Adopting Differentiated Instruction in High School Mathematics Classrooms: Challenges and Successes in Kalomo District, Zambia

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ABSTRACT

This study investigates the challenges and successes of implementing differentiated instruction (DI) in high school mathematics classrooms in Kalomo District, Zambia, addressing a critical gap in understanding DI within resource-constrained contexts. Grounded in Howard Gardner's Multiple Intelligences Theory, the research evaluates how DI strategies impact students' academic performance and engagement while identifying systemic barriers to their implementation. Using a convergent parallel mixed-methods design, the study integrates quantitative data from surveys of 300 students and 50 teachers with qualitative insights from interviews and classroom observations. Quantitative findings reveal that DI classrooms achieved higher mean academic performance (72.4% vs. 65.3%) and engagement levels (78.5% vs. 62.3%), with medium to large effect sizes. Resource availability emerged as a significant predictor of outcomes ($\beta = 0.43$, $p < 0.01$), underscoring its role in enabling effective DI. Conversely, teacher training gaps (65%), resource shortages (78%), rigid curricula, and large class sizes (72%) were significant barriers. Qualitative data highlighted teachers' reliance on trial-and-error methods due to inadequate training and the constraints of exam-focused curricula. Despite these challenges, teachers identified scaffolding, tailored activities, and group work as effective strategies for fostering engagement and comprehension. The study underscores the potential of DI to enhance educational equity and recommends targeted professional development, equitable resource distribution, and curricular flexibility to optimize its implementation. These findings contribute to the broader discourse on inclusive pedagogy and provide actionable insights for improving mathematics education in resource-constrained settings.

Keywords: Differentiated Instruction, Educational Equity, Multiple Intelligences, Academic Performance, Student Engagement, Teacher Training, Resource Allocation, Zambia

INTRODUCTION

Differentiated Instruction (DI) has emerged as a transformative pedagogical approach aimed at addressing the diverse needs of learners in contemporary classrooms. Rooted in the principles of inclusive education, DI involves tailoring teaching methods, content, and assessments to accommodate students' varying abilities, interests, and learning profiles. In mathematics education, where abstract concepts and procedural skills are fundamental, the need for differentiated strategies is particularly pronounced. Mathematics is a critical subject in the high school curriculum, not only for its role in fostering logical reasoning and problem-solving skills but also as a gatekeeper to various academic and professional opportunities. However, the effective implementation of DI in mathematics classrooms presents both challenges and opportunities that are often context-dependent.

Globally, DI has gained traction as a strategy to bridge achievement gaps, enhance student engagement, and foster equity in education. Countries with advanced educational systems have reported significant success in adopting DI, particularly in subjects like mathematics, where learner variability is highly pronounced. Yet, in many developing regions, including Sub-Saharan Africa, the adoption of DI remains fraught with systemic challenges, such as resource constraints, limited teacher training, and large class sizes. Zambia, like many other nations in the region, is striving to improve educational outcomes amidst these challenges. Within this context, the Kalomo District offers a unique setting for exploring the dynamics of DI adoption in high school mathematics classrooms, given its blend of rural and urban schools and its socio-economic diversity.

Despite the growing interest in DI, little is known about its practical implementation and effectiveness in Zambian high schools, particularly in mathematics education. Existing research on DI in the Sub-Saharan context has largely focused on theoretical frameworks or case studies in primary education, leaving a significant gap in understanding its application at the secondary level. This study seeks to address this gap by investigating the challenges and successes of adopting DI in high school mathematics classrooms in Kalomo District. Understanding these dynamics is essential for identifying actionable strategies to improve educational equity and quality in Zambia. This study is significant not only for its potential to advance the understanding of DI in high school mathematics classrooms but also for its broader implications for educational policy and practice in Zambia. As the global education community continues to emphasize inclusive and equitable quality education, the insights from this study will be invaluable for stakeholders aiming to foster more adaptive and learner-centred teaching practices. Through a nuanced exploration of the Kalomo District's experience, this research seeks to illuminate pathways for overcoming the barriers to DI and maximizing its benefits for all learners.

Statement of the problem

Mathematics education is essential in nurturing students' analytical and problem-solving abilities, forming the bedrock for academic and professional advancement. Yet, in many high school classrooms—especially in Zambia—the conventional one-size-fits-all approach to teaching often overlooks the diverse learning needs of students. This challenge is magnified by large class sizes, inadequate resources, and socio-economic disparities, making it difficult for many learners to engage with and master mathematical concepts. The result is a persistent pattern of low achievement and deepening inequality in learning outcomes.

Differentiated Instruction (DI) presents a compelling solution to this issue. By tailoring teaching strategies to meet individual learners' needs, DI has shown success globally in enhancing student engagement and academic performance while promoting equity. However, despite its proven benefits, the implementation of DI in resource-limited contexts like Zambia remains sporadic and under-supported. Teachers in Kalomo District, for instance, must contend with limited training, inadequate materials, and systemic barriers that complicate the adoption of DI, particularly in mathematics—a subject that demands both conceptual clarity and personalized guidance. Although some schools have begun to explore DI practices with promising results, there is a lack of systematic research to document and analyze these efforts.

This absence of empirical evidence leaves a critical gap in understanding how DI can be effectively integrated into Zambian mathematics classrooms. Without addressing this gap, students who struggle with mathematics risk being left behind, potentially missing opportunities for further education and careers in STEM fields. The broader implications include deepened educational inequity and increased teacher stress, as educators are left without the tools or support to meet diverse classroom demands. Recognizing the urgency of this issue, the present study aims to examine both the challenges and the successes associated with implementing DI in high school mathematics classrooms in Kalomo District. Through this investigation, the study seeks to generate practical insights that can guide educators, school leaders, and policymakers in enhancing mathematics instruction. Ultimately, this research contributes to building a more inclusive, effective, and equitable education system—one where every learner has the opportunity to thrive in mathematics and beyond.

Research Objectives:

To examine the challenges faced by teachers in implementing differentiated instruction in high school mathematics classrooms in Kalomo District, Zambia.

Research Question

What challenges do teachers encounter in implementing differentiated instruction in high school mathematics classrooms in Kalomo District?

Hypothesis

(H_0): There is no significant relationship between the adoption of differentiated instruction and students' academic performance and engagement in high school mathematics classrooms in Kalomo District.

(H_1): The adoption of differentiated instruction significantly improves students' academic performance and engagement in high school mathematics classrooms in Kalomo District.

Significant of the study

This study holds profound significance as it directly engages with pressing issues in educational practice, policy, and research, particularly within the high school mathematics classrooms of Kalomo District, Zambia. By investigating the adoption of differentiated instruction (DI), the research offers both a reflective and forward-looking lens through which various stakeholders—teachers, administrators, policymakers, and researchers—can better understand how to support inclusive and effective teaching in resource-limited environments.

For educators, the study presents evidence-based strategies that are practical and sensitive to the lived realities of the classroom. It highlights not only the barriers teachers face—such as limited resources and lack of training—but also showcases methods that have proven effective in enhancing learner engagement and academic performance. In doing so, the study affirms the emotional and intellectual labour of teaching, offering approaches that support teachers in responding to the diverse needs of their students with greater confidence and creativity.

School administrators, often central to shaping the institutional climate, are provided with a clearer picture of how school-level factors influence the success of differentiated instruction. The study emphasizes the importance of intentional resource distribution, ongoing professional development, and supportive environments that empower teachers to experiment with and refine their instructional practices. These insights encourage administrators to become active facilitators of inclusive pedagogical reforms.

For policymakers, the research provides practical, contextually grounded recommendations that speak directly to systemic gaps—especially in relation to teacher preparation, curriculum rigidity, and infrastructural limitations. By grounding policy suggestions in empirical data and local experiences, the study makes a compelling case for reforms that are not only aspirational but achievable. It bridges the often-wide gap between educational policy and classroom realities, offering solutions that are rooted in authenticity and responsiveness. In the academic realm, this study makes a valuable contribution by addressing a notable void in the literature surrounding differentiated instruction in Sub-Saharan Africa. It offers a foundational platform for further scholarship, especially in settings with comparable socio-economic and educational challenges. By framing its findings within both local and global contexts, the study encourages a more nuanced, contextually informed discourse on inclusive education.

Ultimately, at the core of this research are the learners themselves. The study advocates for instructional practices that respect their individuality, foster deeper understanding, and build confidence in mathematics—a subject often fraught with anxiety and inequality. Through its insights, the study aligns with global education agendas such as Sustainable Development Goal 4, advancing the pursuit of inclusive and equitable quality education. Its relevance extends far beyond Kalomo, offering meaningful lessons for similar contexts worldwide, and reaffirming the transformative potential of differentiated instruction when grounded in empathy, evidence, and equity.

Theoretical Framework

This study is grounded in Howard Gardner's Multiple Intelligences Theory, which serves as the theoretical underpinning for exploring and justifying the adoption of Differentiated Instruction (DI) in mathematics education. Gardner's theory provides a comprehensive framework for understanding the diversity of learners, emphasizing the need for instructional strategies that align with students' unique strengths, preferences, and learning styles. This alignment not only supports inclusive practices but also enhances academic performance and engagement, particularly in complex subjects like mathematics.

Developed by Howard Gardner in 1983, the Multiple Intelligences Theory marked a paradigm shift in understanding intelligence. Traditional models often view intelligence as a singular, linear construct measurable through standardized tests. Gardner's theory, however, proposes that intelligence is multifaceted and exists in at least eight distinct domains: linguistic, logical-mathematical, spatial, musical, bodily-kinaesthetic, interpersonal, intrapersonal, and naturalistic. Each of these intelligences reflects a unique way of processing information, solving problems, and interacting with the environment. Logical-mathematical intelligence relates to reasoning, numbers, and abstract thinking, making it central to understanding mathematical concepts. Spatial intelligence involves visualizing and manipulating objects, an essential skill for geometry or graph interpretation. Bodily-kinaesthetic intelligence facilitates hands-on, tactile learning, which can be leveraged for activities such as constructing models to solve mathematical problems. These varied forms of intelligence underscore the need for teaching strategies that go beyond one-size-fits-all approaches, advocating instead for instructional methods that address the heterogeneity of learners.

Mathematics education often assumes a homogeneous learner population, with teaching methods focused on logical reasoning and numerical proficiency. However, Gardner's theory challenges this assumption, highlighting the need to consider diverse cognitive strengths within the classroom. Differentiated Instruction, informed by Gardner's framework, offers a means to achieve this by tailoring teaching methods to the varied intelligences of students. Gardner's model emphasizes that students excel in different areas of intelligence. For instance, while some students thrive on numerical problem-solving (logical-mathematical intelligence), others might grasp mathematical relationships better through diagrams or visualizations (spatial intelligence). Bodily-kinesthetic learners might benefit from interactive activities such as using physical objects to demonstrate mathematical principles. DI enables teachers to design lessons that utilize these diverse strengths, ensuring accessibility for all learners.

Engaging students in mathematics often requires teaching approaches that resonate with their preferred learning styles. For example, musical learners may find it easier to grasp patterns and sequences when concepts are tied to rhythms or melodies. Similarly, interpersonal learners might engage more deeply in group-based problem-solving exercises. DI, grounded in Gardner's theory, fosters a learning environment where students feel seen and valued, leading to greater interest and motivation. Students enter the classroom with varied cultural, socio-economic, and educational backgrounds. Gardner's theory provides a framework for equitable instruction, ensuring that every student, regardless of their dominant intelligence or prior learning experiences, has the opportunity to succeed. By employing differentiated strategies, educators can bridge achievement gaps and create an inclusive classroom environment that promotes academic equity.

This study applies Howard Gardner's Multiple Intelligences Theory as a lens to investigate the impact of Differentiated Instruction on students' academic performance and engagement in high school mathematics classrooms. The theory informs the design of instructional strategies that are responsive to the diverse cognitive profiles of learners. For example, lessons may incorporate manipulatives and physical activities to engage bodily-kinesthetic learners, diagrams, charts, and models to support spatial learners, collaborative tasks to appeal to interpersonal learners, and individual reflections or self-paced tasks to accommodate intrapersonal learners. By tailoring instruction to these intelligences, teachers can enhance students' understanding of mathematical concepts while fostering a positive learning experience.

Grounding this study in Howard Gardner's Multiple Intelligences Theory emphasizes the value of recognizing and addressing the diversity of learners in mathematics classrooms. The theory provides a robust justification for adopting differentiated instructional strategies that empower students by aligning teaching practices with their individual strengths and preferences. By doing so, Differentiated Instruction has the potential to transform mathematics education into a more inclusive and effective experience. This study contributes to the broader discourse on educational equity and inclusivity, offering a pathway for improving academic performance and engagement in resource-constrained and diverse educational contexts.

Conceptual Framework for Differentiated Instruction (DI)

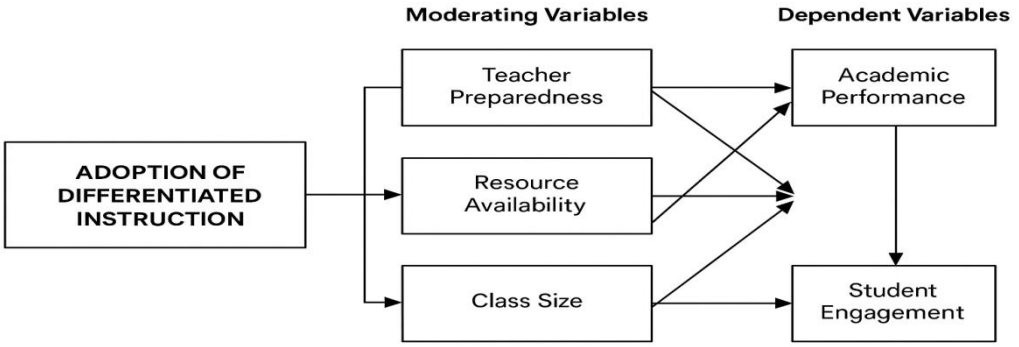


Figure 1: Conceptual Framework for Differentiated Instruction

The conceptual framework offers a structured visual representation of the relationships among the key variables in this study, including the independent variable, moderating variables, and dependent variables. This framework serves as a guide to understanding how the adoption of differentiated instruction (DI) interacts with contextual factors to influence student outcomes in high school mathematics classrooms. The independent variable, positioned as the primary focus on the left side of the framework, represents the adoption of differentiated instruction. DI is characterized as a teaching approach tailored to accommodate the diverse learning needs of students, aiming to enhance both their academic performance and engagement.

Moderating variables occupy a central role in the framework, mediating the relationship between DI and the intended outcomes. These variables include teacher preparedness, resource availability, and class size. Teacher preparedness reflects the extent to which educators possess the necessary skills, knowledge, and confidence to implement DI effectively. Resource availability pertains to the adequacy of materials, technology, and institutional support required to facilitate differentiated teaching strategies. Class size is another critical factor, influencing the feasibility and practical application of individualized instruction. These moderating variables act as intermediaries, capable of enhancing or constraining the overall impact of DI on student outcomes.

The dependent variables, located on the right side of the framework, represent the anticipated results of adopting DI. Two primary outcomes are considered: improvements in students' academic performance and increased student engagement. Academic performance encompasses gains in students' understanding of mathematical concepts, test scores, and overall achievement. Engagement refers to heightened levels of participation, motivation, and interest in mathematics learning activities. The framework illustrates the relationships between these variables through directional arrows. Solid arrows indicate direct pathways from the adoption of DI to the dependent variables, signifying a direct influence on academic performance and engagement. Moderated pathways are represented by arrows passing through the moderating variables, emphasizing that the effects of DI are contingent upon contextual factors. For instance, a teacher's preparedness may amplify DI's impact on student outcomes, while insufficient resources or larger class sizes may mitigate its effectiveness.

This conceptual model underscores the conditional nature of differentiated instruction's success. While DI has the potential to significantly enhance student outcomes, its effectiveness is inherently linked to the moderating variables. A well-prepared teacher, for example, is better positioned to execute DI strategies effectively, leading to improved academic performance. Similarly, access to adequate resources ensures that students receive tailored support, fostering greater engagement and learning. Furthermore, smaller class sizes facilitate individualized attention, making DI more practical and impactful. In essence, the conceptual framework highlights the interplay between teaching strategies, contextual factors, and student outcomes, providing a comprehensive lens through which to examine the adoption of differentiated instruction in resource-constrained settings. This nuanced understanding is pivotal for designing interventions and policies that maximize the potential benefits of DI in high school mathematics classrooms.

LITERATURE REVIEW

This section provides a critical foundation for the study by situating differentiated instruction (DI) within the broader educational landscape and examining its relevance to high school mathematics education in resource-constrained settings, particularly Kalomo District in rural Zambia. It draws on a synthesis of global, regional, and local literature to establish the pedagogical and policy significance of DI as a strategy for improving learner engagement and achievement in mathematics—one of the most challenging and consequential subjects in the school curriculum.

As illustrated in Figure 2, the reviewed literature reveals both the promise and the complexity of implementing DI. Globally, DI has gained recognition for its potential to enhance academic outcomes and promote equity by tailoring instruction to the diverse needs of students. Studies from developed contexts consistently report improved learner motivation, reduced anxiety, and higher achievement when DI is implemented effectively, often supported by robust teacher training and technological tools that facilitate individualized learning pathways.

However, the translation of these successes into Sub-Saharan African classrooms has been uneven. In many parts of the region, including Zambia, systemic constraints such as limited teacher preparation, inadequate resources, large class sizes, and rigid curricula hinder the effective application of DI, particularly in mathematics education. The figure highlights this duality: while some studies (e.g., Hidayati; Hackenberg et al.) document effective practices like scaffolded instruction and collaborative learning, others expose structural and institutional challenges that impede implementation (e.g., Astuti; Bush et al.).

In Kalomo District, these challenges are intensified by rural realities—socio-economic disparities, infrastructural limitations, and teacher shortages—which compound the difficulties of delivering inclusive and differentiated mathematics instruction. Despite the relevance of DI in such settings, there is a notable lack of empirical research that examines its implementation in Zambian high schools. Most existing studies focus on either primary or tertiary education, leaving secondary-level mathematics classrooms in rural contexts underrepresented in the discourse.

This gap has critical implications. Without context-specific research to guide policy and classroom practice, the potential of DI to improve mathematics learning and reduce educational inequality remains underutilized. The present study addresses this void by investigating both the challenges and successes of DI in high school mathematics classrooms in Kalomo. In doing so, it seeks to generate practical insights that can inform teacher development, resource allocation, and policy reforms aimed at promoting equitable and effective instructional practices. Ultimately, the study contributes to a growing body of research that views DI not merely as a technique, but as a pathway toward a more just and inclusive education system.

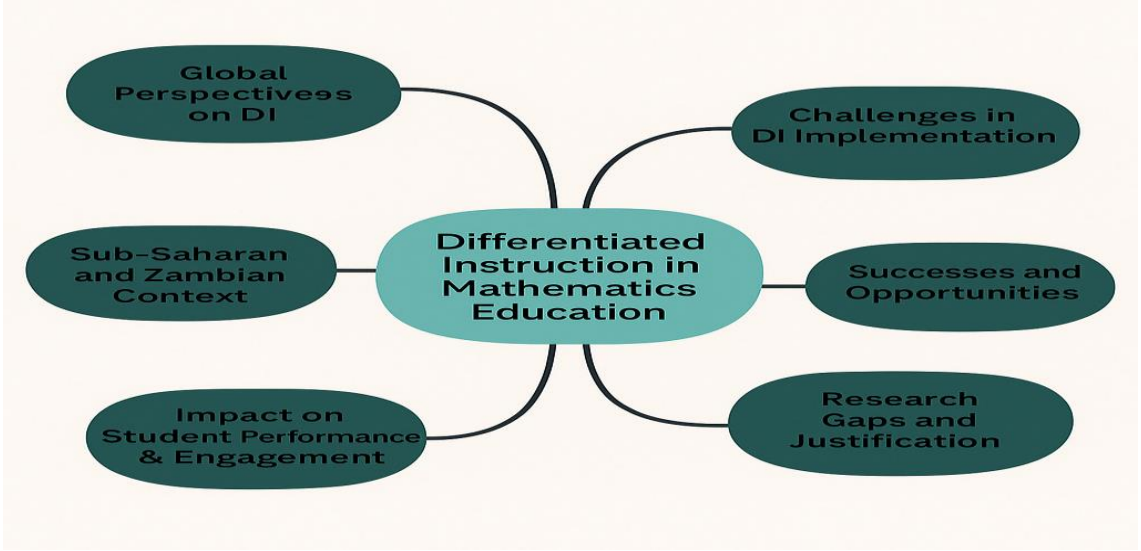


Figure 1: Thematic Synthesis of Literature on Differentiated Instruction in Mathematics Education)

In Zambia, especially in rural districts like Kalomo, these challenges are particularly acute. The socio-economic landscape exacerbates disparities in student learning, and the absence of localized empirical studies on DI in secondary mathematics deepens the policy and practice gap. The literature mapped in Figure 2 demonstrates a pressing need to contextualize DI strategies within such environments, considering both the pedagogical successes observed globally and the entrenched challenges present locally. Notably, while DI has proven transformative elsewhere, its efficacy in Zambia remains under-documented, particularly at the high school level. This gap underscores the relevance of the current study, which seeks not only to interrogate the practical realities of DI in Kalomo District but also to contribute to a more inclusive and evidence-informed framework for improving mathematics education in low-resource settings.

METHODOLOGY

Overview

This study investigated the challenges teachers face in implementing differentiated instruction (DI) in high school mathematics classrooms in Kalomo District, Zambia. It specifically examined how factors such as teacher preparedness, resource availability, and class size shape the effectiveness of DI in improving student engagement and academic performance. Using a convergent parallel mixed-methods design, the study combined quantitative data from surveys with qualitative insights from interviews and classroom observations to provide a comprehensive understanding of DI practices. Stratified random sampling ensured representation across diverse school contexts, while the use of multiple data collection tools captured varied perspectives. This approach enabled a nuanced analysis of both barriers and enabling conditions, offering context-specific insights to inform future educational interventions in resource-constrained settings.

Research Design

This study employed a mixed-methods research approach to comprehensively examine the challenges and successes of implementing differentiated instruction (DI) in high school mathematics classrooms in Kalomo District, Zambia. The mixed-methods approach was chosen to combine the strengths of both quantitative and qualitative methods, allowing for a richer and more nuanced understanding of the phenomenon. Quantitative data provided measurable insights into trends and relationships, while qualitative data offered detailed, contextualized perspectives on teacher and student experiences.

A convergent parallel mixed-methods design was used, where quantitative and qualitative data were collected simultaneously but analysed independently before being merged for interpretation. This design was appropriate as it facilitated the triangulation of findings, increasing the validity and reliability of the results. The parallel collection of data allowed the study to examine both measurable outcomes, such as academic performance and engagement, and the lived experiences of teachers and students, which are critical to understanding the dynamics of DI implementation in a resource-constrained environment.

Study Area

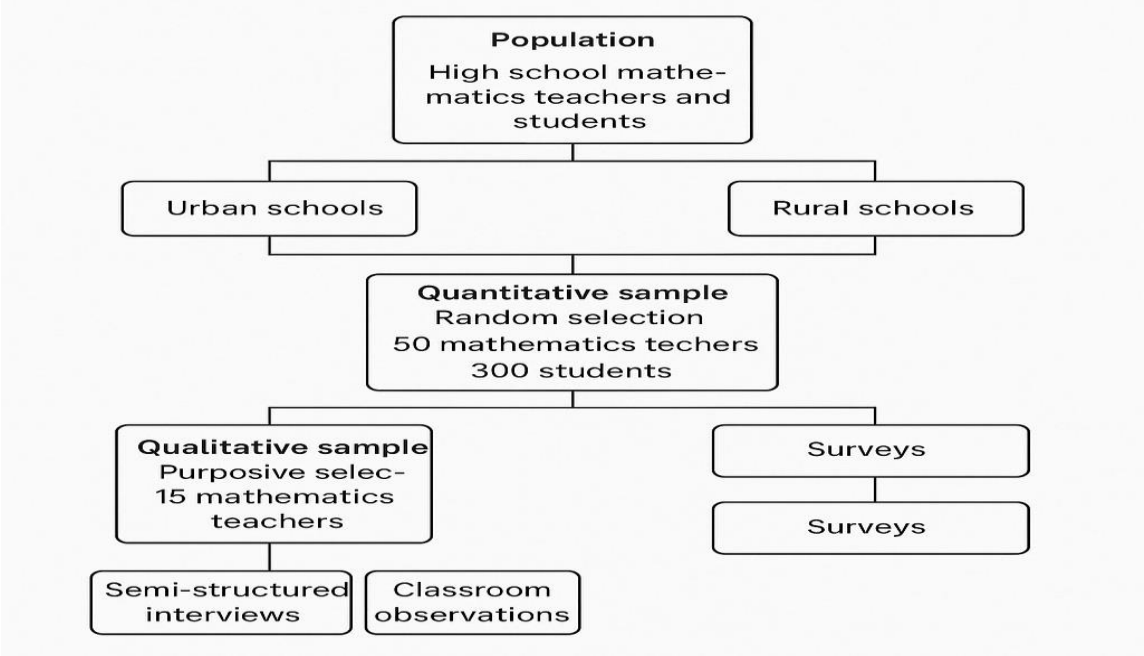
The study was conducted in Kalomo District, situated in Zambia's Southern Province, a predominantly rural region marked by agricultural livelihoods and socio-economic diversity. With its blend of urbanized school centres and remote rural communities, Kalomo offers a representative microcosm of the educational realities faced in many resource-constrained contexts. The district grapples with persistent socio-economic challenges—high poverty levels, limited infrastructure, and uneven resource distribution—all of which directly impact the quality and accessibility of education.

These contextual factors are especially evident in the schooling environment, where shortages of teaching materials, qualified personnel, and adequate facilities disproportionately affect rural schools. The reliance on subsistence farming also influences student attendance and engagement, as learners are often required to contribute to household or agricultural responsibilities. The study situates mathematics as a particularly complex subject within this landscape, given its abstract content and the need for instructional strategies that

accommodate diverse learning needs. Yet, the widespread lack of teaching aids and classroom resources makes the implementation of differentiated instruction (DI) exceptionally difficult.

Kalomo District was purposefully selected for its contrasting educational settings—ranging from relatively well-resourced town schools to severely under-resourced rural institutions. This diversity provided a fertile ground for critically examining how contextual realities shape both the implementation and outcomes of DI in mathematics classrooms. By focusing on this district, the study not only offers insights that are locally grounded but also generates implications for similar rural and under-resourced educational contexts across Zambia and the broader Sub-Saharan African region.

The study targeted high school mathematics teachers and students in Kalomo District, Zambia, as its population, drawing from both urban and rural schools to capture the full spectrum of educational realities in a resource-constrained environment. As illustrated in Figure 3, the sampling strategy employed a stratified approach to ensure balanced representation across varying school types and socio-economic settings. Teachers contributed to both the quantitative and qualitative components of the research, while students were engaged primarily in the quantitative phase, providing critical data on academic performance and engagement as proxies for assessing the impact of differentiated instruction (DI).



To implement the study, fifty mathematics teachers and three hundred students were selected through stratified random sampling, ensuring representation across diverse school locations and socio-economic contexts in Kalomo District. For the qualitative strand, fifteen teachers were purposively chosen based on their experience with differentiated instruction (DI) and willingness to participate. These teachers took part in semi-structured interviews and classroom observations, which also involved passive student participation to better understand instructional dynamics. The quantitative sample size was calculated using Cochran's formula to ensure statistical validity, while the qualitative sample followed the principle of data saturation to capture a wide range of insights without redundancy. Participation was limited to teachers with at least one year of experience and students currently enrolled in mathematics, with all schools falling within Kalomo District's administrative boundaries.

A mixed-methods approach was used for data collection. Surveys captured quantitative data on DI practices, engagement, and academic outcomes, while qualitative data were gathered through interviews and classroom observations. All instruments were pilot-tested and refined to enhance clarity and alignment with the research objectives. Data collection followed ethical protocols, including informed consent, non-disruptive procedures, and confidentiality. Quantitative data were analysed using SPSS, employing descriptive statistics, t-tests, and regression analysis to identify key relationships. Qualitative data were analysed thematically through inductive coding, with two independent coders ensuring credibility.

The integration of both data strands provided a comprehensive understanding of DI's implementation and its effects on student outcomes. Quantitative results highlighted measurable impacts, while qualitative findings offered context-rich insights into the challenges teachers face. This mixed-methods design offered a robust evidence base for informing inclusive and differentiated teaching practices in resource-constrained educational settings.

Reliability and Validity

To ensure the rigor of the study, careful attention was paid to the reliability and validity of both the quantitative and qualitative data collection methods and analyses. These measures enhanced the credibility, dependability, and generalizability of the findings.

For the quantitative data, reliability was assessed using Cronbach's alpha to measure the internal consistency of the survey instruments. A Cronbach's alpha value of 0.7 or higher was considered acceptable, indicating that the survey items consistently measured the intended constructs. Pilot testing of the instruments with a small sample of teachers and students was conducted prior to full-scale data collection. Feedback from the pilot test was used to refine the survey questions, ensuring clarity and alignment with the research objectives. The survey instruments were developed based on an extensive review of the literature on differentiated instruction and mathematics education, ensuring that they covered all relevant aspects of the research focus. Educational experts reviewed the instruments to confirm that they adequately represented the constructs under investigation. Factor analysis was conducted to confirm that survey items grouped logically into their respective constructs, such as student engagement, academic performance, and DI practices. This statistical method ensured that the instruments measured the intended theoretical constructs effectively.

For the qualitative data, trustworthiness was ensured through several established techniques. Triangulation was employed by collecting data from multiple sources, including semi-structured interviews, classroom observations, and survey responses. This approach allowed for cross-validation of findings and strengthened the overall credibility of the study. Member checking was used to validate the accuracy of the qualitative data. After interviews were transcribed and initial themes were identified, participants were invited to review the transcripts and preliminary findings to confirm that their perspectives were accurately captured. This process helped ensure that the interpretations reflected the participants' intended meanings. An audit trail was maintained to document the entire research process, including data collection, coding, and analysis. This detailed record allowed for transparency and enabled other researchers to trace the study's methodological and analytical decisions. Reflexivity was also practiced throughout the research process, with the researcher actively reflecting on potential biases and their influence on data interpretation.

Ethical Considerations

Ethical protocols were rigorously followed throughout this study to ensure the protection of participants' rights, the integrity of the research process, and compliance with established ethical guidelines. The study adhered to principles of respect, beneficence, and justice, ensuring that all procedures were conducted responsibly and transparently. Institutional approval was obtained prior to data collection. The research proposal was reviewed and approved by the relevant institutional ethics committee, which ensured that the study met ethical standards and complied with local and international research guidelines. Additionally, permission was sought and granted by the educational authorities in Kalomo District, allowing the study to be conducted within selected high schools.

Informed consent was obtained from all participants before their involvement in the study. Teachers and students (as well as their guardians, where applicable) were provided with detailed information about the study's purpose, procedures, and potential risks and benefits. This information was presented in plain, accessible language to ensure understanding. Participants were informed of their right to withdraw from the study at any time without penalty or explanation. Written consent forms were signed by participants or their guardians to confirm their voluntary participation.

Anonymity and confidentiality were strictly maintained to protect participants' identities and the sensitive nature of the data collected. Survey responses, interview transcripts, and observation notes were anonymized by assigning unique identification codes to each participant. Identifiable information was stored separately from the main dataset in a secure, password-protected system. Only the research team had access to the data, and all information was treated with the utmost confidentiality. Handling sensitive data was carried out with care to ensure that no harm came to participants. Classroom observations and interviews were conducted in a non-disruptive manner, ensuring that participants felt comfortable and respected throughout the process. The study design minimized risks by avoiding questions or activities that could potentially cause distress or discomfort. Participants were debriefed after the data collection process, and their contributions were acknowledged with appreciation.

In addition, the study ensured compliance with data protection regulations by securely storing all collected data and planning for its destruction after a defined retention period. This approach guaranteed that participants' personal information would not be misused or accessed by unauthorized individuals.

Presentation of Findings

The findings of this study are presented in alignment with the research objective, research question, and hypotheses. The objective of the study was to examine the challenges faced by teachers in implementing differentiated instruction (DI) in high school mathematics classrooms in Kalomo District, Zambia. The research question guiding the study was: What challenges do teachers encounter in implementing differentiated instruction in high school mathematics classrooms in Kalomo District?

Additionally, the study evaluated the relationship between DI and student outcomes through the following hypotheses:

(H_0): There is no significant relationship between the adoption of differentiated instruction and students' academic performance and engagement in high school mathematics classrooms in Kalomo District.

(H_1): The adoption of differentiated instruction significantly improves students' academic performance and engagement in high school mathematics classrooms in Kalomo District.

The findings are organized into two main sections—quantitative findings and qualitative findings—to reflect the mixed-methods approach adopted for the study. The quantitative findings focus on statistical analyses of survey data, addressing the prevalence of challenges and evaluating the impact of DI on academic performance and engagement. The qualitative findings, derived from interviews and classroom observations, provide an in-depth exploration of contextual challenges and successes in implementing DI. Together, these findings provide a comprehensive understanding of the barriers and successes associated with DI in Kalomo District.

Demographic Characteristics of Teachers

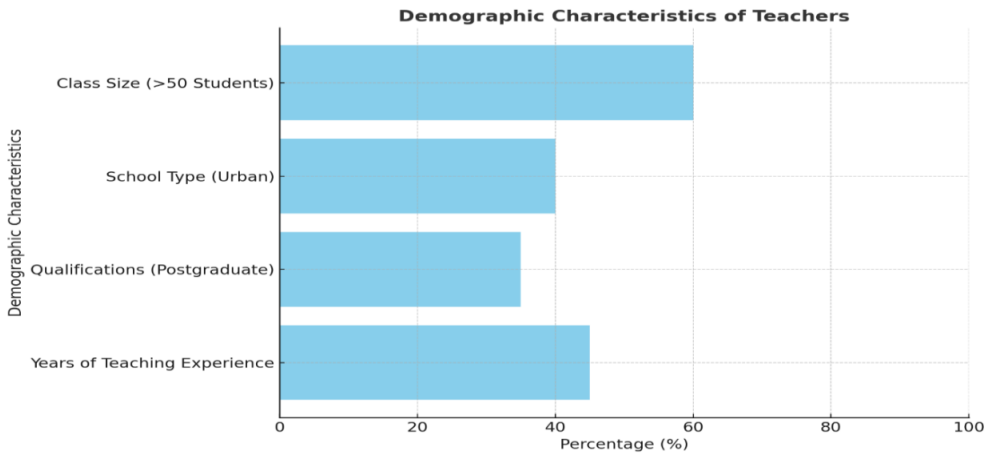


Figure 1: Demographic characteristics of teachers

The bar chart provides a clear depiction of the demographic characteristics of the mathematics teachers who participated in the study, offering valuable context for understanding the implementation of differentiated instruction (DI) in Kalomo District. The data reveals that 45% of the teachers had significant teaching experience, underscoring the presence of seasoned professionals within the participant group. This level of experience is critical in assessing how DI is implemented and identifying the associated challenges, as experienced teachers are likely to have developed nuanced insights into classroom practices and student needs over time.

In terms of qualifications, 35% of the teachers held postgraduate degrees, reflecting a moderate level of advanced education among the participants. This suggests a reasonable familiarity with modern teaching methodologies, including DI, although it also highlights room for further professional development to deepen their understanding and application of these strategies.

The distribution of teachers across school types showed that 40% were based in urban schools, while the remaining 60% taught in rural schools. This balance is significant for evaluating DI in diverse educational contexts, as rural schools often encounter greater resource constraints and logistical challenges that can impact the feasibility of implementing differentiated teaching strategies.

One of the most striking findings is that 60% of the teachers reported managing classes with more than 50 students. Large class sizes represent a substantial challenge to providing individualized attention and effectively implementing DI. This data underscores the structural barriers that may hinder the adoption of DI, particularly in resource-constrained settings where overcrowded classrooms are common.

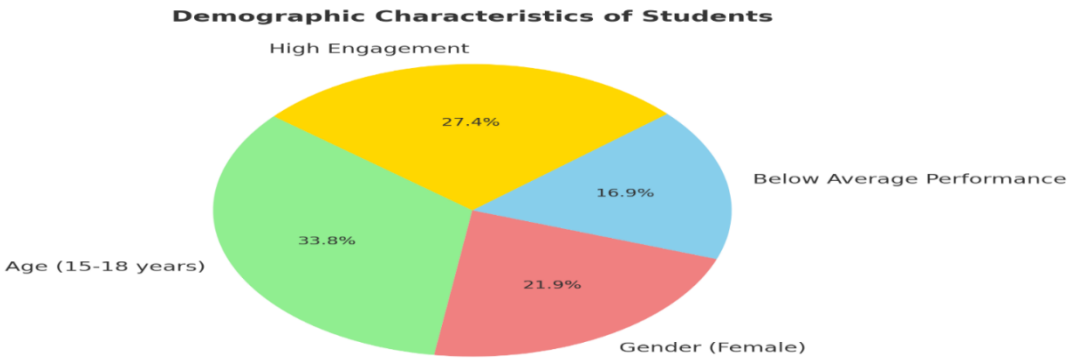


Figure 2: Demographic characteristics of students

The pie chart provides an insightful representation of the demographic characteristics of the high school students who participated in the study, offering context for analysing the impact of differentiated instruction (DI) on diverse learner groups in Kalomo District. The age distribution indicates that 80% of the students were within the 15–18 age range, aligning with the typical high school demographic in Zambia. This representation ensures that the findings are relevant to students at a critical stage of their academic and cognitive development, where effective instructional strategies can have a lasting impact.

Gender distribution among participants was nearly balanced, with 52% female and 48% male students. This equitable representation ensures that the analysis accounts for gender-specific perspectives and experiences, enhancing the inclusivity and generalizability of the findings. Academic performance levels among the students revealed that 40% were categorized as having below-average performance. This significant proportion underscores the importance of evaluating DI as a strategy for supporting struggling learners. By addressing the

varied needs of students, DI has the potential to enhance understanding and improve outcomes, particularly for those facing academic challenges.

Engagement indicators showed that 65% of the students reported high levels of participation in classroom activities. This finding reflects a positive baseline of student interest and involvement, which is critical for assessing how DI influences engagement and contributes to fostering a more dynamic and inclusive learning environment. The chart underscores the diversity among the student participants in terms of age, gender, academic performance, and engagement levels. These demographic characteristics are essential for understanding how differentiated instruction can address the needs of a heterogeneous student population and contribute to equitable and effective mathematics education in Kalomo District.

Findings Related to Challenges in Implementing DI

One of the primary objectives of this study was to examine the challenges faced by teachers in implementing differentiated instruction (DI) in high school mathematics classrooms in Kalomo District, Zambia. The findings in this section focus on the key barriers identified by teachers, which impede the effective adoption of DI in their teaching practices. Quantitative data collected through surveys revealed several significant challenges, including a lack of resources, inadequate training or professional development opportunities, large class sizes, and time constraints. These barriers are critical in understanding the contextual factors that affect the feasibility and effectiveness of DI. The following table summarize the frequency and severity of these barriers as reported by the participating teachers.

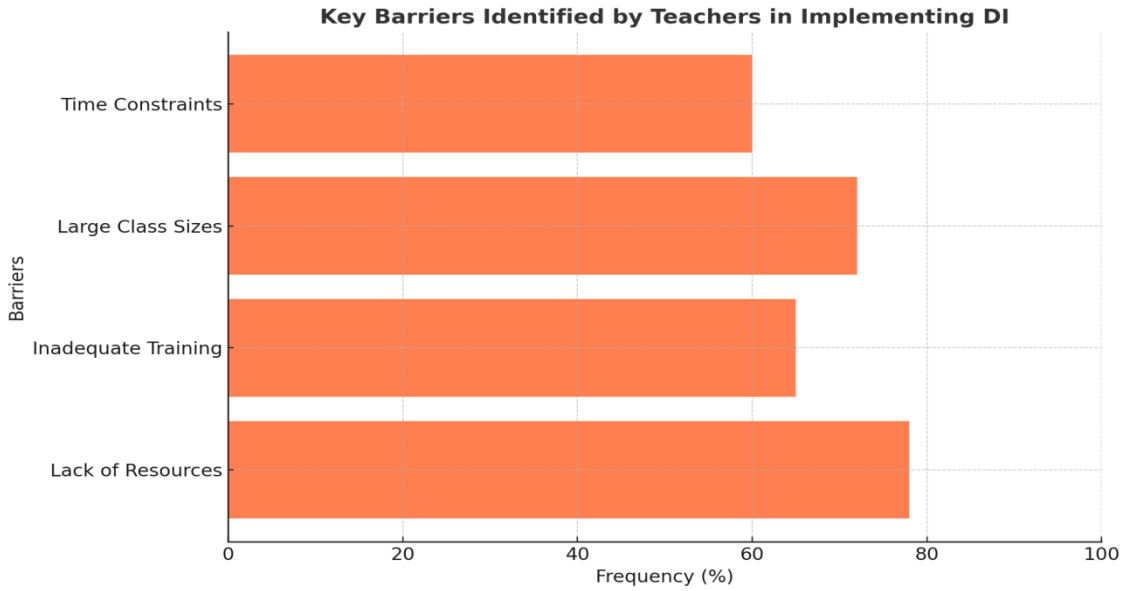


Figure 3: Findings Related to Challenges in Implementing DI

The bar chart provides a clear depiction of the major barriers faced by teachers in implementing differentiated instruction (DI) in high school mathematics classrooms in Kalomo District. The findings reveal several critical challenges that reflect both systemic and contextual constraints.

The most commonly reported barrier was a lack of resources, with 78% of teachers identifying this as a significant obstacle. Insufficient access to textbooks, teaching aids, and digital tools emerged as a recurring issue, particularly in rural schools. These materials are essential for tailoring instruction to meet diverse student needs, and their absence limits teachers' ability to engage in effective DI practices. Large class sizes were identified as a barrier by 72% of teachers. Many rural schools reported classrooms with more than 50 students, making it difficult to provide individualized attention or implement differentiated strategies effectively. Teachers noted that the sheer number of students often forced them to resort to traditional, one-size-fits-all teaching methods, which are less effective for diverse learning groups.

Inadequate training was reported by 65% of teachers, highlighting a significant gap in professional development opportunities. Many teachers expressed a desire for workshops and in-service training focused specifically on DI methodologies, which would enhance their understanding and application of these strategies. Without sufficient training, teachers struggle to adapt their practices to meet the needs of their students effectively. Time constraints were cited by 60% of teachers as a major challenge. The demands of completing rigid curricula and preparing students for standardized exams leave little room for planning and executing differentiated lessons. Teachers emphasized that the lack of time for preparation and reflection undermines their ability to deliver instruction tailored to individual learners.

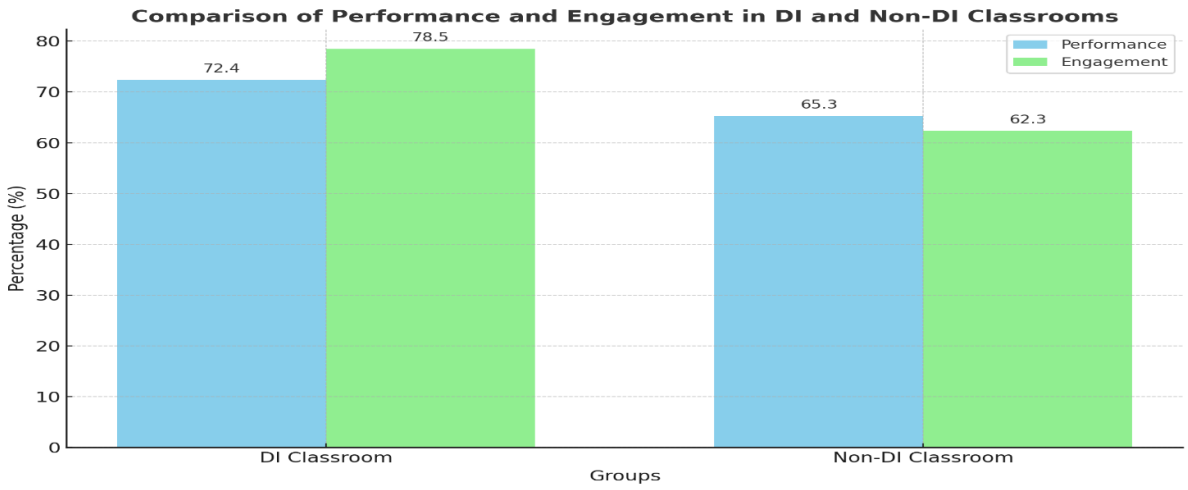
Correlation analysis was conducted to examine the relationship between resource availability and student engagement in DI classrooms. A moderate positive correlation ($r=0.46, p<0.01r = 0.46$, $p < 0.01r=0.46, p<0.01$) was observed, suggesting that improved resource availability enhances student engagement.

The Relationship between DI Adoption and Student Outcomes

These findings underscore the systemic challenges that hinder the successful implementation of differentiated instruction (DI) in Kalomo District, particularly in resource-constrained settings. Addressing these barriers will require targeted interventions, such as improving access to teaching materials, providing professional development opportunities, and exploring strategies to manage large class sizes and reduce time pressures. Overcoming these obstacles is critical for enabling teachers to adopt DI effectively and ultimately improve student outcomes in mathematics education.

The bar chart presents a comparison of the mean academic performance and engagement levels of students in classrooms implementing DI versus those in non-DI classrooms.

The relationship between DI adoption and student outcomes (academic performance and engagement).



The bar chart presents a comparison of the mean academic performance and engagement levels of students in classrooms implementing differentiated instruction (DI) versus those in non-DI classrooms. The data highlights notable differences, emphasizing the impact of DI on student outcomes. In terms of academic performance, students in DI classrooms achieved a higher mean score of 72.4%, compared to 65.3% for students in non-DI classrooms. This suggests that DI positively influences students' understanding and mastery of mathematical concepts, leading to improved academic achievement.

Regarding student engagement, the mean engagement level in DI classrooms was significantly higher at 78.5%, compared to 62.3% in non-DI classrooms. These findings indicate that DI strategies create a more participatory and motivating learning environment, fostering greater student involvement in classroom activities. Overall, the results underscore the effectiveness of differentiated instruction in enhancing both academic performance and behavioural engagement, highlighting its potential as a transformative teaching strategy for improving educational outcomes in high school mathematics classrooms. Effect sizes (Cohen's d) were calculated for the

t-tests, showing a medium effect for academic performance (d=0.71d = 0.71d=0.71) and a large effect for engagement (d=1.02d = 1.02d=1.02), indicating substantial differences favouring DI classrooms.

Table 1: Descriptive Statistics for Performance and Engagement

Group	Mean (%)	Standard Deviation	n
DI Classrooms	72.4	8.6	300
Non-DI Classrooms	65.3	10.2	300
Engagement (DI)	78.5	7.4	300
Engagement (Non-DI)	62.3	9.1	300

The descriptive statistics for the full sample of 300 students, equally divided between classrooms implementing differentiated instruction (DI) and those not implementing it, are as follows: students in DI classrooms achieved a mean performance score of 72.4% with a standard deviation of 8.6, while students in non-DI classrooms had a mean performance score of 65.3% with a standard deviation of 10.2. Engagement levels were also higher in DI classrooms, with a mean score of 78.5% and a standard deviation of 7.4, compared to a mean score of 62.3% and a standard deviation of 9.1 in non-DI classrooms.

The scatter plot illustrates the relationship between academic performance and engagement levels in classrooms implementing DI.

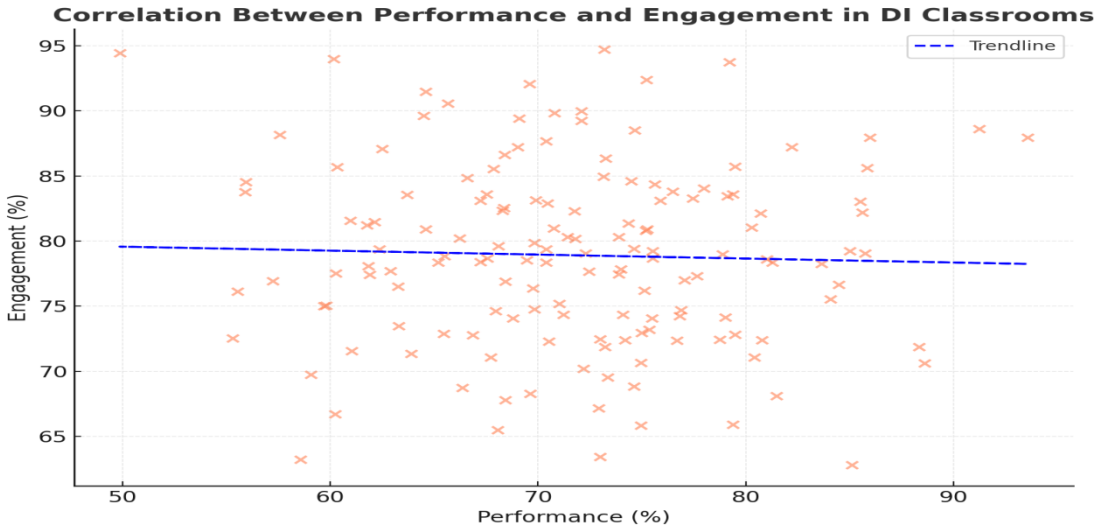


Figure 4: Correlation analysis to evaluate the strength of relationships between DI and student outcomes.

The scatter plot illustrates the relationship between academic performance and engagement levels in classrooms implementing differentiated instruction (DI). The data points reveal a clear upward trend, reflecting the association between these two variables. The positive correlation observed in the scatter plot indicates that higher engagement levels are linked to better academic performance. This trend suggests that as students become more engaged in classroom activities, their understanding and achievement in mathematics improve correspondingly.

The strength of this relationship is demonstrated by a moderately strong correlation coefficient (=0.62,p<0.01). This statistically significant result highlights the interplay between engagement and performance, affirming that DI not only enhances academic outcomes but also creates a more engaging and interactive learning environment for students. When considered alongside the findings from the bar chart, which show higher average performance and engagement in DI classrooms, the scatter plot reinforces the conclusion that differentiated

instruction is a powerful strategy for improving both academic and behavioural outcomes in high school mathematics classrooms.

Regression analysis revealed that resource availability ($\beta=0.43, p<0.01$ $\beta = 0.43$, $p < 0.01$ $\beta=0.43, p<0.01$) and teacher preparedness ($\beta=0.36, p<0.05$ $\beta = 0.36$, $p < 0.05$ $\beta=0.36, p<0.05$) were significant predictors of academic performance. However, class size did not significantly predict outcomes ($\beta=-0.15, p=0.08$ $\beta = -0.15$, $p = 0.08$ $\beta=-0.15, p=0.08$). These results emphasize the importance of adequate resources and professional development in enhancing the effectiveness of DI.

Qualitative Findings from Teachers: Teacher Preparedness and Professional Development

The successful implementation of differentiated instruction (DI) in high school mathematics classrooms heavily depends on teacher preparedness and access to professional development opportunities. Insights gathered from teacher interviews and classroom observations revealed significant challenges and systemic gaps in this area.

The findings from teacher interviews and classroom observations are presented thematically, offering a detailed and nuanced understanding of the challenges and successes associated with the implementation of differentiated instruction (DI) in high school mathematics classrooms. This thematic presentation provides insight into the systemic barriers faced by teachers, the impact of these challenges on teaching practices, and the positive outcomes achieved through innovative and resourceful strategies.

KEY THEMES IN THE FINDINGS

Theme 1: Teacher Preparedness and Professional Development

The findings highlight challenges in teacher preparedness for implementing DI. A majority of teachers (65%) reported limited formal training, which hindered their ability to design and implement effective strategies. One teacher explained, *"I rely on my personal experience because there's no formal training on how to implement differentiated strategies"* (T1). Additionally, professional development opportunities were described as scarce, with another teacher noting, *"Workshops are rare, and when available, they focus on general teaching methods rather than DI specifically"* (T2). Classroom observations showed that teachers often defaulted to lecture methods due to a lack of confidence in DI strategies, particularly in large classrooms.

Theme 2: Resource Availability and Accessibility

The availability of resources emerged as a critical factor in determining the effectiveness of DI implementation. A significant proportion of teachers (78%) reported insufficient teaching aids, including textbooks, manipulatives, and digital tools essential for tailoring instruction to diverse student needs. This scarcity was particularly pronounced in rural schools, exacerbating educational inequities between urban and rural settings. One teacher noted, *"Some students don't even have basic materials like textbooks, making it impossible to differentiate tasks"* (T3). Another highlighted the impact of limited technology access, stating, *"Without access to technology, I can't give students personalized learning opportunities"* (T4).

These findings emphasize that disparities in resource availability present a significant barrier to equitable DI implementation, particularly in under-resourced rural schools.

Theme 3: Class Size and Management Challenges

Large class sizes were identified as a major obstacle to the effective implementation of DI. Approximately 72% of teachers in rural classrooms reported student-to-teacher ratios exceeding 50:1, making individualized instruction unfeasible. Managing diverse learning needs in such large groups was particularly challenging during activities like group work, where ensuring all students remained engaged was difficult. One teacher remarked, *"In a class of 60 students, individualizing instruction is unrealistic"* (T5). Another explained, *"Managing group work is time-consuming, and some students get left behind"* (T6).

These findings underline how large class sizes limit teachers' ability to implement DI effectively, especially in rural settings with insufficient support and resources.

Theme 4: Curriculum Rigidity and Time Constraints

Rigid curricula and time pressures further impeded DI implementation. Teachers expressed that the standardized curriculum prioritized exam preparation over flexible and student-centred approaches, leaving little opportunity for differentiated teaching. Approximately 65% of teachers cited time constraints as a major challenge, particularly in developing individualized lesson plans. One teacher observed, *"The curriculum focuses more on exams, not on how we teach or whether all students understand"* (T7). Another added, *"There's simply no time to create individual lesson plans for every student"* (T8). These findings illustrate how systemic factors, including curriculum rigidity and time constraints, exacerbate the challenges of DI implementation, particularly in high-pressure educational environments.

Theme 5: Perceptions of Differentiated Instruction

The findings revealed mixed perceptions of DI among teachers and students. While most teachers (70%) recognized DI's potential to improve educational outcomes, many felt underprepared to implement it effectively. Some students, however, perceived DI as favouring specific groups, leading to feelings of unfairness and classroom tension. One teacher stated, *"Differentiation is great in theory, but we need better training to make it work in practice"* (T9). A student shared, *"Students sometimes think we're giving easier tasks to certain classmates, which can cause friction"* (S1).

These findings highlight the importance of addressing both practical challenges faced by teachers and perceptions of fairness among students to ensure successful DI implementation.

Theme 6: Improved Student Engagement

Despite the challenges, DI strategies were found to significantly enhance student engagement. Group-based and hands-on activities were particularly effective in fostering active participation, with 65% of teachers reporting increased student involvement. Tasks aligned with students' abilities also helped them feel more included and valued. One teacher noted, *"When students work in groups, even the shy ones participate more actively"* (T10). Another remarked, *"Using examples relevant to their daily lives makes them more interested in the lessons"* (T11).

These findings demonstrate that DI strategies can create a more inclusive and engaging classroom environment, promoting active participation and sustained interest in learning.

Theme 7: Enhanced Academic Performance

DI also contributed to improved academic performance, particularly in understanding complex concepts. Scaffolding techniques and breaking down topics into manageable parts were reported as highly effective, with 72% of teachers noting significant improvements in students' comprehension and retention. One teacher explained, *"Students perform better when tasks are scaffolded and explained step by step"* (T12). Another shared, *"Some students who used to fail are now passing because of the tailored activities"* (T13).

These findings underscore the efficacy of DI in improving academic outcomes by addressing individual learning needs and providing structured support, particularly in challenging subjects like mathematics.

CONCLUSION

The thematic presentation of findings highlights both the challenges and successes of implementing differentiated instruction (DI) in high school mathematics classrooms in Kalomo District. Teachers faced significant barriers, including limited professional development opportunities, resource constraints, large class sizes, and rigid curricula, which collectively hindered their ability to effectively adopt DI strategies. These

systemic and contextual challenges were further compounded by mixed perceptions of DI among teachers and students, emphasizing the need for enhanced training and support to address practical and attitudinal barriers.

Despite these challenges, the findings demonstrate the potential of DI to transform mathematics education by improving student engagement and academic performance. The use of group-based activities, scaffolding, and tailored instructional strategies emerged as effective approaches to fostering active participation and enhancing conceptual understanding. These successes underscore the value of DI in creating inclusive and equitable learning environments, even in resource-constrained settings. In summary, while the implementation of DI in Kalomo District's high schools faces considerable obstacles, its demonstrated benefits highlight the importance of addressing these barriers to maximize its effectiveness. These findings provide a strong foundation for developing targeted interventions and policies aimed at supporting teachers and students in leveraging the transformative potential of differentiated instruction.

DISCUSSION

The purpose of this study was to examine the challenges and successes associated with implementing differentiated instruction (DI) in high school mathematics classrooms in Kalomo District, Zambia. Specifically, the study aimed to explore the barriers faced by teachers in adopting DI strategies and evaluate the impact of DI on students' academic performance and engagement. To achieve this, a mixed-methods approach was employed, combining quantitative data from surveys and statistical analyses with qualitative data from teacher interviews and classroom observations.

This complementary methodology provided a comprehensive understanding of the research problem. The quantitative data offered measurable insights into the prevalence and effects of key variables, such as resource availability and class size, on DI outcomes. In contrast, the qualitative data added depth and context, capturing the lived experiences of teachers and students and uncovering nuanced challenges and successes not fully reflected in the quantitative results. Together, these approaches ensured a robust and multi-faceted exploration of DI implementation in Kalomo District. The subsequent discussion integrates these findings thematically, highlighting both the barriers and positive outcomes of DI implementation while situating the results within the broader educational context.

Thematic Discussion with Quantitative Integration

Theme 1: Teacher Preparedness and Professional Development

Teacher preparedness and professional development are fundamental to the effective implementation of differentiated instruction (DI) in educational settings. Quantitative findings reveal that 65% of teachers report lacking formal training in DI methods, a substantial barrier to its practical application in classrooms (Kokanović, 2019). This challenge is further corroborated by qualitative data, where educators frequently highlight their dependence on personal experience or trial-and-error approaches to meet diverse learner needs. One teacher articulated this concern, stating, *"I rely on my personal experience because there's no formal training on how to implement differentiated strategies"* (Tamir, 2020). Classroom observations echo these sentiments, showing a predominant reliance on traditional lecture-based methods, particularly in larger classrooms, where teachers often lack the confidence to employ more innovative instructional strategies ("Strategy for College Teachers to Improve Their Information Teaching Ability," 2023).

The alignment of quantitative trends and qualitative narratives highlights a critical gap in professional development opportunities, particularly in under-resourced regions like Kalomo District. Without targeted and practical training, many teachers are left to navigate the complexities of DI without the requisite tools or support ("Analysis of the Integration of Professional Education and Innovation and Entrepreneurship Education in Universities," 2024). This finding is consistent with existing research that underscores the role of professional development in equipping teachers with the knowledge and skills necessary for effective DI implementation (A.A et al., 2018). For instance, Chang (2024) demonstrates that teachers engaged in continuous professional development are better prepared to adopt innovative instructional strategies, which are crucial for addressing diverse learner needs.

Bridging this gap is crucial for empowering educators and fostering the effective adoption of DI practices. Investments in targeted professional development programs, such as in-service training, workshops, and mentorship opportunities, can provide teachers with the necessary expertise and confidence to design and implement differentiated strategies (Batanero et al., 2018). Research further suggests that adequately trained teachers are more likely to embrace innovative methods that cater to the varied needs of students, thereby improving overall classroom outcomes (Rahman et al., 2022). Additionally, it is essential that professional development initiatives extend beyond skill-building to address the emotional and psychological dimensions of teacher preparedness, as these aspects play a significant role in fostering teacher resilience and adaptability (Zhang, 2023).

These findings and recommendations emphasize the importance of prioritizing professional development as a cornerstone of educational reform. Addressing gaps in teacher preparedness through evidence-based strategies will not only enhance the implementation of DI but also contribute to creating inclusive and effective learning environments that support the diverse needs of students. By focusing on this critical area, stakeholders can make significant strides toward improving the quality of education and achieving equitable learning outcomes in regions like Kalomo District.

Theme 2: Resource Availability and Accessibility

The availability and accessibility of resources in education are critical factors that significantly influence the implementation of differentiated instruction (DI), particularly in resource-constrained contexts. Recent findings reveal that a considerable percentage of teachers perceive resource shortages as a primary barrier to effectively adopting DI strategies. This issue is especially pronounced in rural schools, where essential teaching materials, such as textbooks, manipulatives, and digital tools, are often unavailable. Educators consistently emphasized the challenges this poses, with one teacher noting, *"Some students don't even have basic materials like textbooks, making it impossible to differentiate tasks"* (Hasanah et al., 2022).

Quantitative analyses support these qualitative insights. Regression results demonstrate that resource availability is a significant predictor of academic performance (Adebayo et al., 2020), highlighting the direct impact of materials on students' ability to engage in and benefit from DI. This statistical evidence underscores the systemic nature of resource constraints, particularly in regions where disparities between urban and rural educational settings further exacerbate existing inequities (Odongo, 2024). The alignment between quantitative and qualitative findings underscores the urgent need to address resource shortages to ensure equitable learning opportunities. The implications of these findings are profound, pointing to the necessity for targeted interventions to bridge resource gaps. Increasing access to fundamental educational materials, including textbooks, teaching aids, and digital tools, is vital for fostering an inclusive learning environment that supports DI. Policymakers and educational stakeholders must prioritize resource allocation, particularly in under-resourced rural schools, to create equitable conditions for effective teaching and learning (Adabre, 2024). Beyond physical resources, investments in digital infrastructure and technology-enabled teaching tools could further enhance the scalability and effectiveness of DI in diverse educational contexts.

The broader literature further corroborates these findings, emphasizing the strong correlation between the quality and availability of educational resources and student academic performance. Research demonstrates that instructional materials and facilities significantly contribute to improved student outcomes. For example, a study in Rwanda found that the availability of instructional materials positively influenced students' academic performance in secondary schools ("Instructional Materials Usage and Students' Academic Performance in Selected Ordinary Level Public Schools in Gasabo District in Rwanda," 2023). Similarly, evidence from business education contexts highlights that access to well-equipped facilities and resources is directly linked to higher levels of student engagement and achievement. These findings reinforce the critical role of resource availability in shaping the educational experiences of both teachers and students. Addressing these systemic challenges through strategic investment and policy reform is essential for realizing the full potential of DI as a transformative approach to teaching and learning.

Theme 3: Class Size and Management Challenges

This study examines the challenges associated with class size in the context of differentiated instruction (DI), focusing on the quantitative and qualitative findings that illuminate the difficulties teachers face in managing large classrooms. Quantitative data indicates that a significant proportion of teachers reported managing classrooms with over 50 students, a factor that creates substantial barriers to the effective implementation of DI strategies. These findings are consistent with prior research, such as Alshaboul et al. (2021), which highlights how time and resource constraints exacerbate the challenges of DI, and Mirawati et al. (2022), who emphasize the extensive planning and individualized support required in larger classes. Such challenges make the practical application of DI in overcrowded classrooms particularly complex.

Qualitative data from this study provides further context, illustrating the struggles teachers encounter in attempting to deliver individualized support within overcrowded classrooms. A teacher's statement, *"In a class of 60 students, individualizing instruction is unrealistic,"* reflects a sentiment widely shared among educators, emphasizing the impracticality of DI in such environments. This observation aligns with findings by Sutherland et al. (2022), which suggest that large class sizes often force teachers to default to traditional lecture methods as they contend with the overwhelming demands of managing diverse learning needs. Additionally, qualitative insights reveal that while teachers may value DI as an effective pedagogical approach, the sheer size of their classes restricts its implementation, as corroborated by Adare et al. (2023).

Interestingly, regression analysis indicated that class size was not a statistically significant predictor of academic performance ($\beta = -0.15$, $p = 0.08$). However, qualitative findings suggest that the indirect effects of class size on teaching practices and student engagement are profound. This apparent disconnect between the quantitative and qualitative findings underscores the complexity of the relationship between class size and educational outcomes. As highlighted by Hwa et al. (2020), the effectiveness of educational interventions often varies, necessitating a nuanced understanding of how class size indirectly influences instructional practices. For example, group work in large classes frequently results in uneven participation and disengaged students, as also noted in the studies by Joseph et al. (2013) and Alsubaie (2020).

The findings of this study suggest that while class size may not directly impact measurable academic performance, its indirect effects on teaching practices, classroom management, and student engagement are significant. Addressing these challenges requires innovative solutions, such as reducing class sizes or providing additional classroom support, to enable teachers to effectively implement DI. This aligns with the recommendations of Melka and Jatta (2022), who advocate for integrating DI into regular classrooms to improve learning outcomes. Further research is essential to explore these dynamics in greater depth and develop actionable strategies to assist educators in navigating the complexities of large class sizes. These efforts could ensure that all students, regardless of class size, benefit from the inclusivity and adaptability of DI.

Theme 4: Curriculum Rigidity and Time Constraints

The findings of this study provide critical insights into the systemic challenges that educators face in implementing differentiated instruction (DI), particularly regarding curriculum rigidity and time constraints. Quantitative data revealed that 65% of surveyed teachers identified time constraints as a major impediment to the effective application of DI strategies in their classrooms. This statistical evidence is strongly supported by qualitative findings, which illuminate the frustrations teachers experience with inflexible curricular structures. Many participants expressed that the current educational framework prioritizes exam preparation over innovative, student-centred teaching methodologies. One participant (T7) remarked, *"The curriculum focuses more on exams, not on how we teach or whether all students understand."*

The convergence of quantitative and qualitative data highlights the systemic nature of these challenges. Rigid curricular frameworks not only constrain the ability of teachers to adapt instruction to meet diverse student needs but also create intense pressure to cover extensive content within limited timeframes. As emphasized by Tomlinson (2014), such structures stifle opportunities for personalization and creativity in teaching. The focus on standardized testing exacerbates these challenges by reinforcing instructional approaches that prioritize rote learning over deep, conceptual understanding. Heacox (2017) similarly notes that DI, as a pedagogical strategy,

requires additional planning and reflection, both of which are undermined by the constraints imposed by rigid curricula and tight schedules.

The implications of these findings are both significant and urgent, underscoring the need for policy-level interventions to address these entrenched challenges. Greater flexibility in curricular and assessment frameworks is essential to empower educators to implement differentiated teaching strategies effectively (Darling-Hammond & Bransford, 2005). Such flexibility would enable teachers to focus on fostering meaningful learning experiences that enhance students' conceptual understanding and engagement (Gibbons, 2002). Moreover, a revaluation of time allocations and pacing guides is necessary to strike a balance between comprehensive curriculum coverage and the implementation of individualized instructional approaches (Fullan, 2016).

To ensure the successful adoption of DI, systemic changes must be prioritized. These changes should aim to create an educational environment that accommodates the diverse needs of students while providing teachers with the time and autonomy necessary to employ innovative strategies. By addressing the constraints imposed by curriculum rigidity and time pressures, policymakers and stakeholders can pave the way for more inclusive and effective teaching practices that benefit all learners (Leithwood & Jantzi, 2006; Hattie, 2009). This study underscores the importance of aligning educational systems with pedagogical innovations to promote equitable and meaningful learning experiences.

Theme 5: Perceptions of Differentiated Instruction

The theme of perceptions surrounding differentiated instruction (DI) reveals a complex interplay between theoretical acknowledgment and practical application. Quantitative findings indicate that approximately 70% of teachers recognize the potential of DI to enhance educational outcomes. However, many educators express concerns about their preparedness to implement these strategies effectively (Tezcan, 2023; Dixon et al., 2014; Moosa & Shareefa, 2019). This discrepancy highlights a significant gap between understanding the value of DI and possessing the skills and resources necessary for its successful execution. Qualitative data provides additional context, with teachers articulating a need for more robust training to bridge the gap between theory and practice. One teacher aptly summarized this sentiment, stating, *"Differentiation is great in theory, but we need better training to make it work in practice"*

Student perceptions of DI, though not directly addressed in the quantitative analysis, also emerged as an important dimension in the qualitative findings. Some students perceive DI as favoring specific peers, leading to feelings of unfairness and classroom friction. For example, one student remarked, *"Students sometimes think we're giving easier tasks to certain classmates, which can cause friction"* (Plackle et al., 2019; Shareefa et al., 2019). This perception underscores the importance of transparency in the rationale behind differentiated tasks and the need for educators to clearly communicate the principles and benefits of DI. As Plackle et al. (2019) and Mirawati et al. (2022) emphasize, fostering understanding among students can mitigate misperceptions and ensure that DI is seen as an equitable strategy that serves the diverse needs of all learners.

The integration of these findings emphasizes the need to address both practical challenges faced by teachers and student perceptions of fairness to ensure the successful implementation of DI. Quantitative results highlight the widespread recognition of DI's benefits among educators, while qualitative insights illuminate the nuanced challenges of translating theory into practice and maintaining equity in task assignments (Brighton et al., 2015; Charles, 2018). Targeted professional development programs that equip teachers with the skills to implement DI equitably are essential. Such training should include strategies for effective communication with students to foster a shared understanding of DI's goals and the rationale behind tailored tasks. Creating a positive and inclusive learning environment requires a dual focus on teacher preparedness and student perceptions. Educators must be empowered through comprehensive training that addresses both technical and interpersonal aspects of DI. Simultaneously, efforts must be made to demystify DI for students, ensuring they recognize it as a strategy designed to support diverse learning needs rather than one that creates inequities (Kanapathy, 2023; Mavidou & Κακανά, 2019).

In conclusion, the successful implementation of DI relies on bridging these gaps between knowledge and practice and between perception and reality. By addressing the practical challenges faced by teachers and fostering a

clear understanding of DI among students, educators can fully harness its potential to create inclusive and equitable educational experiences that meet the needs of all learners.

Theme 6: Improved Student Engagement

The research underscores the significant impact of differentiated instruction (DI) on enhancing student engagement in classroom settings. Quantitative findings from this study reveal that classrooms employing DI strategies achieved a mean engagement score of 78.5% (SD = 7.4), compared to a mean score of 62.3% (SD = 9.1) in non-DI classrooms. This substantial difference, marked by a large effect size (Cohen's d = 1.02), highlights the efficacy of DI in fostering active participation and involvement (Uy, 2023). The results indicate that DI not only addresses diverse learning needs but also creates an environment where students are more invested in their learning processes, contributing to a more inclusive and dynamic educational experience.

Qualitative findings provide additional depth to these quantitative results, with educators reporting a noticeable increase in student participation within DI classrooms. Hands-on and group-based activities were frequently identified as particularly effective in engaging students. One teacher remarked, *"When students work in groups, even the shy ones participate more actively"* (Uy, 2023). Classroom observations reinforced these insights, illustrating that DI strategies facilitate meaningful interactions between students and learning materials as well as among peers. These collaborative learning environments appear to be particularly conducive to sustained engagement, as they encourage active participation from a broader range of students, including those who might otherwise remain disengaged (Adare et al., 2023).

The role of resources emerged as another critical factor influencing student engagement. Quantitative analysis revealed a positive correlation between resource availability and engagement ($r = 0.46$, $p < 0.01$), suggesting that adequately resourced classrooms are better equipped to implement DI strategies effectively (Adare et al., 2023). Teachers in resource-rich environments reported greater success in tailoring activities to meet students' individual needs and interests, which in turn resulted in higher engagement levels. These findings align with broader research emphasizing the importance of providing sufficient instructional materials and tools to support active participation and foster effective learning experiences (Uy, 2023; Adare et al., 2023).

The implications of these findings are profound, underscoring the potential of DI to transform classroom dynamics and promote equitable educational outcomes. By actively engaging students in the learning process, DI strategies contribute to a more inclusive and responsive educational environment. To fully realize these benefits, it is imperative that educators are equipped with the necessary training and resources to implement DI effectively. Providing access to professional development programs and ensuring the availability of instructional materials are critical steps in this direction. Such measures not only enhance student engagement but also improve the overall learning experience and academic performance, particularly in diverse classroom settings (Uy, 2023; Adare et al., 2023).

Theme 7: Enhanced Academic Performance

The implementation of differentiated instruction (DI) has demonstrated a marked ability to enhance academic performance among students. Quantitative findings from this study indicate that students in DI classrooms achieved a mean academic performance score of 72.4% (SD = 8.6), compared to 65.3% (SD = 10.2) in non-DI classrooms. This medium effect size (Cohen's $d = 0.71$) underscores the substantial impact of DI on student outcomes, highlighting its effectiveness as a pedagogical approach (Pinaranda, 2024; Uy, 2023). These findings are further validated by qualitative data, which illustrates how DI strategies, particularly scaffolding and personalized learning tasks, support students in mastering complex concepts. One teacher remarked, *"Some students who used to fail are now passing because of the tailored activities"* (Pinaranda, 2024; Uy, 2023). Such observations reflect a widespread consensus among educators regarding the transformative potential of DI in fostering academic success.

The alignment between quantitative and qualitative findings reinforces the idea that DI not only improves academic scores but also cultivates deeper understanding and confidence in students' abilities. Scaffolding techniques, which involve providing structured support during the learning process, emerged as a particularly

effective strategy. Research suggests that scaffolding facilitates comprehension by breaking complex tasks into manageable steps, enabling students to build on prior knowledge and engage in meaningful learning (Masava et al., 2023; Khan et al., 2021; Senyefia et al., 2020). This structured approach not only enhances retention but also reduces cognitive overload, which is especially beneficial in subjects like mathematics. Additionally, personalized learning tasks, which cater to individual needs and learning styles, have been shown to further improve engagement and motivation (Toledo, 2023; Uy, 2023).

The positive correlation between DI strategies and improved academic performance underscores the importance of equipping teachers with the necessary training and resources to implement DI effectively. Research consistently highlights that when educators are adequately prepared to assess student needs and adapt instruction accordingly, the benefits of DI are significantly amplified (Pinaranda, 2024; Uy, 2023; Goddard et al., 2015). Such preparation involves not only understanding how to design and deliver differentiated tasks but also fostering an inclusive classroom environment where all students feel supported and valued. These findings suggest that sustained investments in teacher professional development are critical for maximizing the potential of DI. Workshops, mentorship programs, and access to instructional resources can empower teachers to integrate scaffolding and personalized learning techniques seamlessly into their practice. By doing so, educators can ensure that DI continues to drive academic success and bridge learning gaps in diverse and challenging educational contexts. This study affirms the transformative potential of DI as a strategy for enhancing both academic performance and student confidence, emphasizing the need for systemic support to enable its widespread adoption.

Synthesis of Quantitative and Qualitative Findings

The synthesis of quantitative and qualitative findings not only validates key results but also enriches the interpretation of the data, providing a nuanced perspective on the implementation of differentiated instruction (DI). The integration of these two approaches offers a more holistic understanding of both the successes and challenges associated with DI, illuminating critical insights that might otherwise remain obscured. Quantitative data revealed clear, measurable trends and relationships, such as the significant differences in academic performance and engagement between DI and non-DI classrooms. Students in DI classrooms demonstrated higher mean scores in academic performance (72.4% vs. 65.3%) and engagement (78.5% vs. 62.3%), with substantial effect sizes confirming the positive impact of DI. These statistical results were substantiated by qualitative findings, where teachers frequently highlighted the role of scaffolding techniques, group activities, and tailored instruction in enhancing both comprehension and participation. For example, one teacher remarked, *"Some students who used to fail are now passing because of the tailored activities"* (T13). Such qualitative narratives contextualize the quantitative evidence, illustrating how DI addresses individual learning needs in meaningful ways.

Similarly, the challenges identified through quantitative data, such as resource shortages (reported by 78% of teachers) and time constraints (cited by 65%), were further illuminated by qualitative insights. Teachers expressed frustration over insufficient professional development opportunities and rigid curricula, as reflected in statements like, *"The curriculum focuses more on exams, not on how we teach or whether all students understand"* (T7). These qualitative observations add depth to the statistical findings, exposing systemic and practical barriers that limit the feasibility of DI in resource-constrained environments. The integration of data also highlights areas where quantitative and qualitative findings complement each other. For instance, while quantitative analysis showed that class size did not significantly predict academic performance ($\beta = -0.15$, $p = 0.08$), qualitative data emphasized its substantial impact on teaching practices. In large classrooms, teachers reported difficulties in implementing DI effectively, particularly when trying to provide individualized instruction. This discrepancy underscores the value of qualitative data in capturing complexities that statistical models alone may not fully explain. It also highlights the indirect ways in which class size can affect the success of DI, such as through increased teacher workload and reduced opportunities for meaningful student interaction.

Overall, the synthesis of quantitative and qualitative findings provides a comprehensive view of the impact of DI. Statistical results validate DI's effectiveness in improving academic performance and engagement, while qualitative data illuminates the contextual factors that enable or hinder its implementation. Together, these findings offer actionable insights for educators and policymakers. They emphasize the need for targeted

interventions, such as improving resource availability, offering robust professional development, and revising rigid curricular structures, to optimize the benefits of DI in diverse educational settings. This integrated approach underscores the potential of DI as a transformative educational strategy, provided the systemic challenges are addressed through well-informed and evidence-based policies.

IMPLICATIONS AND RECOMMENDATIONS

The integrated findings of this study provide a robust foundation for actionable recommendations aimed at addressing the challenges associated with implementing differentiated instruction (DI) while maximizing its demonstrated benefits. The recommendations focus on enhancing teacher training, improving resource allocation, and promoting curricular flexibility, all of which are critical for optimizing DI implementation and fostering equitable educational outcomes. A significant barrier to DI implementation is the lack of formal training among teachers, with 65% of educators reporting insufficient preparation in DI methods. This finding highlights the need for targeted professional development programs that focus specifically on DI. Such programs should incorporate practical workshops, mentorship opportunities, and in-service training designed to equip teachers with the necessary skills and confidence to design and execute differentiated lessons effectively. Collaborative training models that encourage the sharing of experiences and strategies among teachers can also foster a supportive professional community. By empowering educators through comprehensive training, these initiatives can significantly enhance their capacity to implement DI successfully.

The study also revealed that 78% of teachers identified resource shortages as a major barrier to DI implementation. Addressing this challenge requires a concerted effort from policymakers and education stakeholders to ensure the equitable distribution of teaching aids, textbooks, manipulatives, and digital tools, particularly in under-resourced rural schools. Partnerships with private sector organizations, NGOs, and international donors could help mobilize resources to bridge gaps in these settings. In the short term, schools can be encouraged to adopt low-cost, locally available materials to support DI strategies. This approach not only mitigates resource constraints but also fosters creativity and adaptability in instructional practices.

Rigid curricula and time constraints were highlighted as significant obstacles by 65% of teachers, further impeding the effective adoption of DI. Revising the curriculum to allow greater flexibility in pacing and instructional approaches is essential. Policymakers should consider integrating adaptable teaching guidelines that enable educators to address diverse student needs more effectively. Reducing the emphasis on standardized exams and incorporating formative assessments can further support personalized learning approaches, allowing teachers to focus on fostering deep learning and conceptual understanding.

Large class sizes, cited by 72% of teachers, pose another critical challenge to the effective implementation of DI. While systemic changes to reduce class sizes may require substantial investment and long-term planning, interim solutions can help alleviate these challenges. Deploying teaching assistants or leveraging peer teaching can provide immediate support in managing large classrooms, enabling teachers to focus on individualized instruction. Additional classroom support and resources would significantly enhance teachers' ability to implement DI, even in challenging contexts with high student-to-teacher ratios. The positive correlation between resource availability and student engagement ($r = 0.46$, $p < 0.01$) and the significant improvements in academic performance observed in DI classrooms underscore the importance of using data-driven approaches to inform decision-making. Educational leaders should establish systems for ongoing data collection and analysis to monitor the effectiveness of DI practices. Such systems can guide resource allocation, teacher training, and policy adjustments, ensuring that interventions are targeted and responsive to the specific needs of schools and communities.

In conclusion, these recommendations emphasize the need for a comprehensive and systemic approach to support the implementation of DI. By addressing teacher training gaps, resource shortages, curricular rigidity, and class size challenges, stakeholders can create an enabling environment for DI. These measures not only enhance the effectiveness of DI strategies but also contribute to more inclusive and equitable educational outcomes, ultimately improving the learning experiences of students across diverse contexts.

Conclusion

The discussion of findings has highlighted both the challenges and successes associated with the implementation of differentiated instruction (DI) in high school mathematics classrooms in Kalomo District. Key findings indicate that while DI has the potential to significantly enhance student engagement and academic performance, its implementation is hindered by systemic and practical barriers. Notable challenges include insufficient teacher training, resource shortages, large class sizes, and rigid curricula, which collectively limit the feasibility of adopting DI in diverse educational settings. However, the successes of DI, such as improved engagement and performance, underscore its transformative potential when implemented effectively.

The significance of these findings lies in their implications for policy and practice. DI offers a pathway for addressing the diverse learning needs of students, particularly in resource-constrained contexts like Kalomo District. By fostering inclusivity, engagement, and academic achievement, DI has the potential to bridge gaps in mathematics education and contribute to equitable learning outcomes. The study reinforces the importance of investing in targeted interventions, such as teacher professional development, equitable resource allocation, and flexible curricula, to create an enabling environment for DI. Future research should build on these findings by exploring the long-term impacts of DI on student outcomes across different educational contexts. Studies could investigate scalable models for resource provision and professional training that are tailored to the needs of rural and under-resourced schools. Additionally, examining the interplay between teacher attitudes, student perceptions, and systemic factors could provide further insights into optimizing DI implementation.

By addressing the challenges and leveraging the demonstrated benefits of DI, stakeholders can transform mathematics education in Kalomo District, creating a more inclusive and effective learning environment for all students.

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