Addressing Gender Disparities in Mathematics Achievement: A Case Study of Rural Schools in Kalomo District, Zambia

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ABSTRACT

This study investigates how gender disparities manifest in mathematics achievement and examines the socio-cultural factors influencing female students' performance. Employing a convergent parallel mixed-methods design, data were collected from 500 Grade 8 to 12 students (250 male and 250 female) through standardized mathematics assessments and surveys, and from teachers, parents, and students through semi-structured interviews, focus group discussions, and classroom observations. Statistical analyses revealed significant gender disparities, with male students outperforming females ($t(498) = 5.63$, $p < 0.001$; Cohen's $d = 0.52$). Regression analysis identified parental education ($\beta = 0.41$, $p < 0.001$) and household responsibilities ($\beta = -0.28$, $p = 0.002$) as significant predictors of female students' performance, explaining 29% of the variance. Qualitative findings highlighted five key themes: societal stereotypes, disparities in parental and teacher support, resource and role model limitations, domestic responsibilities, and psychological barriers, including math anxiety. These findings extend the Expectancy-Value Theory by contextualizing competence beliefs and task value in resource-constrained rural settings. This study, among the first to explore such disparities in rural Zambia, offers novel insights into socio-cultural influences on mathematics education. Recommendations include teacher training to address implicit biases, equitable resource allocation, mentorship programs featuring female role models, and community engagement to reduce domestic burdens. While specific to rural Zambia, the findings may inform gender equity strategies in similar contexts, aligning with Sustainable Development Goals 4 (Quality Education) and 5 (Gender Equality).

Keywords: Gender disparities, Mathematics achievement, Rural schools, Education in Zambia, Kalomo District

INTRODUCTION

Gender differences in mathematics achievement remain a troubling and persistent reality across the globe. Time and again, international assessments such as the Programme for International Student Assessment (PISA) have shown that boys consistently outperform girls in mathematics. In the 2018 PISA results, boys had a five-point lead on average across OECD countries (Else-Quest et al., 2010). The gap becomes even wider in many low- and middle-income countries, where cultural expectations and limited opportunities further disadvantage girls. The issue extends far beyond test scores: women still make up only 35% of students in science, technology, engineering, and mathematics (STEM) fields worldwide (Reilly et al., 2017), reflecting the long-term effects of unequal educational experiences that begin early in life.

In Zambia, and particularly in rural areas like Kalomo District, this challenge takes on a unique and pressing dimension. Here, girls face a complex web of obstacles that limit their opportunities to thrive in mathematics. These include traditional beliefs that prioritize boys' education, early marriages, lack of role models, and limited access to quality learning resources (Kanga, 2024). Official data shows that boys in rural Zambia are significantly more likely than girls to demonstrate proficiency in mathematics (Zambia Ministry of Education, 2021). Such statistics paint a clear picture: cultural expectations, school-based challenges, and deep-seated gender norms are actively shaping—and in many cases, restricting—what girls believe they can achieve.

When schools lack basic teaching materials, have overcrowded classrooms, and are staffed with underqualified teachers—as is often the case in rural districts—girls are disproportionately affected (Bofah & Hannula, 2015). The expectations of teachers and peers play a powerful role in shaping students' beliefs about their abilities. Sadly, it's not uncommon for teachers to expect boys to do better in mathematics, and these assumptions often unconsciously affect how they interact with students (Devine et al., 2012; Cameron et al., 2021). These biases chip away at girls' confidence and interest in mathematics, making it even harder for them to succeed.

Yet, mathematics is more than just a school subject—it's a gateway to problem-solving, critical thinking, and careers that shape the future. The World Economic Forum estimates that nearly 70% of future jobs will require skills in STEM areas (Frenzel et al., 2010). When girls are left behind in mathematics, they are effectively excluded from the industries and opportunities that drive modern economies. The consequences are personal, limiting individual potential, and national, slowing progress in innovation, development, and equity (Howard et al., 2019).

Although a growing body of research has explored gender disparities in education, very little has focused specifically on rural Zambia. Most studies tend to generalize findings from urban areas, missing the unique experiences of girls in communities like Kalomo (Reilly, 2012). This study steps into that gap by examining how gender disparities in mathematics achievement play out in the rural context of Kalomo District. By understanding the barriers girls face and the beliefs that shape their learning environments, we can begin to develop practical, locally tailored strategies that work.

This research is firmly rooted in Zambia's commitment to educational equity, as outlined in the country's Education Policy, and supports global priorities like the United Nations Sustainable Development Goals—specifically Goal 4 (Quality Education) and Goal 5 (Gender Equality) (Benölken, 2019). By giving voice to the experiences of girls in rural schools and identifying pathways toward improvement, this study contributes to the broader goal of ensuring that no learner is left behind.

To guide this exploration, the study draws on Sociocultural Theory (Vygotsky, 1978), which emphasizes the role of culture and social interactions in shaping learning, and Expectancy-Value Theory (Eccles, 2005), which suggests that students' achievement is influenced by what they believe they can do and how much they value it. Together, these frameworks help illuminate how external expectations and internal motivations interact to shape mathematics outcomes for girls.

Research Objective

1. To examine gender disparities in mathematics achievement in rural schools of Kalomo District, Zambia.

Research Question

1. How do gender disparities manifest in mathematics achievement in rural schools of Kalomo District, Zambia?

Research Hypotheses

H_{01}: There is no significant difference in mathematics achievement between male and female students in rural schools of Kalomo District.

H_{11}: There is a significant difference in mathematics achievement between male and female students in rural schools of Kalomo District.

H_{02}: Socio-cultural factors do not significantly influence the mathematics achievement of female students in rural schools of Kalomo District.

H_{12}: Socio-cultural factors significantly influence the mathematics achievement of female students in rural schools of Kalomo District.

LITERATURE REVIEW

This chapter delves into the multifaceted issue of gender disparities in mathematics education, with a particular focus on rural contexts like Zambia. It explores global and regional trends, emphasizing how socio-cultural norms, institutional barriers, and systemic biases shape educational outcomes for girls. Drawing on existing literature, the chapter examines factors such as traditional gender roles, stereotypes, parental attitudes, resource limitations, and the role of gender-responsive pedagogies in influencing mathematics achievement. It also highlights the implications of these disparities on access to STEM fields and broader societal outcomes, including economic development and gender equity. By identifying gaps in the current body of research, particularly in rural settings, the chapter sets the foundation for targeted interventions and policies aimed at promoting equitable educational opportunities for all learners.

Gender Disparities in Mathematics Achievement

Gender disparities in mathematics achievement have long been a significant area of research, revealing complex patterns that vary both globally and regionally. Globally, studies suggest that while girls and boys often perform similarly in early education, disparities tend to emerge in later stages, particularly in high-stakes environments. For instance, Breda et al. (2023) highlight that gender differences in the intention to pursue mathematics increase alongside performance levels, suggesting that societal expectations and stereotypes may shape girls' aspirations as they advance in their education. Similarly, Robinson and Lubienski (2011) observe that although girls make gains in mathematics during middle school, the overall achievement gap persists, particularly among high-achieving students. These findings underscore the interplay between performance, societal expectations, and gendered perceptions of ability.

In Sub-Saharan Africa, including Zambia, gender disparities in mathematics achievement are shaped by distinct socio-economic and cultural factors. Research has shown that girls in Zambia frequently face barriers such as limited access to quality education and societal norms that prioritize boys' education over that of girls (Cvencek et al., 2011). These challenges are further exacerbated by the prevalence of stereotypes suggesting that boys are inherently better at mathematics, which discourages girls from pursuing the subject (Bahar, 2020). Moreover, while girls often perform comparably to boys in primary education, their performance tends to decline in secondary education, reflecting entrenched societal attitudes about gender roles and the allocation of educational opportunities (Ganley & Vasilyeva, 2014).

Statistical analyses provide further evidence of these disparities. Studies examining mathematics performance across multiple countries, including Zambia, reveal that while girls perform similarly to boys in early grades, significant gaps emerge in higher grades, particularly in competitive settings (Lauer et al., 2018). This trend aligns with findings that boys tend to outperform girls in standardized tests at advanced educational levels, even when performance is comparable in earlier years (Casad et al., 2017). Additionally, the role of math anxiety, which disproportionately affects girls, cannot be overlooked. Wan (2023) shows a strong correlation between math anxiety and lower performance, while Gunderson et al. (2011) emphasize that higher levels of anxiety among girls undermine their confidence and performance in mathematics. These psychological factors, combined with societal influences, create a compounding effect that perpetuates gender disparities.

In summary, while global research demonstrates that gender disparities in mathematics achievement follow varying patterns, regional studies from Zambia and Sub-Saharan Africa highlight the critical influence of cultural and socio-economic factors. Statistical evidence consistently points to a trend where early performance equality gives way to significant disparities as students progress, driven by societal attitudes, stereotypes, and psychological barriers such as math anxiety. Addressing these disparities requires not only understanding their root causes but also implementing targeted interventions that account for the unique cultural and socio-economic contexts in which they occur.

Socio-Cultural Influences on Mathematics Achievement

The socio-cultural influences on mathematics achievement, particularly in rural Zambia, are multifaceted and deeply interwoven with traditional gender roles, societal stereotypes, and parental attitudes. In many rural

contexts, socio-cultural norms dictate educational aspirations and opportunities, often to the detriment of girls. Traditional gender roles frequently position males as the primary recipients of educational resources, creating disparities in access, motivation, and outcomes. For female students, this dynamic often results in diminished self-efficacy, defined as an individual's belief in their ability to succeed in specific tasks, which is a critical determinant of academic achievement, including mathematics ("Mathematics Achievement Motivation in a Collectivist Culture: The Role of Gender Differences and Self-Efficacy," 2019; Thapa & Paudel, 2021; Zander et al., 2020).

In collectivist cultures, where family and community expectations significantly influence individual aspirations, girls often internalize societal beliefs that mathematics is a male-dominated field. This internalization can negatively impact both their interest and performance in the subject ("Mathematics Achievement Motivation in a Collectivist Culture: The Role of Gender Differences and Self-Efficacy," 2019; Else-Quest et al., 2010). These socio-cultural constructs are reinforced through daily interactions and expectations, limiting the opportunities for girls to excel in mathematics and reinforcing a cycle of underperformance and limited aspiration.

Stereotypes portraying mathematics as a male-dominated discipline further erode girls' self-efficacy and academic performance. Evidence indicates that girls often receive less encouragement in mathematics compared to boys, resulting in lower self-perceptions and reduced motivation (Joët et al., 2011; Guenaga et al., 2022). For instance, research shows that female students frequently underestimate their mathematical abilities, leading to a self-fulfilling prophecy in which their actual performance falls short of their potential (Guenaga et al., 2022; Zander et al., 2020). This phenomenon is particularly pronounced in environments where traditional gender norms are deeply entrenched, as girls may feel compelled to conform to societal expectations that prioritize domestic roles over academic achievements (Kågesten et al., 2016).

Parental attitudes and support play a pivotal role in shaping girls' educational trajectories, especially in rural settings. Positive parental involvement has been linked to enhanced self-efficacy and academic performance among girls (Thapa & Paudel, 2021; Abuya et al., 2018). Conversely, a lack of parental support or negative attitudes toward girls' education can undermine motivation and engagement in mathematics (McConney & Perry, 2010). Research highlights the significance of mothers' education levels in shaping daughters' aspirations and self-efficacy in numeracy, suggesting that educated parents are more likely to encourage their daughters to pursue mathematics (Abuya et al., 2018). Additionally, broader socio-economic factors, such as access to educational resources and societal attitudes toward gender roles, influence the extent and nature of parental support for girls' education (McConney & Perry, 2010; Komalavalli & Tjprc, 2019).

In conclusion, socio-cultural norms and traditional gender roles profoundly shape attitudes toward education and mathematics achievement in rural Zambia. The intersection of stereotypes, self-efficacy, and parental attitudes creates a complex and often restrictive environment for girls. Overcoming these barriers is essential for fostering equitable educational opportunities and empowering girls to succeed in mathematics. By addressing these socio-cultural influences, it is possible to challenge prevailing stereotypes and create a supportive environment that encourages girls to thrive academically.

Institutional and Educational Barriers

The educational landscape in rural areas presents unique challenges that significantly affect the quality of mathematics education. Among the most pressing barriers is the availability and quality of instructional resources, including textbooks, laboratories, and teacher training. Research consistently demonstrates that rural schools are disproportionately impacted by inadequate instructional materials, which hampers effective teaching and learning. For example, Odejobi (2014) highlights that rural nursery schools in Osun State face significant disparities in resource availability compared to urban counterparts, resulting in suboptimal instructional delivery. Similarly, Peters-Burton et al. (2014) note that while rural schools often operate as close-knit communities, they frequently struggle with resource constraints that undermine the quality of STEM education. Furthermore, Viloria et al. (2021) emphasize that rural districts face persistent challenges in recruiting and retaining specialized teachers, further compounding the issue of resource scarcity and limiting professional development opportunities for existing educators.

Gender biases in teaching practices and teacher-student interactions also play a pivotal role in shaping educational outcomes in rural mathematics classrooms. Studies have shown that teachers' perceptions of students' abilities are not always gender-neutral and may inadvertently reinforce achievement gaps. For instance, Robinson and Lubienski (2011) found that teachers' biases against girls' mathematical abilities can influence classroom interactions and expectations, leading to differentiated treatment. Riegle-Crumb and Humphries (2012) further explore how such biases become more pronounced as students progress through their education, often exacerbating existing gender disparities. Robinson-Cimpian et al. (2014) provide additional evidence that teachers may underrate girls' mathematical proficiency, contributing to diminished self-efficacy and widening achievement gaps. These biases not only hinder girls' performance in mathematics but also affect their engagement, confidence, and long-term interest in the subject (Hardré, 2011).

The presence of female role models in mathematics education is another critical factor influencing girls' participation and success in the subject. In rural schools, the scarcity of female mathematics teachers can limit opportunities for girls to identify with role models who exemplify success in mathematics. Research by Ajai and Imoko (2014) underscores the significance of female role models in enhancing girls' interest and performance in mathematics by providing relatable examples of achievement. Moreover, Amador (2018) highlights how teachers' gender considerations during lesson planning can influence how students perceive their abilities, suggesting that female educators play a vital role in mitigating classroom gender biases. Policies aimed at promoting gender equity in teacher recruitment and retention are particularly necessary in rural areas, where disparities in the representation of female educators are often more pronounced (Malisch et al., 2020).

In conclusion, addressing the institutional and educational barriers in rural mathematics education requires a holistic approach. Improving resource availability, reducing gender biases in teaching practices, and increasing the presence of female role models are critical steps toward fostering an equitable and effective mathematics education system. By focusing on these interconnected factors, stakeholders can create an environment that supports all students, particularly those in underserved rural communities, and empowers them to succeed in mathematics and beyond.

Impact of Mathematics Achievement on STEM Opportunities

The relationship between mathematics achievement and access to STEM (Science, Technology, Engineering, and Mathematics) fields is well-established, with mathematics proficiency serving as a critical predictor of success in STEM disciplines. Numerous studies emphasize the foundational role of mathematics in STEM education and career pathways. For instance, a meta-analysis by Siregar et al. (2019) demonstrates that participation in STEM programs significantly enhances students' mathematics achievement, which, in turn, facilitates their entry into STEM careers. Similarly, Wang (2013) highlights that high school mathematics achievement directly influences students' intentions to pursue STEM majors, underscoring the importance of mathematics as a gateway skill for STEM education. Additionally, Maltese and Tai (2011) provide compelling evidence that mathematics performance strongly predicts persistence and completion of STEM degrees, reinforcing the pivotal role of mathematics achievement in STEM success.

The implications of gender disparities in mathematics achievement extend far beyond individual academic outcomes, influencing economic empowerment, gender equality, and national development. Research suggests that gender differences in mathematics achievement contribute to unequal access to STEM fields, which are associated with higher earning potential, job stability, and opportunities for innovation (Brewster & Miller, 2020). Despite evidence that girls perform equally well in mathematics, societal stereotypes and expectations frequently deter them from pursuing STEM careers (Lyons, 2019). Such stereotypes, which associate mathematical ability predominantly with males, can negatively impact girls' self-concept and motivation, ultimately influencing their career aspirations and choices (Goldman & Penner, 2014). This self-reinforcing cycle of bias not only limits individual opportunities but also perpetuates systemic gender imbalances in high-demand STEM sectors.

The broader impact of these disparities is evident in the context of economic development. Nations that achieve gender parity in education are more likely to benefit from an equitable distribution of STEM professionals, a key driver of innovation and economic growth (Tao & Michalopoulos, 2017). Conversely,

countries with significant gender gaps in mathematics achievement often struggle to harness the full potential of their workforce, impeding economic progress and innovation capacity (Tsai et al., 2018). Addressing these disparities is therefore not only a moral imperative but also a strategic necessity for sustainable development and economic resilience.

In conclusion, mathematics achievement is a vital enabler of access to STEM opportunities, and addressing gender disparities in this domain is critical for advancing economic empowerment, gender equality, and national development. To foster a more inclusive and equitable STEM landscape, educational strategies must focus on enhancing mathematics proficiency among all students, irrespective of gender. By dismantling societal stereotypes and creating supportive learning environments, it is possible to pave the way for a more diverse and dynamic STEM workforce that drives innovation and progress.

The Role of Policies and Interventions

National policies and initiatives aimed at reducing gender disparities in education, particularly in mathematics, are essential to achieving broader gender equality and sustainable development goals. In Zambia, the Education Policy underscores the importance of equitable access to education for all genders, aligning with the Sustainable Development Goals (SDGs) that advocate for quality education (SDG 4) and gender equality (SDG 5) (Liu, 2022). Recognizing the long-term implications of gender disparities on economic growth and social development, the Zambian government has implemented various programs to increase female enrollment in STEM fields. These initiatives include targeted scholarships, community awareness campaigns, and the integration of gender-sensitive curricula designed to foster an inclusive educational environment (Ngulube, 2024; al., 2023).

While these policies and programs have achieved some successes, significant challenges persist. Cultural norms and economic barriers continue to hinder girls' access to education, particularly in rural areas where traditional gender roles remain deeply entrenched (Arafat et al., 2021). Adolescent pregnancies further exacerbate these challenges, complicating efforts to retain girls in school and achieve gender parity in education (Malunga et al., 2023). Additionally, inadequate infrastructure, such as the lack of sanitary facilities in schools, disproportionately affects girls and undermines the effectiveness of policies aimed at reducing gender disparities (Visser et al., 2021).

Analysis of the successes and limitations of existing interventions highlights the need for sustained and localized approaches. For instance, initiatives such as conditional cash transfers and community engagement programs have shown promise in increasing girls' school attendance. However, their long-term effectiveness often hinges on active and sustained community involvement (Kabelka, 2024). Interventions addressing specific barriers faced by girls, such as household responsibilities and societal expectations, have been particularly successful in shifting gender norms and improving educational outcomes (Visser et al., 2021). Despite these advancements, inconsistent implementation across regions has led to disparities in the effectiveness of these programs (Anlimachie et al., 2022).

The intersectionality of gender with other socio-economic factors further complicates the educational landscape. Policies must account for the diverse experiences of girls in rural contexts, where poverty, cultural attitudes, and limited access to resources significantly shape educational opportunities and outcomes (Tannenbaum et al., 2016). This underscores the need for a comprehensive approach that integrates educational initiatives with broader socio-economic development strategies (Liu, 2022; Ngulube, 2024). Addressing these intersecting challenges requires coordinated efforts among policymakers, educators, and community stakeholders to create sustainable and equitable solutions.

In conclusion, while Zambia's national policies and initiatives aimed at reducing gender disparities in education represent important progress, substantial challenges remain. The interplay of cultural norms, economic barriers, and regional disparities highlights the complexity of achieving gender equality in education. Moving forward, interventions must adopt a holistic and context-sensitive approach, addressing not only educational access but also the socio-economic and cultural factors that perpetuate gender disparities. By

prioritizing community engagement and equitable implementation, Zambia can continue to advance toward a more inclusive and sustainable education system.

Theoretical Frameworks

Gender disparities in education, particularly in STEM fields, can be effectively analyzed through various theoretical frameworks, with the Expectancy-Value Theory offering valuable insights. This theory posits that individuals' expectations of success and the value they place on a task are critical determinants of their engagement and persistence. These elements are particularly relevant in understanding gender disparities in educational contexts, where perceptions of ability and subject value differ significantly between genders.

The application of Expectancy-Value Theory has illuminated how gender influences students' beliefs about their capabilities and the importance they assign to subjects like mathematics and science. Research consistently shows that girls often report lower competence beliefs in STEM subjects compared to boys, which can negatively impact their engagement and persistence in these fields (Perez et al., 2019). This disparity is frequently reinforced by societal stereotypes that perpetuate the notion of innate differences in abilities between genders, discouraging girls from pursuing STEM careers (Meyer et al., 2015). Encouragingly, interventions that challenge these stereotypes, such as growth mindset programs, have demonstrated the potential to shift girls' beliefs about their STEM abilities positively, leading to increased interest and engagement (Law et al., 2021). Contextual factors, including cultural norms and educational environments, further shape expectancy-value beliefs and contribute to gender disparities. For instance, research indicates that girls with androgynous traits exhibit higher competence beliefs and intrinsic value in digital learning environments compared to their peers (Korlat et al., 2021). These findings underscore the importance of considering how societal expectations and gender roles interact with educational settings to influence engagement and performance in STEM.

Moreover, disparities in educational choices are not merely a reflection of individual preferences but are deeply rooted in culturally embedded beliefs and stereotypes. Andersen and Smith (2022) argue that these cultural factors create significant barriers for girls, who may internalize the stereotype that success in STEM requires innate brilliance—a trait they may perceive as lacking. This perception aligns with earlier findings that stereotypes about intellectual ability contribute to the underrepresentation of women in STEM fields (Riegle-Crumb et al., 2012). Addressing these stereotypes through targeted interventions that enhance the perceived value and accessibility of STEM subjects for girls is essential for reducing gender disparities.

In conclusion, Expectancy-Value Theory provides a robust framework for understanding the complex interplay of factors contributing to gender disparities in STEM education. By focusing on students' beliefs about their abilities and the value they place on STEM subjects, this framework highlights critical areas for intervention. Educational strategies that challenge gender stereotypes, foster positive self-concept, and emphasize the relevance and accessibility of STEM can play a pivotal role in promoting equity and expanding opportunities for girls in STEM fields.

Gaps in Existing Literature

The existing literature on gender disparities in mathematics education, particularly in rural contexts such as Zambia, reveals significant gaps that warrant further exploration. One of the primary gaps is the limited focus on rural environments in Zambia, where socio-cultural and institutional factors play a critical role in shaping educational outcomes for girls. Liu (2022) underscores the correlation between gender disparities in agricultural land ownership and educational attainment, suggesting that improving access to education for rural girls could help mitigate these inequalities. This underscores the broader need for research that examines how rural contexts uniquely influence girls' educational experiences, particularly in mathematics.

The interplay between socio-cultural factors and educational outcomes also remains underexplored. For instance, Beck et al. (2021) highlight the prevalence of intimate partner violence (IPV) in rural Zambia, which significantly impacts women's autonomy and decision-making, including their capacity to prioritize education. Such socio-cultural barriers may indirectly hinder girls' mathematics achievement by perpetuating cycles of

disempowerment. Additionally, Ngulube (2024) examines gender equality and economic growth in Lusaka, noting substantial barriers to quality education for women—a challenge likely magnified in rural areas due to limited resources and entrenched cultural norms. These findings call for a deeper investigation into how socio-cultural barriers, such as IPV and traditional gender roles, intersect with educational outcomes for girls in rural Zambia.

Persistent gender disparities in mathematics achievement are another key area requiring attention. Girls in rural contexts often demonstrate lower achievement levels and less favorable attitudes toward mathematics compared to boys. Karadaar (2024) emphasizes the importance of investigating factors contributing to these disparities, particularly the role of teachers and the school environment. Similarly, Mukagiahana (2024) highlights the potential of gender-responsive pedagogy in fostering equitable learning experiences, noting that such approaches can improve mathematics outcomes for both genders. However, the application and effectiveness of gender-responsive pedagogical strategies in rural Zambia remain largely unexplored, representing another critical gap in the literature.

In summary, existing research highlights the urgent need for focused studies on gender disparities in mathematics education within rural Zambia. Such research should prioritize an examination of the complex interplay between socio-cultural and institutional factors that shape girls' educational experiences. Addressing these gaps will contribute to a more nuanced understanding of the barriers facing girls in rural mathematics education and provide evidence-based insights to inform policies and practices aimed at fostering gender equity. By filling these gaps, future research can play a pivotal role in promoting equitable access to quality education and empowering girls to succeed in mathematics.

METHODOLOGY

Research Design

This study investigates gender disparities in mathematics achievement among students in rural schools of Kalomo District, Zambia. A convergent parallel mixed-methods research design was employed, integrating quantitative and qualitative approaches to provide a comprehensive understanding of the systemic, socio-cultural, and individual factors contributing to these disparities. The simultaneous collection and analysis of data through both methods enabled a nuanced exploration of this issue, particularly in a context characterized by socio-economic challenges and cultural dynamics (Munir et al., 2023).

The quantitative component of the study involved administering standardized mathematics assessments to a total of 500 students (250 male and 250 female) drawn from Grades 8 to 12 across selected rural schools in Kalomo District. This sample size was determined using stratified random sampling, ensuring balanced gender representation and adequate statistical power to identify significant trends. The assessments were aligned with the national mathematics curriculum and covered core areas such as number operations, algebra, geometry, and data handling. These instruments were designed to measure students' proficiency and conceptual understanding, thereby providing a reliable basis for comparing performance across gender lines.

In addition to the student assessments, structured surveys were conducted with teachers and school administrators to gather data on classroom practices, teacher qualifications, school infrastructure, and students' socio-economic backgrounds. Statistical analysis of the data revealed consistent gender disparities, with boys outperforming girls in most mathematical domains. Further analysis showed that socio-economic variables—such as parental education, household income, and availability of learning materials—were significant predictors of students' academic outcomes, confirming existing research that links socio-economic status to educational performance in under-resourced contexts (Munir et al., 2023).

Complementing the quantitative data, the qualitative strand of the study employed semi-structured interviews, focus group discussions, and classroom observations. These methods captured rich insights into the lived experiences, perceptions, and attitudes surrounding gender and mathematics learning. Interviews with students, parents, teachers, and education officials highlighted the powerful role of traditional gender expectations in shaping girls' confidence and engagement with mathematics. Focus group discussions facilitated collective

reflection on the social and institutional challenges that girls face, while classroom observations revealed subtle but persistent gender biases in teaching styles and student participation. These findings underscore the need for educational strategies that address both structural inequalities and entrenched social attitudes (Akyıldız & Ahmed, 2021).

By integrating quantitative and qualitative data through triangulation, the study enhances the robustness of its findings. While quantitative results quantified the extent of gender disparities, qualitative insights illuminated the underlying socio-cultural dynamics. This holistic approach is essential for understanding the multifaceted nature of educational inequities, particularly in rural, resource-constrained settings where systemic and cultural factors intersect (Akyıldız & Ahmed, 2021). The findings have significant implications for educational policy and practice. Addressing gender disparities in mathematics requires targeted interventions that tackle both systemic and cultural barriers

Study Area:

Kalomo District, located in Zambia's Southern Province, is predominantly rural and marked by widespread poverty, deeply rooted cultural practices, and inadequate infrastructure. The district's economy relies heavily on smallholder farming, which underscores the socio-economic challenges experienced by its residents. Educational infrastructure in Kalomo remains underdeveloped, with many schools grappling with shortages of classrooms, teaching materials, and qualified educators, further constraining the quality of education available to students.

The barriers to educational equity in Kalomo are particularly pronounced for female students. Girls in the district face several challenges, including long and unsafe distances to schools, limited access to reliable transportation, and cultural norms that traditionally prioritize boys' education over that of girls. These obstacles are exacerbated by high rates of early marriages and adolescent pregnancies, which frequently disrupt girls' education and hinder their engagement with subjects like mathematics. Such disruptions often lead to lower academic performance, diminished confidence, and restricted opportunities for girls to pursue higher education or careers in STEM fields.

These socio-economic and cultural factors create a unique educational landscape in Kalomo District, highlighting the need for targeted and context-sensitive interventions. The interplay of poverty, cultural norms, and resource constraints not only impacts educational equity but also underscores the broader systemic challenges faced by rural communities. Kalomo serves as a compelling case study for examining gender disparities in mathematics achievement, offering critical insights into how localized dynamics influence broader educational trends. Understanding these dynamics is essential for developing evidence-based strategies to address the challenges faced by rural schools, promote gender equity, and improve educational outcomes for all students in similar contexts.

Sample Size:

To capture a well-rounded and representative picture of gender disparities in mathematics achievement in rural Zambia, this study used a carefully planned sampling approach. Schools were first grouped according to their geographical location within Kalomo District. From these clusters, schools were randomly selected to reflect a mix of sizes, resource levels, and academic performance. Within each selected school, both students and teachers were sampled to ensure fair representation across different grades and genders.

In total, 500 students were included in the study—250 boys and 250 girls, drawn from Grades 8 to 12. These grade levels were purposefully chosen because they mark important transitions in mathematics education, ranging from foundational skills to more advanced topics. To maintain balance, each grade contributed around 100 students, with an even split between males and females. This sample size was large enough to allow meaningful comparisons across gender and other demographic factors. To enrich the findings, a smaller group of 40 students (20 boys and 20 girls) was selected from the main sample for semi-structured interviews and focus group discussions. These conversations helped uncover students' personal experiences, thoughts, and feelings about mathematics learning and gender expectations.

The study also engaged 50 mathematics teachers, chosen based on their active involvement in teaching Grades 8 to 12, their teaching experience (minimum one year), and their familiarity with the rural school context. All participating teachers completed structured surveys covering their qualifications, classroom practices, and views on gender in mathematics. From this group, 15 teachers took part in in-depth interviews to share their insights and challenges more openly. To bring institutional context into the picture, 20 rural schools were selected to represent a broad spectrum of resource conditions and student performance levels. Data from these schools were collected through institutional surveys, while classroom observations were carried out in 10 of them. These visits provided a closer look at how teaching practices, student participation, and gender dynamics played out in real-time.

By blending stratified random sampling for students with purposive sampling for teachers and schools, the study was able to combine statistical reliability with contextual richness. The mixed-methods design brought together numbers and narratives, helping to paint a complete and nuanced picture of the factors that shape gender differences in mathematics achievement across Kalomo District.

Sampling Techniques

This study utilized a combination of probability and non-probability sampling techniques to ensure a robust and comprehensive understanding of gender disparities in mathematics achievement in rural schools of Kalomo District. By integrating stratified random sampling and purposive sampling, the research balanced representativeness for the quantitative component and depth for the qualitative exploration.

Stratified random sampling, a probability sampling method, was employed to ensure balanced representation of male and female students in the quantitative component. The student population, comprising Grades 8 to 12, was divided into two strata: male and female. School registers from rural schools in Kalomo District served as the sampling frame for each stratum. A proportionate number of students from each stratum was randomly selected using a random number of generator or selection software. This approach ensured equitable gender representation in the sample, facilitating reliable statistical comparisons of performance and reducing sampling bias by giving equal consideration to male and female students. The final sample included 500 students, with an equal gender distribution of 250 male and 250 female participants, allowing for precise statistical analysis of gender disparities in mathematics achievement.

Purposive sampling, a non-probability method, was used for the qualitative component to select participants with direct experiences and unique perspectives on the factors influencing gender disparities in mathematics achievement. Participants were identified based on predefined criteria aligned with the study's objectives. Female students with low mathematics achievement and male students with high achievement were selected to explore contrasting experiences and attitudes. Teachers of both genders, with varying years of experience in rural schools, were included to provide insights into pedagogical practices and their role in shaping gender disparities. Parents or guardians actively involved in educational decisions, particularly for girls, were included to explore family-level factors influencing educational outcomes. Additionally, community leaders, as key informants with knowledge of local socio-cultural norms affecting education, were recruited. Participants in these groups were identified through referrals from teachers or school administrators, ensuring relevance and alignment with the study’s criteria.

This dual approach allowed the study to achieve both breadth and depth. Stratified random sampling ensured statistical representativeness in the quantitative analysis, enabling the identification of measurable trends and patterns. In contrast, purposive sampling facilitated a nuanced understanding of the qualitative findings, capturing the complexity of experiences and attitudes surrounding gender disparities. By integrating quantitative data from 500 students and qualitative data from targeted participants, the study generated actionable insights into localized and systemic factors driving gender disparities in mathematics achievement in Kalomo District. The methodological integration also enabled triangulation, linking quantitative trends with qualitative experiences to provide a comprehensive and context-sensitive understanding of the issue.

Data Collection Methods:

The data collection process for this study utilized both quantitative and qualitative methods, ensuring a comprehensive analysis of gender disparities in mathematics achievement in rural schools in Kalomo District. This mixed-methods approach integrated these dimensions to provide robust statistical evidence and contextual depth.

Quantitative data were collected through standardized mathematics tests and structured surveys. Mathematics tests assessed the proficiency levels of Grade 8 to 12 students, enabling the identification of performance disparities between male and female students. These tests were designed to capture both foundational and advanced mathematics competencies, allowing for detailed comparisons of achievement across genders. Structured surveys complemented the test data by gathering demographic and contextual information from students, including age, household size, parental education levels, and socio-economic status. Teachers and school administrators also participated in structured surveys, which collected data on pedagogical practices, teacher qualifications, resource availability, and perceptions of gender roles in mathematics education. This quantitative data provided measurable insights into the extent and patterns of gender disparities and the institutional and socio-economic factors contributing to them.

Qualitative data were gathered through semi-structured interviews, focus group discussions, and classroom observations. Semi-structured interviews were conducted with students, teachers, parents, and community leaders to explore their experiences, attitudes, and perceptions regarding gender and mathematics education. These interviews illuminated the socio-cultural and institutional dynamics influencing girls' participation and performance in mathematics. Focus group discussions created participatory spaces for students and teachers to share their perspectives, fostering dialogue on the systemic and cultural factors contributing to gender disparities. Classroom observations offered contextual insights into teaching practices, gender dynamics, and participation patterns, providing a nuanced understanding of how these factors operated within the learning environment.

By combining quantitative methods, such as test scores and surveys, with qualitative methods, such as interviews, focus groups, and observations, this study ensured a holistic analysis. The integration of these approaches allowed for triangulation of findings, strengthening the validity and reliability of the results. This comprehensive approach not only illuminated measurable trends but also captured the lived experiences and socio-cultural nuances influencing gender disparities in mathematics achievement in Kalomo District. These insights are critical for developing targeted, evidence-based interventions to promote educational equity in similar contexts.

Data Analysis:

The data analysis process incorporated both statistical and thematic approaches to rigorously test the stated hypotheses and ensure a comprehensive understanding of gender disparities in mathematics achievement in Kalomo District.

Quantitative data, including mathematics test scores and survey responses, were analyzed using statistical tools such as SPSS. To address Hypothesis 1 (H_{01}: There is no significant difference in mathematics achievement between male and female students in rural schools of Kalomo District; H_{11}: There is a significant difference), independent t-tests were employed to compare the mean mathematics scores of male and female students. These tests determined whether observed differences in performance were statistically significant, with effect sizes calculated to assess the magnitude of these differences. This dual analysis provided insights not only into statistical significance but also into the practical implications of the disparities.

For Hypothesis 2 (H_{02}: Socio-cultural factors do not significantly influence the mathematics achievement of female students in rural schools of Kalomo District; H_{12}: Socio-cultural factors significantly influence), regression analysis was conducted. Socio-cultural factors such as parental education, household responsibilities, and societal attitudes were included as independent variables, with mathematics achievement as the dependent variable. The regression model assessed the predictive power and influence of these variables

on the mathematics achievement of female students, identifying which factors significantly contributed to performance outcomes.

Descriptive statistics, including means, standard deviations, and frequencies, summarized the quantitative data, providing an overview of mathematics achievement trends and socio-cultural contexts. Additionally, ANOVA (Analysis of Variance) was applied to compare mathematics performance across different groups, such as socio-economic categories and schools with varying resource levels, further enriching the analysis.

Qualitative data, derived from transcripts of interviews, focus group discussions, and classroom observation notes, were analyzed using thematic analysis. This approach involved systematically coding the data to identify recurring patterns, themes, and relationships related to gender disparities in mathematics education. Themes such as societal attitudes toward gender roles, parental support, teacher-student dynamics, and the availability of role models were explored in depth.

The mixed-methods approach ensured that the stated hypotheses were thoroughly tested and the findings were both statistically robust and contextually rich. Quantitative results provided empirical evidence for or against the hypotheses, revealing measurable trends and disparities in mathematics achievement. Qualitative findings offered nuanced explanations of the socio-cultural and institutional factors underpinning these trends, enhancing the depth and applicability of the study's conclusions. This integration enabled a comprehensive analysis of gender disparities in mathematics achievement, providing actionable insights for addressing the challenges faced by female students in rural schools of Kalomo District.

Ethical Considerations:

The study adhered to strict ethical guidelines to ensure the rights, dignity, and well-being of all participants were respected throughout the research process. Several ethical considerations were implemented to maintain the integrity and credibility of the study.

Prior to participation, all participants were provided with clear and detailed information about the study's purpose, procedures, potential risks, and benefits. Consent forms were written in accessible language to ensure participants fully understood their rights, including the right to withdraw from the study at any time without penalty. For students under the age of 18, parental or guardian consent was obtained alongside the student's assent. The voluntary nature of participation was emphasized to prevent any coercion or obligation to participate. Participants' confidentiality was safeguarded by anonymizing all collected data. Identifiable information, such as names, school affiliations, and personal details, was replaced with unique codes to protect participants' identities. Data were stored securely on password-protected devices and encrypted systems, accessible only to authorized research personnel. During the dissemination of findings, results were presented in aggregate form to ensure that no individual or institution could be identified.

Ethical clearance was obtained from an institutional review board (IRB) or ethics committee prior to the commencement of the study. Permissions were also secured from relevant authorities, including the Zambian Ministry of Education and the district education office in Kalomo, to access schools and conduct research activities. School administrators were consulted to gain approval for engaging teachers and students and for conducting classroom observations. These permissions ensured institutional support and compliance with local regulations and policies.

Throughout all stages of the research, the study prioritized participants' autonomy, privacy, and well-being. By adhering to these ethical considerations, the research upheld the highest standards of integrity and demonstrated respect for all stakeholders involved. These measures not only ensured compliance with ethical research practices but also fostered trust and collaboration among participants and institutions, contributing to the overall reliability and validity of the findings.

RESULTS

This section presents the findings of the study, which aimed to examine gender disparities in mathematics achievement in rural schools of Kalomo District, Zambia. The research objective was to explore how these

disparities manifest and identify the socio-cultural factors influencing female students' performance in mathematics. The study addressed the following research question: *How do gender disparities manifest in mathematics achievement in rural schools of Kalomo District, Zambia?*

The analysis was guided by two hypotheses:

Hypothesis 1

(H_{01}): There is no significant difference in mathematics achievement between male and female students in rural schools of Kalomo District.

(H_{11}): There is a significant difference in mathematics achievement between male and female students in rural schools of Kalomo District.

Hypothesis 2

(H_{02}): Socio-cultural factors do not significantly influence the mathematics achievement of female students in rural schools of Kalomo District.

(H_{12}): Socio-cultural factors significantly influence the mathematics achievement of female students in rural schools of Kalomo District.

The findings are organized to provide a comprehensive understanding of the study's results. First, the quantitative findings are presented, including statistical analyses of mathematics test scores and survey responses. These findings highlight patterns of gender disparities and the measurable impact of socio-cultural factors on students' performance. Following this, the qualitative findings derived from interviews, focus group discussions, and classroom observations are discussed. These provide in-depth insights into the lived experiences, perceptions, and contextual factors influencing gender disparities in mathematics education. This integrated approach ensures that the statistical trends identified in the quantitative analysis are contextualized and enriched by the qualitative exploration, offering a holistic understanding of the issue.

Quantitative Findings

The demographic characteristics of the participants provide essential context for the analysis. The sample included 500 students (250 male and 250 female) from Grades 8 to 12 in rural schools in Kalomo District. The age of the participants ranged from 13 to 19 years, with a mean age of 15.8 years (SD = 1.2). The gender distribution was intentionally balanced to facilitate equitable comparisons in mathematics achievement across male and female students. Overall mathematics performance revealed a gender difference. Male students achieved a mean mathematics score of 65.4 (SD = 12.7), while female students scored an average of 58.2 (SD = 14.5). This suggests potential disparities, prompting further hypothesis testing to confirm the statistical significance of these observations.

The first hypothesis sought to determine whether there was a significant difference in mathematics achievement between male and female students in rural schools of Kalomo District. The null hypothesis (H_{01}) posited that no significant difference exists, while the alternative hypothesis (H_{11}) proposed that a significant difference does exist. To test this hypothesis, an independent samples t-test was conducted to compare the mean mathematics scores of male and female students. Prior to analysis, the assumptions of normality and homogeneity of variances were assessed. Normality was tested using the Shapiro-Wilk test for both male ($W = 0.976$, $p = 0.10$) and female ($W = 0.981$, $p = 0.12$) students, indicating that the data were approximately normally distributed. Levene's test for equality of variances yielded $F = 2.18$ with a p-value of 0.14, confirming that the assumption of equal variances was satisfied.

The results of the independent t-test revealed a statistically significant difference in mathematics achievement between male and female students, with a t-value of 5.63 ($df = 498$) and a p-value of less than 0.001. The effect size, as measured by Cohen's d, was 0.52, indicating a medium effect. These findings provide sufficient evidence to reject the null hypothesis (H_{01}) and accept the alternative hypothesis (H_{11}), thereby confirming that male students significantly outperformed female students in mathematics achievement.

Hypothesis 2

The second hypothesis examined whether socio-cultural factors significantly influenced the mathematics achievement of female students in rural schools of Kalomo District. The null hypothesis (H_{02}) stated that these factors had no significant influence, while the alternative hypothesis (H_{12}) suggested that they did.

To test this hypothesis, a multiple regression analysis was conducted to explore the effects of parental education, household responsibilities, and societal attitudes on female students' mathematics performance. Before proceeding with the analysis, several assumptions were tested. Linearity was confirmed through scatterplots comparing predicted and observed values, while the Durbin-Watson statistic was 1.89, indicating that the residuals were independent. Multicollinearity was not an issue, as the variance inflation factor (VIF) values ranged from 1.1 to 1.3. Homoscedasticity was confirmed through visual inspection of residual plots, and the normality of residuals was validated using the Shapiro-Wilk test ($W = 0.978$, $p = 0.09$).

The regression model was found to be statistically significant, with $F(3, 246) = 18.92$ and $p < 0.001$. The model accounted for 29% of the variance in female students' mathematics achievement, as indicated by an R^2 value of 0.29. Among the predictors, parental education emerged as a strong and positive influence on mathematics achievement ($\beta = 0.41$, $p < 0.001$), while household responsibilities showed a significant negative effect ($\beta = -0.28$, $p = 0.002$), suggesting that the burden of domestic tasks interferes with girls' academic performance. Societal attitudes toward gender and mathematics had a weaker influence and did not reach statistical significance ($\beta = -0.15$, $p = 0.08$). These results led to the rejection of the null hypothesis (H_{02}) and the acceptance of the alternative hypothesis (H_{12}), indicating that socio-cultural factors—especially parental education and household responsibilities—play a significant role in shaping female students' mathematics outcomes.

Overall, the quantitative findings reveal a clear pattern of gender disparities in mathematics achievement among rural learners in Kalomo District. Male students consistently outperformed their female peers, while socio-cultural dynamics, particularly those related to family background and gendered household expectations, significantly influenced girls' academic performance. These findings underscore the urgent need to confront both systemic and cultural barriers in order to promote equitable mathematics achievement for all learners, regardless of gender.

Qualitative Findings

The qualitative analysis identified five key themes that illuminate the socio-cultural and institutional factors influencing gender disparities in mathematics achievement in rural schools in Kalomo District. These themes, supported by illustrative quotes, are presented below without interpretation or discussion. These themes, supported by illustrative quotes, are presented below without interpretation or discussion and are visually summarized in Figure 1.

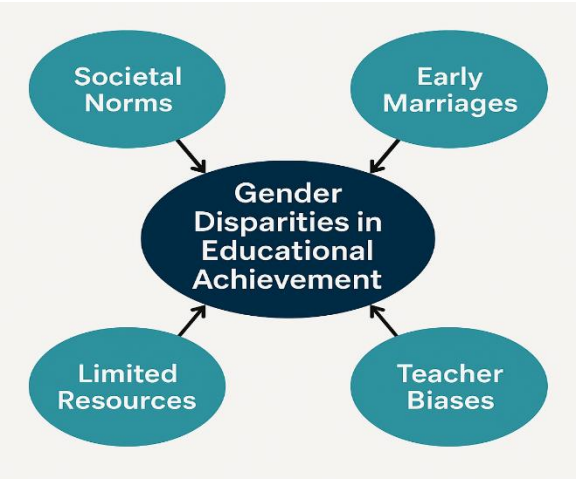

Figure 1: Thematic Diagram on factors contributing to gender disparities in mathematics

Theme 1: Societal Expectations and Gender Stereotypes

Societal norms and cultural beliefs perpetuate the idea that mathematics is a subject suited for boys, leading to diminished confidence and engagement among girls. These stereotypes are reinforced in families, communities, and classrooms. Some of the participants had the following to narrate: *"In our culture, people believe boys are naturally better at mathematics, so girls often feel like they don't belong in the subject." (Female student, Grade 11) "When girls fail in mathematics, it's seen as normal. When boys fail, people think something is wrong." (Male teacher) "Some parents openly say they expect their sons to perform better than their daughters in school." (Female teacher)*

Theme 2: Disparities in Parental and Teacher Support

Support from parents and teachers is pivotal, yet many female students reported receiving less encouragement and attention compared to their male peers. Parental priorities and teacher expectations often reflect gender biases, shaping students' confidence and performance in mathematics. Some of the participants had the following to narrate *"My parents support my education, but they focus more on my brother's studies because they think he has a better future in mathematics." (Female student, Grade 9) "Girls in my class are less likely to ask questions because they feel the teacher gives more attention to boys." (Female student, Grade 10). "Some teachers unconsciously favour boys in mathematics, giving them more opportunities to answer questions or participate." (Male teacher)*

Theme 3: Resource and Role Model Limitations

The lack of adequate educational resources, such as textbooks and classroom materials, disproportionately affects girls' learning experiences. The absence of female mathematics teachers exacerbates the lack of role models for female students. Some of the participants had the following to narrate: *"In our school, we share textbooks, and often boys get them first. This makes it harder for girls to keep up." (Female student, Grade 8) "We've never had a female mathematics teacher, which I think would make a big difference for girls." (Male teacher) "The infrastructure is so poor that we don't even have enough desks. Girls sometimes sit at the back, which affects their participation." (Female student, Grade 12)*

Theme 4: Balancing Educational and Domestic Responsibilities

Girls face significant challenges in balancing schoolwork with domestic responsibilities, such as household chores and caregiving. These additional burdens often interfere with their ability to focus on their studies and participate fully in mathematics education. Some of the participants had the following to narrate: *"I wake up early to help with cooking and cleaning before going to school. By the time I reach class, I'm already tired." (Female student, Grade 10) "When my younger siblings are sick, I have to miss school to take care of them, but my brother doesn't have to do that." (Female student, Grade 9) "Girls in rural areas have so many responsibilities at home that it's hard for them to concentrate on their education." (Community leader)*

Theme 5: Psychological Barriers and Math Anxiety

Math anxiety and a lack of self-confidence emerged as significant psychological barriers among female students. Many girls expressed fear of making mistakes in class, which prevented them from participating actively in mathematics lessons. Some of the participants had the following to narrate *"I feel nervous when the teacher asks me to solve a math problem in front of the class because I'm afraid of getting it wrong." (Female student, Grade 11) "Some girls think they can't do well in mathematics because they've been told it's too hard for them." (Male teacher) "Math feels intimidating to many girls because they don't believe they are capable, even when they are." (Female teacher)*

The participant narratives further underscores the themes. One female student shared how she was discouraged from studying mathematics by her family, who prioritized her household responsibilities over academics. A male teacher recounted his efforts to encourage girls to participate in class despite cultural stereotypes.

Another female student described how her self-confidence improved after receiving support from a teacher who believed in her potential.

DISCUSSION

This section explores the findings in relation to the study's research objective, research question, and hypotheses, providing a detailed and thoughtful analysis. By weaving together the quantitative results with qualitative insights, the discussion presents a holistic interpretation of the ways in which gender disparities in mathematics achievement emerge in rural schools of Kalomo District, Zambia. Furthermore, it examines the socio-cultural factors shaping the performance of female students, offering a nuanced understanding of the systemic and individual barriers that perpetuate these inequalities. Through this integration, the discussion not only contextualizes the findings within the broader framework of educational and societal dynamics but also highlights their significance for addressing gender disparities in education.

The research objective was to investigate gender disparities in mathematics achievement in rural schools of Kalomo District, Zambia, with the research question focusing on how these disparities manifest. The findings reveal a pronounced gender gap, with male students consistently outperforming female students in mathematics achievement. Additionally, socio-cultural factors, notably parental education and household responsibilities, emerged as significant influences on female students' performance. These results confirm the presence of gender disparities and provide critical insights into the socio-cultural dynamics underlying these inequalities, effectively addressing the research question and advancing understanding of the issue.

Findings in Relation to Hypothesis 1 (H_{11}): Gender Disparities in Mathematics Achievement

The quantitative analysis revealed a statistically significant difference in mathematics achievement between male and female students in rural schools of Kalomo District. Male students attained a mean score of 65.4 (SD = 12.7), significantly outperforming their female counterparts, who achieved a mean score of 58.2 (SD = 14.5). An independent t-test ($t(498) = 5.63$, $p < 0.001$) confirmed the significance of this disparity, supporting Hypothesis 1 (H_{11}: There is a significant difference in mathematics achievement between male and female students) and leading to the rejection of the null hypothesis (H_{01}: There is no significant difference in mathematics achievement between male and female students). The observed effect size (Cohen's $d = 0.52$) indicates a medium effect, underscoring the meaningful nature of this gender disparity.

This finding aligns with Recber et al. (2017), who identified societal expectations and higher self-efficacy among males as key contributors to performance differences in mathematics. The medium effect size, as defined by Mata et al.'s (2012) interpretation of Cohen's benchmarks, reinforces that the observed gender gap is not a statistical anomaly but a substantial educational concern. Furthermore, Wang and Degol (2017) emphasize that self-efficacy, societal stereotypes, and structural inequities play critical roles in perpetuating gender disparities in mathematics and STEM fields. These factors are particularly relevant in rural contexts like Kalomo District, where entrenched cultural norms and limited educational resources exacerbate inequalities.

The findings underscore the urgent need for targeted interventions to address socio-cultural and systemic barriers that disproportionately affect female students in rural areas. While this study highlights significant gender disparities in mathematics achievement, further research is necessary to investigate the specific mechanisms underlying these differences within the unique socio-economic and cultural contexts of rural Zambia. Understanding how localized factors intersect with broader societal influences will be crucial for developing context-sensitive strategies that promote gender equity in mathematics education. By shedding light on these disparities, this study contributes to the growing body of evidence calling for systemic reforms to ensure equitable access to quality education for all students. Such efforts are essential not only for addressing educational inequities but also for unlocking the untapped potential of female learners, fostering national development, and advancing global goals related to gender equality and quality education.

Qualitative findings provide a richer, contextual understanding of these disparities, highlighting how socio-cultural dynamics shape educational experiences and outcomes for female students. Female participants

consistently expressed feelings of inadequacy and diminished confidence in their mathematical abilities. These perceptions were often linked to societal stereotypes portraying mathematics as a male-dominated domain, which discouraged active participation and fostered a sense of alienation from the subject. Such observations align with the work of Aboagye et al. (2021), who documented heightened levels of math anxiety among female students, particularly in complex areas such as geometry. This anxiety, coupled with societal messaging, creates a compounding effect, deterring female students from fully engaging with mathematics and pursuing related fields.

Classroom dynamics further exacerbate these issues, with some participants reporting experiences of differential treatment. Female students described scenarios where teachers unintentionally favored male students, providing them with more opportunities to participate in class discussions or receive individualized support. One participant noted, “In class, boys are often the first to be called on to answer questions. It makes girls feel like we are not as capable.” Such teacher-student interactions reflect implicit biases, as noted by Meyer et al., who emphasized the role of unconscious attitudes in perpetuating gender gaps in STEM fields.

Resource inequities also emerged as a key barrier to female students’ success in mathematics. Participants highlighted limited access to textbooks and other learning materials, with boys often prioritized when resources were scarce. Additionally, the lack of female role models in mathematics education further deepened the gap. One teacher observed, “Our school has never had a female mathematics teacher. If we did, I think it would show girls that they can succeed in this subject too.” These findings are consistent with previous research indicating that the absence of relatable role models can discourage girls from pursuing mathematics and STEM careers (Meyer et al.).

The interplay of these factors—societal expectations, classroom dynamics, and resource inequities—is reflected in the data and narratives, painting a comprehensive picture of the systemic challenges female students face in achieving equitable outcomes in mathematics. The medium effect size observed in the quantitative analysis underscores the tangible impact of these disparities, while the qualitative insights reveal the lived realities behind the numbers.

By integrating statistical trends with contextual narratives, this study provides a nuanced understanding of gender disparities in mathematics achievement in rural schools. The findings underscore the importance of addressing not only measurable performance gaps but also the socio-cultural and institutional barriers that perpetuate them. Together, these results highlight the urgent need for targeted interventions that challenge stereotypes, foster inclusive learning environments, and provide equitable access to resources and role models to support female students in their mathematics education journey.

Findings in Relation to Hypothesis 2 (H_{12}): Influence of Socio-Cultural Factors

The influence of socio-cultural factors on female students' mathematics achievement is a crucial area of research, illustrating the complex interplay between family background, societal expectations, and educational outcomes. The regression analysis conducted in this study confirmed that socio-cultural factors significantly impact female students' performance in mathematics, thereby validating Hypothesis 2 (H_{12}: Socio-cultural factors significantly influence the mathematics achievement of female students) and rejecting the null hypothesis (H_{02}: Socio-cultural factors do not significantly influence the mathematics achievement of female students). The model explained 29% of the variance in mathematics performance, with parental education and household responsibilities emerging as significant predictors.

Parental education demonstrated a strong positive influence on female students' mathematics achievement ($\beta = 0.41$, $p < 0.001$). Higher levels of parental education were associated with increased academic support and encouragement, enabling girls to challenge traditional gender norms and aspire toward success in mathematics. This finding aligns with existing research, which highlights the critical role of parental involvement in fostering academic performance and resilience in the face of societal pressures (Makarova et al., 2019; Yağan, 2023). Qualitative findings reinforced this pattern, with female students reporting that their parents’ encouragement motivated them to excel despite societal stereotypes. For example, one participant noted, "My father always tells me that mathematics is important for my future, and he supports me even when others say

it's not a subject for girls." These accounts reflect broader evidence that parental support, both emotional and academic, can mitigate the impact of cultural biases on girls' educational outcomes (Appiah et al., 2022; DC, 2023).

In contrast, household responsibilities were identified as a significant barrier to female students' mathematics achievement ($\beta = -0.28$, $p = 0.002$). Female students frequently reported that domestic duties such as cooking, cleaning, and caregiving reduced the time and energy available for academic pursuits. This finding aligns with research highlighting how entrenched gender roles disproportionately burden girls, creating significant obstacles to academic success, particularly in STEM fields ("Factors that Contribute to Junior High School Female Students' Negative Attitudes toward the Study of Mathematics in the Fanteakwa District, Ghana", 2023; Pokharel, 2023). One student explained, "After school, I have to help with chores before I can even start my homework. Sometimes, I'm too tired to finish it." This dynamic, characterized by limited study time and increased stress, has been shown to negatively affect girls' performance in mathematics and related subjects ("Gender as Determinant of Students Performance in Mathematics Periodic Tests and Terminal Examination in Federal Capital Territory Secondary Schools in Nigeria", 2021).

While societal attitudes toward gender roles were not a statistically significant predictor in the regression analysis ($\beta = -0.15$, $p = 0.08$), qualitative data highlighted their pervasive and insidious impact. Participants frequently described societal norms that marginalize girls in educational settings, reinforcing stereotypes that mathematics is a male-dominated subject. Teachers and students alike noted the absence of female role models in mathematics as a significant factor influencing girls' confidence and aspirations. One teacher commented, "If we had more female mathematics teachers, girls might feel like they belong in this subject." This finding aligns with existing research suggesting that relatable role models are critical in shaping girls' self-efficacy and motivation in STEM fields (Makarova et al., 2019; Martínez et al., 2020). Furthermore, societal stereotypes perpetuated through cultural and institutional messaging contribute to lower self-efficacy among girls, as they internalize the belief that mathematics is unsuitable for them (Yağan, 2023; Lu et al., 2023).

The findings emphasize the need to address both systemic and cultural barriers to improve female students' attitudes and performance in mathematics. Research suggests that dismantling stereotypes and providing equitable support structures, including parental involvement and teacher encouragement, are essential steps toward achieving gender equity in education (Kuśnierz et al., 2020). While quantitative results highlight significant predictors, the qualitative insights illustrate how deeply embedded societal norms and expectations shape girls' academic experiences, underscoring the multifaceted nature of the challenge.

Emerging Themes and their Connection to the Objective

The qualitative analysis of gender disparities in mathematics achievement has identified five critical themes that collectively highlight the systemic, cultural, and individual factors influencing girls' engagement and performance in mathematics. These themes provide valuable insights into the barriers girls face in mathematics education, directly addressing the research objective of understanding these challenges.

Societal Expectations and Gender Stereotypes

Societal stereotypes that frame mathematics as a subject inherently suited to male competence remain deeply entrenched, creating significant barriers to girls' full engagement and achievement in the discipline. These pervasive beliefs, often subtly reinforced in families, schools, and communities, contribute to the development of a negative self-perception among girls. This detrimental self-view is closely linked to lower levels of confidence, reduced participation in mathematics-related activities, and a reluctance to pursue further studies or careers in mathematics-intensive fields (Marakshina, 2023; John et al., 2022; Luttenberger et al., 2018).

Girls frequently internalize the notion that mathematics is a male-dominated domain, a belief that not only undermines their self-efficacy but also diminishes their motivation to strive for excellence in the subject. This internalized stereotype becomes a self-limiting factor, shaping their attitudes and decisions in ways that reinforce the very disparities the stereotypes create (Hildebrand et al., 2022; Xie et al., 2022). The qualitative findings of this study highlight the ways in which external pressures from peers and educators amplify these

effects, creating classroom and social environments where girls feel less capable and valued compared to their male counterparts. As one participant expressed, "Mathematics is seen as something boys are naturally better at. It's hard to feel confident when people expect you to fail."

Such sentiments are not isolated but are echoed in broader societal attitudes that assign higher expectations and encouragement to boys in mathematical pursuits while often viewing girls' abilities in this area with skepticism or resignation (Milovanović, 2020; John et al., 2022). The interplay of these societal and institutional factors reinforces a cycle of disengagement, where girls, doubting their capabilities, are less likely to seek help, actively participate in class, or pursue opportunities that could help them excel. Addressing these stereotypes requires not only a shift in cultural and educational narratives but also intentional efforts to create inclusive and supportive environments that challenge these long-standing biases. Encouragingly, research has shown that interventions aimed at promoting positive reinforcement and equal opportunities can help break the cycle of internalized stereotypes, empowering girls to see themselves as equally capable and deserving of success in mathematics.

Disparities in Parental and Teacher Support

The findings highlight pronounced disparities in the support provided by parents and teachers to boys and girls in mathematics education, revealing an entrenched bias that often favors boys in both academic encouragement and expectations. Parents and teachers frequently hold lower expectations for girls' mathematical performance, which can negatively influence girls' confidence, self-efficacy, and motivation to excel in the subject (Figueira et al., 2023; Wang et al., 2023). This subtle but pervasive bias shapes the ways in which girls perceive their own abilities and limits their willingness to engage deeply with mathematics.

The impact of teacher attitudes is particularly striking. Teachers with math anxiety, for example, may unconsciously transmit their biases, such as by calling on boys more often or assigning them more challenging tasks, which reinforces the perception that boys are naturally better at mathematics (Wang et al., 2023). One student shared her frustration, saying, "In class, the teacher always seems to assume the boys will have the right answer, so they get more chances to participate." This unequal treatment creates a learning environment where girls feel undervalued and less capable, contributing to their underachievement.

Parental support also plays a critical role in shaping attitudes toward mathematics, yet the findings reveal disparities in the level and quality of encouragement given to girls. A participant recounted, "My brother always gets more help with math at home because they think he has a better chance of succeeding." This lack of equitable support undermines girls' belief in their abilities, particularly in households where traditional gender roles and societal expectations frame boys as more likely to succeed in subjects like mathematics. Studies confirm that such disparities in parental encouragement can lead to diminished self-efficacy and a lack of interest in mathematics among girls (Thapa & Paudel, 2021; Dangur-Levy, 2023). These findings underscore the vital importance of parental and teacher support in fostering positive attitudes and outcomes in mathematics for girls. When teachers and parents actively challenge stereotypes and provide equal encouragement, girls are more likely to develop the confidence and motivation needed to succeed in mathematics. Ensuring that this support is both intentional and equitable is crucial for addressing the broader gender disparities in mathematics education and empowering girls to realize their full potential in the subject.

Resource and Role Model Limitations

The findings reveal that limited access to resources and the absence of female role models in mathematics education disproportionately impact girls' learning experiences and their ability to thrive in mathematics. The availability of female mathematics teachers or mentors has been shown to significantly enhance girls' self-efficacy, motivation, and aspirations in the subject, as female role models can provide relatable examples of success and break down stereotypes associated with gendered expectations in STEM fields (Macmull & Ashkenazi, 2019). However, in many rural schools, the scarcity of female mathematics teachers creates a void that can lead to feelings of isolation among female students and diminished ambition to pursue mathematics-related opportunities (Xie et al., 2022; Wang et al., 2023).

In addition to the lack of role models, unequal access to essential educational resources further compounds the challenges faced by female students. Textbooks, tutoring services, and extracurricular programs often play a pivotal role in reinforcing classroom learning and fostering mastery of mathematics concepts. Yet, when these resources are scarce, boys are frequently given priority access, reflecting deep-seated societal norms that prioritize boys' academic needs over girls' (Ali & Hassan, 2019; Thapa & Paudel, 2021). A teacher highlighted this disparity, stating, "When resources are limited, boys often get priority, leaving girls with fewer opportunities to practice and improve." This unequal distribution of resources not only undermines girls' academic progress but also signals a lack of institutional commitment to their educational equity.

The absence of dedicated spaces or programs for girls to engage with mathematics outside the classroom exacerbates the issue. While boys may benefit from greater encouragement to participate in competitive or advanced mathematics activities, girls often lack similar opportunities, further widening the gap in confidence and achievement. The cumulative effect of these systemic barriers creates an environment where girls struggle to see themselves as capable or successful in mathematics, perpetuating gender disparities in the field. Addressing these limitations requires targeted interventions that ensure equitable access to resources and increase the representation of female role models in mathematics education. By providing girls with the tools and encouragement needed to succeed, alongside visible examples of women excelling in mathematics, schools and policymakers can help dismantle the structural inequities that hinder girls' full participation in the subject.

Balancing Educational and Domestic Responsibilities

The findings highlight the significant challenges posed by domestic responsibilities on girls' academic engagement and performance in mathematics. Household chores and caregiving duties disproportionately burden female students, reducing the time and energy they can devote to their studies. This dynamic is particularly detrimental in subjects like mathematics, where consistent practice and sustained focus are essential for mastery (Milovanović, 2020; Mier et al., 2019). These domestic obligations often result in girls having less time for homework, revision, or participation in additional learning activities, placing them at a distinct disadvantage compared to their male peers.

Cultural and societal expectations frequently position girls as primary contributors to domestic tasks, reinforcing traditional gender roles that prioritize household responsibilities over academic pursuits (Mier et al., 2019; Sun, 2023). As one participant shared, "I wake up early to help at home, and by the time I get to school, I'm too tired to focus in class." This reality not only affects girls' immediate ability to engage with their lessons but also erodes their confidence and aspirations, as they internalize the perception that their education is less valued than their domestic contributions.

The impact of these responsibilities extends beyond the classroom, as girls often struggle to find the time and space needed for independent study or to seek help in challenging subjects like mathematics. This situation is compounded in rural contexts, where limited access to time-saving amenities such as running water or electricity further intensifies the demands placed on girls. The cumulative effect of these barriers creates a cycle where girls are less able to perform well academically, which in turn reinforces societal biases about their capabilities in mathematics and other disciplines.

Breaking this cycle requires a collective effort to challenge traditional gender norms and reallocate domestic responsibilities more equitably within households. Schools and communities can play a critical role by advocating for and implementing support structures, such as after-school programs and peer mentoring initiatives, that provide girls with dedicated time and resources to focus on their studies. Moreover, raising awareness among parents about the long-term benefits of girls' education can help shift attitudes and reduce the prioritization of domestic duties over academic success. By addressing these systemic barriers, stakeholders can create an environment where girls have the opportunity to thrive academically without the disproportionate burden of domestic responsibilities.

Psychological Barriers and Math Anxiety

Math anxiety has emerged as a profound psychological barrier that significantly impacts girls' engagement and performance in mathematics. Research consistently shows that girls report higher levels of math anxiety compared to boys, which correlates negatively with their mathematical achievement (Herawati et al., 2021; Daker et al., 2021; Milovanović, 2020). This anxiety often manifests as fear, stress, and a lack of confidence, particularly when solving problems or answering questions in classroom settings. The qualitative findings revealed that many female students experience a deep reluctance to participate in mathematics-related activities, driven by a fear of making mistakes and confirming societal stereotypes about their abilities.

One participant expressed this fear succinctly: "I'm scared to answer questions in math because if I get it wrong, it just proves what everyone thinks about girls and math." Such sentiments highlight how deeply internalized beliefs, shaped by societal stereotypes and reinforced through negative feedback, contribute to the perpetuation of math anxiety among girls (Lucietto & Rada, 2022; Lauer et al., 2018). This psychological barrier not only limits girls' willingness to engage actively in mathematics but also affects their self-perception, making it more challenging for them to see themselves succeeding in the subject.

Math anxiety is further exacerbated by classroom dynamics where girls feel less encouraged to participate or are more likely to be judged harshly for mistakes. Negative feedback, whether from peers or teachers, reinforces the perception that they are less capable than their male counterparts. This cycle of anxiety and reduced participation creates a self-fulfilling prophecy, where girls underperform, thereby validating the stereotypes that undermine their confidence in the first place.

The findings emphasize that addressing math anxiety is critical to improving girls' mathematical performance and overall attitudes toward the subject. Research supports the implementation of targeted interventions to reduce anxiety, such as fostering a growth mindset, providing positive reinforcement, and creating an inclusive classroom environment where mistakes are viewed as learning opportunities (Kuśnierz et al., 2020). Teachers play a pivotal role in reshaping these narratives by actively challenging stereotypes and ensuring equal opportunities for all students to engage and excel in mathematics.

The themes identified in this qualitative analysis, including psychological barriers such as math anxiety, are intricately connected to the broader systemic and societal factors influencing gender disparities in mathematics achievement. Together with societal expectations, disparities in support, resource limitations, and domestic responsibilities, these psychological barriers create a challenging educational landscape for girls. Addressing these issues requires a comprehensive approach involving educators, parents, and policymakers to foster equitable opportunities, dismantle harmful stereotypes, and create a supportive environment that empowers girls to succeed in mathematics and beyond.

Implications of Findings

The study's findings have significant theoretical, practical, and societal implications for addressing gender disparities in mathematics achievement in rural, resource-limited contexts. Theoretically, the study builds on Expectancy-Value Theory by highlighting how socio-cultural factors—particularly parental education and household responsibilities—shape girls' self-efficacy and engagement in mathematics. It underscores the importance of considering both internal beliefs and external influences when analyzing gender disparities in STEM education.

Practically, the findings suggest actionable interventions, including:

- Teacher training to reduce gender bias and promote inclusive teaching,
- Equitable resource allocation to rural schools,
- Community engagement to support girls' education,
- Mentorship programs featuring female role models in mathematics and STEM.

Societally, the study aligns with Zambia's education priorities and the UN Sustainable Development Goals, especially SDG 4 (Quality Education) and SDG 5 (Gender Equality). Promoting girls' success in mathematics contributes to human capital development and inclusive economic growth.

RECOMMENDATIONS

Policy Recommendations

To address gender disparities in mathematics achievement, a coordinated effort by government bodies, schools, and community stakeholders is essential. Policymakers should prioritize the following actions:

- Develop and implement policies that explicitly promote gender equity in mathematics education, ensuring girls have equal access to resources, opportunities, and support.
- Increase funding for rural schools to provide adequate textbooks, learning materials, and infrastructure, with a focus on addressing disparities that disproportionately affect girls.
- Engage parents, community leaders, and educators through awareness programs that emphasize the value of girls' education, challenge harmful stereotypes, and encourage equitable support for all students.
- Establish mechanisms to regularly assess the implementation and effectiveness of gender-focused educational policies, using data-driven approaches to identify gaps and inform adjustments.

Practical Interventions

Practical steps are necessary to address the immediate challenges girls face in mathematics education:

- Equip teachers with the skills to identify and challenge gender biases, foster inclusive classroom practices, and support students experiencing math anxiety. These programs should include workshops, mentoring, and ongoing professional development.
- Integrate gender-responsive content and teaching methods into the mathematics curriculum to ensure inclusivity and relevance for all students.
- Establish mentorship programs that connect female students with successful women in STEM fields, including female mathematics teachers. This can inspire girls to view mathematics as a viable and rewarding field.
- Create school-based initiatives, such as after-school tutoring and peer study groups, to provide girls with additional learning opportunities in a supportive environment. Programs that reduce domestic burdens, such as school meal initiatives or child care support, can also help girls focus on their studies.

Further Research

While this study provides valuable insights, it also highlights areas requiring further investigation:

- Future research should explore whether similar gender disparities exist in urban and peri-urban settings, identifying differences in socio-cultural and systemic factors.
- Long-term studies are needed to understand how socio-cultural influences and interventions evolve over time and their sustained impact on mathematics achievement.
- Investigate how other factors, such as socioeconomic status, ethnicity, and disability, intersect with gender to influence mathematics performance.
- Conduct experimental or quasi-experimental studies to evaluate the effectiveness of specific interventions, such as teacher training or mentorship programs, in reducing gender disparities.

CONCLUSION

This study has provided a comprehensive analysis of the factors contributing to gender disparities in mathematics achievement in rural schools of Kalomo District, Zambia. By integrating quantitative and qualitative findings, the study has illuminated the multifaceted nature of these disparities, which are shaped by

systemic, cultural, and individual factors. The findings not only validate existing theories, such as the Expectancy-Value Theory, but also extend their applicability by incorporating socio-cultural and contextual influences unique to resource-constrained rural settings.

Parental education and household responsibilities emerged as significant predictors of female students' mathematics achievement, highlighting the profound impact of socio-cultural dynamics on academic outcomes. These insights demonstrate the importance of addressing gendered expectations and providing targeted support to alleviate domestic burdens, which disproportionately affect girls' engagement in mathematics. Furthermore, the findings reveal that psychological barriers, such as math anxiety, and systemic challenges, including limited access to resources and female role models, exacerbate the existing disparities, reinforcing the need for comprehensive interventions.

This discussion also underscores the urgency of challenging entrenched societal stereotypes that undermine girls' confidence and participation in mathematics. It is evident that teachers, parents, and community leaders play pivotal roles in shaping attitudes and behaviors that either perpetuate or mitigate these disparities. Therefore, interventions must focus on fostering equitable teaching practices, raising awareness about the value of girls' education, and ensuring access to supportive learning environments.

The study's implications for policy and practice are robust, advocating for teacher training programs that address implicit biases, equitable allocation of educational resources, and the implementation of mentorship initiatives to inspire and empower female students. These recommendations align with Zambia's commitments to achieving Sustainable Development Goals (SDGs) 4 and 5, emphasizing the broader societal impact of addressing gender disparities in education.

While this study provides critical insights, it is not without limitations. The findings are context-specific, focusing on rural schools in Kalomo District, which may limit their generalizability to other settings. Future research should explore similar dynamics in urban and peri-urban areas to capture a broader picture of gender disparities in mathematics education. Additionally, longitudinal studies could provide deeper insights into how socio-cultural factors and interventions evolve over time.

In conclusion, this study contributes to the growing body of knowledge on gender disparities in mathematics education by providing a nuanced understanding of the systemic, cultural, and individual barriers that girls face in rural Zambia. By addressing these barriers through informed policies and targeted interventions, stakeholders can create a more equitable educational landscape that empowers girls to achieve their full potential, thereby fostering gender equality and sustainable development. These findings serve as a call to action for educators, policymakers, and researchers to prioritize gender equity in mathematics education and to work collaboratively toward creating an inclusive and supportive learning environment for all students.

REFERENCES

1. Aboagye, K., Ke, Y., & Mante, D. (2021). Factors influencing students' perceived difficulties in studying geometry: a case of konogo-odumasi, ghana. Open Journal of Social Sciences, 09(09), 526-540. https://doi.org/10.4236/jss.2021.99038
2. Abuya, B., Mumah, J., Austrian, K., Mutisya, M., & Kabiru, C. (2018). Mothers' education and girls' achievement in kibera: the link with self-efficacy. Sage Open, 8(1). https://doi.org/10.1177/2158244018765608
3. Ajai, J. and Imoko, B. (2014). Gender differences in mathematics achievement and retention scores: a case of problem-based learning method. International Journal of Research in Education and Science, 1(1), 45. https://doi.org/10.21890/ijres.76785
4. al., B. (2023). Addressing gender disparities in education: empowering girls through education in pakistan. Russian Law Journal, 11(12s). https://doi.org/10.52783/rlj.v11i12s.1997
5. Ali, N. and Hassan, N. (2019). Mathematics anxiety and mathematics motivation among students in the faculty of science of a public university in malaysia. International Journal of Academic Research in Progressive Education and Development, 8(4). https://doi.org/10.6007/ijarped/v8-i4/6786

6. Amador, J. (2018). Teachers' gender considerations during elementary mathematics lesson design. School Science and Mathematics, 118(7), 290-299. https://doi.org/10.1111/ssm.12299
7. Andersen, I. and Smith, E. (2022). Social contexts and gender disparities in students' competence beliefs: the role of gender-stereotypical beliefs and achievement patterns in the classroom for students' self-concept in gender-stereotypical subjects. Frontiers in Education, 7. https://doi.org/10.3389/feduc.2022.840618
8. Anlimachie, M., Avoada, C., & Amoako-Mensah, T. (2022). Leapfrogging inequality strategies for transformed rural education: a school district case, ghana. Australian and International Journal of Rural Education, 33-51. https://doi.org/10.47381/aijre.v32i1.282
9. Appiah, J., Korkor, S., Arthur, Y., & Obeng, B. (2022). Mathematics achievement in high schools, the role of the teacher-student relationship, students' self-efficacy, and students' perception of mathematics. International Electronic Journal of Mathematics Education, 17(3), em0688. https://doi.org/10.29333/iejme/12056
10. Arafat, A., Ahmad, N., & Ismail, S. (2021). Socio-cultural gender norms and economic barriers in the context of rural high school girls' dropout in bangladesh: a qualitative study. Malaysian Journal of Social Sciences and Humanities (Mjssh), 6(8), 436-447. https://doi.org/10.47405/mjssh.v6i8.962
11. Bahar, A. (2020). Trends in gender disparities among high-achieving students in mathematics: an analysis of the american mathematics competition (amc). Gifted Child Quarterly, 65(2), 167-184. https://doi.org/10.1177/0016986220960453
12. Beck, D., Veliz, P., Munro-Kramer, M., Ngoma, T., Scott, N., Kaiser, J., … & Lori, J. (2021). Home birth in rural zambia: the role of intimate partner violence and autonomous decision-making. Journal of Midwifery & Women S Health, 66(2), 256-264. https://doi.org/10.1111/jmwh.13208
13. Breda, T., Jouini, E., & Napp, C. (2023). Gender differences in the intention to study math increase with math performance. Nature Communications, 14(1). https://doi.org/10.1038/s41467-023-39079-z
14. Brewster, B. and Miller, T. (2020). Missed opportunity in mathematics anxiety. International Electronic Journal of Mathematics Education, 15(3), em0600. https://doi.org/10.29333/iejme/8405
15. Casad, B., Hale, P., & Wachs, F. (2017). Stereotype threat among girls. Psychology of Women Quarterly, 41(4), 513-529. https://doi.org/10.1177/0361684317711412
16. Charlesworth, T. and Banaji, M. (2019). Gender in science, technology, engineering, and mathematics: issues, causes, solutions. Journal of Neuroscience, 39(37), 7228-7243. https://doi.org/10.1523/jneurosci.0475-18.2019
17. Cvencek, D., Meltzoff, A., & Greenwald, A. (2011). Math-gender stereotypes in elementary school children. Child Development, 82(3), 766-779. https://doi.org/10.1111/j.1467-8624.2010.01529.x
18. Daker, R., Gattas, S., Sokolowski, H., Green, A., & Lyons, I. (2021). First-year students' math anxiety predicts stem avoidance and underperformance throughout university, independently of math ability. NPJ Science of Learning, 6(1). https://doi.org/10.1038/s41539-021-00095-7
19. Dangur-Levy, S. (2023). Sources of mathematics self-efficacy: the interactive role of parental education and perceptions of teachers. Canadian Review of Sociology/Revue Canadienne De Sociologie, 60(4), 668-685. https://doi.org/10.1111/cars.12454
20. DC, K. (2023). From home to classroom: investigating girls' participation in secondary level mathematics. Academic Journal of Mathematics Education, 6(1), 58-70. https://doi.org/10.3126/ajme.v6i1.63799
21. Else-Quest, N., Hyde, J., & Linn, M. (2010). Cross-national patterns of gender differences in mathematics: a meta-analysis.. Psychological Bulletin, 136(1), 103-127. https://doi.org/10.1037/a0018053
22. Figueira, P., Gusmão, T., & Freitas, P. (2023). Effects of the math anxiety of parents and teachers on students. Psico-Usf, 28(1), 1-12. https://doi.org/10.1590/1413-82712023280101
23. Ganley, C. and Vasilyeva, M. (2014). The role of anxiety and working memory in gender differences in mathematics.. Journal of Educational Psychology, 106(1), 105-120. https://doi.org/10.1037/a0034099
24. Goldman, A. and Penner, A. (2014). Exploring international gender differences in mathematics self-concept. International Journal of Adolescence and Youth, 21(4), 403-418. https://doi.org/10.1080/02673843.2013.847850

25. Guenaga, M., Eguíluz, A., Garaizar, P., & Mimenza, A. (2022). The impact of female role models leading a group mentoring program to promote stem vocations among young girls. Sustainability, 14(3), 1420. https://doi.org/10.3390/su14031420
26. Gunderson, E., Ramirez, G., Levine, S., & Beilock, S. (2011). The role of parents and teachers in the development of gender-related math attitudes. Sex Roles, 66(3-4), 153-166. https://doi.org/10.1007/s11199-011-9996-2
27. Hardré, P. (2011). Motivation for math in rural schools: student and teacher perspectives. Mathematics Education Research Journal, 23(2), 213-233. https://doi.org/10.1007/s13394-011-0012-5
28. Herawati, M., Muhid, A., & Hamdani, A. (2021). Self-efficacy, social support, academic flow, and math anxiety among islamic senior high school students. Psympathic Jurnal Ilmiah Psikologi, 7(2), 315-326. https://doi.org/10.15575/psy.v7i2.8474
29. Hildebrand, L., Posid, T., Moss-Racusin, C., Hymes, L., & Cordes, S. (2022). Does my daughter like math? relations between parent and child math attitudes and beliefs. Developmental Science, 26(1). https://doi.org/10.1111/desc.13243
30. Householder, D. (2020). Gender differences in attitudes and achievement in mathematics among ghanaian jhs students. International Journal of Education, 12(3), 84. https://doi.org/10.5296/ije.v12i3.17136
31. Joët, G., Usher, E., & Bressoux, P. (2011). Sources of self-efficacy: an investigation of elementary school students in france.. Journal of Educational Psychology, 103(3), 649-663. https://doi.org/10.1037/a0024048
32. John, J., Insouvanh, K., & Robnett, R. (2022). The roles of gender identity, peer support, and math anxiety in middle school math achievement. Journal of Research on Adolescence, 33(1), 230-250. https://doi.org/10.1111/jora.12800
33. Kabelka, H. (2024). Drivers of child marriage in eastern and western provinces in zambia and effective preventive interventions: findings from a rapid document review and three stakeholder meetings.. https://doi.org/10.21203/rs.3.rs-3914273/v1
34. Kågesten, A., Gibbs, S., Blum, R., Moreau, C., Chandra-Mouli, V., Herbert, A., … & Amin, A. (2016). Understanding factors that shape gender attitudes in early adolescence globally: a mixed-methods systematic review. Plos One, 11(6), e0157805. https://doi.org/10.1371/journal.pone.0157805
35. Karadaar, I. (2024). Gender dynamics in high school mathematics education: impact of teachers and school environment on female students attitudes and achievement. AJEIT, 8(1), 39-48. https://doi.org/10.11648/j.ajeit.20240801.15
36. Komalavalli, T. (2019). The relationship between mathematics self-efficacy and achievement in mathematics. International Journal of Environment Ecology Family and Urban Studies, 9(3), 1-6. https://doi.org/10.24247/ijeefusjun20191
37. Korlat, S., Kollmayer, M., Holzer, J., Lüftenegger, M., Pelikan, E., Schober, B., … & Spiel, C. (2021). Gender differences in digital learning during covid-19: competence beliefs, intrinsic value, learning engagement, and perceived teacher support. Frontiers in Psychology, 12. https://doi.org/10.3389/fpsyg.2021.637776
38. Kuśnierz, C., Rogowska, A., & Павлова, Ю. (2020). Examining gender differences, personality traits, academic performance, and motivation in ukrainian and polish students of physical education: a cross-cultural study. International Journal of Environmental Research and Public Health, 17(16), 5729. https://doi.org/10.3390/ijerph17165729
39. Lauer, J., Esposito, A., & Bauer, P. (2018). Domain-specific anxiety relates to children's math and spatial performance.. Developmental Psychology, 54(11), 2126-2138. https://doi.org/10.1037/dev0000605
40. Lauer, J., Esposito, A., & Bauer, P. (2018). Domain-specific anxiety relates to children's math and spatial performance.. Developmental Psychology, 54(11), 2126-2138. https://doi.org/10.1037/dev0000605
41. Law, F., McGuire, L., Winterbottom, M., & Rutland, A. (2021). Children's gender stereotypes in stem following a one-shot growth mindset intervention in a science museum. Frontiers in Psychology, 12. https://doi.org/10.3389/fpsyg.2021.641695

42. Liu, S. (2022). Gender disparities in rural education attainments and agricultural landownership from the perspective of sustainable development goals (sdgs): evidence from 16 sub-sahara african countries. Rausp Management Journal, 57(4), 401-412. https://doi.org/10.1108/rausp-01-2022-0031
43. Liu, S. (2022). Gender disparities in rural education attainments and agricultural landownership from the perspective of sustainable development goals (sdgs): evidence from 16 sub-sahara african countries. Rausp Management Journal, 57(4), 401-412. https://doi.org/10.1108/rausp-01-2022-0031
44. Lu, Y., Zhang, X., & Zhou, X. (2023). Assessing gender difference in mathematics achievement. School Psychology International, 44(5), 553-567. https://doi.org/10.1177/01430343221149689
45. Lucietto, A. and Rada, E. (2022). Math anxiety – a literature review on confounding factors. Journal of Research in Science Mathematics and Technology Education, 5(2), 117-129. https://doi.org/10.31756/jrsmte.12040
46. Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. Psychology Research and Behavior Management, Volume 11, 311-322. https://doi.org/10.2147/prbm.s141421
47. Lyons, E. (2019). The emergence of gender gaps in math learning during a single high-quality instructional opportunity.. https://doi.org/10.3102/1437576
48. Macmull, M. and Ashkenazi, S. (2019). Math anxiety: the relationship between parenting style and math self-efficacy. Frontiers in Psychology, 10. https://doi.org/10.3389/fpsyg.2019.01721
49. Makarova, E., Aeschlimann, B., & Herzog, W. (2019). The gender gap in stem fields: the impact of the gender stereotype of math and science on secondary students' career aspirations. Frontiers in Education, 4. https://doi.org/10.3389/feduc.2019.00060
50. Malisch, J., Harris, B., Sherrer, S., Lewis, K., Shepherd, S., McCarthy, P., … & Deitloff, J. (2020). In the wake of covid-19, academia needs new solutions to ensure gender equity. Proceedings of the National Academy of Sciences, 117(27), 15378-15381. https://doi.org/10.1073/pnas.2010636117
51. Maltese, A. and Tai, R. (2011). Pipeline persistence: examining the association of educational experiences with earned degrees in stem among u.s. students. Science Education, 95(5), 877-907. https://doi.org/10.1002/sce.20441
52. Malunga, G., Sangong, S., Saah, F., & Bain, L. (2023). Prevalence and factors associated with adolescent pregnancies in zambia: a systematic review from 2000–2022. Archives of Public Health, 81(1). https://doi.org/10.1186/s13690-023-01045-y
53. Marakshina, J. (2023). The russian version of the abbreviated math anxiety scale: psychometric properties in adolescents aged 13–16 years. Frontiers in Psychology, 14. https://doi.org/10.3389/fpsyg.2023.1275212
54. Martínez, S., Regueiro, B., Piñeiro, I., Estévez, I., & Arias, A. (2020). Gender differences in mathematics motivation: differential effects on performance in primary education. Frontiers in Psychology, 10. https://doi.org/10.3389/fpsyg.2019.03050
55. Mata, L., Monteiro, V., & Peixoto, F. (2012). Attitudes towards mathematics: effects of individual, motivational, and social support factors. Child Development Research, 2012, 1-10. https://doi.org/10.1155/2012/876028
56. McConney, A. and Perry, L. (2010). Socioeconomic status, self-efficacy, and mathematics achievement in australia: a secondary analysis. Educational Research for Policy and Practice, 9(2), 77-91. https://doi.org/10.1007/s10671-010-9083-4
57. Meyer, M., Cimpian, A., & Leslie, S. (2015). Women are underrepresented in fields where success is believed to require brilliance. Frontiers in Psychology, 6. https://doi.org/10.3389/fpsyg.2015.00235
58. Mier, H., Schleepen, T., & Berg, F. (2019). Gender differences regarding the impact of math anxiety on arithmetic performance in second and fourth graders. Frontiers in Psychology, 9. https://doi.org/10.3389/fpsyg.2018.02690
59. Milovanović, I. (2020). Math anxiety, math achievement and math motivation in high school students: gender effects. Croatian Journal of Education - Hrvatski Časopis Za Odgoj I Obrazovanje, 22(1). https://doi.org/10.15516/cje.v22i1.3372
60. Mukagiahana, J. (2024). Teachers understanding of gender responsive pedagogy and its application in teaching process: case after teacher training program interventions in rwanda. Journal of Pedagogical Research. https://doi.org/10.33902/jpr.202423067
61. Ngulube, L. (2024). Gender equality and economic growth: a case of lusaka district, zambia. Asian Journal of Education and Social Studies, 50(7), 181-196. https://doi.org/10.9734/ajess/2024/v50i71455

62. Ngulube, L. (2024). Gender equality and economic growth: a case of lusaka district, zambia. Asian Journal of Education and Social Studies, 50(7), 181-196. https://doi.org/10.9734/ajess/2024/v50i71455
63. Odejobi, C. (2014). A comparative study of language instructional delivery system between nursery schools in rural and urban areas in osun state. World Journal of Education, 4(5). https://doi.org/10.5430/wje.v4n5p31
64. Perez, T., Wormington, S., Barger, M., Schwartz-Bloom, R., Lee, Y., & Linnenbrink-Garcia, L. (2019). Science expectancy, value, and cost profiles and their proximal and distal relations to undergraduate science, technology, engineering, and math persistence. Science Education, 103(2), 264-286. https://doi.org/10.1002/sce.21490
65. Peters-Burton, E., Kaminsky, S., Lynch, S., Behrend, T., Han, E., Ross, K., … & House, A. (2014). wayne school of engineering: case study of a rural inclusive stem-focused high school. School Science and Mathematics, 114(6), 280-290. https://doi.org/10.1111/ssm.12080
66. Pokharel, J. (2023). Cultural discontinuity as a major problem of rai students' learning of mathematical. Innovative Research Journal, 2(2), 76-85. https://doi.org/10.3126/irj.v2i2.56160
67. Recber, S., Işıksal-Bostan, M., & Koç, Y. (2017). Investigating self-efficacy, anxiety, attitudes and mathematics achievement regarding gender and school type. Anales De Psicología, 34(1), 41. https://doi.org/10.6018/analesps.34.1.229571
68. Riegle-Crumb, C. and Humphries, M. (2012). Exploring bias in math teachers' perceptions of students' ability by gender and race/ethnicity. Gender & Society, 26(2), 290-322. https://doi.org/10.1177/0891243211434614
69. Riegle-Crumb, C., King, B., Grodsky, E., & Muller, C. (2012). The more things change, the more they stay the same? prior achievement fails to explain gender inequality in entry into stem college majors over time. American Educational Research Journal, 49(6), 1048-1073. https://doi.org/10.3102/0002831211435229
70. Robinson, J. and Lubienski, S. (2011). The development of gender achievement gaps in mathematics and reading during elementary and middle school. American Educational Research Journal, 48(2), 268-302. https://doi.org/10.3102/0002831210372249
71. Robinson, J. and Lubienski, S. (2011). The development of gender achievement gaps in mathematics and reading during elementary and middle school. American Educational Research Journal, 48(2), 268-302. https://doi.org/10.3102/0002831210372249
72. Robinson-Cimpian, J., Lubienski, S., Ganley, C., & Çopur-Genctürk, Y. (2014). Teachers' perceptions of students' mathematics proficiency may exacerbate early gender gaps in achievement.. Developmental Psychology, 50(4), 1262-1281. https://doi.org/10.1037/a0035073
73. Siregar, N., Rosli, R., Maat, S., & Capraro, M. (2019). The effect of science, technology, engineering and mathematics (stem) program on students' achievement in mathematics: a meta-analysis. International Electronic Journal of Mathematics Education, 1(1). https://doi.org/10.29333/iejme/5885
74. Sun, R. (2023). The effect of mathematics anxiety on math performance. Lecture Notes in Education Psychology and Public Media, 15(1), 133-139. https://doi.org/10.54254/2753-7048/15/20231045
75. Tannenbaum, C., Greaves, L., & Graham, I. (2016). Why sex and gender matter in implementation research. BMC Medical Research Methodology, 16(1). https://doi.org/10.1186/s12874-016-0247-7
76. Tao, H. and Michalopoulos, C. (2017). Gender equality and the gender gap in mathematics. Journal of Biosocial Science, 50(2), 227-243. https://doi.org/10.1017/s0021932017000141
77. Tariq, V., Qualter, P., Roberts, S., Appleby, Y., & Barnes, L. (2013). Mathematical literacy in undergraduates: role of gender, emotional intelligence and emotional self-efficacy. International Journal of Mathematical Education in Science and Technology, 44(8), 1143-1159. https://doi.org/10.1080/0020739x.2013.770087
78. Thapa, D. and Paudel, T. (2021). Undergraduate female students' motivation and perceived self-efficacy in mathematics. Voice of Teacher, 6(1), 33-42. https://doi.org/10.3126/vot.v6i1.44065
79. Thapa, D. and Paudel, T. (2021). Undergraduate female students' motivation and perceived self-efficacy in mathematics. Voice of Teacher, 6(1), 33-42. https://doi.org/10.3126/vot.v6i1.44065
80. Tsai, S., Smith, M., & Hauser, R. (2018). Gender gaps in student academic achievement and inequality., 181-218. https://doi.org/10.1108/s1479-353920180000020008

81. Viloria, M., Mireles, S., Al-Tameemi, W., & Uribe, M. (2021). Professional development for secondary school teachers and educational professionals in stem fields. Theory & Practice in Rural Education, 11(1). https://doi.org/10.3776/tpre.2021.v11n1p94-112
82. Visser, M., Rensburg, M., Garforth, L., & Tefera, N. (2021). A large-scale community intervention to change gender perceptions in rural Ethiopia. Journal of Community & Applied Social Psychology, 31(5), 571-589. https://doi.org/10.1002/casp.2540
83. Wan, S. (2023). Girls' comparative advantage in language arts explains little of the gender gap in math-related fields: a replication and extension. Proceedings of the National Academy of Sciences, 120(40). https://doi.org/10.1073/pnas.2305629120
84. Wang, C., Xian, L., & Wang, H. (2023). The mediating effect of math self-efficacy on the relationship between parenting style and math anxiety. Frontiers in Psychology, 14. https://doi.org/10.3389/fpsyg.2023.1197170
85. Wang, X. (2013). Why students choose stem majors. American Educational Research Journal, 50(5), 1081-1121. https://doi.org/10.3102/0002831213488622
86. Xie, F., Duan, X., Ni, X., Li, L., & Zhang, L. (2022). The impact of parents' intelligence mindset on math anxiety of boys and girls and the role of parents' failure beliefs and evaluation of child's math performance as mediators. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.687136
87. Yağan, E. (2023). The effect of stereotype threat on academic success of female students. International Journal of Psychology and Educational Studies, 10(4), 1102-1113. https://doi.org/10.52380/ijpes.2023.10.4.1169
88. Zander, L., Höhne, E., Harms, S., Pfost, M., & Hornsey, M. (2020). When grades are high but self-efficacy is low: unpacking the confidence gap between girls and boys in mathematics. Frontiers in Psychology, 11. https://doi.org/10.3389/fpsyg.2020.552355