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Challenges Experienced by Mathematics Teachers in the Implementation of Grade 12 Mathematics Curriculum in Community Learning Centres: South African Perspective

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Abstract. This study examined the challenges experienced in implementing the Grade 12 Mathematics curriculum in Community Learning Centres (CLCs). The study aimed to identify these challenges and explore the factors influencing challenges experienced by teachers towards curriculum implementation. The study utilized a multiple case study design and qualitative methods, to explore the challenges towards curriculum implementation. The data was collected through structured interviews with 12 teachers from different CLCs. Thematic analysis was used to analyse the data and identify key insights and findings. The participants of the study involved 12 teachers from different CLCs in Gauteng Province, South Africa. Through a comprehensive review of existing literature and the results from the interview questions, the study identified resource constraints, socio-economic disparities, teacher capacity issues, and infrastructure limitations as primary obstacles to effective curriculum implementation. Despite these challenges, many teachers demonstrated positive attitudes towards the curriculum, although frustrations persist due to inadequate resources, limited support, and insufficient training. The study recommends targeted interventions and policy initiatives to address these challenges, including investing in teacher training and professional development programs, addressing resource constraints and infrastructure limitations, and fostering collaboration among stakeholders. By strategically addressing these challenges through the adoption of deliverology and implementation of science frameworks, CLCs have the potential to optimize student outcomes and foster equitable access to high-quality education for all students.

Keywords: community learning centres; deliverology; implementation science; curriculum implementation; grade 12 mathematics

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1. Introduction

Community Education and Training Colleges (CETCs), previously known as public adult learning centres (PALCs) (Mginywa, 2021), were established in South Africa in April 2015. The primary objective of CETCs is to address educational inequalities in communities. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2015), Community Learning Centres (CLCs) serve as vital resources for individuals and communities, particularly in areas where access to quality education and learning opportunities may be limited. Moreover, CLCs play a crucial role in providing education and support to underserved communities, offering opportunities for individuals to access learning programs that may otherwise be unavailable (Aitchison & Land, 2019; Mthethwa & Land, 2022).

Within the educational landscape, the effective implementation of the curriculum in CLCs is paramount for ensuring that students receive quality education and support for their academic and personal development. In particular, the implementation of the Grade 12 Mathematics curriculum holds significant importance, as it serves as a gateway to higher education and various career pathways (Department of Basic Education (DBE, 2011). The Curriculum and Assessment Policy Statement (CAPS) for Mathematics in South Africa provides a comprehensive framework for teaching and learning mathematics, outlining essential concepts, skills, and objectives for Grade 12 students (DBE, 2011).

However, despite the guidelines provided by the CAPS document, CLCs encounter various challenges in the effective implementation of the Grade 12 Mathematics curriculum. These challenges span resource constraints, socio-economic disparities, teacher capacity issues, and infrastructure limitations, all of which impact the delivery and outcomes of mathematics education in CLCs (Ayaya, et, al., 2020; Green, 2015; Hanemann, 2015; Legotlo, 2014). Understanding the complexities of curriculum implementation in CLCs is crucial for addressing these challenges and improving educational outcomes for Grade 12 students. Additionally, exploring the challenges experienced by teachers towards curriculum implementation, sheds light on the factors influencing instructional practices and student engagement in mathematics education (Blazar & Kraft, 2017; Ramnarain & Hlatswayo, 2018). Previous studies have primarily focused on single-framework approaches or different educational contexts, such as traditional schools or higher education institutions, which do not comprehensively address the unique challenges faced by South African CLCs. This gap highlighted the need for research that specifically addresses the multifaceted challenges within CLCs, and explores effective strategies for overcoming them.

This study aimed to address the challenges faced by teachers in CLCs in delivering the Grade 12 Mathematics curriculum effectively. By introducing a dual-framework approach, using deliverology and the implementation science framework, this study aims to comprehensively address the complex factors influencing the effective implementation of the Grade 12 Mathematics

curriculum in CLCs. Deliverology focuses on setting clear goals, monitoring progress, and implementing targeted interventions, while implementation science (methods and strategies for evidence-based practice) emphasizes the translating of policy into practice and considering contextual factors (Cook, Lyon, Locke, Waltz & Powell, 2019). This combined approach distinguishes the study from previous research, by offering a more holistic and nuanced understanding of curriculum implementation challenges specific to South African CLCs. Through a comprehensive review of existing literature, this study seeks to identify the key challenges faced by CLCs in implementing the Grade 12 Mathematics curriculum, and to explore the factors influencing the challenges experienced by teachers towards curriculum implementation (Battey & Leyva, 2018; Fisher & Royster, 2016; Saxena, 2017).

The ultimate goal of this research is to support the advancement of mathematics education in CLCs, and to empower students to reach their full potential by fostering positive teacher attitudes, identifying barriers, and leveraging strengths through collaborative efforts and evidence-based interventions. By synthesizing empirical evidence and theoretical frameworks, this study strives to contribute to the on-going dialogue about curriculum implementation in CLCs, and to inform policy and practice initiatives aimed at enhancing mathematics education for Grade 12 students. In light of the significance of mathematics education for individual empowerment and societal development, addressing the underlying issues hindering effective curriculum implementation in CLCs was imperative. The study's findings are expected to provide valuable insights and practical recommendations that can be used by educators, policymakers, and other stakeholders, to create an environment conducive to meaningful learning experiences and equitable outcomes for Grade 12 students in South African CLCs.

2. Literature review

The study utilized two theoretical frameworks, namely deliverology and the implementation science framework, to analyze the implementation of the Grade 12 Mathematics curriculum in CLCs. Deliverology, developed by Sir Michael Barber, emphasizes clear goal setting, data-informed decision making, progress monitoring, and accountability (Mouton, 2021). Implementation Science focuses on evidence-based practices, stakeholder engagement, collaboration, and continuous improvement (Schildkamp, 2019). In the context of the study, deliverology provided a useful framework; however, it was not directly applicable to the research questions related to curriculum implementation in CLCs. Therefore, the study also adopted the implementation science framework to address the research question. The integration of these frameworks in the study allowed for a comprehensive understanding of the complex factors influencing curriculum implementation in CLCs.

The advantages of using these frameworks include clear goal setting, data-informed decision making, continuous monitoring and evaluation, collaboration, stakeholder engagement, resource optimization, capacity building, continuous improvement and adaptation, and sustainability. However, there are also disadvantages, such as the focus on quantitative metrics, increased pressure and

stress, and the challenge of sustaining evidence-based practices in the long run (Barber, et, al., 2015; Dobroszek, et, al., 2021; Gewirtz, et, al., 2021; Goldstein & Olszewski, 2015). Thus, the integration of deliverology and implementation science in CLCs brings benefits such as accountability, data-driven decision making, continuous improvement, timely intervention, enhanced student performance, and sustainable educational practices. This integrated approach ensures a structured, supportive, and dynamic environment for effective curriculum implementation in CLCs.

3. Research Question

What are the challenges faced by teachers towards the implementation of the Grade 12 Mathematics curriculum in Community Learning Centres (CLCs), and how do these challenges impact teaching practices and student outcomes?

4. Methodology

4.1 Research Design

This study employed a multiple case study design to explore the challenges of curriculum implementation in Gauteng CLCs, and examined the impact of these challenges on teaching practices and student outcomes. According to Hunziker & Blankenagel, (2024); multiple case study theories involve looking at several instances of a phenomenon, in order to grasp its intricacies and the ways it varies among different settings. Specifically, this method allows for more thorough examination and comparison (Hunziker & Blankenagel, 2024); thus, the context of the study extends to uncovering more disparities in challenges experienced by teachers during curriculum implementation of the Grade 12 Mathematics Curriculum which is taught at Gauteng CLCs. Gauteng is a province in South Africa constituting of 47 CLCs, and the focus of this study was narrowed down to 12 CLCs in using purposive sampling. In the context of the study, purposive sampling was utilized to select CLCs and teachers who are most related and well-informed about issues and complexities within Mathematics curriculum implementation for Grade 12 ensures collecting detailed and meaningful data. The 12 selected centres are in Gauteng North Region known as Tshwane. The focus of this study was based on the challenges faced by teachers towards the curriculum implementation of Grade 12 Mathematics in CLCs and the impact of these challenges on teaching practices and student outcomes.

Therefore, a multiple-case study design was chosen due to the various cases that influence curriculum implementation in different CLCs. Furthermore, the cases involved teachers' challenges, experiences, perspectives, and perceptions of curriculum implementation, hence qualitative methods and analyses were adopted. Qualitative methods allowed for in-depth exploration and understanding of complex phenomena within their natural contexts (Creswell, et, 2023). Through structured interviews and thematic analysis, this research aimed to uncover rich insights into the challenges, experiences, perspectives, and perceptions of stakeholders involved in Grade 12 Mathematics education in CLCs. Semi-structured interviews were used to ensure that data collection was

consistent, and a comprehensive, systematic comparison of responses across different participants and cases could be made. That is, the semi structured interviews conducted with Grade 12 Mathematics teachers combined a set of predefined open-ended questions with flexibility, so that the interviewer could explore responses in greater depth.

4.2 Participants

The study included a total of 12 teachers of Grade 12 Mathematics in CLCs. To ensure diversity of participants, the researchers employed purposive and stratified random sampling (Creswell & Poth, 2018). Stratified random sampling is a method of probability sampling in which the population is divided into subgroups based on one or more variables, as described by Davis (2015). Power analysis was employed to determine a sample size of 12 teachers, which was sufficient to achieve adequate statistical ability for detecting meaningful differences and patterns in challenges experienced by teachers towards curriculum implementation (Kang, 2021), thereby ensuring the robustness and reliability of findings within the context of the research objectives. Utilizing a power analysis helped the study to incorporated factors such as effect size, that is (out of the 18 participants of the study, only 12 were interviewed) within the data, as suggested by Trafimow & Earp (2017).

The researcher approached the selected CLCs through formal invitations and information sessions, ensuring voluntary participation by clearly explaining the study's purpose, benefits, and confidentiality measures to the teachers, and obtaining their informed consent prior to inclusion (Eeckhout, et, al., 2023). The study adopted purposive sampling techniques, because it allowed for the intentional selection of participants who had specific knowledge and experience relevant to the research focus (Adeoye, 2023), thereby enhancing the depth and relevance of the data collected. The twelve participants were recruited from CLCs in various regions within the Tshwane region, to gather diverse perspectives on challenges experienced by teachers towards the curriculum implementation of Grade 12 Mathematics. The study utilized stratified random sampling to choose a sample of teachers from each of the selected CLCs. This method was employed to guarantee that the sample accurately represented the population in terms of specific variables such as teachers' challenges, experiences, perspectives, and perceptions (Davis, 2015). The sample was divided into two groups, based on factors such as the CLCs' environment, such as geographical dynamics, performance in Mathematics, and the teachers' service in the CLCs. Participants are subsequently chosen at random from each stratum utilizing random sampling techniques (Dhivyadeepa, 2015). The sample size was determined through a power analysis, based on a calculation that helped to determine a minimum sample for the study; this analysis considered factors such as the desired level of the effect size (Rust, 2014). Moreover, the chosen sampling method guaranteed that participants possessed the required expertise, direct experience, and valuable insights pertaining to the research objectives (Setia, 2016).

4.3 Data Gathering Procedure and Instruments

The selected CLCs were observed prior to the teachers' structured interviews for six weeks to understand how teachers implemented the curriculum and to identify any challenges they faced in effective implementation. However, observation was not used as an instrument for data collection for the purpose of this study; instead only interviews were used as an instrument to fully capture teacher's challenges, experience, perspective and perceptions in implementing the Grade 12 Mathematics curriculum. The structured interviews used in the study were valid, as they were carefully designed and adopted (Husband, 2020; Ruslin, et, al.,2022) and a pilot study was conducted to validate the instrument to explore a wide range of relevant topics related to the Grade 12 Mathematics curriculum implementation.

Data were collected through semi-structured interviews conducted with participants. The interviews were guided by a set of open-ended questions (Slade & Sergent, 2018), designed to explore challenges faced by teachers regarding Grade 12 Mathematics' curriculum implementation. The semi-structured interviews effectively captured rich qualitative data about teachers' challenges, experiences, perceptions and perspectives, ensuring comprehensive insights into the challenges and factors influencing curriculum implementation in CLCs.

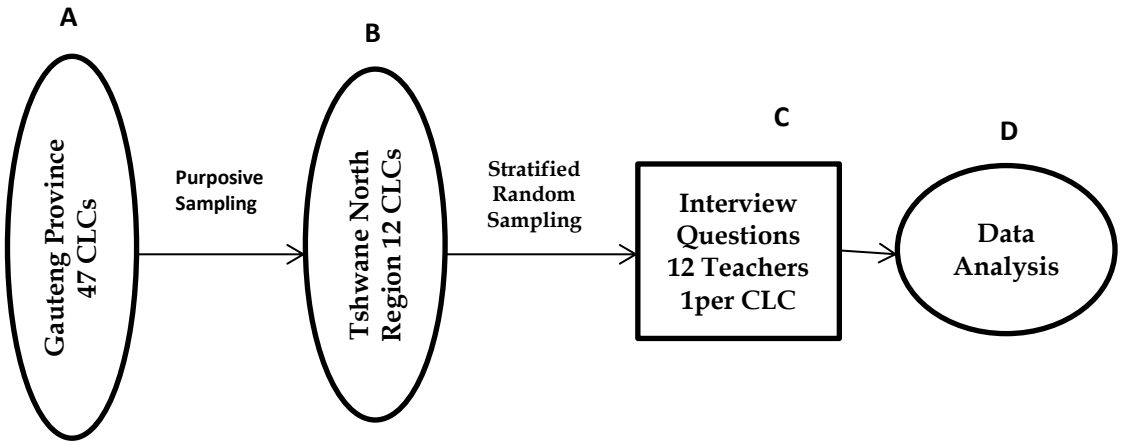

Figure 1: *Data collection processes*

Moreover, the semi-structured interview questions covered topics such as resource constraints, socio-economic disparities, teacher capacity issues, infrastructure limitations, and the impact of these challenges on teaching practice and student outcomes (see Figure 1).The above figure illustrates the research process for a study on curriculum implementation in CLCs within Gauteng Province, specifically focusing on the Gauteng North Region. It shows that based on the 47 CLCs in Gauteng Province, 12 CLCs from the Gauteng North Region were selected. One mathematics teacher per centre was interviewed using structured interview questions. After the data were collected

from these interviews, data were subjected to analysis to derive results and insights.

4.4 Data Analysis

Thematic analysis was employed to analyze the qualitative data gathered from the structured interviews. This method involved systematically coding and categorizing patterns and themes within the data, to identify key insights and findings (Slade & Sergent, 2018). The analysis process involved multiple stages, including familiarization with the data, coding of themes, identification of patterns, and interpretation of findings. Through an iterative process of data analysis, themes related to curriculum implementation challenges and teacher attitudes were identified and examined. To validate the results of the data analysis, the researcher employed peer debriefing (Sabnis & Wolgemuth, 2024), during which participants reviewed and critiqued the findings to ensure the accuracy and credibility of the interpretations.

5. Ethical consideration

This study about Grade 12 Mathematics' curriculum implementation in CLCs adheres to Tshwane University of Technology's (TUT) ethics policy, ensuring the dignity, rights, and well-being of participants are protected. Informed consent was obtained, providing participants with details about the study, their rights, and any associated risks and benefits. Confidentiality and anonymity were strictly maintained, with no identifying information disclosed in reports. Participation was voluntary, and participants could withdraw at any time without negative consequences. The researchers ensured objectivity and impartiality, to avoid biases that could affect the study's outcomes.

6. Results

The purpose of this study was to delve into the implementation of the Grade 12 mathematics curriculum in CLCs. Utilizing both deliverology and the implementation science frameworks, the study aimed to scrutinize the challenges experienced by teachers towards curriculum implementation, and offered recommendations to enhance mathematics education in CLCs. While deliverology primarily concentrates on policy and strategy implementation at governmental or organizational levels, it does not directly align with the focus of this study on curriculum implementation in CLCs (Birch & Jacob, 2019). However, the study acknowledges the value of certain concepts, such as curriculum implementation, based on deliverology. The principal analyses of the data regarding the implementation of the Grade 12 mathematics curriculum encompassed resource constraints, socio-economic disparities, teacher capacity issues, and infrastructure limitations. Furthermore, the study adopts the Implementation Science Framework, which emphasizes the enhancing of the implementation of evidence-based interventions in education (Nilsen & Bernhardsson, 2019).

According to Williams et al. (2020), both deliverology and the Implementation Science frameworks stress the importance of establishing clear goals, monitoring progress, utilizing data for decision-making, and engaging stakeholders. In the

context of curriculum implementation for Grade 12 Mathematics in CLCs, both frameworks prove valuable in guiding efforts to improve instruction and student outcomes. Deliverology is employed to establish clear goals and track progress at the regional level, specifically in Tshwane North. Meanwhile, the Implementation Science Framework guides the development and implementation of evidence-based practices in CLCs (Gewirtz et al., 2021). Despite their differing emphases and approaches, both deliverology and the Implementation Science Framework contribute significantly to enhancing the curriculum implementation of Grade 12 Mathematics in CLCs. The interview results from multiple cases (see Appendix 1) of the teachers were analyzed within the framework of these two methodologies, with a primary focus on the implementation of the Grade 12 mathematics curriculum. Findings and results are tabled below:

Table 1: Representations of results and findings from teachers' interviews

Framework Category	Response
Satisfaction with Mathematics Curriculum (Bovill & Woolmer, 2019)	*Most respondents express dissatisfaction with the Grade 12 mathematics curriculum in CLCs, citing issues such as inadequate coverage of concepts* ***(Answer A)****, resource disparities* ***(Answer B****), and limitations in time and support (****Answer E****). However, some express satisfaction with the curriculum itself, but highlight the need for additional materials and support* (***Answer C***).
Improving Mathematics Curriculum (Bovill & Woolmer, 2019)	*Suggestions for improvement include dividing the curriculum to address knowledge gaps (****Answer A****), providing textbooks and study materials (****Answer B, Answer D****), tailoring the curriculum to suit CLC students (****Answer F****), incorporating more engaging activities and workshops (****Answer G, Answer H****), and enhancing technology integration (****Answer K, Answer L****).*
Additional Comments on Curriculum (Cook, et, al., 2019)	*Additional comments emphasize the importance of closing the gap between Grade 11 and Grade 12 syllabi (****Answer A****), providing ongoing teacher development* ***(Answer B)****, and ensuring age-appropriate materials and support for CLC students* ***(Answer F****).*
Use of Online Problem-Solving Resources (Saxena, 2017)	*Limited use of online problem-solving resources is reported due to lack of access and awareness (****Answer A****). However, some educators utilize digital platforms like Zoom and WhatsApp for teaching and communication* ***(Answer B).***
Integration of Digital Resources (Saxena, 2017)	*The integration of digital resources faces challenges related to access to technology and data connectivity (****Answer B****). Educators primarily use cell phones and tablets to engage students, supplemented by traditional teaching methods (****Answer D****).*
Challenges in Resource Distribution (Ayaya, et, al., 2020)	*Inequities in resource distribution among teachers impact teaching practices, with some educators lacking textbooks and photocopying materials (****Answer C****). This affects the ability to provide consistent materials and support to students (****Answer F****).*
Utilization of Supplementary Teaching Material	*Educators incorporate various supplementary resources such as cell phones, textbooks, and past Answer papers to enrich teaching methods (****Answer D****). However, challenges in resource*

(Ferri, et, al., 2020; Aquino, 2022).	*access and student connectivity hinder full utilization and impact teaching effectiveness (**Answer G**).*
Interactive Digital Learning Platforms (AlNajdi, 2022)	*While recognized as beneficial, interactive digital learning platforms face accessibility challenges due to limited smartphone ownership and data availability (**Answer K**). Suggestions for improvement include providing tablets and addressing infrastructure issues (**Answer K**).*
Data Analysis and Visualization (AlNajdi, 2022)	*Limited use of data analysis tools in CLCs is reported, with reliance on SBA tasks for identifying areas of student difficulty (**Answer H**). The need for training in technology-driven data analysis methods is highlighted (**Answer I**).*
Incorporation of Problem-Solving Resources (Ferri, et, al., 2020)	*The incorporation of problem-solving resources and real-life scenarios is minimal, with most teaching focused on theoretical problem-solving (**Answer J**). Instances of improvement in student performance due to such resources are not provided (**Answer L**).*

The table (Table 1) explores teachers implementation of the Grade 12 Mathematics curriculum in CLCs, using the frameworks of deliverology and implementation science. Within the constraints of the two frameworks and key variables of the study, the research question presents two (2) segments of the findings. The first segment seeks to address mathematics curriculum in CLCs, hence the key fining 1. The second segment intend to address the challenges faced by teachers when implementing the grade 12 curriculum in the CLCs, hence key finding 2. Therefore, the second segment examines how these challenges impact teaching practices and student outcomes, emphasizing barriers to effective curriculum delivery and the need for targeted interventions to improve educational effectiveness in CLCs. From the synthesis of the results in table 1, there's a pattern that reveals dissatisfaction among educators due to issues like inadequate concept coverage and resource disparities, which fall under the first segment of the research question. Key finding 1 below examines the extent of influence of the components in the implementation of the Grade 12 mathematics curriculum.

Key finding 1

The findings suggest that the challenges faced in the implementation of the Grade 12 Mathematics curriculum in CLCs are multifaceted. According to ***Answer H*** "*The curriculum is not an issue, the way I see it, the issue is the resources.*" This highlights a common sentiment, where resource constraints significantly impact educational outcomes. Literature supports this, noting that inadequate resources such as textbooks and teaching materials hinder effective teaching and learning (Ayaya, et, al., 2020; Green, 2015; Hanemann, 2015; Legotlo, 2014; Du Plessis & Mestry, 2019; Hilton III, 2020).

Answer B "*the lack of classrooms, the lack of enough time for studies and the lack of teaching materials e.g. Data.*" This aligns with literature about infrastructure challenges in educational settings, including overcrowded classrooms and insufficient study time, which can impede student engagement and learning (Meier & West, 2020; Barrett, et, al., 2019). Resource disparities, including limited access to textbooks, is reflected in *Answer K* as follows: "*No resources for our learners e.g., textbooks, videos. Learners depend on the lecturers' information in the*

classroom only." This reflects a lack of digital resources and supports findings that digital divide and limited access to technology hinder educational progress (Lythreatis, et, al., 2022; Lembani, et, al., 2020).

Photocopying materials, and digital resources hinder teaching practices and impact student outcomes ***Answer M*** *adds,* "*We lack technological resources to aid teaching,*" highlighting the importance of integrating technology in education. Literature emphasizes the need for advanced technological support to enhance teaching methods and improve learning outcomes (Lythreatis, et, al., 2022; Olanrewaju, et, al., 2021). These challenges are compounded by issues of technology access and data connectivity, which restrict the utilization of interactive digital learning platforms and data-driven teaching methods. ***Answer M*** also notes: "*The manner in which the content of the curriculum is outdated, which calls for more advanced technology.*" This underscores the importance of updating curriculum content to align with technological advancements and contemporary educational needs (Castro, 2019; Khoza, & Biyela, 2020).

To address these challenges effectively, a multi-dimensional approach is required, incorporating elements of both deliverology and Implementation Science Frameworks. Deliverology emphasizes setting clear goals, identifying key performance indicators, and implementing targeted interventions to achieve desired outcomes (Birch & Jacob, 2019). In this context, government support is essential for providing equitable access to resources, such as textbooks, digital devices, and infrastructure improvements. Additionally, ongoing teacher training programs should be implemented to enhance educators' capacity to utilize technology and data analysis tools effectively (Smith, 2017).

Implementation Science offers insights into the systematic processes involved in translating policy into practice, focusing on factors such as context, stakeholders, and implementation strategies (Nilsen & Bernhardsson, 2019). In the case of CLCs, understanding the unique contextual factors, such as socio-economic disparities and infrastructure limitations, is crucial for developing tailored implementation strategies. This may involve establishing partnerships with community organizations and leveraging existing resources, to bridge gaps in access and support (Eagle, et, al., 2015). By applying principles from both deliverology and implementation science, policymakers and educators can work collaboratively to address the challenges faced in implementing the Grade 12 Mathematics curriculum in CLCs. This holistic approach aims to optimize teaching practices, enhance student outcomes, and foster equitable access to quality education for all learners.

Table 2: Syntheses of results and recommendations

Framework Category	Implementation Challenge	Implications for Improvement
Resource Constraints	*Shortages of textbooks and learning materials*	*Addressing the shortage of essential resources through increased funding and resource allocation*
	Technological limitations	*Upgrading technological infrastructure to facilitate the integration of digital resources into instruction*

Socio-Economic Disparities	*Economic challenges*	*Implementing equitable funding mechanisms to support CLCs in economically marginalized areas*
	Impact on student achievement	*Providing additional support and resources for students from poor backgrounds*
Teacher Capacity	*Lack of qualified teachers*	*Offering targeted professional development programs to enhance teachers' skills and expertise*
	Need for professional development	*Developing tailored training programs focused on Grade 12 Mathematics curriculum and instructional practices*
Infrastructure Limitations	*Overcrowded classrooms and inadequate facilities*	*Investing in infrastructure improvements to create conducive learning environments in CLCs*
	Limited access to technology	*Increasing access to technology and digital resources to enhance Mathematics instruction*
Teacher Attitudes	*Positive attitudes*	*Leveraging teachers' commitment to providing quality education by addressing underlying challenges*
	Challenges and frustrations	*Providing support and resources to address barriers hindering effective curriculum implementation*

Key finding 2

The results of the study highlight significant challenges in the implementation of Grade 12 Mathematics curriculum in CLCs. ***Answer L*** highlights "*Not fair to our learners because they have not received anything from our center.*" This underscores the issue of resource constraints, where inadequate provision of educational materials and support, negatively impacts student learning outcomes (Ayaya, et. al., 2020; Green, 2015; Hanemann, 2015; Legotlo, 2014; Du Plessis & Mestry, 2019; Hilton III, 2020). These challenges span across resource constraints, socio-economic disparities, teacher capacity issues, infrastructure limitations, and teacher attitudes (Aquino, 2023). "*To approach, we use different methods to teach e.g. handout notes, previous question papers, assessing class tests.*" ***(Answer M)***; ***Answer* C** notes, "*The manner in which the content of the curriculum is outdated, which calls for more advanced technology.*" This aligns with literature emphasizing the importance of updating curriculum content, and integrating advanced technology to enhance educational relevance and engagement (Grimus, 2020; Mwapwele, et, al., 2019).

Each category of challenges presents implications for improvement, emphasizing the need for targeted interventions and policy initiatives to enhance the effectiveness of Grade 12 Mathematics education in CLCs. "*The current teaching methods do not cater to the different learning styles of students*" ***(from multiple responses)***. These implications align with the principles of deliverology and implementation science frameworks, emphasizing the importance of addressing systemic challenges and fostering collaboration among stakeholders to achieve positive student outcomes (Birch & Jacob, 2019). The findings include resource constraints, socio-economic disparities, teacher capacity issues, and infrastructure limitations. ***Answer J*** states, "*We facing challenges of the lack of classrooms and also lack of enough time and without resources to teach.*" This points to

socio-economic disparities and infrastructure limitations, that hinder effective teaching and learning (Mpu & Adu, 2021; Aruleba & Jere, 2022). Despite these challenges, many teachers demonstrate positive attitudes towards the curriculum, although frustrations persist due to inadequate resources, limited support, and insufficient training. "*To approach, we use different methods to teach e.g. handout notes, previous question papers, assessing class tests*" ***(Answer M)***. ***Answer B*** mentions, "*Extra work should be given to learners in the form of tests,*" highlighting efforts to adapt teaching strategies, but also indicating potential gaps in instructional design and support for student learning (Mwapwele, et, al., 2019). "*Prior knowledge and discussion of mathematical concepts with the learners*" ***(Answer A).*** Addressing these challenges is crucial for enhancing the effectiveness of Grade 12 Mathematics in CLCs.

7. Discussions

The challenges identified in the implementation of Grade 12 Mathematics curriculum in CLCs reflect broader systemic issues within the educational landscape. Infrastructure limitations, such as overcrowded classrooms and out-dated facilities, hinder the delivery of quality instruction, and limit students' access to essential resources (Grimus, 2020). Additionally, the lack of access to technology impedes CLCs' ability to leverage digital tools and resources to enhance Mathematics instruction (Mwapwele, et, al., 2019). Despite these obstacles, many teachers demonstrate positive attitudes towards the curriculum, emphasizing their commitment to providing quality education (Ramzan, et, al., 2023). However, frustrations persist due to resource constraints, limited support, and inadequate training, underscoring the need for comprehensive interventions to address these issues. Investing in teacher training and professional development programs tailored to Grade 12 Mathematics, addressing resource constraints through increased funding and support, and improving infrastructure to create conducive learning environments, are essential steps in overcoming implementation challenges (Birch & Jacob, 2019). Furthermore, fostering collaboration among educators, administrators and policymakers, can facilitate the development and implementation of effective strategies to enhance Grade 12 Mathematics education in CLCs. By addressing these challenges comprehensively, CLCs can improve student outcomes and ensure equitable access to quality education for all students.

Resource Constraints: Shortages of textbooks and learning materials were highlighted as a significant challenge (Ayaya, et, al., 2015; Hanemann, 2015; Legotlo, 2014; Du Plessis & Mestry, 2019; Hilton III, 2020). This shortage not only limits students' access to essential resources, but also hampers teachers' ability to deliver comprehensive instruction. Technological Limitations: Another aspect of resource constraints is the limited access to technology. CLCs with outdated or inadequate technological infrastructure struggle to integrate digital resources into Mathematics lessons, hindering students' engagement and learning experiences (Barber, et, al., 2015).

Socio-Economic Disparities: Economic challenges across communities impact CLCs' ability to secure funding and resources (Mouton, 2021; Grimus, 2020;

Graven, 2014; Mwapwele, et, al., 2019). CLCs in economically marginalized areas face additional hurdles in providing quality education, exacerbating inequalities in learning outcomes. Moreover, these disparities contribute to variations in student achievement levels, with students from economically disadvantaged backgrounds often lacking access to educational resources, and support systems.Teacher Capacity: The shortage of qualified Mathematics teachers poses a significant challenge, with many educators lacking the necessary training and experience to effectively teach the curriculum (Smith, 2018). Professional development programs tailored to Grade 12 Mathematics are crucial in enhancing teacher capacity, and improving instructional quality. However, the need for such programs remains unmet in many CLCs, highlighting the importance of targeted interventions in this area (Johnson & Smith, 2020).

Infrastructure Limitations: Overcrowded classrooms and inadequate facilities impede the delivery of quality instruction (Meier & West, 2020; Barrett, et, al., 2019). These physical constraints create challenges in engaging students in meaningful learning experiences and hinder the effectiveness of teaching strategies. Limited access to technology exacerbates infrastructure limitations, particularly in CLCs with outdated or inadequate technological resources, further hindering students' ability to develop essential skills (Castro, 2019; Khoza, & Biyela, 2020).Teacher Attitudes: Despite the challenges, many teachers demonstrate positive attitudes towards the Grade 12 Mathematics curriculum, emphasizing their commitment to providing quality education (Dreer, 2024). However, frustrations persist due to resource constraints, limited support and inadequate training, underscoring the need for comprehensive interventions to address these issues effectively.

The implications of these findings are profound, emphasizing the need for targeted interventions and policy initiatives, to address the challenges identified. Investing in teacher training and professional development programs can enhance teacher capacity and improve instructional quality (Birch & Jacob, 2019). Additionally, addressing resource constraints and infrastructure limitations through increased funding and support, is crucial for creating conducive learning environments for students (Lythreatis, et, al., 2022; Olanrewaju, et, al., 2021). Fostering collaboration among educators, administrators and policymakers can facilitate the development of innovative solutions to overcome implementation challenges. By adopting a comprehensive and collaborative approach, CLCs can enhance the effectiveness of Grade 12 Mathematics education and promote positive student outcomes.

8. Conclusion

This study examined the challenges experienced by mathematics teachers when implementing the Grade 12 Mathematics curriculum in CLCs in South Africa. The findings highlight various challenges, including limited resources, socio-economic disparities, teacher capacity issues, and infrastructure limitations. These challenges greatly affect teaching practices and student outcomes, emphasizing the need for targeted interventions and policy initiatives. By integrating the frameworks of deliverology and Implementation Science, this

study offers a comprehensive approach to addressing these challenges and improving curriculum implementation Grade 12 in CLCs. This integration is relatively new in educational research, providing a unique multi-dimensional strategy to enhance curriculum delivery. Recommendations include increasing funding and resource allocation, upgrading technological infrastructure, implementing fair funding mechanisms, providing targeted professional development programs, investing in infrastructure improvements, increasing access to technology and digital resources, and fostering collaboration among stakeholders. Addressing these challenges through evidence-based interventions can enhance the effectiveness of Grade 12 Mathematics education and promote equal access to quality education for all students. Future research should focus on evaluating the impact of these interventions and exploring additional strategies to further improve curriculum implementation in CLCs.

Some limitations of this study include relying on self-reported data from teachers, which may introduce biases, and the limited geographic scope limited to Tshwane North, which may not represent the full diversity of CLCs across different regions. Despite these limitations, the findings remain valid as they provide valuable insights into common challenges faced by educators, aligning with broader educational research. To mitigate these limitations, future research should include a broader geographic scope and incorporate multiple data sources, such as student performance metrics, to strengthen the findings. The findings of this study emphasize the importance of addressing resource constraints, socio-economic disparities, and infrastructure limitations to improve Grade 12 Mathematics education in CLCs. This aligns with previous studies emphasizing the need for equitable resource distribution and targeted teacher training to enhance educational outcomes (Ayaya et al., 2020; Lembani, et, al., 2020). The insights gained from this study contribute to the body of knowledge by highlighting the significance of a multi-dimensional approach, integrating principles from both deliverology and implementation science, to effectively address systemic challenges in education. This innovative approach provides a strong framework for policymakers and educators to collaboratively address and overcome barriers in educational settings.

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Appendix 1

Answer A - Case 1 – CLC 1	
	themes
Perceptions of the Mathematics Curriculum	*Lack of sufficient resources to effectively teach mathematics.* *Students are still grappling with the basics of mathematics, which is exacerbated by the inadequacy of resources.* *The respondent perceives the curriculum as unfair, particularly noting that it does not adequately address the basic mathematical needs of the students*
Teaching Approaches	*Group work, where students collaborate to discuss and solve mathematical problems, is employed in the mathematics classes at the community learning center.* *group work is considered the most effective approach for teaching mathematics in the community learning center. This method encourages active participation and collaborative problem-solving among students.* *The respondent suggests emphasizing teaching approaches that involve building on students' prior knowledge and engaging them in discussions about mathematical concepts.*
Resources and Support	*The respondent indicates a lack of resources for teaching mathematics at the community learning center. They are required to borrow textbooks and guidelines from nearby schools due to the absence of provided resources.* *Since there are no resources provided, the respondent cannot comment on their sufficiency.* *There is currently no support from the management of the community learning center for teaching mathematics. This lack of support includes no class visits or assistance provided by the management.* *The respondent expresses a need for workshops, textbooks, and curriculum guidelines to enhance the mathematics curriculum at the community learning center.*
Answer B - Case 2 – CLC 2	
Perceptions of the Mathematics Curriculum	*Reliance on traditional "talk and textbook" methods for instruction.* *Additional teaching hours provided to support student understanding.* *Inadequacies in the curriculum leading to higher dropout and failure rates.* *Emphasis on the need for textbooks and data to better support students.*
Teaching Approaches	*traditional methods such as talk and textbook approaches in their mathematics classes at the community learning center.* *Despite using talk and textbook methods, Respondent B considers an integrated approach to be the most effective for teaching mathematics.* *The respondent recommends emphasizing extra work in the form of tests as a teaching approach in the mathematics curriculum.*

Resources and Support	*Respondent B utilizes previous textbooks, papers, and social media as resources for teaching mathematics at the community learning center. These resources are relied upon for instructional materials and additional practice.* *the current resources are insufficient to meet the needs of the mathematics curriculum in the community learning center. Issues such as a lack of printing materials (like paper and ink) and inadequate availability of textbooks for students are highlighted as significant challenges.* *Respondent B emphasizes the need to meet with the subject advisor for additional resources and support to improve the mathematics curriculum.*
Answer C - Case 3 – CLC 3	
Perceptions of the Mathematics Curriculum	*The curriculum is perceived as well-structured and comprehensive, covering all necessary topics.* *There is a lack of practical application and real-world examples in the curriculum.* *Suggested improvements include introducing more hands-on activities and projects to enhance practical learning.*
Teaching Approaches	*utilizes problem-solving activities and group discussions as teaching approaches in their mathematics classes at the community learning center.* *problem-solving activities are considered the most effective approach for teaching mathematics in the community learning center. This method encourages critical thinking, application of concepts, and collaboration among students.* *The respondent suggests emphasizing practical problem-solving and real-world applications in the mathematics curriculum.*
Resources and Support	*Respondent C mentions having access to textbooks, some online resources, and a computer lab for teaching mathematics at the community learning center.* *The respondent reports receiving support from the management of the community learning center in terms of providing necessary materials and occasional training sessions.* *Respondent C identifies the need for more funding to acquire materials such as manipulatives, which are crucial for enhancing practical learning in mathematics.*
Answer D - Case 4 – CLC 4	
Perceptions of the Mathematics Curriculum	*The curriculum is comprehensive and covers essential topics thoroughly.* *It aligns well with standardized assessments, ensuring students are prepared for exams.* *The curriculum lacks emphasis on practical applications and real-world problem-solving.*
Teaching Approaches	*primarily uses lectures and demonstrations to ensure clarity and understanding in their mathematics classes at the community learning center.* *a combination of lectures and problem-solving exercises is considered the most effective approach for teaching mathematics in the community learning center.*

	The respondent recommends emphasizing a blend of theoretical understanding through lectures and practical skills through problem-solving in the mathematics curriculum.
Resources and Support	*Respondent D indicates that they have access to textbooks, some online resources, and a computer lab for teaching mathematics at the community learning center.* *the current resources are adequate for meeting the needs of the mathematics curriculum in the community learning center.* *The respondent acknowledges receiving support from the management of the community learning center, which includes providing necessary materials and occasional opportunities for professional development.*
Answer E - Case 5 – CLC 5	
Perceptions of the Mathematics Curriculum	*Perception that the curriculum content provided each quarter is limited.* *Strength in teaching and learning through structured lesson presentations in the classroom.* *A major weakness is the extensive burden of marking a high volume of scripts in a short time.* *Suggested changes include better time allocation between teaching, learning, and assessment activities, as well as adequate time for marking and submitting mark sheets.*
Teaching Approaches	*Respondent E uses a teaching approach that starts with a good presentation, emphasizing the importance of clarity and organization in delivering content in their mathematics classes at the community learning center.* *According to Respondent E, a student-centered approach is considered the most effective for teaching mathematics in the community learning center.* *The respondent suggests emphasizing a blend of student-centered and teacher-centered approaches in the mathematics curriculum. They advocate for a learning environment where students are encouraged to discover concepts themselves, supplemented by guidance and support from teachers as needed.*
Resources and Support	*Respondent E lists textbooks, a chalkboard, and copies of materials for students who do not have textbooks as the available resources for teaching mathematics at the community learning center.* *he current resources are not sufficient to fully meet the needs of the mathematics curriculum at the community learning center. The lack of charts and additional visual aids for formulas is highlighted as a specific area where resources are lacking*
Answer F - Case 6 – CLC 6	
Perceptions of the Mathematics Curriculum	*The curriculum is well-structured and similar to mainstream schools, benefiting Grade 12 students from those settings.* *It includes most of the topics necessary to advance to the next level and achieve the matric certificate.* *A significant weakness is the assumption that Grade 12 students have a solid foundation from lower grades, which many students from Grade 9 and level 4 lack.*

	Suggested improvements include making the curriculum more practical and tailored to the needs of CLC students, especially those who have been out of school for a long time.
Teaching Approaches	*Respondent F employs a combination of teacher and student-centered approaches in their mathematics classes at the community learning center.* *the interactive participative method is considered the most effective approach for teaching mathematics in the community learning center.* *The respondent recommends emphasizing an interactive approach in the mathematics curriculum.*
Resources and Support	
Answer G - Case 7 – CLC 7	
Perceptions of the Mathematics Curriculum	*The curriculum is perceived as comprehensive and suitable for the students.* *It covers a wide range of topics and prepares students adequately for their final exams.* *A weakness is the curriculum's assumption of prior knowledge, which may not be possessed by all students, particularly those who have been out of formal schooling.* *Suggested improvements include incorporating more practical applications to make mathematics more engaging and relevant to the students.* *Incorporate more practical applications of mathematics to enhance engagement and relevance for students.*
Teaching Approaches	*Respondent G utilizes a mix of teacher-centered and student-centered approaches in their mathematics classes at the community learning center, adapting based on the topic and students' needs.* *According to Respondent G, a hands-on, problem-solving approach is considered the most effective for teaching mathematics in the community learning center.* *The respondent suggests emphasizing problem-based learning in the mathematics curriculum. Problem-based learning encourages critical thinking, problem-solving skills, and the practical application of mathematical concepts.*
Resources and Support	
Answer H - Case 8 – CLC 8	
Perceptions of the Mathematics Curriculum	*The current mathematics curriculum is perceived as comprehensive and suitable for the students at the community learning center.* *It covers a wide range of topics effectively.* *It prepares students adequately for their final exams.* *Assumes a level of prior knowledge that some students may not have, especially those returning after a period of absence from formal schooling.*
Teaching Approaches	*Respondent G employs a combination of teacher-centered and student-centered approaches in their mathematics classes at the*

	community learning center. *According to Respondent G, a hands-on, problem-solving approach is considered the most effective for teaching mathematics in the community learning center.* *The respondent advocates for emphasizing problem-based learning (PBL) more in the mathematics curriculum.*
Resources and Support	
Answer I - Case 9 – CLC 9	
Perceptions of the Mathematics Curriculum	*The respondent perceives the current mathematics curriculum as appropriate and very engaging for the students at the community learning center.* *The presence of extensive Euclidean geometry content is identified as a weakness. This content area is highlighted as particularly challenging for students, indicating a need for improvement in how it is taught and presented.*
Teaching Approaches	*Respondent H employs a student-centered approach in their mathematics classes at the community learning center.* *According to Respondent H, group assessment is considered the most effective teaching approach for mathematics in the community learning center.* *The respondent suggests emphasizing peer assessment and group assessment in the mathematics curriculum. These approaches are seen as beneficial because they encourage students to evaluate each other's work and collaborate effectively.*
Resources and Support	*Respondent H indicates that teachers have access to textbooks, but students are required to purchase their own resources.* *According to Respondent H, the sufficiency of resources in meeting the needs of the mathematics curriculum depends on whether students have purchased the required materials.* *Respondent H identifies the need for workshops focused on the subject of mathematics. These workshops are seen as essential for up skilling teachers and learning from best practices employed by other educators.*
Answer J - Case 10 – CLC 10	
Perceptions of the Mathematics Curriculum	*The respondent perceives the current mathematics curriculum as unfair due to the lack of material and workshops provided by the college, which affects their learning experience and support.* *The respondent acknowledges a perceived strength in the curriculum, indicating that it is effective or robust in some aspects, though specifics are not detailed.* *Identified weakness includes the complexity of language used in the curriculum, suggesting a need for simplification to improve comprehension and learning outcomes.*
Teaching Approaches	*The respondent uses a variety of teaching approaches in their mathematics classes at the community learning center, including teacher-centered instruction, peer assessment, and group assessment*

	According to the respondent, a student-centered approach is considered the most effective for teaching mathematics in the community learning center. *The respondent recommends emphasizing the student-centered approach in the mathematics curriculum. They believe that when students are actively involved in the lesson, they can ask questions freely and the teacher can better assess and address their difficulties.*
Resources and Support	*Respondent highlights a severe lack of resources from the college, stating that only previous question papers are available.* *According to the respondent, the current resources are inadequate as only lecturers possess them, and students do not have access.* *The respondent reports receiving no support from the management of the community learning center in teaching mathematics. There are no workshops provided, and there appears to be no specific implementation for grade 12*
Answer K - Case 11 – CLC 11	
Perceptions of the Mathematics Curriculum	*The respondent perceives the current mathematics curriculum in the community learning center as insightful and providing a good foundation for higher learning. It is viewed as of good quality overall.* *One of the strengths identified is that the curriculum serves as a solid foundation for higher education. Students who master this content are better prepared for the challenges they face in their first year of study at higher education institutions.* *A weakness highlighted is the lack of attendance and access to correct study materials like books. There is also a perceived need for more study time to improve learning outcomes.* *The respondent suggests improving community engagement and resources as a way to enhance the mathematics curriculum. This recommendation aims to address the weaknesses by providing better support and access to necessary materials for effective learning.*
Teaching Approaches	*The respondent utilizes a student-centered approach in their mathematics classes at the community learning center, emphasizing that students learn better when actively participating in the lesson. However, they also employ teacher-centered methods for certain topics.* *According to the respondent, face-to-face teaching is currently considered the most effective approach for teaching mathematics in the community learning center.* *The respondent suggests emphasizing a blend of face-to-face teaching and online resources in the mathematics curriculum.*
Resources and Support	*The respondent mentions sharing classes with nearby high schools, where they have access to chalks, textbooks, and mentorship support from senior lecturers and management.* *the current resources are insufficient to meet the needs of the mathematics curriculum. The community learning center serves students preparing for both NSC (National Senior Certificate) and*

	ASC (Adult Senior Certificate), but the classes are not enough. *To improve the mathematics curriculum, the respondent emphasizes the need for more time with students. Having dedicated classes would allow for longer contact hours, enabling teachers to cover the entire curriculum comprehensively.*
Answer L - Case 12 – CLC 12	
Perceptions of the Mathematics Curriculum	*The current mathematics curriculum is perceived as lacking resources such as textbooks and videos for students. This leads to a heavy reliance on information provided solely by lecturers in the classroom.* *One strength identified is the curriculum's relevance to day-to-day problem-solving skills, suggesting that it effectively connects theoretical learning with practical applications.* *A major weakness highlighted is the absence of essential resources like textbooks and videos for students. This limitation restricts students' access to supplementary materials outside of classroom lectures.* *The respondent suggests providing extra classes, particularly for students coming from lower academic levels (e.g., level 4), who lack foundational mathematics knowledge. This recommendation aims to address the gap in basic skills and enhance overall understanding among students.*
Teaching Approaches	*The respondent uses textbooks, study guides, and provides extra time in their mathematics classes at the community learning center.* *According to the respondent, leveraging today's technology and providing students with more study time is considered the most effective approach for teaching mathematics in the community learning center.* *The respondent emphasizes the need for proper materials in mathematics education, including access to various books and workshops that utilize modern technology.*
Resources and Support	*The respondent mentions having access to textbooks and study guides for teaching mathematics in the community learning center* *According to the respondent, the current resources are not sufficient to meet the needs of the mathematics curriculum. Many students lack access to these resources, which could hinder their ability to study effectively outside of class.* *To improve the mathematics curriculum, the respondent suggests that access to the internet is crucial.*
Perceptions of the Mathematics Curriculum	*The respondent perceives the current mathematics curriculum positively, emphasizing the provision of good materials for students.* *A significant weakness noted is the high dropout rate among students in the learning center. This suggests challenges in student retention and engagement within the current curriculum framework.* *The respondent suggests enhancing the provision of textbooks for students to use at home, which supports self-study and reinforces*

	learning.
Teaching Approaches	*The respondent uses a combination of using a whiteboard and providing copies from previous question papers in their mathematics classes at the community learning center.* *According to the respondent, while they consider the student-centered method effective in theory, the reality in the community learning center suggests that many students, who are also parents, tend to rely heavily on the teacher for guidance and support.* *The respondent suggests emphasizing a practical teaching approach that involves group work among students themselves in the mathematics curriculum.*
Resources and Support	*The respondent indicates that the resources available for teaching mathematics in the community learning center are limited to teachers' guidelines and previous question papers.* *According to the respondent, these current resources are not sufficient to meet the needs of the mathematics curriculum. More materials are needed to adequately support teaching and learning activities, including textbooks, supplementary exercises, and educational tools*