E-Journal of Humanities, Arts and Social Sciences (EHASS)
ISSN – Online 2720-7722 | Print 2821-8949
Volume 6 Issue 9 2025 pp 2081 - 2099
Available online at: https://noyam.org/journals/ehass/
DOI: https://doi.org/10.38159/ehass.20256925

Gender Disparities in High School Mathematics Achievement: Factors and Interventions

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ABSTRACT

Gender disparities in mathematics achievement persist in high school settings, influenced by many factors, including sociocultural norms, teaching methodologies, and student self-efficacy. This paper is based on the literature review investigating the underlying factors contributing to these disparities and evaluating effective interventions that can bridge the achievement gap between genders. The study was grounded in social cognitive, social cognitive career theory and gender role socialisation theories. Content analysis was utilised to analyse data collected from various literature on gender disparities. Findings indicated that while girls often exhibit higher self-efficacy in mathematics, systemic biases and stereotype threats significantly hinder their performance. The findings of this study further indicate that a combination of individual, familial, and educational factors significantly influences gender disparities in high school mathematics achievement. Math anxiety, self-efficacy and the quality of teacher-student interactions emerged as key determinants of these disparities. Furthermore, the study identified targeted interventions, such as fostering a growth mindset and enhancing parental involvement, as effective strategies for reducing the gender gap in mathematics achievement. The study recommended implementing comprehensive educational policies and programmes that address the cognitive, emotional, and social dimensions of mathematics learning. It highlights underexplored constructs, such as stereotype threat and gender-specific affective experiences, broadening the scope of academic investigation. The study offers a systematic methodology for literature reviews while also examining context-sensitive interventions through content analysis for pattern recognition. Moreover, it also informs educational policy and practice, laying a foundation for future empirical research and promoting equitable mathematics achievement across diverse educational contexts.

Keywords: Mathematics achievement, Gender disparities, Interventions

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Publication History
Received:
16th March, 2025
Accepted:
21st July, 2025
Published:
28th August, 2025

To Cite this Article:
Chiphambo, Shakespear. "Gender Disparities in High School Mathematics Achievement: Factors and Interventions," *E-Journal of Humanities, Arts and Social Sciences* 6, no. 9 (2025): 2081 - 2099, https://doi.org/10.38159/ehass.20256925.

INTRODUCTION

The topic of gender disparities in high school mathematics achievement has garnered significant attention in educational research, reflecting broader societal concerns regarding equity and access to education. Often viewed as a gatekeeper for future academic and career opportunities, mathematics is critical for success in various fields, particularly in STEM (Science, Technology, Engineering, and Mathematics) disciplines. Despite the increasing emphasis on STEM education, persistent gender gaps in mathematics achievement remain evident, with girls frequently underperforming relative to their male counterparts in high school settings.[1] This disparity affects immediate academic outcomes and has long-

[1] Ilija Milovanović, "Math Anxiety, Math Achievement and Math Motivation in High School Students: Gender Effects," *Croatian Journal of Education - Hrvatski Časopis Za Odgoj i Obrazovanje* 22, no. 1 (April 20, 2020), https://doi.org/10.15516/cje.v22i1.3372;

term implications for college attendance and career choices, particularly in fields that require strong mathematical skills.[2]

Understanding the underlying causes of these differences is crucial for developing targeted strategies to enhance the mathematical performance of all students, particularly those from underrepresented groups. Research indicates that mathematics anxiety, self-efficacy, and social support significantly shape students' mathematical experiences and outcomes.[3] Furthermore, parental attitudes and teacher support cannot be overlooked, as they significantly impact students' perceptions of their abilities and their engagement with mathematics.[4]

Equitable achievement in mathematics education is illustrated by both boys and girls showing similar interest levels in mathematics. However, significant gender disparities in mathematics achievement persist, with numerous studies indicating that female students often underperform compared to their male counterparts, particularly in high-stakes testing environments.[5] This gap is detrimental to the educational aspirations of young women while reinforcing the negative stereotypes about what girls can do with and in mathematics, leading to problematic outcomes later in life in terms of education and career opportunities.[6]

Addressing this reality is imperative to foster an inclusive educational environment that promotes equal opportunities for all students. The achievement gaps necessitate purposeful solutions for the societal factors, pedagogical practices, and learners' motivational beliefs that lie deep within these gaps.[7] The purpose of this paper is to explore the multifaceted factors contributing to gender disparities in high school mathematics achievement and to identify effective interventions that can mitigate these disparities. The review seeks to further explore appropriate strategies and measures to improve female learners' performance in mathematics towards achieving gender equity in STEM education and disrupting social stereotypes detrimental to female students' academic achievement.[8]

Raymon Pomoy Española, "Achievement Profiles in Math, Science, and English: Exploring Contextualized Sex Differences," *Jurnal Pendidikan Progresif* 13, no. 1 (2023): 103–18, https://doi.org/10.23960/jpp.v13.i1.202308.

[2] Pamela E. Davis-Kean et al., "It Matters How You Start: Early Numeracy Mastery Predicts High School Math course-taking and College Attendance," *Infant and Child Development* 31, no. 2 (March 26, 2022), https://doi.org/10.1002/icd.2281; Glona Lee and Sandra D. Simpkins, "Ability Self-concepts and Parental Support May Protect Adolescents When They Experience Low Support from Their Math Teachers," *Journal of Adolescence* 88, no. 1 (April 18, 2021): 48–57, https://doi.org/10.1016/j.adolescence.2021.01.008; Milovanović, "Math Anxiety, Math Achievement and Math Motivation in High School Students: Gender Effects."

[3] Mutia Herawati, Abdul Muhid, and Asep Saepul Hamdani, "Self-Efficacy, Social Support, Academic Flow, and Math Anxiety among Islamic Senior High School Students," *Sympathic : Jurnal Ilmiah Psikologi* 7, no. 2 (January 3, 2021): 315–26, https://doi.org/10.15575/psy.v7i2.8474; Fraulein Retanal et al., "Controlling-Supportive Homework Help Partially Explains the Relation between Parents' Math Anxiety and Children's Math Achievement," *Education Sciences* 11, no. 10 (October 11, 2021): 620, https://doi.org/10.3390/educsci11100620; Rose K. Vukovic et al., "Mathematics Anxiety in Young Children: Concurrent and Longitudinal Associations with Mathematical Performance," *Contemporary Educational Psychology* 38, no. 1 (January 2013): 1–10, https://doi.org/10.1016/j.cedpsych.2012.09.001.

[4] Allyson J. Kiss and Rose Vukovic, "Exploring Educational Engagement for Parents with Math Anxiety," *Psychology in the Schools* 58, no. 2 (February 20, 2021): 364–76, https://doi.org/10.1002/pits.22451; Michela DiStefano et al., "Relations between Math Achievement, Math Anxiety, and the Quality of Parent–Child Interactions While Solving Math Problems," *Education Sciences* 13, no. 3 (March 15, 2023): 307, https://doi.org/10.3390/educsci13030307.

[5] Emmanuel Amoah, "Gender and Other Significant Factors Causing Disparities in Senior High School Students' Mathematics Performance," *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 15, no. 1 (January 16, 2024): 26–33, https://doi.org/10.61841/turcomat.v15i1.14020; Zhe Wang et al., "The Longitudinal Role of Mathematics Anxiety in Mathematics Development: Issues of Gender Differences and Domain-specificity," *Journal of Adolescence* 80, no. 1 (April 18, 2020): 220–32, https://doi.org/10.1016/j.adolescence.2020.03.003.

[6] Yao Yang, Yukiko Maeda, and Marcia Gentry, "The Relationship between Mathematics Self-Efficacy and Mathematics Achievement: Multilevel Analysis with NAEP 2019," *Large-Scale Assessments in Education* 12, no. 1 (May 10, 2024): 16, https://doi.org/10.1186/s40536-024-00204-z.

[7] Khairiani Idris et al., "High School Students' Attitudes toward Mathematics and Its Relation to Mathematics Learning Achievement," *Jurnal Riset Pendidikan Matematika* 8, no. 1 (June 7, 2021): 33–45, https://doi.org/10.21831/jrpm.v8i1.37002; Harun Harun, Badrun Kartowagiran, and Abdul Manaf, "Student Attitude and Mathematics Learning Success: A Meta-Analysis," *International Journal of Instruction* 14, no. 4 (October 1, 2021): 209–22, https://doi.org/10.29333/iji.2021.14413a.

[8] Judith Annie Bautista-Quispe et al., "Monitoring, Support and Inter-Learning in Teaching Performance in Basic Education of the Area of Mathematics. A Case Study in Puno (Perú)," *International Journal of Learning, Teaching and Educational Research* 22, no. 5 (May 30, 2023): 474–92, https://doi.org/10.26803/ijlter.22.5.24; Sevda YERDELEN-DAMAR et al., "Investigating the Interrelationships among Science and Mathematics Achievement, Attitudes towards STEM, and Gender," *Bartın Üniversitesi Eğitim Fakültesi Dergisi* 10, no. 2 (June 5, 2021): 342–57, https://doi.org/10.14686/buefad.778281; Burçin Coşkun and Kübra Karakaya Özyer, "The Effect of Student Characteristics and Socioeconomic Status on Mathematics Achievement in Türkiye: Insights from TIMSS 2011-2019," *International Journal of Assessment Tools in Education* 10, no. 3 (September 22, 2023): 454–81, https://doi.org/10.21449/ijate.1272517.

The following objectives underlie the study:

- To explore the underlying factors influencing gender disparities in high school mathematics achievement
- To evaluate the effectiveness of specific interventions designed to improve the mathematics performance of female students.

The research seeks to answer the following questions:

- What factors contribute to gender disparities in high school mathematics achievement?
- How do targeted interventions impact the performance of female students in mathematics?

These questions seek to uncover the complex interplay of cognitive, emotional, and social factors that influence students' mathematical performance and evaluate the effectiveness of various educational interventions to reduce these disparities.

THEORETICAL FRAMEWORK

In exploring the theoretical frameworks relevant to understanding gender disparities in high school mathematics achievement, several significant theories emerge. These frameworks elucidate the underlying factors contributing to gender differences in mathematical performance and guide effective interventions to address these disparities.

The Social Cognitive Career Theory (SCCT), developed by Lent, Brown and Hackett in 1994, is one of the most critical perspectives in this area. The Social Cognitive Career Theory (SCCT) maintains that a person's beliefs about self-efficacy, expected outcomes, and goals are crucial predictors of the person's educational and career aspirations. To some extent, SCCT explains why there are gaps between boys and girls in mathematics achievement due to different levels of self-efficacy and socialisation that influence students' perceptions of success in STEM subjects. Previous research suggests that self-efficacy is relatively low for girls in mathematics, affecting their performance and career aspirations.[9] In this sense, students' self-perceptions affect their behaviour in and out of the classroom, which means that enhancing the self-image of females in mathematics can help them achieve better.[10]

The Gender Role Socialisation Theory is also pertinent to this topic. The theory of Gender Role Socialisation, as advanced by Eagly and Wood, suggests that culture has certain expectations concerning a person's gender that direct a person's behaviour and choices.[11] The theory suggests that boys and girls are exposed to specific gender social norms at an early age, which affects their interaction with mathematical concepts. Research has indicated that societal bias causes mathematics anxiety and lower self-esteem expectations in students, especially within stereotypes of male superiority.[12] For instance, studies show that girls tend to be more fearful of math and, as a result, do worse in it.[13] Educators can help construct better learning outcomes by changing these social constructs using gender-responsive teaching methodologies and classroom strategies.[14]

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[9] Einar M. Skaalvik, Roger A. Federici, and Robert M. Klassen, "Mathematics Achievement and Self-Efficacy: Relations with Motivation for Mathematics," *International Journal of Educational Research* 72 (2015): 129–36, https://doi.org/10.1016/j.ijer.2015.06.008.

[10] David M. Sparks and Kathryn Pole, "'Do We Teach Subjects or Students?' Analyzing Science and Mathematics Teacher Conversations about Issues of Equity in the Classroom," *School Science and Mathematics* 119, no. 7 (November 25, 2019): 405–16, https://doi.org/10.1111/ssm.12361.

[11] Alice H. Eagly and Wendy Wood, "The Origins of Sex Differences in Human Behavior: Evolved Dispositions versus Social Roles.," *American Psychologist* 54, no. 6 (June 1999): 408–23, https://doi.org/10.1037/0003-066X.54.6.408.

[12] X Ma and Jiangming Xu, "The Causal Ordering of Mathematics Anxiety and Mathematics Achievement: A Longitudinal Panel Analysis," *Journal of Adolescence* 27, no. 2 (April 23, 2004): 165–79, https://doi.org/10.1016/j.adolescence.2003.11.003.

[13] Kennedy Oduro Aboagye, Yan Denk Ke, and David Anim Mante, "Factors Influencing Students' Perceived Difficulties in Studying Geometry: A Case of Konogo-Odumasi, Ghana," *Open Journal of Social Sciences* 09, no. 09 (2021): 526–40, https://doi.org/10.4236/jss.2021.99038.

[14] Josiane Mukagiahana, Aimable Sibomana, and Joseph Ndiritu, "Teachers Understanding of Gender Responsive Pedagogy and Its Application in Teaching Process: Case after Teacher Training Program Interventions in Rwanda," *Journal of Pedagogical Research*, February 17, 2024, https://doi.org/10.33902/JPR.202423067.

Lev Vygotsky's sociocultural theory around the turn of the 20th century is pertinent to this paper. The theory proposes that a person's cognitive ability develops primarily through social interactions and enculturation. The theory draws attention to the dominant impact of outer social phenomena such as the language, culture, or relationships existing on a person regarding the learning process within the school context.

In Vygotsky's context, the social setting comprising teachers' expectations and students' interactions affects how boys and girls relate to math, which is quite relevant while discussing the issue of gender gaps in math performance.[15] In employing those, it is evident that grasping the complexities of the phenomena called gender gaps in mathematics requires cognitive, affective, and sociocultural scaffolds. For example, gender-neutral pedagogy allows teachers to attempt to solve these disparities through teaching and enables students not to feel discriminated against or disadvantaged during the learning process.[16]

Combining SCCT with Gender Role Socialisation Theory and Sociocultural Theory comprehensively explains secondary school students' gaps in mathematics achievement based on gender. These theories point out the issues behind these gaps and direct the needed action to achieve equality among students in the field of mathematics.

METHODOLOGY

This paper took a conceptual approach by analysing literature to research the existing gender gap in mathematics achievement at the high school level. By providing research synthesis, theoretical frameworks, and empirical models, it sought to uncover gaps in intervention processes that facilitate narrowing gender gaps. A narrative literature review was conducted to understand scholarly research and policy documents within and beyond the educational practices regarding the gender gap in mathematics. The materials were chosen based on pertinent and plausible published works that were not older than five years. Thematic areas like social context, classroom environment, self-efficacy, and other interventions were used to address the problem.

This analysis draws from the existing gaps in gender theories, educational psychology, and math education to create a conceptual model of the gap and suggest appropriate solutions. A review of intervention gap: socio-cultural influences, academic environment, curriculum and pedagogical practices, student attitudes and self-perception, access to resources, assessment and evaluation practices, socio-economic and structural factors, intervention design and implementation, teacher professional development, use of technology and digital tools, mentorship and role models, peer-led and collaborative learning strategies, parental and community engagement, policy and institutional support, assessment and monitoring of interventions were conducted to evaluate their effectiveness in bridging the achievement gap.

These methodological strategies guarantee a systematic and rigorous review of gender differences in mathematics achievement, serving as a platform for further empirical work and policy interventions.

DISCUSSION

GENDER DISPARITIES IN MATHEMATICS EDUCATION

Socio-Cultural Influences

Socio-cultural influences play a significant role in shaping students' attitudes and performance in mathematics. Gender stereotypes and societal expectations often dictate the perceived capabilities of different genders in mathematical fields, leading to a self-fulfilling prophecy where girls may underperform due to societal beliefs about their abilities in mathematics.[17] Research indicates that these stereotypes can discourage girls from pursuing advanced mathematics courses, as they internalise the

[15] Moisés Esteban-Guitart, "The Biosocial Foundation of the Early Vygotsky: Educational Psychology before the Zone of Proximal Development.," *History of Psychology* 21, no. 4 (November 2018): 384–401, https://doi.org/10.1037/hop0000092.

[16] Mukagiahana, Sibomana, and Ndiritu, "Teachers Understanding of Gender Responsive Pedagogy and Its Application in Teaching Process: Case after Teacher Training Program Interventions in Rwanda."

[17] Paul L. Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School," *Gifted Child Quarterly* 67, no. 2 (April 8, 2023): 151–72, https://doi.org/10.1177/00169862221128299.

assumption that they are less capable than their male counterparts.[18] Furthermore, parental attitudes towards mathematics education significantly impact children's engagement and performance. Supportive parental involvement can enhance children's self-efficacy and interest in mathematics, while negative attitudes can lead to anxiety and disengagement.[19]

Peer influence is another critical factor in mathematics education, particularly during adolescence when social dynamics become more pronounced. Studies have shown that peers can motivate or demotivate students regarding their subject choices and performance.[20] For instance, a supportive peer group that values academic achievement can encourage the student to excel in mathematics. In contrast, a group that prioritises other interests may lead to decreased motivation and performance in the subject.[21] This peer influence is particularly pronounced in co-educational settings, where students often compare themselves against their peers, further reinforcing or challenging existing gender stereotypes in mathematics.[22]

This implies that socio-cultural influences, including gender stereotypes, parental attitudes, and peer dynamics, significantly affect students' engagement and performance in mathematics. Addressing these influences is crucial for fostering a more equitable educational environment that encourages all students to pursue and excel in mathematics, regardless of gender or background.[23]

Academic Environment

The academic environment, particularly the expectations and biases of teachers, plays a pivotal role in shaping students' experiences in mathematics. Research has shown that teacher expectations can significantly influence student performance, with higher expectations often leading to better outcomes.[24] However, conscious or unconscious biases can result in differential treatment of students based on gender or socio-economic status, which can adversely affect students' self-esteem and motivation in mathematics.[25] For example, teachers may unintentionally provide more encouragement to male students, reinforcing gender disparities in mathematics achievement.[26]

Another critical aspect of the academic environment is the gender representation within the mathematics teaching staff. The presence of female mathematics teachers can serve as a powerful role model for female students, helping to challenge stereotypes and encourage girls to pursue mathematics.[27] Conversely, a predominantly male teaching staff may perpetuate the notion that mathematics is male-dominated, potentially discouraging female students from engaging fully in the subject.[28] This representation can impact not only students' aspirations but also their perceptions of their capabilities in mathematics.

The availability of role models in STEM fields further enhances the educational environment. When students see successful individuals from diverse backgrounds in mathematics and related fields, it can inspire them to envision similar paths for themselves.[29] Programmes highlighting the

[18] Yuhuan Zhang et al., "Does Private Supplementary Tutoring Matter in Chinese Students' Learning of Mathematics: A Longitudinal Study," *ZDM – Mathematics Education* 54, no. 3 (June 17, 2022): 737–47, https://doi.org/10.1007/s11858-022-01346-6.

[19] Steve Murphy et al., "Parents' Experiences of Mathematics Learning at Home during the COVID-19 Pandemic: A Typology of Parental Engagement in Mathematics Education," *Educational Studies in Mathematics*, April 3, 2023, https://doi.org/10.1007/s10649-023-10224-1.

[20] Abigail K. Roberts and Erica D. Spangenberg, "Peer Tutors' Views on Their Role in Motivating Learners to Learn Mathematics," *Pythagoras* 41, no. 1 (September 28, 2020), https://doi.org/10.4102/pythagoras.v41i1.520.

[21] Luann Ley Davis, Fred Spooner, and Alicia Saunders, "Efficacy of Peer-Delivered Mathematical Problem-Solving Instruction to Students With Extensive Support Needs," *Exceptional Children* 89, no. 1 (October 16, 2022): 101–18, https://doi.org/10.1177/00144029221098764.

[22] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."

[23] Murphy et al., "Parents' Experiences of Mathematics Learning at Home during the COVID-19 Pandemic: A Typology of Parental Engagement in Mathematics Education."

[24] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."

[25] Zhang et al., "Does Private Supplementary Tutoring Matter in Chinese Students' Learning of Mathematics: A Longitudinal Study."

[26] Jennifer Randall and Alejandra Garcia, "Let's Go Girls!: Evaluating the Effectiveness of Tutoring and Scholarships on Primary School Girls' Attendance and Academic Performance in the Democratic Republic of the Congo (DRC)," *FIRE: Forum for International Research in Education* 6, no. 3 (October 19, 2020): 19–35, https://doi.org/10.32865/fire202063222.

[27] Randall and Garcia, "Let's Go Girls!: Evaluating the Effectiveness of Tutoring and Scholarships on Primary School Girls' Attendance and Academic Performance in the Democratic Republic of the Congo (DRC)."

[28] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."

[29] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."

achievements of women and minorities in mathematics can help counteract stereotypes and promote a more inclusive view of who can succeed in these areas.[30] Thus, fostering an educational environment that is supportive, inclusive, and representative is essential for improving student outcomes in mathematics.

Curriculum and Pedagogical Practices

The inclusivity of teaching methods and materials is crucial for engaging diverse learners in mathematics. Research indicates that traditional teaching approaches often fail to accommodate students' varied learning styles and backgrounds, leading to disengagement and underperformance.[31] Inclusive pedagogical practices, such as differentiated instruction and culturally relevant teaching, have enhanced student engagement and achievement in mathematics. By recognising and valuing students' diverse experiences, educators can create a more equitable learning environment that fosters success for all learners.

The relevance of curriculum content to diverse learners is another critical factor in mathematics education. Curricula that reflect the interests and experiences of students can significantly enhance motivation and engagement. For instance, incorporating real-world applications of mathematics that resonate with students' lives can make the subject more relatable and meaningful. Additionally, culturally responsive curricula can help bridge the gap between students' home and school experiences, fostering a sense of belonging and increasing their investment in learning mathematics.

The impact of cooperative versus competitive learning strategies also plays a significant role in student outcomes. Research suggests that cooperative learning strategies, which emphasise collaboration and peer support, can improve mathematical understanding and performance. In contrast, competitive environments may exacerbate anxiety and hinder learning, particularly for students who struggle with mathematics. By prioritising cooperative learning approaches, educators can create a more supportive atmosphere that encourages risk-taking and fosters a growth mindset among students.

Student Attitudes and Self-Perception

Student attitudes and self-perception are critical determinants of success in mathematics. Self-confidence and mathematics self-efficacy significantly influence students' willingness to engage with challenging mathematical concepts. Research has shown that students who believe in their mathematical abilities are more likely to persist in facing difficulties and achieve higher performance levels. Conversely, low self-efficacy can lead to avoidance of mathematics-related tasks and a lack of motivation to pursue further studies in the field.

Fear of failure and mathematics anxiety are prevalent issues that can undermine students' performance and engagement in mathematics. Studies indicate that students who experience high levels of anxiety related to mathematics often perform worse than their peers, as anxiety can interfere with cognitive processes necessary for problem-solving. This fear can be exacerbated by negative experiences in the classroom, such as harsh grading practices or a lack of supportive feedback from teachers. Addressing these emotional barriers is essential for creating a positive learning environment that fosters resilience and encourages students to take risks in their mathematical learning.

Motivation and aspirations in mathematics-related careers are also closely linked to students' attitudes and self-perception. Research has shown that students who perceive mathematics as relevant to their future career goals are more likely to engage deeply with the subject. Programmes that connect mathematics education to real-world applications and career pathways can enhance students' motivation and aspirations, particularly for underrepresented groups in STEM fields. By fostering positive attitudes and self-perceptions, educators can help students develop a strong foundation for future success in mathematics and related disciplines.

[30] Zhang et al., "Does Private Supplementary Tutoring Matter in Chinese Students' Learning of Mathematics: A Longitudinal Study."
[31] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."

Access to Resources

Access to resources is a fundamental factor influencing students' success in mathematics education. The availability of textbooks, technology, and supplementary learning materials can significantly impact students' learning experiences and outcomes.[32] Research indicates that students with access to high-quality resources are likely to perform well in mathematics, as these materials provide essential support for understanding complex concepts.[33] However, disparities in resource availability often exist, particularly in underfunded schools or low-income communities, leading to inequitable educational experiences.[34]

Participation in extracurricular mathematics programmes can also enhance students' mathematical skills and confidence. Programmes such as math clubs, competitions, and tutoring initiatives provide additional opportunities for students to engage with mathematics outside the classroom.[35] These extracurricular activities can foster a sense of community and belonging among students, further motivating them to pursue mathematics.[36] However, access to such programmes can vary widely, with students from lower socio-economic backgrounds often facing barriers to participation.[37]

Differences in access to tutoring or remedial support can exacerbate inequalities in mathematics education. Research has shown that students who receive targeted tutoring or support are more likely to improve their mathematical skills and confidence.[38] However, access to such resources is often limited for students from disadvantaged backgrounds, who may not have the financial means to afford private tutoring.[39] Addressing these disparities is crucial for ensuring that all students can succeed in mathematics, regardless of socioeconomic status.

Assessment and Evaluation Practices

Assessment and evaluation practices in mathematics education can significantly influence student outcomes. Research has shown that gender differences often emerge in performance on standardised mathematics assessments, with boys frequently outperforming girls.[40] This disparity can be attributed to various factors, including societal expectations, teacher biases, and differences in self-perception.[41] Addressing these gender disparities in assessment practices is essential for promoting equity in mathematics education and ensuring all students can demonstrate their abilities.

The role of formative versus summative assessments is another critical consideration in shaping student outcomes. Formative assessments, which provide ongoing feedback and opportunities for improvement, can enhance student learning and engagement in mathematics. In contrast, summative assessments, which typically evaluate student performance at the end of a learning period, may not accurately reflect students' understanding or growth. By incorporating more formative assessment practices, educators can create a more supportive learning environment that encourages risk-taking and fosters a growth mindset among students.

Equity in assessment design and implementation is essential for ensuring all students have a fair opportunity to succeed in mathematics. Research indicates that assessments should accommodate diverse learning styles and backgrounds, providing multiple means of demonstrating understanding. Additionally, training for educators on equitable assessment practices can help mitigate biases and ensure that all students are evaluated fairly. By prioritising equity in assessment, educators can promote a more inclusive mathematics education that supports the success of all learners.

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[32] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."
[33] Zhang et al., "Does Private Supplementary Tutoring Matter in Chinese Students' Learning of Mathematics: A Longitudinal Study."
[34] Murphy et al., "Parents' Experiences of Mathematics Learning at Home during the COVID-19 Pandemic: A Typology of Parental Engagement in Mathematics Education."
[35] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."
[36] Zhang et al., "Does Private Supplementary Tutoring Matter in Chinese Students' Learning of Mathematics: A Longitudinal Study."
[37] Murphy et al., "Parents' Experiences of Mathematics Learning at Home during the COVID-19 Pandemic: A Typology of Parental Engagement in Mathematics Education."
[38] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."
[39] Zhang et al., "Does Private Supplementary Tutoring Matter in Chinese Students' Learning of Mathematics: A Longitudinal Study."
[40] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."
[41] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."

Socio-Economic and Structural Factors

Socio-economic and structural factors significantly impact gender disparities in mathematics education. Research indicates that the location of schools—whether urban or rural-can influence access to quality educational resources and opportunities. Urban schools often have more resources and experienced teachers, while rural schools may struggle with funding and access to advanced courses, exacerbating existing inequalities. These disparities can disproportionately affect female students, who may have fewer opportunities to engage with advanced mathematics in rural settings.

The influence of socioeconomic status on the quality of education is another critical factor in mathematics achievement. Students from low-income families often face multiple barriers, including limited access to educational resources, extracurricular programmes, and tutoring services. These challenges can hinder their performance in mathematics and limit their aspirations for higher education and careers in STEM fields. Addressing these socioeconomic disparities is essential for promoting equity in mathematics education and ensuring all students succeed.

School policies promoting gender equity in mathematics education can also play a vital role in addressing disparities. Research suggests that schools with proactive policies to increase female participation in mathematics and STEM fields can significantly improve outcomes for girls.[42] These policies may include targeted outreach programmes, mentorship opportunities, and teacher professional development on gender equity issues. By fostering a supportive and equitable educational environment, schools can help close the gender gap in mathematics and encourage all students to pursue their interests in the subject.

Intervention Design and Implementation

Effective interventions in educational settings, particularly those aimed at supporting female students in mathematics, often share several key characteristics. These include incorporating mentoring programmes and peer learning opportunities, which have been shown to enhance academic performance and self-efficacy among students. Mentoring programmes, especially those that connect female students with successful women in STEM fields, provide role models and create a supportive environment, encouraging persistence in challenging subjects like mathematics.[43] Peer learning, on the other hand, fosters collaboration and allows students to learn from one another, which can be particularly beneficial for female students who may feel isolated in traditionally male-dominated fields.[44] Tailoring these interventions to address the unique challenges female students face is crucial. For instance, understanding the specific barriers that hinder their participation in mathematics, such as societal stereotypes and lack of confidence, allows for the design of targeted strategies that can effectively mitigate these issues.[45]

Engaging stakeholders such as teachers, parents, and community members is another vital component of successful intervention design. Teachers play a critical role in implementing these programmes and can benefit from professional development that equips them with gender-sensitive teaching practices.[46] Involving parents in the educational process can enhance the support system for female students, as parental encouragement has been linked to increased academic motivation and achievement.[47] Community engagement is equally important; programmes that challenge gender

[42] Morgan et al., "Racial and Ethnic Disparities in Advanced Science and Mathematics Achievement During Elementary School."

[43] Salam Shirali Kharamin and Mahboubeh Moradian, "Investigating the Effectiveness of Transactional Analysis (TA) Training on the Mental Health of Female Middle School Students," *KMAN Counseling and Psychology Nexus* 1, no. 1 (2023): 183–88, https://doi.org/10.61838/kman.psychnexus.1.1.21.

[44] Aysha Mohmmed Amer Alsoqae and Safia Belal, "Student Academic Success Factors in Selected Nursing Collages in Saudi Arabia," *International Journal of Innovative Research in Medical Science* 9, no. 06 (June 1, 2024): 317–30, https://doi.org/10.23958/ijirms/vol09-i06/1885.

[45] Liang Wang et al., "Moderating Effect of Gender and Engineering Identity on the Association between Interpersonal Relationships and Mental Health of Female Engineering Students," *International Journal of Environmental Research and Public Health* 19, no. 16 (August 21, 2022): 10425, https://doi.org/10.3390/ijerph191610425.

[46] Adrianna Kezar et al., "Tailoring Programs to Best Support Low-Income, First-Generation, and Racially Minoritized College Student Success," *Journal of College Student Retention: Research, Theory & Practice* 25, no. 1 (May 1, 2023): 126–52, https://doi.org/10.1177/1521025120971580.

[47] Tanya L. Eckert et al., "Assessing Children's Perceptions of Intervention Acceptability Ratings," *Psychology in the Schools* 58, no. 10 (October 29, 2021): 1962–79, https://doi.org/10.1002/pits.22564.

stereotypes and promote mathematics as an inclusive field can create a more supportive environment for female students.[48] By fostering collaboration among these stakeholders, interventions can be more comprehensive and impactful, ultimately leading to improved educational outcomes for female students in mathematics.

Moreover, the effectiveness of interventions can be significantly enhanced by utilising data-driven approaches to assess their impact and make necessary adjustments. Continuous monitoring and evaluation of intervention outcomes allow educators to appropriately identify and scale successful models.[49] This iterative process helps refine the interventions and ensures that they remain relevant to the evolving needs of female students. By combining evidence-based practices with stakeholder engagement and tailored support, educational institutions can create a robust framework for enhancing the participation and success of female students in mathematics.[50]

Teacher Professional Development

The professional development of teachers is essential for fostering an educational environment that supports female students in mathematics. Training programmes that focus on gender-sensitive teaching practices can significantly enhance teachers' ability to address the unique needs of female students. Such training equips educators with the skills to recognise and counteract unconscious biases that may affect their teaching and interactions with students.[51] Research indicates that teachers aware of their biases are more likely to create inclusive classrooms, encouraging all students, particularly girls, to engage actively in mathematics.[52] This awareness is crucial in dismantling stereotypes that often discourage female students from pursuing STEM subjects.

In addition to addressing biases, capacity-building programmes designed to support female students in mathematics can empower teachers to implement effective instructional strategies. These programmes can include workshops on differentiated instruction, culturally responsive teaching, and technology integration in the classroom.[53] By enhancing teachers' pedagogical skills, these professional development initiatives can lead to improved student engagement and performance in mathematics. Furthermore, when teachers are well-equipped to support female students, they can foster a classroom culture that values diversity and encourages collaboration, which is particularly beneficial for girls who may thrive in supportive peer environments.[54]

Ultimately, the success of teacher professional development programmes hinges on their alignment with the specific challenges faced by female students in mathematics. Continuous feedback from teachers and students can inform the development of these programmes, ensuring they remain relevant and effective.[55] By prioritising gender-sensitive training and capacity-building initiatives, educational institutions can create a more equitable learning environment that enhances educators' teaching practices and significantly improves the academic outcomes for female students in mathematics.[56]

Use of Technology and Digital Tools

The integration of technology and digital tools in education has the potential to revolutionise the learning experience for female students in mathematics. E-learning platforms provide flexible and accessible

[48] Yue Yin Soo et al., "Educators' Roles and Challenges in Supporting Tertiary Education Students' Mental Health: A Qualitative Study in Malaysia," *The Journal of Mental Health Training, Education and Practice* 18, no. 6 (November 10, 2023): 397–409, https://doi.org/10.1108/JMHTEP-02-2023-0013.

[49] Blaženka Divjak et al., "Assessment Validity and Learning Analytics as Prerequisites for Ensuring Student-centred Learning Design," *British Journal of Educational Technology* 54, no. 1 (January 15, 2023): 313–34, https://doi.org/10.1111/bjet.13290.

[50] Sadeq Al-Fayyadh et al., "Targeting Smoking Triggers: A Nurse-Led Intervention for Tobacco Smoking Cessation," *Nurse Media Journal of Nursing* 12, no. 3 (December 28, 2022): 437–51, https://doi.org/10.14710/nmjn.v12i3.47107.

[51] Wang et al., "Moderating Effect of Gender and Engineering Identity on the Association between Interpersonal Relationships and Mental Health of Female Engineering Students."

[52] Kezar et al., "Tailoring Programs to Best Support Low-Income, First-Generation, and Racially Minoritized College Student Success."

[53] Kezar et al., "Tailoring Programs to Best Support Low-Income, First-Generation, and Racially Minoritized College Student Success."

[54] Shirali Kharamin and Moradian, "Investigating the Effectiveness of Transactional Analysis (TA) Training on the Mental Health of Female Middle School Students."

[55] Divjak et al., "Assessment Validity and Learning Analytics as Prerequisites for Ensuring Student-centred Learning Design."

[56] Eckert et al., "Assessing Children's Perceptions of Intervention Acceptability Ratings."

resources catering to diverse learning styles and paces, supporting individualised learning experiences.[57] These platforms often include interactive elements such as quizzes, video tutorials, and discussion forums, which can enhance engagement and understanding of complex mathematical concepts. Research has shown that female students benefit from using technology as it allows them to explore mathematical ideas in a safe and supportive environment, free from the pressures of traditional classroom settings.[58]

Moreover, the gender-targeted use of educational apps, games and simulations can play a significant role in skill development for female students. These tools can be designed to address girls' specific interests and learning needs, making mathematics more relatable and enjoyable.[59] For instance, gamified learning experiences can foster a sense of achievement and motivation, encouraging female students to persist in their studies despite challenges.[60] Additionally, simulations that model real-world applications of mathematics can help demystify the subject and illustrate its relevance to everyday life, thereby increasing female students' interest and confidence in pursuing mathematics.[61]

Blended learning approaches, which combine online and face-to-face instruction, have also proven effective for female students in mathematics. This model allows for personalised learning experiences while providing collaborative learning opportunities in traditional classroom settings.[62] Studies indicate that blended learning can improve academic performance and greater satisfaction among female students, as it accommodates their diverse needs and preferences.[63] By leveraging technology and digital tools thoughtfully and inclusively, educators can create a more equitable and engaging learning environment that empowers female students to excel in mathematics.[64]

Mentorship and Role Models

Mentorship programmes that involve women in STEM fields have a profound impact on the academic trajectories of female students in mathematics. These programmes provide not only guidance and support but also serve as a source of inspiration, showcasing successful female role models who have navigated similar challenges.[65] The presence of mentors can significantly enhance female students' self-efficacy and motivation as they witness firsthand the possibilities that lie ahead in their academic and professional journeys. Research has demonstrated that female students who engage with mentors are more likely to pursue advanced studies and careers in mathematics and related fields, thereby reducing gender disparities in STEM.[66]

Representing female role models in mathematics curricula and activities is equally crucial. Incorporating stories and contributions of women mathematicians into the curriculum can help challenge stereotypes and broaden female students' perspectives regarding their potential in the field.[67] When

[57] Saki Tsukahara et al., "Association of EHealth Literacy With Lifestyle Behaviors in University Students: Questionnaire-Based Cross-Sectional Study," *Journal of Medical Internet Research* 22, no. 6 (June 24, 2020): e18155, https://doi.org/10.2196/18155.

[58] Giselle Melo et al., "Tailored Nutritional Intervention through Digital Technology for Brazilian Adolescents," *Cadernos de Educação Tecnologia e Sociedade* 16, no. 4 (March 19, 2024): 1098–1109, https://doi.org/10.14571/brajets.v16.n4.1098-1109.

[59] Haining Bai, "Design and Application of Decision Support System for Educational Management Based on Big Data," *Journal of Electrical Systems* 20, no. 6s (April 29, 2024): 1645–55, https://doi.org/10.52783/jes.3084.

[60] Xue Luo and Xu Huang, "The Effects of a Yoga Intervention on Balance and Flexibility in Female College Students during COVID-19: A Randomized Controlled Trial," *PLOS ONE* 18, no. 3 (March 22, 2023): e0282260, https://doi.org/10.1371/journal.pone.0282260.

[61] Khaerul Anam, Muhamad Sadli, and Hadi Wijaya, "Analysis of Artificial Intelligence (AI) Utilization for Improving Motor Skills Learning Outcomes among Elementary School Teacher Education (PGSD) Students," *DIAJAR: Jurnal Pendidikan Dan Pembelajaran* 3, no. 2 (April 28, 2024): 202–9, https://doi.org/10.54259/diajar.v3i2.2492.

[62] Joram Weber and Claudio R. Nigg, "Promoting Fruit and Vegetable Consumption during the COVID-19 Pandemic – SportStudisMoveYou (SSMY): A Randomized Controlled Trial," *AIMS Public Health* 9, no. 4 (2022): 690–702, https://doi.org/10.3934/publichealth.2022048.

[63] Rachel Ayala Guzman et al., "A Cross-Sectional Examination of Race, Gender, and Intersectionality on Protective Behavioral Strategies and Alcohol Outcomes among Black and White College Students.," *Experimental and Clinical Psychopharmacology* 32, no. 6 (December 2024): 682–92, https://doi.org/10.1037/pha0000712.

[64] Shomi Anand et al., "Assessment of Depression, Anxiety, Stress, and Cognitive Parameters in Medical Students: A Pilot Study," *Asian Journal of Medical Sciences* 14, no. 2 (February 1, 2023): 214–17, https://doi.org/10.3126/ajms.v14i2.49269.

[65] Shirali Kharamin and Moradian, "Investigating the Effectiveness of Transactional Analysis (TA) Training on the Mental Health of Female Middle School Students."

[66] Wang et al., "Moderating Effect of Gender and Engineering Identity on the Association between Interpersonal Relationships and Mental Health of Female Engineering Students."

[67] Kezar et al., "Tailoring Programs to Best Support Low-Income, First-Generation, and Racially Minoritized College Student Success."

students see themselves reflected in the material they study, it fosters a sense of belonging and encourages them to envision a future in mathematics. This representation can take various forms, including guest lectures, workshops, and collaborative projects with female mathematicians, all of which can enhance the educational experience for female students.[68]

Encouraging female students to pursue mathematics through real-life success stories is a powerful strategy for fostering interest and resilience. Sharing narratives of women who have overcome obstacles to success in mathematics can motivate students to persevere in the face of challenges.[69] These stories highlight the importance of determination and hard work and provide relatable examples that female students can aspire to emulate. By creating a supportive network of mentors and role models, educational institutions can cultivate an environment where female students feel empowered to pursue their passions in mathematics and STEM fields.[70]

Peer-Led and Collaborative Learning Strategies

Implementing cooperative learning models has been shown to influence female students' performance in mathematics significantly. These models promote collaboration and teamwork, allowing students to engage in problem-solving activities together, which can enhance their understanding of mathematical concepts.[71] Research indicates that female students often thrive in collaborative environments where they can share ideas and support one another, leading to improved academic outcomes.[72] By fostering a sense of community and belonging, cooperative learning strategies can help mitigate feelings of isolation that female students may experience in traditionally male-dominated subjects like mathematics.[73]

Single-gender study groups are another effective strategy for fostering confidence and focus among female students. These groups create a safe space for girls to express themselves and engage in discussions without the pressures that may arise in mixed-gender settings.[74] Studies have shown that female students in single-gender groups often report higher participation and engagement as they feel more comfortable sharing their thoughts and asking questions.[75] This approach enhances their mathematical skills and confidence, encouraging them to take risks and embrace challenges.[76]

Encouraging collaborative problem-solving in mathematics classrooms can further enhance the learning experience for female students. By working together to tackle complex problems, students can develop critical thinking skills and learn to appreciate diverse perspectives.[77] This collaborative approach improves mathematical understanding and fosters essential social skills that are valuable in academic and professional settings. Educators can facilitate this process by designing group activities requiring cooperation and communication, creating an inclusive and supportive learning environment for female students.[78]

Parental and Community Engagement

Parental support and involvement play a crucial role in the success of interventions to improve female students' mathematics performance. Research has consistently shown that students perform better academically when parents actively engage in their children's education.[79] This involvement can take

[68] Eckert et al., "Assessing Children's Perceptions of Intervention Acceptability Ratings."
[69] Divjak et al., "Assessment Validity and Learning Analytics as Prerequisites for Ensuring Student-centred Learning Design."
[70] Soo et al., "Educators' Roles and Challenges in Supporting Tertiary Education Students' Mental Health: A Qualitative Study in Malaysia."
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[74] Kezar et al., "Tailoring Programs to Best Support Low-Income, First-Generation, and Racially Minoritized College Student Success."
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[77] Soo et al., "Educators' Roles and Challenges in Supporting Tertiary Education Students' Mental Health: A Qualitative Study in Malaysia."
[78] Maximiliane Uhlich et al., "Different Components of Sexual Narcissism Are Differentially Associated With Specific Sexual Aggression Strategies: An Exploratory Study Among Male and Female College Students," *International Journal of Sexual Health* 36, no. 1 (January 2, 2024): 111–25, https://doi.org/10.1080/19317611.2024.2311142.
[79] Eckert et al., "Assessing Children's Perceptions of Intervention Acceptability Ratings."

various forms, including attending school events, participating in parent-teacher conferences, and encouraging at home. Having supportive parents who advocate for their education can significantly enhance female students' motivation and confidence in pursuing challenging subjects like mathematics.[80]

Community-driven programmes that challenge gender stereotypes in mathematics are also essential for fostering a supportive environment for female students. These initiatives can include workshops, seminars, and outreach programmes that aim to raise awareness about the importance of gender equity in STEM fields.[81] By engaging community members in discussions about the value of mathematics for all students, regardless of gender, these programmes can help to dismantle harmful stereotypes and create a culture that encourages female students to excel in mathematics.[82]

Awareness campaigns promoting mathematics for girls can further enhance community engagement and support. These campaigns can highlight the achievements of female mathematicians and the importance of mathematics in various career paths, thereby inspiring young girls to pursue their interests in the subject.[83] By fostering a community that values and supports female students in mathematics, educational institutions can create a more equitable learning environment that empowers girls to succeed.[84]

Policy and Institutional Support

School-level policies to reduce gender gaps in mathematics achievement are critical for creating an equitable educational environment. Such policies can include targeted recruitment efforts for female students in advanced mathematics courses and implementing gender-sensitive teaching practices.[85] Research indicates that when schools adopt gender equity policies, female students are more likely to engage in mathematics and achieve higher academic outcomes.[86] By prioritising gender equity in their policies, educational institutions can help to dismantle systemic barriers that have historically hindered female students' participation in mathematics.[87]

Access to scholarships, awards, and competitions targeting female students can also be a powerful incentive for encouraging their participation in mathematics. These initiatives provide financial support and recognise and celebrate female students' achievements in the field.[88] Research has shown that when female students are acknowledged for their accomplishments, it boosts their confidence and motivates them to pursue further studies in mathematics and related disciplines.[89] Educational institutions can foster a culture of achievement and aspiration by creating opportunities for female students to excel and be recognised.[90]

Institutional efforts to create an equitable learning environment are essential for supporting female students in mathematics. This includes providing resources such as tutoring, mentoring, and counselling services specifically designed for female students. Research indicates that when institutions invest in support services tailored to the needs of female students, it leads to improved academic performance and retention rates. By fostering an inclusive and supportive environment, educational institutions can empower female students to overcome challenges and succeed in mathematics.

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[80] Divjak et al., "Assessment Validity and Learning Analytics as Prerequisites for Ensuring Student-centred Learning Design."
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[90] Al-Fayyadh et al., "Targeting Smoking Triggers: A Nurse-Led Intervention for Tobacco Smoking Cessation."

Assessment and Monitoring of Interventions

Evaluating the outcomes of interventions to support female mathematics students is essential for understanding their effectiveness. Various methods can be employed to assess intervention outcomes, including pre-and post-intervention assessments, surveys, and focus groups. These evaluation techniques provide valuable insights into the impact of the interventions on female students' academic performance, self-efficacy, and overall engagement in mathematics. By systematically assessing the outcomes, educators can identify successful strategies and areas for improvement, ensuring that interventions remain relevant and practical.

Longitudinal studies that track the sustained impact of interventions on female students' performance are particularly valuable. Such studies allow researchers to examine the long-term effects of interventions and determine whether the benefits persist over time. For instance, tracking the academic trajectories of female students who participated in mentoring programmes can provide insights into the lasting influence of these interventions on their educational and career choices. By understanding the long-term impact, educators can refine their approaches and develop more effective strategies for supporting female students in mathematics.

Identifying and scaling successful intervention models is crucial for maximising the impact of educational initiatives. When recognised, effective interventions can be adapted and implemented in other academic settings, reaching a broader audience of female students. Research has shown that scaling successful models can significantly improve female students' academic performance and engagement in mathematics. By fostering a culture of continuous improvement and adaptation, educational institutions can ensure that their interventions are responsive to the evolving needs of female students.

RECOMMENDATIONS

Based on the conceptual analysis of gender disparities in high school mathematics achievement, the following recommendations are proposed:

Gender-sensitive pedagogical approaches

Teachers must take responsibility for incorporating inclusive teaching strategies that cater to diverse learning styles and challenge gender stereotypes in mathematics, promote collaborative learning environments where male and female students feel encouraged to participate and use real-world problem-solving scenarios that highlight the relevance of mathematics across genders.

Teacher training and awareness

The Department of Education must be responsible for providing professional development programmes to help educators recognise and address gender biases in teaching practices, encourage teachers to use gender-neutral language and examples in classroom discussions and assessments and train educators to build mathematical confidence among female students through positive reinforcement and mentorship.

Mentorship and role models in STEM

The following steps must be taken to deal with gender disparities in schools: establish mentorship programmes connecting female students with successful women in STEM fields, introduce career awareness initiatives to expose students to female role models in mathematics-related careers and encourage female students to participate in mathematics competitions and STEM clubs to build confidence and interest.

Policy and institutional reforms

Policymakers and schools must take a stand in fighting gender disparities by implementing gender-responsive educational policies that promote equity in mathematics achievement, ensuring that school curricula challenge traditional gender norms, encouraging female participation in advanced mathematics, and providing scholarships and support programmes to increase female representation in higher-level mathematics courses and STEM careers.

Parental and community engagement

Schools and stakeholders must be responsible for conducting awareness campaigns to educate parents about their role in shaping children's attitudes towards mathematics, encourage family support programmes that promote a positive mathematical identity among female learners and foster community partnerships to provide additional learning opportunities, such as tutoring and extracurricular STEM programmes.

CONCLUSION

This paper posits that individual, familial and educational factors, including mathematics anxiety, self-efficacy, and teacher-student interactions, significantly influence gender disparities in high school mathematics achievement. Furthermore, it has been argued that targeted interventions, such as fostering a growth mindset and enhancing parental involvement, can effectively reduce these disparities and improve overall mathematical achievement for all students. By addressing both the cognitive and emotional dimensions of learning mathematics, this research aims to contribute to developing more equitable educational practices that support the success of all students, regardless of gender. Exploring gender disparities in high school mathematics achievement is an academic endeavour and a vital step toward fostering a more equitable educational landscape. As scholars delve deeper into the factors and interventions that can bridge these gaps, it becomes increasingly clear that a multifaceted approach is necessary to ensure all students succeed in mathematics and beyond.

SCHOLARLY SIGNIFICANCE

Theoretical Framework Integration

Utilising the Social Cognitive Theory, Social Cognitive Career Theory, and Gender Role Socialisation Theory, this research provides an integrated understanding of the psychological, social and cultural dimensions attributed to gendered outcomes in mathematics, thereby enriching the literature. Strengthening existing literature involves providing insights that enhance its clear reasoning.

Synthesis of multidimensional factors

This study provided an integrative self-efficacy and math anxiety, family roles like parental involvement, and educational domains discussing teacher-student relationships and teaching strategies within educational gender gap discourse. This analysis enables an in-depth comprehension of the reasons behind gender disparity in academic achievement, as opposed to shallow interpretations.

Evidence-based interventions

Implementing and assessing gender-responsive pedagogy alongside growth mindset and mindfulness strategies supports the study's practical claim in tailoring context-sensitive educational changes aimed at bridging gender disparities within the mathematics context.

Focus on underexplored constructs

Researching elements like stereotype threats and qualitative metrics of teacher-student interactions, along with gendered affective dimensions of learning mathematics, augments the scope of scholarly discourse on gender and mathematics education. Thus, this focus broadens the scope of scholarly inquiry.

Policy and practice implications

Aligning research with targeted, actionable reforms reveals systemic change pathways. Constructing comprehensive educational policy frameworks alongside active development partnerships between families and schools, designed to foster holistic reforms, guides educators professionally towards deeply embedded educational change. This integrates theory with practice.

Methodological contribution
The application of content analysis to has uncovered recurring themes across several studies, providing a systematic approach for examining the literature concerning gender inequities in scholarly work, which can be employed by other researchers performing literature or meta-synthetic reviews.

Contextual relevance
While the research is based on existing literature, it has the potential to impact policy and practice at global and local levels of education, especially in areas where gender inequities are deeply rooted due to sociocultural reasons. This work can be built upon by other researchers undertaking empirical studies or action research aimed at specific contexts.

Further research on gender disparities in mathematics
The following are topics for further research studies to expand on this paper's focus:

- Conduct longitudinal studies to assess the long-term impact of interventions on mathematics achievement.
- Explore the intersectionality of gender with other socio-economic factors, such as race and income, in influencing mathematics performance.
- Investigate the effectiveness of digital learning tools and AI-driven tutoring in reducing gender gaps in mathematics achievement.

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