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MAPPING RESEARCH TRENDS ON GENDER DISPARITIES IN MATHEMATICS EDUCATION: A BIBLIOMETRIC ANALYSIS FROM A VYGOTSKIAN PERSPECTIVE

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ABSTRACT

A total of 200 publications indexed in Google Scholar during 2019–2024 were retrieved using Publish or Perish and analyzed with VOSviewer. Co-authorship analysis reveals two dominant and closely connected research clusters, primarily rooted in quantitative and policy-oriented studies, reflecting a geographical dominance in Italy driven by a dense institutional collaboration network. Keyword co-occurrence analysis identifies four major thematic clusters, highlighting the central role of socio-psychological factors, particularly self-efficacy and stereotypes, alongside achievement measurement, macro-level policy analysis, and emerging intersectional perspectives. Interpreted through Vygotsky's socio-cultural theory, these findings indicate that gender gaps in mathematics are increasingly understood as socially mediated phenomena shaped by cultural tools and learning environments. This study contributes a theoretically grounded bibliometric synthesis and offers pedagogical implications for mathematics education that emphasize scaffolding, inclusive classroom practices, and the reduction of stereotype-based barriers within students' zones of proximal development.

Keywords: Bibliometric Analysis, Gender Disparities, Mathematics Education, STEM, VOSviewer.

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PRELIMINARY

Gender disparities in mathematics education remain a persistent global issue, particularly in relation to students' participation and achievement in Science, Technology, Engineering, and Mathematics (David, 2023; Durrani & Kataeva, 2025; Falentino et al., 2024). A substantial body of research has documented differences in mathematics performance, learning trajectories, and STEM career aspirations between male and female students across various educational contexts (Berisha et al., 2025; *Gender Differences in Education, Skills and STEM Careers in Latin America and the Caribbean*, n.d.; Nekhubvi,

2025; Penner & Willer, 2019). These disparities have frequently been associated with socio-psychological factors such as self-efficacy, motivation, anxiety, and gender stereotypes, rather than innate cognitive ability differences (Chan, 2022; Chiphambo, 2025; Kray et al., 2025). Consequently, contemporary scholarship increasingly emphasizes the role of learning environments and social contexts in shaping gendered outcomes in mathematics education. This growing volume of diverse research underscores the necessity of a structural literature mapping to clarify dominant themes and collaboration networks.

Previous studies addressing gender gaps in mathematics and STEM have employed diverse methodological approaches, including large-scale assessments, experimental designs, and qualitative classroom-based research(*Addressing the gender gap in STEM education across educational levels Analytical report*, n.d.; Beroíza-valenzuela, 2024). These studies provide important insights into the mechanisms underlying gender disparities; however, the literature remains fragmented across disciplinary boundaries such as psychology, sociology, economics of education, and mathematics education. As a result, it is often difficult to obtain a comprehensive overview of how research on gender disparities in mathematics education has evolved, which themes dominate the field, and which directions remain underexplored.

Bibliometric analysis offers a systematic approach to addressing this limitation by enabling the mapping of large bodies of scholarly literature to reveal publication trends, collaboration networks, and conceptual structures(Muntazhimah, 2022). Unlike narrative or traditional systematic reviews, bibliometric methods allow researchers to identify dominant research clusters and emerging topics based on quantitative patterns within the literature. The primary distinction lies in scale: traditional reviews provide a narrow, in-depth text synthesis, whereas bibliometrics offers a broad, algorithmic mapping of massive bibliographic datasets. Nevertheless, many existing bibliometric studies on gender or STEM education remain largely descriptive and rarely incorporate an explicit theoretical framework to interpret their findings.

Interpreting gender disparities in mathematics education requires moving beyond viewing gender as a mere demographic variable toward understanding it as a socially constructed phenomenon. From a socio-cultural perspective, learning and cognitive development are understood as processes mediated through social interaction and cultural tools(Muhayimana, 2017; Takeaways, 2025). Vygotsky's socio-cultural theory highlights the importance of language, norms, and shared meanings in shaping learners' participation and development within the zone of proximal development (ZPD)(Arshad & Chen, 2009;

Of et al., 2021; Shabani, 2010). In this theory, cultural tools refer to the psychological and physical instruments—such as language, signs, and societal beliefs—that individuals use to make sense of, communicate within, and master their environment. Within this framework, gender stereotypes and beliefs about mathematical ability can be conceptualized as cultural tools that influence students' engagement, self-regulation, and opportunities for meaningful mathematical learning. Integrating this theoretical lens into bibliometric analysis enables a deeper interpretation of research trends beyond surface-level descriptions.

Despite the growing volume of research on gender disparities in mathematics education, there is still a lack of bibliometric studies that systematically map the field while explicitly interpreting its intellectual structure through a socio-cultural theoretical framework. Addressing this gap, the present study combines bibliometric mapping with Vygotsky's socio-cultural perspective to provide a theoretically grounded synthesis of recent research on gender disparities in mathematics education. Accordingly, this study aims to: (1) map collaborative authorship patterns in research on gender disparities in mathematics education; (2) identify dominant and emerging thematic clusters shaping the field; and (3) interpret these patterns through a Vygotskian socio-cultural lens to derive implications for mathematics teaching and learning. By doing so, this study seeks to contribute an integrative overview that is relevant for researchers, teacher educators, and practitioners concerned with equity in mathematics education.

METHODS

This study employed a descriptive quantitative bibliometric design to map publication trends, collaboration networks, and conceptual structures in research on gender disparities in mathematics education. Bibliometric analysis was selected to systematically examine patterns within a large corpus of scholarly literature rather than synthesizing findings from individual empirical studies. Table 1. Describe the Research Design Stages and Bibliometric Workflow of this study.

A. Data Collection

Bibliographic data were retrieved from Google Scholar using Harzing's Publish or Perish (PoP) software. The search was conducted in November 2024 using combinations of the keywords gender gap, gender disparities, mathematics education, STEM, and achievement. The publication period was limited to 2019–2024 to capture recent developments in the field. The initial search yielded 200 documents.

Table 1. **Research Design Stages and Bibliometric Workflow**

No.	Stage	Process/Tool	Data Inpot/Output	Benchmark of Success
1.	Data Retrieval	Utilizing the Publish or Perish (PoP) software to extract information from Google Scholar.	The first raw dataset, consisting of approximately 200 documents.	The collection of adequate and suitable bibliographic data, based on established inclusion criteria.
2.	Data Reprocessing	Performing manual screening and data normalization to ensure consistency.	Refined bibliographic records (author names and keywords have been standardized).	Guaranteed data quality and full readiness for processing using the VOSviewer software.
3.	Bibliometric Mapping	Using VOSviewer to analyze and map co-authorship, keyword co-occurrence, and temporal layering.	Six resulting network visualization maps (listed as Images 1 to Image 6).	Successful visualization displaying strong and easily identifiable intellectual and conceptual clusters.
4.	Interpretation & Synthsis	Analyzing results by combining specific expertise in the related field with the conceptual framework of Vygotsky's Theory.	Sections covering the presentation of Results, Discussion of findings, and drawing of the final Conclusion.	Successfully connecting quantitative data network patterns with relevant socio-cultural dynamics and practical implications for pedagogy (learning).

A. Data Screening and Preprocessing

The retrieved records were screened for relevance based on titles and abstracts. Metadata preprocessing included the normalization of author names to resolve variations and the standardization of keywords by merging synonymous terms (e.g., gender differences and gender gap). This process ensured consistency and reduced bias in network visualization.

B. Data Analysis

The cleaned dataset was analyzed using VOSviewer (version 1.6.20). Two primary analyses were conducted: (1) co-authorship analysis to examine patterns of scholarly collaboration, and (2) keyword co-occurrence analysis to identify thematic clusters. Network visualization, density visualization, and temporal overlay visualization were

generated using full counting methods. Thresholds were set to include authors and keywords with a minimum frequency of occurrence sufficient to ensure meaningful clustering.

C. Analytical Framework

Findings from the bibliometric maps were interpreted using Vygotsky's socio-cultural theory. This framework was employed to explain how dominant research themes reflect socially mediated processes in mathematics learning, particularly the role of cultural tools such as stereotypes and beliefs in shaping gendered learning trajectories.

RESULT AND DISCUSSION

A. Mapping Collaborative Networks

As illustrated in Figure 1, The co-authorship network analysis reveals that research on gender disparities in mathematics education is structured around a limited number of highly connected authors, forming originating from Italy. This concentration highlights the maturity of gender studies within the European educational system, where gender equity is deeply institutionalized as a core research priority. This structural advantage allows European scholars to dominate the theoretical and methodological discourse in this field. Key authors such as Contini function as intellectual bridges, connecting otherwise separate research groups and facilitating the circulation of ideas across clusters.

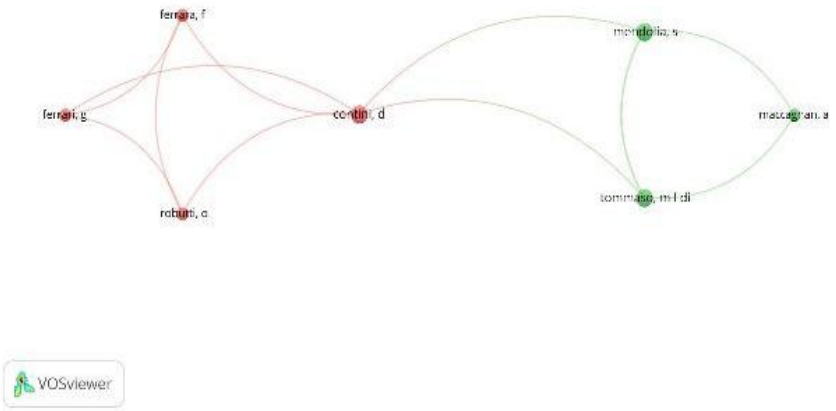


Figure 1. Co-authorship Network Visualization

This collaborative structure suggests that the field remains relatively centralized, with knowledge production driven by a small number of recurring research teams. While such concentration can strengthen theoretical consistency and methodological rigor, it may also limit the diversity of perspectives represented in the literature. From the standpoint of

mathematics education research, this pattern highlights an opportunity for broader international collaboration, particularly involving researchers from underrepresented regions, to enrich discussions on gender equity with more varied socio-cultural contexts.

B. Identification of High-Cohesion Research Clusters

Figure 4 reveals that the keyword co-occurrence analysis identifies several dominant conceptual clusters that define the intellectual structure of gender-related research in mathematics education. Among these, socio-psychological constructs—such as self-efficacy, motivation, mathematics anxiety, and gender stereotypes—emerge as the most central and interconnected themes. This finding indicates that contemporary research increasingly frames gender disparities not merely as differences in achievement outcomes, but as processes shaped by learners' beliefs, emotions, and identity construction within mathematical learning environments.

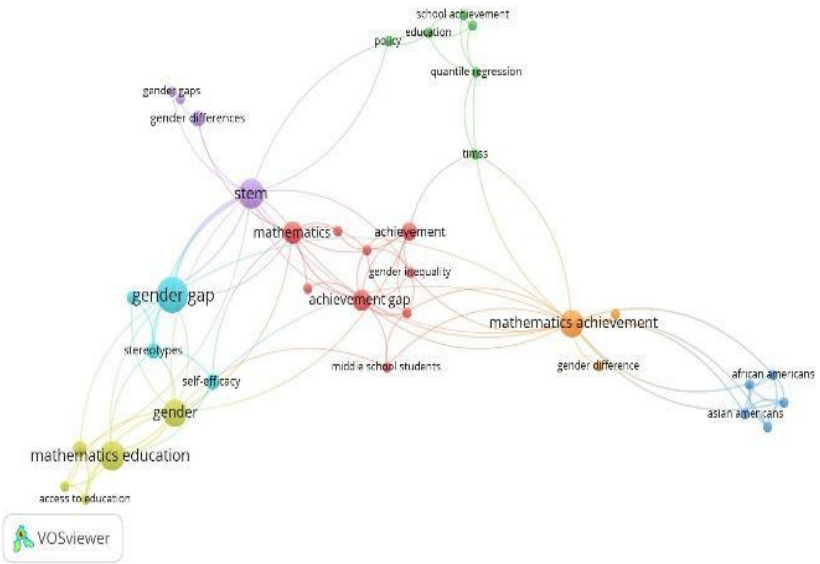


Figure 2. Keyword Co-occurrence Network Visualization Figure

In addition to socio-psychological factors, other clusters emphasize achievement measurement, STEM participation, and educational policy. However, these clusters appear less densely connected than those focusing on affective and identity-related variables. The prominence of socio-psychological themes reflects a broader shift in mathematics education research toward understanding learning as a socially situated activity, where classroom interactions, cultural expectations, and implicit norms play a critical role in shaping students' engagement with mathematics. This perspective is empirically supported by the keyword co-occurrence network, where the high density and strong link strength

among affective, identity, and socio-psychological nodes demonstrate that gender differences in mathematics are closely linked to how learners perceive themselves and are positioned within instructional environments.

C. Evolving Research Trends: From Achievement Measurement to Intersectional Perspectives

The temporal overlay analysis suggests a gradual evolution in research focus over time. Earlier studies primarily emphasized the measurement of gender gaps in mathematics achievement and participation in STEM-related pathways. More recent research, however, increasingly incorporates intersectional perspectives that consider the interaction of gender with socio-economic status, cultural background, and educational policy contexts.

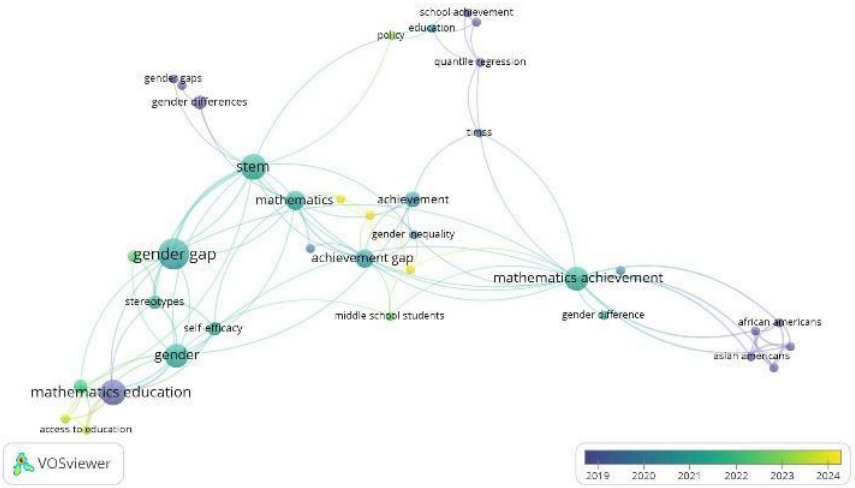


Figure 3. Temporal Overlay of Keyword Co-occurrence Figure

This shift reflects a growing recognition that gender disparities in mathematics education cannot be adequately explained through achievement metrics alone. Instead, recent studies acknowledge the complexity of learners' experiences and the influence of broader socio-cultural and institutional factors. Such developments align with contemporary approaches in mathematics education that prioritize equity, inclusion, and responsiveness to diverse learner identities.

Educational Implications for Gender-Responsive Mathematics Instruction

The findings of this bibliometric analysis have important implications for mathematics education practice. The centrality of self-efficacy and gender stereotypes in the literature underscores the importance of instructional strategies that foster positive mathematical identities among all students. Teachers are encouraged to design learning activities that promote meaningful participation, support collaborative problem solving,

and provide scaffolding that enables learners to engage productively with mathematical tasks. The findings of this bibliometric analysis have important implications for mathematics education practice. The centrality of self-efficacy and gender stereotypes in the literature aligns with Albert Bandura's Social Cognitive Theory, which posits that environmental factors—such as societal biases—strongly dictate an individual's cognitive self-belief. This thematic prominence corroborates the landmark meta-analysis by Else-Quest et al. (2010), which demonstrated that gender disparities in math are often driven by socio-emotional variables and attitudinal variations rather than actual cognitive deficiencies. Furthermore, the continuous mapping of stereotype threats in our bibliometric data mirrors the structural findings of Wang and Degol (2017), confirming that cultural stereotyping remains a persistent barrier to developing robust mathematical identities among female students.

Consequently, this body of evidence underscores the importance of instructional strategies that foster positive mathematical identities among all students. Teachers are encouraged to design learning activities that promote meaningful participation, support collaborative problem solving, and provide scaffolding that enables learners to engage productively with mathematical tasks. Furthermore, the increasing attention to intersectional perspectives suggests that gender-responsive mathematics instruction should be context-sensitive rather than uniform. Educators and curriculum designers need to consider how gender interacts with cultural norms, language practices, and institutional structures within specific learning environments. By addressing these factors, mathematics education can move toward more equitable and inclusive practices that support diverse learners' engagement and achievement.

CONCLUSION

This bibliometric study maps recent research on gender disparities in mathematics education and reveals a field that has progressively shifted toward socio-cultural and psychological explanations of achievement gaps. Co-authorship analysis highlights concentrated collaboration patterns, which signals regional dominance and highlights the necessity for future collaboration diversification to ensure more inclusive socio-cultural perspectives. Meanwhile, keyword analysis underscores the central role of self-efficacy and stereotypes as dominant explanatory themes. Interpreted through Vygotsky's socio-cultural theory, these findings support the view that gender disparities in mathematics are socially produced and mediated by cultural tools within educational contexts.

From a pedagogical perspective, the results suggest that mathematics instruction should move beyond deficit-oriented comparisons and instead focus on creating learning environments that actively counter stereotypes and support students' development within their zones of proximal development. Scaffolding strategies, inclusive classroom discourse, and reflective teacher practices are essential for reducing gender-based barriers to participation and achievement.

Despite its contributions, this bibliometric study is subject to several limitations. First, the data retrieval was restricted to specific indexing databases [such as Scopus / Web of Science], potentially omitting relevant publications indexed elsewhere or published in non-English journals. Second, while keyword and co-authorship analyses effectively map macro-level trends, they inherently favor dominant research patterns, which may overlook marginal yet innovative local perspectives. Finally, as a bibliometric overview, this study categorizes the structural landscape of the literature but does not critically evaluate the empirical quality or the practical effectiveness of the instructional interventions documented in the analyzed texts.

Future research is encouraged to integrate bibliometric insights with empirical classroom studies to develop and evaluate instructional interventions that promote equity in mathematics education.

DECLARATIONS

Author Contribution	:	Author 1: Conceptualization, Writing - Original Draft, Editing and Visualization. Author 2: Writing - Review & Editing, Data Collection Author 3: Writing - Review & Editing, Data Collection Author 4: Writing - Review & Editing, Data Screening and Preprocessing. Author 5: Writing - Review & Editing, Data Screening and Preprocessing. Author 6:Formal Analysis and Methodology Author 7: Formal Analysis and Methodology Author 8 : Writing - Review & Editing
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REFERENCES

Addressing the gender gap in STEM education across educational levels Analytical report. (n.d.). https://doi.org/10.2766/260477

Arshad, M., & Chen, W. U. H. (2009). *Vygotsky ' s socio-cultural theory of literacy Scaffolding children to read and write at an early age*. *11*(2).

Berisha, F., Kolgjini, J., Berisha, E., & Kolloni, Y. (2025). Gendered Confidence Gaps and Empowering Future STEM Careers : Insights from Expectancy-Value Theory. *Journal for STEM Education Research*, *0123456789*. https://doi.org/10.1007/s41979-025-00168-x

Beroíza-valenzuela, F. (2024). *STEM and gender gap : a systematic review in WoS , Scopus , and ERIC databases*. *May*, 1–10. https://doi.org/10.3389/feduc.2024.1378640

Chan, R. C. H. (2022). A social cognitive perspective on gender disparities in self - efficacy , interest , and aspirations in science , technology , engineering , and mathematics (STEM): the influence of cultural and gender norms. *International Journal of STEM Education*, *0*. https://doi.org/10.1186/s40594-022-00352-0

Chiphambo, S. (2025). *Gender Disparities in High School Mathematics Achievement : Factors and Interventions*. *6*(9), 2081–2099.

David, J. (2023). *Gender Disparities in Stem Education and Career Choice*. *07*(01), 1–5.

Durrani, N., & Kataeva, Z. (2025). STEM teachers ' agency for gender equality in STEM education : A mixed-methods study. *International Journal of Educational Research*, *131*(April 2024), 102585. https://doi.org/10.1016/j.ijer.2025.102585

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin*, 136(1), 103–127.

Falentino, C., Presma, E., Dinurrohmah, S., & Tanlianto, A. (2024). *Beyond the Gap : Understanding Gender Disparities in Indonesia ' s National Science Olympiad Achievements*. *4*(6).

Gender Differences in Education, Skills and STEM Careers in Latin America and the Caribbean. (n.d.).

Kray, L. J., Mishra, S., Townsend, C. H., & Kennedy, J. A. (2025). Trends in Cognitive Sciences Psychological drivers of gender disparities in leadership paths. *Trends in Cognitive Sciences*, *xx*(xx), 1–15. https://doi.org/10.1016/j.tics.2025.10.008

Muhayimana, T. (2017). *The Relevance of the Vygotsky ' s Sociocultural Approaches to Promote Interaction in EFL Classroom*. *2*(3), 259–278.

Muntazhimah. (2022). *Jurnal Pendidikan Progresif Bibliometric Analysis of Mathematics Learning Video using VOSviewer* . *12*(2), 853–865. https://doi.org/10.23960/jpp.v12.i2.202236

Nekhubvi, V. (2025). *Research in Business & Social Science Assessing gender disparities and variability in STEM education using subject scores*. *14*(2), 352–364.

Of, B., With, P., & Psychology, C. (2021). *Sallehuddin bin md yusof*.

Penner, A. M., & Willer, R. (2019). *Men ' s Overpersistence and the Gender Gap in Science and Mathematics*. https://doi.org/10.1177/2378023118821836

Shabani, K. (2010). *Vygotsky ' s Zone of Proximal Development : Instructional Implications and Teachers ' Professional Development*. *3*(4), 237–248.

Takeaways, K. (2025). *Vygotsky ' s Theory of Cognitive Development*. 1–31.

Wang, M. T., & Degol, J. L. (2017). Gender gap in Science, Technology, Engineering, and Mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational Psychology Review*, 29(1), 119–140. doi.org