providing practical recommendations for improving resource distribution and technology integration in these environments. The study revealed several critical insights regarding resource distribution, technology integration, and equity in CLCs. First, teachers consistently identified a lack of access to supplementary teaching materials as a major obstacle. This issue was compounded by limited digital infrastructure, which hindered effective technology integration in the classroom. Teachers reported that these challenges not only affected their ability to teach but also impacted students’ learning outcomes, particularly in subjects like Grade 12 Mathematics.

Moreover, Nilsen and Bernhardsson [5], indicates that resource distribution in CLCs is often inequitable, with substantial disparities in the availability of teaching materials, infrastructure, and support services. Studies by Glewwe *et al.* [6] and Tibane *et al.* [7] highlight that resource constraints in CLCs result in overcrowded classrooms, lack of essential teaching aids, and insufficient professional development opportunities for teachers. In response to these challenges, teachers had developed various coping strategies, such as sharing resources among teachers and making creative use of the limited technology available. However, these efforts were often insufficient to fully mitigate the negative impact of resource and technology deficits on teaching and learning. The study also found that issues of equity; both in terms of resource distribution and access to technology were particularly pronounced in CLCs. Disparities in funding and resource allocation between different CLCs exacerbated existing inequalities, making it difficult to ensure all students received a high-quality education. Informed by the frameworks of deliverology and implementation science, this study proposed several interventions to address these challenges. These included targeted investments in digital infrastructure, professional development for teachers on integrating technology into their teaching, and the creation of policies that promoted more equitable resource distribution across CLCs. By implementing these strategies, CLCs could improve both teaching practices and student outcomes, offering a more equitable and effective educational experience for all students.

2. THEORETICAL FRAMEWORK

The dual theoretical framework of deliverology and implementation science provides a robust foundation for examining and addressing the challenges in resource distribution and technology integration in CLCs. Deliverology, developed by Sir Michael Barber, focuses on setting clear objectives, systematically monitoring progress, and implementing targeted interventions to achieve specific educational outcomes [3], [7]. This framework emphasizes accountability and data-driven decision-making, ensuring that educational policies and practices are effectively translated into improved student performance. On the other hand, implementation science offers a structured approach to integrating research findings into practice, emphasizing

the identification and overcoming of barriers to effective implementation [8]. It provides tools for understanding the complexities of educational environments and for developing strategies that facilitate the adoption of evidence-based practices. In the context of this study, combining deliverology's focus on performance management with implementation science's emphasis on practical application, these dual frameworks enabled a comprehensive analysis of how resource and technology challenges can be addressed to enhance the quality of education in CLCs.

3. METHOD

3.1. Research design

This research study adopted a multiple case study design to investigate the challenges and strategies of teachers regarding resource distribution, technology integration, and their impact on teaching and learning outcomes within CLCs. A multiple-case study design is a qualitative research approach that involves examining multiple individual cases within a specific context to gain a comprehensive understanding of a particular phenomenon [9]. In this study, multiple case study design enabled an in-depth exploration of the unique and shared experiences of six teachers across different CLCs, providing a richer and more nuanced understanding of the challenges faced in these educational settings [10]. This study aimed to explore the specific perceptions and challenges faced by teachers in CLCs, focusing on the implementation of the grade 12 mathematics curriculum. By examining multiple cases, this study compared and contrasted the experiences of teachers from various CLCs, and identified common themes as well as unique issues specific to certain contexts.

3.2. Participants

The study included six teachers from six different CLCs, with one teacher selected from each CLC, specifically focusing on those involved in teaching mathematics. To ensure diversity in participants and gather a comprehensive understanding of the challenges faced, the study employed purposive and stratified random sampling techniques. Purposive sampling was used to select teachers who have relevant experience and knowledge in teaching grade 12 mathematics, ensuring that the participants could provide valuable insights into the study's focus areas [11]. Stratified random sampling was then employed to ensure that the selected participants represented a diverse range of CLCs, considering factors such as geographical location, performance in mathematics, and the teachers' length of service in the CLCs.

The sample was drawn from grade 12 mathematics teachers in six CLCs based on geographical dynamics, with each CLC being more than 25 kilometres apart. This geographical stratification ensured that the selected CLCs represented different environments and contexts, thereby capturing a broader range of experiences and challenges. CLCs that were less than 25 kilometres apart were not considered to avoid redundancy and ensure diversity in the sample. This approach allowed the researchers to select teachers from various CLCs and consider factors such as the CLCs' environment, performance in mathematics, and teachers' service in the CLCs [12], [13]. Based on the identified strata, one grade 12 mathematics teacher was selected from each of the six CLCs.

3.3. Data gathering procedure and instruments

The study conducted semi-structured focus group discussions with teachers to explore their experiences, perceptions, and attitudes towards resource distribution, technology integration, and curriculum implementation in CLCs [14], [15]. Focus group discussions were chosen as the primary method of data collection due to their ability to facilitate interactive exchanges among teachers [8], allowing for the exploration of diverse perspectives and experiences related to curriculum implementation in CLCs. The focus group discussions were guided by a set of open-ended questions designed to delve into the challenges faced by teachers in accessing and utilizing supplementary teaching materials, integrating technology into teaching methods, and promoting equity in resource distribution among teachers [16], [17]. The open-ended nature of the questions allowed participants to express their thoughts and experiences freely, providing rich qualitative data for analysis.

3.4. Focus group discussion protocol

The focus group discussions commenced with an introduction that outlined the study's purpose and the specific objectives of the discussions. Participants were briefed on the significance of their insights, emphasizing how their contributions would aid in identifying and addressing the challenges faced by CLCs. Before starting the discussions, informed consent was obtained from all participants, who were assured of the confidentiality of their responses and their right to withdraw from the study at any time without any consequences [18].

The discussions centered around four main themes, namely resource distribution, technology integration, equity in resource distribution, and curriculum implementation. The questions about resource distribution explored the availability and accessibility of teaching materials, challenges in resource allocation, and the impact of resource constraints on teaching practices and student outcomes; technology integration

questions focused on the use of digital resources in teaching, the challenges of integrating technology into the curriculum, and the perceived benefits and drawbacks. Equity in resource distribution questions examined the fairness of resource allocation among teachers, the influence of socio-economic factors on resource availability, and strategies to promote equitable distribution. Curriculum implementation questions delved into the challenges of implementing the grade 12 mathematics curriculum, the support systems for teachers, and the impact on student learning and performance. The discussions were interactive, encouraging participants to share experiences, offer solutions, and discuss best practices. This study facilitated these exchanges to ensure all participants could contribute and that the conversations stayed focused on key themes [19]. The sessions concluded with a summary of key points, and participants were thanked for their valuable contributions, underscoring the importance of their insights for the study's objectives.

3.5. Data analysis

The qualitative data collected from the focus group discussions were analyzed using a rigorous thematic analysis approach, as illustrated in the Figure 1. The process began with data analysis (A), where all recorded discussions were transcribed to ensure every detail was captured accurately [20]. The transcripts were carefully reviewed multiple times to familiarize the researchers with the data and to begin identifying preliminary patterns and themes. Following this, the researchers engaged in an iterative coding (B) process, breaking down the text into manageable segments and assigning codes to meaningful units of information [4]. This phase included both inductive codes, which emerged directly from the data, reflecting participants' unique perspectives and experiences, and deductive codes, informed by existing literature and the study's conceptual framework [21].

Once the initial coding was complete, the researchers moved to theme development (C), where related codes were grouped into broader categories that encapsulated significant patterns in the data. For example, codes related to the availability and accessibility of teaching materials were grouped under the theme of "resource distribution". Similarly, codes pertaining to the use of digital tools and the challenges of integrating technology into the curriculum were categorized under "Technology Integration". This phase also involved constant comparison, revisiting the data to ensure the themes accurately reflected participants' experiences, merging overlapping themes, splitting broad themes into more specific sub-themes, and re-coding data segments as necessary. To ensure the credibility and trustworthiness (D) of the findings, several strategies were employed. Member checking was conducted by sharing preliminary findings with participants to verify the accuracy and resonance of the themes. This feedback was incorporated into the final analysis, enhancing the validity of the results. Triangulation was used to compare and cross-validate data from different sources and methods, ensuring a comprehensive understanding of the research problem. Additionally, an audit trail was maintained, documenting all steps of the data collection and analysis process, providing transparency and allowing for the replication of the study.

The identified themes were then interpreted in the context of the study's research questions and theoretical frameworks during the interpretation of findings (E) phase. For instance, the theme of "resource distribution" was analyzed in relation to how resource constraints impacted teaching practices and student outcomes, drawing on the principles of deliverology and implementation science to suggest potential interventions. The theme of "technology integration" was examined to understand the barriers and facilitators of digital resource use in CLCs, considering both practical and pedagogical implications. Finally, the presentation of results (F) involved organizing the themes and sub-themes into a coherent narrative that highlighted the key findings of the study. Direct quotes from participants were used to illustrate the themes and provide rich, contextualized insights into the challenges faced by teachers in CLCs. The findings were presented in a way that not only addressed the research questions but also offered practical recommendations for improving resource distribution, technology integration, and curriculum implementation in CLCs. Through this systematic and thorough analysis, the study aimed to provide a deep and nuanced understanding of the challenges faced by teachers in CLCs and to offer evidence-based recommendations for enhancing the quality of education in these vital institutions.

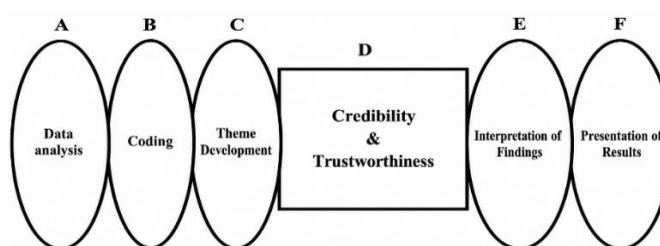


Figure 1. Data analysis process

3.6. Ethical considerations

The study adhered to ethical guidelines for research involving human participants. Informed consent was obtained from all participants, and they were assured of the confidentiality and anonymity of their responses. The researchers also ensured that participants were fully informed about the purpose of the study, their rights, and the potential benefits and risks of their participation. This methodology provides a comprehensive framework for exploring the perceptions and challenges of teachers in CLCs, contributing to a deeper understanding of the factors influencing resource distribution, technology integration, and curriculum implementation in these educational settings.

4. RESULTS AND DISCUSSION

4.1. Focus group discussion results

The study involved structured focus group discussions with six grade 12 mathematics teachers from six CLCs in Gauteng. The primary focus was on exploring the challenges and strategies of teachers regarding resource distribution and technology integration. The discussions were guided by a set of open-ended questions, and the key findings are summarized, as shown in Table 1 (see Appendix).

4.2. Synthesis of results

The focus group discussions reveal several overarching themes regarding the integration of digital resources, equity in resource distribution, and the challenges faced by teachers in CLCs. These themes highlight the significant impact of resource availability and quality on teaching practices and student performance, underscoring the need for improved institutional support and infrastructure.

4.2.1. Integrating digital resources and technology tools in teaching

The analysis shows that teachers are compelled to independently source educational materials due to insufficient institutional support. This self-sourcing is supplemented by occasional workshops aimed at enhancing curriculum understanding. However, external factors such as drug use among students pose additional challenges to the teaching process. While digital platforms like Zoom and Microsoft Teams are utilized for remote teaching, issues related to data availability and internet connectivity limit their effectiveness. Moreover, there is a dependency on personal devices and educational apps to access and distribute materials, which presents challenges, especially for students without access to these technologies.

4.2.2. Equity in resource distribution among teachers

The discussions highlight significant inconsistencies in the distribution of educational materials across different centres. While some centres receive certain resources, others, particularly for grade 12, lack essential study guides and textbooks. Photocopying and printing challenges further exacerbate these issues, making it difficult for teachers to provide necessary study materials. The lack of textbooks and essential writing materials forces teachers to resort to less effective methods, such as extensive board writing, which compromises the time needed to cover the curriculum effectively. Unequal support and resource availability among teachers also emerged as a critical issue, with those possessing adequate resources performing better than their counterparts who lack such support.

4.2.3. Incorporating supplementary resources in teaching

Teachers rely heavily on technology and personal devices to incorporate supplementary resources into their teaching methods. Despite the challenges posed by uneven student access to these technologies, teachers use cell phones, WhatsApp, and other digital tools to facilitate learning. Some teachers suggested that government-provided screen boards could help mitigate these issues by ensuring all students have equal access to visual aids. However, the lack of institutional infrastructure, such as computer labs, limits the full potential of these technological methods. Traditional supplementary resources, such as past question papers and alternative textbooks, remain essential but are often scarce, requiring teachers to find creative ways to multiply and share these materials.

4.2.4. Use of interactive digital learning platforms

The results indicate that interactive digital learning platforms are not widely used due to a lack of infrastructure and resources. Participants recognized the potential benefits of these platforms, such as preparing students for higher education and future technological engagements. However, the absence of such facilities slows down the educational process and hinders adaptation to modern teaching methods. Some teachers use mobile devices and online platforms to bridge this gap, but the effectiveness is limited by data constraints and the availability of devices among students.

4.2.5. Differences in students' academic performance due to varying access to resources

There is a clear correlation between the quality of resources available to students and their academic performance. Students with access to high-quality textbooks and more study hours tend to perform better than those with limited resources. This disparity highlights the critical impact of resource quality on student understanding and retention of material, leading to significant variations in academic outcomes. Teachers attempt to mitigate these differences by using personal funds and devices to provide supplementary materials, however, these efforts are often insufficient to fully bridge the performance gap.

4.2.6. Challenges in accessing or utilizing supplementary teaching material

The primary challenges identified include insufficient institutional support and the necessity for teachers to self-fund resources. These challenges significantly impact the effectiveness of teaching, as teachers struggle to obtain and fully utilize necessary tools and materials. The reliance on personal funds and devices to support students further exacerbates the issue, highlighting the urgent need for better resource allocation and support from educational institutions.

4.3. Discussion

The results of this study underscore the critical need for a strategic approach to addressing the challenges faced by teachers in CLCs. From a deliverology perspective, the systematic approach to setting clear goals and tracking progress [7] is essential for ensuring that technological initiatives are effectively implemented and monitored. Deliverology's emphasis on accountability and performance monitoring can be applied to ensure that resources are equitably distributed among teachers [3]. By setting clear targets for resource allocation and regularly tracking progress, educational institutions can address these disparities. Meanwhile, implementation science contributes by providing strategies to overcome barriers to technology integration, ensuring that evidence-based practices are adopted [8]. This framework also helps identify specific barriers to equitable resource distribution and develop strategies to overcome them [5].

The principles of deliverology can guide the implementation of technology initiatives, ensuring they are systematically integrated into teaching practices [3], while implementation science offers a framework for understanding contextual factors influencing the adoption of these tools and developing tailored interventions to support their use [8]. Moreover, deliverology's focus on setting clear, measurable goals and tracking progress can help ensure the successful implementation of interactive digital learning platforms [3]. Implementation science provides insights into the barriers to resource access and develops strategies to ensure resources are equitably distributed and effectively utilized [5]. This dual approach is crucial for establishing clear targets for resource provision and systematically tracking progress towards these goals, ensuring that teachers have the necessary tools to effectively teach [3]. Moreover, the dual theoretical frameworks of deliverology and implementation science offer a synergistic approach that informs the research by addressing both the strategic and practical aspects of improving educational practices in CLCs. This dual approach enables a dynamic response, with deliverology setting goals and benchmarks while implementation science adapts interventions to address specific challenges, such as data connectivity and self-funding needs [3], [5], [8]. Together, these frameworks create a cycle of continuous improvement that promotes accountability and tailor's solutions to the educational environment, enhancing the effectiveness and sustainability of technological and resource-based interventions.

4.3.1. Integrating digital resources and technology tools in teaching

The necessity for teachers to independently source educational materials due to insufficient institutional support is consistent with the findings of Barton and Dexter [22] and Bailey and Christian [23], who identified similar trends in under-resourced educational settings. Participant A highlighted this challenge, stating, *"For material, us teachers in levels we try to look for material ourselves and then sometimes they took us to workshops so that we can learn more about the curriculum."* The use of digital platforms like Zoom and Microsoft Teams for remote teaching aligns with [11], who emphasized the potential of digital tools to enhance learning. However, issues related to data availability and internet connectivity are well-documented challenges in the literature [1], [24], highlighting the digital divide that impedes effective technology integration in education. Participant B noted, *"Sometimes when am at home or rather maybe am not coming to school because I've attended some training workshops and would with the students use platforms such as Zoom...The challenges ke tsona tsa data and obviously connectivity."*

4.3.2. Equity in resource distribution among teachers

Significant inconsistencies in the distribution of educational materials reflect the systemic inequities discussed by Nkambule and Ngubane [25]. Participant A remarked, *"According to our center we receive materials but up to so far for grade 12 we don't receive anything...when I check maybe with other centers, we are using different materials especially study guides."* The challenges with photocopying and printing resources, as noted by participants, align with findings by Mthethwa and Land [26] and Tapala *et al.* [27], who identified resource

scarcity as a major barrier to effective teaching. Participant B shared, *“Our center is having a lot of photocopying...we don’t get the materials for photocopying so it’s difficult to photocopy lots of information for students.”* The inequitable distribution of textbooks and essential writing materials forces teachers to adopt fewer effective methods, such as extensive board writing, which compromises the time needed to cover the curriculum effectively. Participant E explained, *“You find that you resort to writing because now you are using one textbook...you even lack the whiteboard markers...We don’t have textbooks from the college.”*

4.3.3. Incorporating supplementary resources in teaching

Teachers rely heavily on technology and personal devices to incorporate supplementary resources into their teaching methods. Despite the challenges posed by uneven student access to these technologies, teachers use cell phones, WhatsApp, and other digital tools to facilitate learning [28]. Participant A described using individual students’ cell phones, despite the challenge of not all students having access to them, *“I tend to use cell phones, individual students’ cell phones, even though it’s quite challenging because not all of them are equipped with cell phones...the mitigation for this problem might be the government to supply us with screen boards.”* However, the lack of institutional infrastructure, such as computer labs, limits the full potential of these technological methods. Traditional supplementary resources; such as past question papers and alternative textbooks, remain essential but are often scarce, requiring teachers to find creative ways to multiply and share these materials. Participant D stated, *“Resources normally past question papers, alternative textbooks...I would say that it works for me in enriching lessons...it’s a question of these are scarce resources, multiplying either those textbooks or those past question papers.”*

4.3.4. Use of interactive digital learning platforms

The results indicate that interactive digital learning platforms are not widely used due to a lack of infrastructure and resources. Participant A mentioned, *“Honestly speaking I personally never used it and even here at school according to my observation I’ve never seen anyone using it...since we do have such facilities our education is slow...we need such equipment so that we can be able to teach in a distance from one another.”* Participants recognized the potential benefits of these platforms, such as preparing students for higher education and future technological engagements. Participant B highlighted, *“It will help students in many ways...they will have to use it even in varsity...the main thing is that they must have technological knowledge not only for maths but for any other subjects.”* However, the absence of such facilities slows down the educational process and hinders adaptation to modern teaching methods. Some teachers use mobile devices and online platforms to bridge this gap, but the effectiveness is limited by data constraints and the availability of devices among students [28]. Participant F explained, *“I mostly use cell phones and help the students...when we use these WhatsApp groups and send something homework and activity all the students can get the information...these students need more time and more engagement from the lecturers.”*

4.3.5. Differences in students’ academic performance due to varying access to resources

There is a clear correlation between the quality of resources available to students and their academic performance. Students with access to high-quality textbooks and more study hours tend to perform better than those with limited resources [6]. Participant A noted, *“If a student uses a textbook like ‘3 in 1,’ they perform better than a student using ‘mind the gap’...these resources are different and thus the performance they drive in the student is different.”* This disparity highlights the critical impact of resource quality on student understanding and retention of material, leading to significant variations in academic outcomes. Teachers attempt to mitigate these differences by using personal funds and devices to provide supplementary materials; however, these efforts are often insufficient to fully bridge the performance gap. Participant D supported this observation, stating, *“There are differences because some students do not have textbooks...I shoot the topic and you find that some students do not have smartphones or data.”*

4.3.6. Challenges in accessing or utilizing supplementary teaching material

The primary challenges identified include insufficient institutional support and the necessity for teachers to self-fund resources [29]. These challenges significantly impact the effectiveness of teaching, as teachers struggle to obtain and fully utilize necessary tools and materials. Participant A described, *“I have to make sure that I also acquire like solutions or tools to these resources...sometimes getting those tools so that everything goes accordingly...I find myself sometimes not fully utilizing because of that challenge.”* The reliance on personal funds and devices to support students further exacerbates the issue, highlighting the urgent need for better resource allocation and support from educational institutions. Participant B emphasized, *“There is a lot of challenges as well because most students don’t have materials...I do share my data with students even though it is self-funded...the cell phones and all the gadgets are mine...it becomes a big concern.”*

5. CONCLUSION

This study highlighted the critical challenges faced by teachers in CLCs related to resource distribution, technology integration, and equitable access to educational materials, particularly in the context of grade 12 mathematics instruction. The findings underscored the significant impact that resource availability and quality had on teaching practices and student performance. Inconsistent access to teaching materials, insufficient institutional support, and the need for teachers to self-fund resources were identified as prevalent issues that hindered effective teaching and learning. These challenges revealed broader implications for CLCs, where disparities in resources directly affected educational outcomes. The study contributed to the existing body of knowledge by offering detailed insights into these specific challenges, especially in resource-constrained environments. It applied the dual theoretical frameworks of deliverology and implementation science, providing a structured and evidence-based approach to understanding and addressing these barriers. The findings were particularly relevant for policy-making and institutional planning, as they provided actionable recommendations to improve resource distribution and technology integration in CLCs.

The results suggested several key improvements. First, addressing resource disparities and improving institutional support could lead to more effective teaching practices and improved student outcomes. Second, technology integration, when supported by appropriate infrastructure, could enhance the learning experience and better prepare students for future educational or professional pursuits. These improvements implied that by ensuring consistent access to educational materials and technology, CLCs could significantly enhance both teaching efficacy and student performance, particularly in critical subjects like mathematics. The implications of the findings extended beyond CLCs, offering broader relevance for educational institutions in similar resource-constrained settings globally. Adopting frameworks like deliverology and implementation science, CLCs could establish clear, measurable goals and systematically address the barriers to resource access and technology adoption. These frameworks also facilitated the implementation of evidence-based practices, ensuring that solutions were both practical and effective. In terms of future research, this study opened several new fields of inquiry. One avenue for further research could involve expanding the study to include the perspectives of other key stakeholders, such as students, administrators, and policy-makers, to gain a more holistic understanding of the educational ecosystem in CLCs. Another important area would be to examine the long-term impacts of resource and technology improvements on student performance and career readiness. For future research, this study opened several avenues of inquiry. Expanding the research to include the perspectives of other stakeholders; such as students, administrators, and policy-makers could provide a more holistic understanding of the educational ecosystem in CLCs. Additionally, examining the long-term effects of resource and technology improvements on student performance and career readiness would offer valuable insights into the sustainability and impact of such interventions.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that no conflict of interest existed among the researchers and/or between the researchers and Participants. The research was conducted independently, and no institutional and/or professional relationship influenced the collection of data, analysis, interpretation and/ or reporting of the findings.

INFORMED CONSENT

The authors of this study have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

Ethical approval for the study was granted by the Tshwane university of Technology Ethics Review Committee. The ethics approval reference number is FCRE/MSBE/STD/2023/08.

DATA AVAILABILITY

The raw data supporting the findings of this study are available from the corresponding author, [CCT], upon reasonable request, subject to the ethical requirements governing participant confidentiality, anonymity and data protection.

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APPENDIX

Table 1. Results of teachers focus group discussions

Themes		Participant's response analysis
Integrating digital resources and technology tools in teaching	Self-sourcing and limited institutional support (FGD001)	Participants highlighted the necessity for teachers to independently seek out educational materials due to insufficient institutional support. Participant A mentioned " <i>For material us teachers in levels we try to look for material ourselves and then sometimes they took us to workshops so that we can learn more about the curriculum.</i> " This discussion highlights their efforts to find materials independently and the occasional workshops provided by the institution to aid in understanding the curriculum. However, the participant also noted the significant challenges posed by external factors such as drug use among students, which complicate the teaching process.
	Use of online platforms and connectivity challenges	The use of digital platforms such as Zoom and Microsoft Teams was mentioned as a method for remote teaching. Participant B mentioned " <i>Sometimes when am at home or rather maybe am not coming to school because I've attended some training workshops and would with the students use platforms such as Zoom...The challenges ke tsona tsa data and obviously connectivity.</i> " Thus, this notes that while these platforms are useful, they come with their own set of challenges, including issues related to data availability and internet connectivity. Additionally, there is a lack of familiarity among some students with these digital tools, making effective engagement difficult.
	Dependence on personal devices and apps for educational resources	Participants reported using personal devices and educational apps to access and distribute educational materials. Participant C emphasized the reliance on apps containing question papers and memorandums, which facilitate learning in the absence of readily available resources. Participant C stated " <i>We use such in class re kgona ko araba those questions its makes it easy because the other material is not available...We don't have any computer labs mo center ya rena we use our cell phones and laptops.</i> " However, this reliance on personal devices such as cell phones and laptops poses challenges, especially for students who might not have access to these devices or might use them for non-educational purposes.
Equity in resource distribution among teachers	Inconsistent access to educational materials (FGD002)	Participant A stated " <i>According to our center we receive materials but up to so far for grade 12 we don't receive anything...when I check maybe with other centers, we are using different materials especially study guides.</i> " The participants reported significant inconsistencies in the distribution of educational materials, particularly for grade 12 students. Participant A noted that while their centre receives some materials, grade 12 resources such as study guides are lacking. This inconsistency is exacerbated when comparing different centres, which use varied materials to assist grade 12 students.

Table 1. Results of teachers focus group discussions (continue)

Themes		Participant's response analysis
Equity in resource distribution among teachers	Photocopying and printing challenges	A common issue among participants was the difficulty in accessing photocopying resources. Participant B highlighted the lack of materials for photocopying, which affects their ability to provide students with necessary study materials, leading to poor student performance. Participant B stated <i>"Our center is having a lot of photocopying...we don't get the materials for photocopying so it's difficult to photocopy lots of information for students."</i> Similarly, Participant C mentioned past issues with the photocopying machine, which was a major concern for both teachers and students. Participant C stated <i>"For now the photocopying machine is working but throughout the year since last year we did not have a photocopying machine...even the students were complaining."</i>
	Lack of textbooks and writing materials	Several participants pointed out the inequity in the distribution of textbooks and other essential writing materials. Participant D stated <i>"Some lecturers ba fa di textbooks tse gore ba di kreile mo skolong but nna since ke fitla mo institution ya rena I've never received any textbook."</i> Participant D mentioned that some lecturers receive textbooks while others do not, leading to a shortage of resources in their classes. Participant E stated <i>"You find that you resort to writing because now you are using one textbook...you even lack the white board markers...We don't have textbooks from the college."</i> Participant E described resorting to writing on the board due to the lack of textbooks, which compromises the time needed to cover the curriculum effectively.
	Unequal support and resource availability	Participants expressed concerns about the unequal support and availability of resources among teachers. Participant F emphasized that those with resources tend to perform better, but they themselves lack adequate support and resources from the college. Despite these challenges, they make efforts to provide information through personal means, such as creating WhatsApp groups for their students. Participant F stated <i>"There is no equity...I don't have resources at all...I use cell phones; I try by all means so that the students can get the information...even from the officials it's zero percent support."</i>
Incorporating supplementary resources in teaching	Reliance on technology and personal devices (FGD003)	Participants highlighted the use of technology and personal devices, such as cell phones and WhatsApp, to incorporate supplementary resources into their teaching methods. Participant A mentioned <i>"I tend to use cell phones, individual students' cell phones, even though it's quite challenging because not all of them are equipped with cell phones...the mitigation for this problem might be the government to supply us with screen boards."</i> Participant A described using individual students' cell phones, despite the challenge of not all students having access to them. They suggested that government-provided screen boards could mitigate this issue by ensuring all students can see the explanations. Participant B mentioned <i>"We are obligated to implement new technological methods such as screens and cell phones...technology, we should focus more on gadgets and any technological methods that might ease the situation."</i> Participant B emphasized the need to adopt technological methods, such as screens and gadgets, alongside traditional teaching methods. They acknowledged the shift towards technology in education and the necessity of integrating these tools to ease the teaching process.
	Challenges with technological resources	While some participants were comfortable using technological resources, they pointed out the challenges related to student access and familiarity with these tools. Participant C mentioned their ease in using technological resources but noted that not all students have cell phones or access to data, which makes it difficult to utilize these methods effectively. Participant C mentioned <i>"I do not have any challenges in using the resources because I'm familiar with these technological resources...the only challenge is the challenge I get from the students...not all of them have cell phones and even those who have cell phones, not all of them have access to data."</i> Participant G also discussed using cell phones and WhatsApp to post class activities, but they faced issues related to data access and the availability of textbooks. They sometimes used their Wi-Fi to connect students and sent PDF versions of textbooks to those without access to physical copies. Participant G mentioned <i>"I use some cell phones,</i>

Table 1. Results of teachers focus group discussions (continue)

Themes		Participant's response analysis
Incorporating supplementary resources in teaching	Challenges with technological resources	<i>chalkboard, textbooks, and the activities I post them on WhatsApp groups...the difficult part of it is data sometimes I connect them using my Wi-Fi...I send them textbooks PDFs and source out some textbooks from previous years."</i>
	Use of traditional supplementary resources	Participants also relied on traditional supplementary resources such as past question papers and alternative textbooks. Participant D mentioned using past question papers and alternative textbooks to enrich lessons, despite the scarcity of these resources. They emphasized the importance of ensuring all students are looking at the same materials during lessons. Participant D mentioned <i>"Resources normally past question papers, alternative textbooks...I would say that it works for me in enriching lessons...it's a question of these are scarce resources, multiplying either those textbooks or those past question papers."</i> Participant E also talked about using past question papers and study guides for grade 12, supplemented by WhatsApp methods to deliver information. However, they faced challenges due to some students not having smartphones or data, making it difficult to reach all students effectively. Participant E stated <i>"Most of my colleagues and I are using the past question papers plus the study guide for grade 12...it's just a matter of even WhatsApp methods we use to deliver the message...some students do not have the data or a WhatsApp where they are not using smartphones."</i>
Use of interactive digital learning platforms	Limited use and lack of infrastructure (FGD004)	Participants indicated that interactive digital learning platforms are not widely used in their teaching practices, primarily due to a lack of infrastructure and resources. Participant A said <i>"Honestly speaking I personally never used it and even here at school according to my observation I've never seen anyone using it...since we do have such facilities our education is slow...we need such equipment so that we can be able to teach in a distance from one another."</i> Participant A acknowledged that they have never used such platforms and have not observed their use within their school. They emphasized the need for such equipment, suggesting that its absence slows down the educational process and hinders adaptation to modern teaching methods, especially in light of changes brought by the COVID-19 pandemic.
	Potential benefits of technology integration	Despite the current lack of use, participants recognized the potential benefits that interactive digital learning platforms could bring. Participant B highlighted the importance of technology in preparing students for higher education and other future opportunities. They stressed that familiarity with technology is essential not only for mathematics but for all subjects, suggesting that integrating these platforms would provide students with valuable technological skills. Participant B said <i>"It will help students in many ways...they will have to use it even in varsity...the main thing is that they must have technological knowledge not only for maths but for any other subjects."</i>
	Use of mobile devices and online platforms	Some participants reported using mobile devices and online platforms like WhatsApp to facilitate learning, especially when students are absent. Participant F said <i>"I mostly use cell phones and help the students...when we use these WhatsApp groups and send something homework and activity all the students can get the information...these students need more time and more engagement from the lecturers."</i> Participant F explained that they use WhatsApp groups to send homework and activities, which helps maintain continuity in learning despite limited in-class time. This approach is seen as a partial substitute for more comprehensive digital learning platforms. Participant C mentioned using a tablet to access educational resources such as YouTube and other websites during lessons. Participant C said <i>"Yes, I have used my tablet as a form of interacting with students...I do access YouTube's I do access those websites with these resources while am dealing with that particular lesson in class."</i> They group students who have data to ensure everyone can participate in these digital learning sessions, indicating a practical approach to integrating technology within the constraints they face.

Table 1. Results of teachers focus group discussions (continue)

Themes		Participant's response analysis
Differences in students' academic performance due to varying access to resources	Impact of resource quality on academic performance	Participants observed noticeable differences in students' academic performance based on the quality and availability of resources. Participant A highlighted that student using high-quality textbooks like "3 in 1" performed better compared to those using simpler resources such as "mind the gap". Participant A said <i>"If a student uses a textbook like '3 in 1,' they perform better than a student using 'mind the gap'...these resources are different and thus the performance they drive in the student is different."</i> This disparity in resource quality directly affects students' understanding and retention of the material, leading to variations in academic outcomes. Participant D supported this observation, noting that students who lack access to textbooks or digital resources often struggle. They mentioned taking proactive measures, such as shooting videos of topics to share with students, but acknowledged that not all students have smartphones or data to access these resources, further widening the performance gap. Participant D <i>"There are differences because some students do not have textbooks...I shoot the topic and you find that some students do not have smartphones or data."</i>
Challenges in accessing or utilizing supplementary teaching material	Insufficient resources and self-funding	Participants identified significant challenges in accessing and utilizing supplementary teaching materials, primarily due to insufficient institutional support and the need for self-funding. Participant A mentioned <i>"I have to make sure that I also acquire like solutions or tools to these resources...sometimes getting those tools so that everything goes accordingly...I find myself sometimes not fully utilizing because of that challenge."</i> Participant A described the difficulty in obtaining necessary tools and solutions, which impacts their ability to fully utilize available resources. This often results in less effective teaching and learning experiences. Participant B also emphasized the challenges posed by a lack of student materials and the necessity of using personal funds and devices to support students. They pointed out the negative impact of teaching students who lack even basic study guides or textbooks, which significantly hampers the learning process. Participant B mentioned <i>"There is a lot of challenges as well because most students don't have materials...I do share my data with students even though it is self-funded...the cell phones and all the gadgets are mine...it becomes a big concern."</i>

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