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A Systematic Review of Research on Gender Diversity in STEM Education

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Abstract. Science, technology, engineering, and mathematics (STEM) education research has increased worldwide in recent years. Recognition of STEM education's importance in producing highly skilled scientists and technologists and its economic benefits to society are driving this increase. However, STEM labor force gender representation is a persistent issue. A meta-analysis using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol and a thorough literature search assessed STEM gender diversity. A total of 42 STEM education gender diversity research papers were reviewed using PRISMA. These Scopus papers provide a database from 2013 to 2023. The study used text analysis and synthesis to evaluate and highlight the countries, extract key phrases, identify research issues of interest to scholars, and suggest future research directions. The research findings indicate that current publications primarily focus on developing STEM education programs to attract and provide more opportunities for women. Additionally, other research areas of interest include proposing solutions to enhance gender equality in STEM education, women's awareness, and skills in the STEM field. Furthermore, research gaps have been identified in course design, learning material development for STEM education, and establishing a direction for implementing STEM

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education starting from early elementary school, with the optimal period being before grade 3. These findings can help academics explore STEM research ideas in new situations. However, the investigation was limited by using only a Scopus catalog database; disregarding alternative sources may have led to material being omitted.

Keywords: education; gender gap; PRISMA; review; STEM

1. Introduction

In a world that is becoming increasingly complex, it is vital for those who are interested in pursuing careers in fields such as artificial intelligence, biotechnology, and renewable energy, as well as for all citizens to adapt to the rapid development that is being made in these fields in order to have a good understanding of STEM subjects. Most of the anticipated increases in job opportunities are expected to be concentrated in the STEM domains (Dasgupta & Stout, 2014). Many countries prioritize STEM in education to develop the important abilities required in the 21st century, including creativity, critical thinking, cooperation, communication, and problem-solving (Bataineh et al., 2022).

Although STEM has gained greater significance, there remains a substantial gender gap in terms of both interest and accomplishment in these subjects. This disparity is not only a matter of fairness but also has ramifications for fostering creativity, sustaining competitiveness, and tackling the socioeconomic issues of a country (Wang & Degol, 2017). The persistent lack of female participation in STEM fields has been a matter of constant concern for scholars and politicians alike (Chiang et al., 2023). Gender equality encompasses both the principles of human rights and the equitable involvement of women across all societal domains. This inclusion is crucial for promoting economic advancement, supporting human development, improving regional competitiveness, and raising productivity (Thomas et al., 2015).

Nevertheless, it is said that women exhibit lower rates of enrollment in these subjects, namely in disciplines connected to engineering (Vooren et al., 2022). According to a report by UNESCO, a mere 30% of female students opt for professions and subjects connected to STEM in higher education, while just 28% of researchers working in these fields are women. UNESCO also explains the convincing reasons regarding the perceived alignment of specific STEM areas with female identity, family responsibilities, and the working environment and conditions. Although recognizing the significance of these elements in relation to female involvement in STEM professions, this review specifically concentrates on schooling and does not delve into these aspects. The second half of this research presents and analyzes the primary factors that impact the involvement and achievement of female students in STEM disciplines (Chavatzia, 2017). There is a possibility that emerging countries have a more significant gender imbalance in STEM fields (Chiang et al., 2023). Because it is pointed out that the gender STEM gap starts already around the age of 6, it is essential to encourage girls' interest in

STEM disciplines from a young age so that they can build the confidence to pursue careers in these areas (Benavent et al., 2020).

STEM occupations frequently serve as the foundation of a country's economy because of the influence of scientific knowledge in driving advancements and technological progress in infrastructure construction (Schmader, 2023). Gaining a more comprehensive comprehension of the disparities in emotional learning between genders and how they affect students' educational progress will assist in resolving gender disparities in the pursuit and continuation of STEM disciplines (Pelch, 2018). One further incentive for choosing STEM degrees is that technical and technology professions typically offer the greatest potential for earning compared to other types of work with the gender wage gap largely attributed to the underrepresentation of women in these occupations. The World Employment and Social Outlook report by the International Labor Organization (ILO) in 2018 highlights the fact that women receive lower wages and have fewer job opportunities. This is despite their significant contributions to the household economy and their influential role in promoting peace in countries (ILO, 2017). The issue of gender equality can be seen as a widespread obstacle in the pursuit of sustainable development goals (Filho et al., 2023).

Increasing the participation of women and underrepresented minority groups in these disciplines might alleviate labor shortages in specific STEM industries. Additionally, it will foster increased creativity and guarantee a more extensive information repository. Addressing the gender disparity in STEM education can have positive effects on the labor market by reducing obstacles, enhancing women's employment rates and productivity, and lessening occupational segregation (EIGE, 2021).

STEM disciplines are intricately linked to our comprehension of the natural world and the creation of the physical environment that surrounds us. Hence, the absence of varied viewpoints might result in substantial losses and overlooked prospects (Schmader, 2023). Multiple international research studies and evaluations have recorded gender inequalities in the awareness and perception of STEM fields (Mei et al., 2023). Indeed, the lack of female representation in STEM occupations is apparent (Schmader, 2023) and gender disparities in STEM learning are substantial. Gender stereotypes can also hinder women's capacity to view themselves as appropriate, purpose-driven, and socially compatible in STEM domains (Schmader, 2023), while cultural prejudices act as impediments to student engagement in STEM education (Mei et al., 2023). Owing to cultural influences, women's interest in STEM professions such as computer science and engineering is relatively low. The barriers they face are, however, more deeply rooted in systemic and societal cultural factors than in barriers related to participation and literacy in STEM fields.

Research consistently shows that girls have lower confidence in their math abilities, lower motivation in math and science subjects, and less interest in pursuing STEM-related fields (Benavent et al., 2020; Wang et al., 2013). Female students frequently encounter heightened degrees of nervousness and apprehension in STEM-related circumstances in contrast to their male counterparts (Kans & Claesson, 2022). In consequence, emotional differences between males and females can potentially influence the persistence of learning in STEM fields (Pelch, 2018). Self-efficacy discrepancies between men and women are thought to be a significant element that contributes to the gender gap in STEM areas, particularly with regard to how individuals evaluate their own capabilities. Effort, goal-setting, self-regulation, and career choices are all influenced by self-efficacy beliefs, which is where this phenomenon originates (Sakellariou & Fang, 2021). Women globally do not have enough access to good schooling, especially in the fields of STEM and in certain specialized jobs. This happens because of the complicated ways that many social, national, racial, regional, and local factors interact with one another (Sharma, 2023). The underrepresentation of women in STEM disciplines perpetuates gender stereotypes, which in turn can cause some women to regard STEM education as being primarily for men (EIGE, 2021).

The elimination of biases and the enhancement of girls' confidence in STEM disciplines are of the utmost importance as there is evidence to show that confidence in STEM subjects plays a significant role in the long-term persistence of individuals in these fields (Benavent et al., 2020). A variety of outreach initiatives have been carried out; these involve the participation of children, families, teachers, and women who have experience in STEM fields. These activities are carried out through the three primary methods: Family Chat for Girls4STEM, Professional Chat for Girls4STEM, and an Initial Training Workshop for Girls4STEM (Benavent et al., 2020). In advancing gender diversity in STEM education, it is necessary to take a multifaceted approach in order to reform organizational and educational cultures at the individual and institutional levels to address these systemic hurdles (Pelch, 2018). The goal of this method is to reduce the gender gap in interest in STEM fields (Schmader, 2023).

To increase women's interest in STEM areas and eliminate gender imbalances in STEM knowledge, a comprehensive approach that tackles cultural barriers is necessary. As such, a crucial endeavor in the realm of gender-responsive STEM education programs is creating and executing educational programs that are both accessible and captivating for students of all genders. These programs employ real-life situations, a variety of exemplary figures, and practical learning opportunities. A STEM education program that is responsive to gender focuses on the importance of representation, contextualization, and collaboration in fostering the interest, achievement, and persistence of individuals in STEM at every stage (Mei et al., 2023). Implementing evidence-based policies and programs shows the potential to reduce these obstacles and improve the involvement of girls and women in STEM disciplines (Dasgupta & Stout, 2014).

Efforts to reduce the disparity between genders should focus on various stages of growth and progress. Dasgupta and Stout (2014) examined three developmental stages and identified obstacles within each: (a) childhood and adolescence, (b) emerging adulthood, and (c) early to middle adulthood (Dasgupta & Stout, 2014). Furthermore, scholars have examined the attitudes and interests of students toward STEM, which are associated with their gender perspectives. Additionally, they have proven that the involvement of family, financial resources from family, companions, educators, and personal interests all exert substantial influence on the development of students' attitudes and enthusiasm for STEM (Suwono et al., 2019). Gender disparities in self-efficacy play a significant role in the gender disparity observed in STEM areas, specifically concerning personal proficiency (Sakellariou & Fang, 2021).

There is a scarcity of comprehensive studies on gender diversity in the STEM area. Hence, the objective of this work is to tackle the following concerns:
1) What are the trends in research on gender diversity in STEM fields?
2) Which subjects have been examined in relation to gender diversity in STEM?
3) What are the future research directions on gender diversity in STEM?

2. Methodology

The PRISMA technique serves as a definitive guideline and standard for the execution and documentation of publications pertaining to systematic reviews and meta-analyses. It offers a methodical and clear-cut technique for conducting a comprehensive search, choosing, evaluating, and combining studies involving gender diversity in STEM education (Moher et al., 2010; Nguyen & Nguyen, 2022).

2.1. Data search sources

The document repository was constructed using input information obtained from Scopus and comprised keyword lists, abstracts, and titles of the documents. Scopus is an abstract and citation database of peer-reviewed literature including scientific journals, books, and conference proceedings. Scopus provides a comprehensive overview of worldwide research output in the fields of science, social sciences. For the purpose of doing research in the subject of educational science, these databases are trusted resources that are regarded to be appropriate (Moher et al., 2010; Nguyen & Nguyen, 2022).

2.2. Search criteria

In order to include an article in the study's database, it had to satisfy both of the following search criteria: The search subject keywords necessitate the presence of at least one term associated with "STEM" in the article title, abstract, or author keywords. The search query within the specified parameters requires the presence of at least one of the following terms: "gender inclusion," "gender diversity," or "gender gap" in the title, abstract, or keywords of the article. For example, TITLE-ABS-KEY (["stem" OR "science, technology, engineering, and math"] AND ["gender-inclusive" OR "gender diversity" OR "gender gap"]). In utilizing these criteria it has been determined that the Scopus database has 928 relevant articles.

2.3. Eligibility assessment

In order to evaluate the suitability of gender diversity publications in the field of STEM education which were collected from the Scopus database, their titles and abstracts were analyzed based on the following specified criteria: (a) only papers from peer-reviewed journals were considered owing to their trustworthiness and rigorous review procedures; (b) only publications pertaining to gender diversity in the field of STEM education were chosen with respect to the subjects; (c) all chosen articles were written in English and (d) were published between 2013 and 2023.

Figure 1 presents a flowchart that demonstrates the data process involved in the systematic evaluation according to the PRISMA technique.

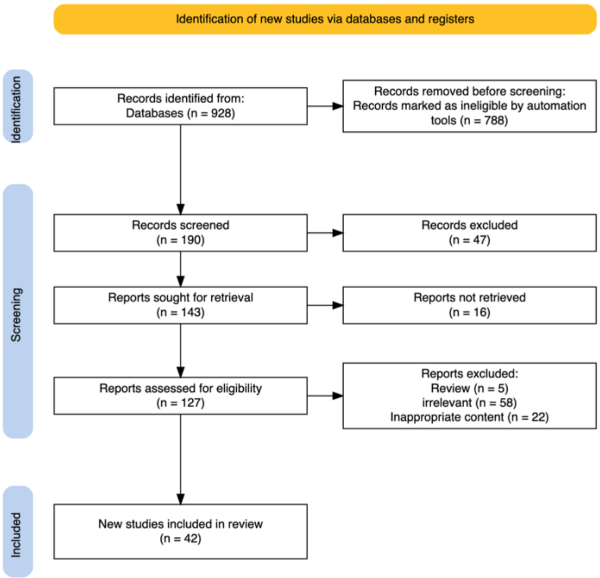

Figure 1. PRISMA diagram illustrating the process of selecting analytical papers

The Scopus database had a total of 928 articles of which 788 exclusions were made through automated screening by eliminating copies that matched the required titles. From the remaining 190 articles, their titles were evaluated for relevance, and those with suitable titles were examined for full-text content. The criteria were developed by experts (Figure 1). Upon careful examination of the article content, the team of authors proceeded to eliminate articles that had less pertinent information related to the topic. In conclusion, a total of 42 publications were incorporated into the analysis.

3. Results and Discussion

3.1. What are the trends in research on gender diversity in STEM fields?

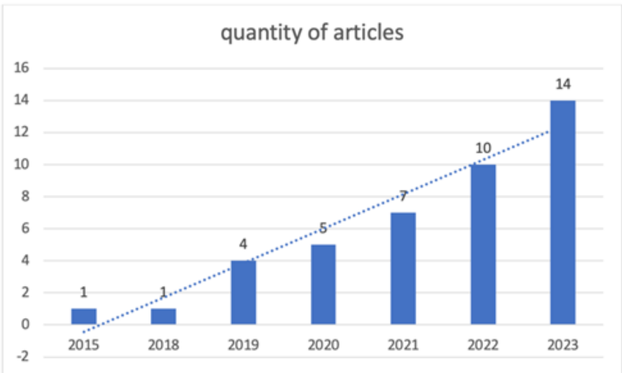

Figure 2. Research trends in gender diversity in STEM education from 2013 to 2023

Figure 2 illustrates the quantity of publications pertaining to gender diversity in the field of STEM education that were published between 2013 and 2023. The data was displayed in chronological order on a timeline. In general, it can be seen that there has been a consistent increase in the number of articles, reaching its highest point in 2023. Between 2015 and 2020, there was an increase in the number of research studies conducted on gender diversity in the STEM area. Nevertheless, the overall number remained relatively limited. The academics' increased interest during this period can be linked to the lack of comprehensive examination into gender diversity in STEM education. Starting in 2021, the research indicated a significant and swift rise, culminating in 2023 with 14 articles (constituting 33.3% of the total articles studied).

Due to the anticipated expansion of job opportunities in STEM sectors in the United States, there has been a high demand for individuals with expertise in science, technology, engineering, and mathematics. American businesses are actively recruiting skilled individuals in these fields on a worldwide level. This situation generates apprehensions regarding the readiness of Americans for STEM occupations, given the limited enrollment of domestic students in these subjects and the significant attrition rate, commonly known as the "leaky pipeline", explaining and defining the reasons behind students' departure from STEM professions for non-STEM ones. However, there does not appear to be a dynamic perspective on changing college majors (Ma & Xiao, 2021).

Women possess significant untapped potential as a workforce, which has the ability to enhance the strength of the STEM labor force on account of the fact that women constitute 50% of the population in the United States (Dasgupta & Stout, 2014). The United States acknowledges the significant contribution of educators in leveraging the potential of women to enhance the diversity of the current STEM workforce and establish a fairer society (Lim et al., 2021). The analysis results indicated that the United States carries out extensive research on gender diversity in STEM education. This finding aligns with the investigation carried out by Le Thi Thu et al. Given the United States' prominent position in worldwide STEM education research, it is unsurprising that there are studies on gender diversity in the STEM profession within the country. In addition, the United States has implemented a Civil Rights law that forbids discrimination, including discrimination based on gender. This act has played a significant role in shaping the United States as a prominent country in terms of gender equality (Quffa, 2016). This partially elucidates the reason behind the country’s significant volume of scholarly articles that delve into the topic of gender diversity in STEM education.

Spain has made a noteworthy contribution to the field of gender diversity in STEM with six publications, thereby indicating the country's interest and active involvement in exploring this topic. China has published four papers on the topic of gender diversity in STEM; while the number may not be as substantial as that of the United States or certain other nations, it nevertheless indicates the country's commitment to and advancement in studying gender diversity in STEM. Additionally, the United Kingdom, South Africa, the Netherlands, and Chile have twenty-one published works on gender diversity in STEM. While the number of publications may not be extensive, it does, however, demonstrate the early interest and endeavors of these countries in fostering study and conversations on gender diversity as they advance STEM in their individual nations.

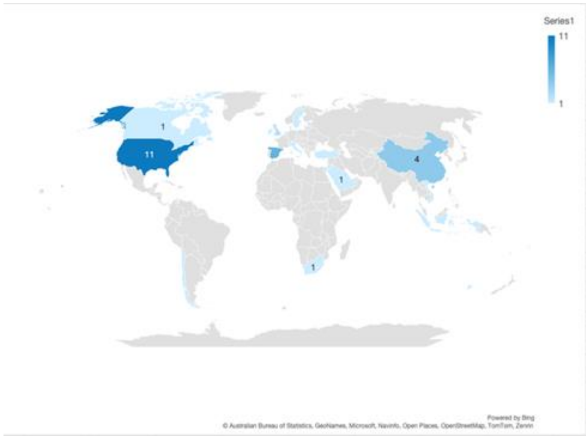

Figure 3. Spatial placement of the authors of the study on gender diversity in STEM education from 2013 – 2023

One approach to analyze the emerging research themes on gender disparity in STEM education might be through studying the frequency of specific phrases. The "word cloud" tool visualizes research publications by displaying keywords in larger and bolder font size, indicating their higher frequency of occurrence (Dicle & Dicle, 2018). Figure 4 provides a concise summary of 1791 relevant phrases. The data from this figure indicated that STEM, gender, learners, women, female students, education, science, and technology are the most commonly mentioned phrases in the publications. Furthermore, previous studies have included additional indexing categories, comprising scientists, careers, motivation, cognition, and curiosity, which propose prospective areas of investigation for future scholars.

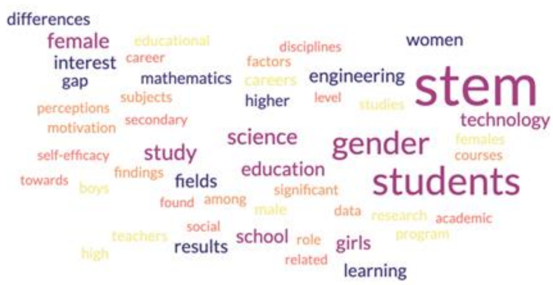

Figure 4. Word cloud (based on keywords) in the field of gender diversity in STEM education

In the sector of education, this research has revealed a strong focus on specific issues in literature reviews. The study identified the most frequently used keywords in research articles by selected writers globally. Figure 5 depicts the top 10 prevailing keywords found in the collection of articles analyzed in this study. Aside from the keyword "STEM," which appears 244 times, authors frequently employ additional terms such as "students" (147 occurrences) and "gender" (110 occurrences) as indexing terms for their works.

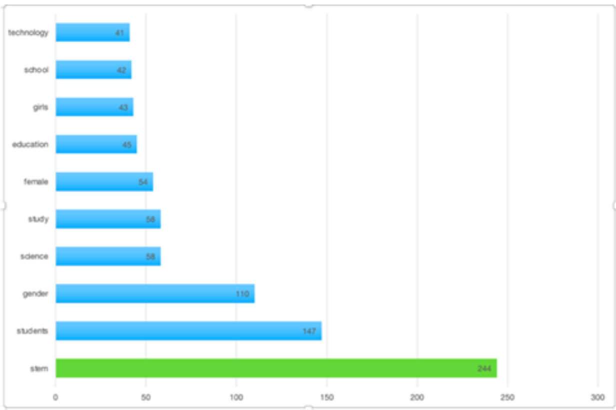

Figure 5. How often keywords are extracted from articles

Figure 5 shows that research on gender diversity in the field of STEM education focuses heavily on women with interest, confidence or choice to pursue STEM subjects or careers. In these studies, many authors focus on female learners in various aspects related to STEM education.

3.2. What content is studied on gender diversity in STEM fields?

Table 2 shows the results obtained after conducting an analysis of 42 articles concerning gender diversity in STEM disciplines. This was done by systematically organizing the subjects that were addressed by the studies:

Table 1.

Key Research Issues

Focus Areas	References
Conducting research on strategies and initiatives to promote gender parity in the STEM sector	(Benavent et al., 2020), (García-Holgado et al., 2020), (Gweshe & Chiware, 2023), (Reinking & Martin, 2018), (Rushton & King, 2020)
Interventions targeting the modification of female students' perspectives on STEM jobs	(Dönmez, 2023)
Conducting a study on the differences in confidence, interest, and goals across genders in the STEM fields, and investigating how cultural and societal expectations impact women's participation in STEM	(Chan, 2022)
Adapting formal and extracurricular educational programs and STEM courses to attract more genders. Adapting programs to boost female STEM enrollment in specific contexts is crucial	(Friedman-Sokuler & Justman, 2020), (Goreth & Vollmer, 2023), (Levine et al., 2015), (Price et al., 2019), (Sangar, 2022), (Schilling & Pinnell, 2018),

	(Sevilla et al., 2023)
Analyzing the influence of STEM educational programs on students' attitudes	(Van Wassenaer et al., 2023)
Conducting research on particular policies that have a strong likelihood of reducing obstacles encountered by women in the field of science	(Greider et al., 2019)
Creating and evaluating virtual STEM laboratories with the aim of engaging female students	(Vergara, 2023)
Conducting research on the emotional components of learning and students' attitudes toward STEM subjects	(Pelch, 2018), (Zhou et al., 2019)
Examining the factors contributing to disparities in gender representation in STEM fields	(Delaney & Devereux, 2019), (Naukkarinen & Bairoh, 2020)
Examining the impact of gender and nationality on the experiences of women in STEM fields	(Lim et al., 2021)
Conducting research on women's cognitive abilities, interests, beliefs, motivation, engagement, advantages, and challenges in STEM fields	(Chiang et al., 2023), (Jiang et al., 2020), (Kans & Claesson, 2022), (Kelly et al., 2019)
Examining obstacles, assistance, and gender inequalities in STEM education selections among high school students	(Merayo & Ayuso, 2023)
Exploring the correlation between self-efficacy and interest in STEM subjects and the probability of enrolling in STEM programs in college	(Sakellariou & Fang, 2021)
Examining gender-related variables shaping decisions in STEM education	(Chauke, 2022), (De las Cuevas et al., 2022), (Martínez et al., 2023)
Investigating the impact of environmental factors (such as formal education, informal education, social support, and media) on high school students' interest in STEM careers; the role of STEM self-efficacy and STEM career awareness as mediators in this relationship	(Wang et al., 2023)
Analyzing the influence of family on gender equality in STEM education	(Anaya et al., 2022), (Liu, 2020)
Investigating the establishment of gender-neutral STEM environments via play	(Rushton & King, 2020)

Examining the influence of ethnicity and gender on the choice of STEM elective courses	(Friedman-Sokuler & Justman, 2020)
Analyzing factors affecting academic performance in STEM disciplines among male and female students.	(Daniela et al., 2022)

Researchers globally have shown a significant amount of interest in the research fields presented in Table 1. These areas are an examination of flexible teaching programs, including both formal and extracurricular ones, as well as STEM classes with the goal of promoting gender diversity (Friedman-Sokuler & Justman, 2020; Goreth & Vollmer, 2023; Levine et al., 2015; Price et al., 2019; Sangar, 2022; Schilling & Pinnell, 2018; Sevilla et al., 2023) and emphasising the significance of making program modifications in order to increase the number of women who participate in STEM fields while taking into account certain contextual factors (Friedman-Sokuler & Justman, 2020; Goreth & Vollmer, 2023; Levine et al., 2015; Price et al., 2019; Sangar, 2022; Schilling & Pinnell, 2018; Sevilla et al., 2023).

There is also a need for the identification of policies and strategies that will promote gender equality in the STEM fields (Benavent et al., 2020; García-Holgado et al., 2020; Gweshe & Chiware, 2023; Reinking & Martin, 2018; Rushton & King, 2020) as well as research to determine the levels of awareness, interest, confidence, motivation, engagement, advantages, and problems that women face when working in STEM disciplines (Chiang et al., 2023; Kans & Claesson, 2022), (Jiang et al., 2020; Kelly et al., 2019). Additionally there is a recognition that gender is one of the elements that influence the outcomes of STEM learning (Anaya et al., 2022; Wang et al., 2023), as well as investigation of the influence of external factors, such as family and environment, on gender equality in STEM education (Daniela et al., 2022).

3.3. What are the future research directions on gender diversity in STEM?

When carefully evaluating the papers in the collected data, of particular interest were the research gaps highlighted by the authors in the limitations section or in the article's conclusion. These can also be used to identify future study directions. This study further investigated potential areas for future research or unresolved issues that could be addressed in relation to gender diversity in STEM professions. The outcomes of this exploration are as follows:

Table 2.

Future Research Directions on Gender Diversity in STEM

Potential future research directions	References
Improving girls' access to STEM education by implementing enriched teaching programs and offering extracurricular activities to address the gender disparity in STEM	(Chan, 2022)
Promoting girls' self-efficacy in STEM fields and challenging traditional gender stereotypes among all students	(Chan, 2022)
Formulating strategies to assist women in STEM and in	(Corrigan et al.,

achieving a balance between problem solving and preventing unintended outcomes	2023)
Developing STEM education programs for students at different stages of education	(Zhou et al., 2019)
Promulgating research policies that promote women's participation in STEM fields	(Lim et al., 2021)
Exploring the opportunities and challenges that girls may face in robotics competitions and STEM education on a broader scale	(Chiang et al., 2023)
Conducting research on women's involvement in STEM disciplines from a range of perspectives and themes and considering how their character attributes both complement and reinforce their abilities	(Chiang et al., 2023)
Creating sustainable and cohesive environments where all students can thrive, build confidence and be accepted in the STEM field.	(Birney & McNamara, 2023)
Proposing ways to develop self-efficacy and interest in STEM subjects to close the gender gap	(Kans & Claesson, 2022), (Sakellariou & Fang, 2021)
Developing STEM courses and activities to engage gender diversity	(Zhao & Perez-Felkner, 2022)
Integrating research design and using a variety of research methods on gender diversity in STEM fields	(Chiang et al., 2023), (Price et al., 2019)
Implementing measures to invite successful women in STEM fields to schools to exchange and share to motivate learners interested in STEM fields	(Price et al., 2019), (Wang et al., 2023)
Delving deeper into learners' STEM learning motivations and preferred modes of learning	(Price et al., 2019), (Sáiz-Manzanares et al., 2021)
Studying the impact of siblings, friends, and teachers on students' STEM learning	(Price et al., 2019)
Investigating and creating STEM-integrated curricula and courses to be introduced as early as primary school, ideally before grade 3, as this is the best opportunity to close the gender gap in STEM disciplines	(Bataineh et al., 2022), (Benavent et al., 2020), (Morales et al., 2023), (Stolk et al., 2021)
Expanding questionnaires to survey learners of gender awareness in STEM fields	(Verdugo-Castro et al., 2022)
Conducting STEM attitudes and preferences intervention research for girls	(Wang et al., 2023), (Zhou et al., 2019)
Investigating measures to close the gender gap in STEM subjects in schools	(De las Cuevas et al., 2022)
Selecting the right context to influence students' parents in improving students' STEM outcomes	(Anaya et al., 2022)

Table 2 offers recommendations for areas of research that can assist researchers in exploring and making progress toward reducing the disparity between genders in the STEM profession. An effective strategy to solve the existing gender gap in STEM is to establish integrated STEM curricula and teaching programs starting from the primary school level (Bataineh et al., 2022; Benavent et al., 2020; Morales et al., 2023; Stolk et al., 2021)). In addition, there are studies that discuss the ways in which the gender gap can be reduced by cultivating self-efficacy and enthusiasm in STEM disciplines (Kans & Claesson, 2022; Sakellariou & Fang, 2021). Research that is experimental in nature could investigate the impact of inviting successful women in STEM disciplines to schools for the purpose of fostering student interest in STEM fields through interactions and the sharing of professional experiences (Price et al., 2019) (Wang et al., 2023). At the same time, there is a significant number of fascinating research avenues that have the potential to narrow the gender gap in the STEM area. The above analysis results also suggest a new research direction on gender equality in STEM education in Vietnam, identifying the reason and proposing solutions to promote gender equality in primary school students.

4. Conclusion

This article presents an exhaustive analysis of the gender disparities that exist in the STEM field. Following the extraction and application of a series of preparatory procedures to data from the Scopus database, a total of 42 articles were selected for analysis. According to the results, the United States appears to be the leading country in terms of conducting research on gender equality in STEM fields, understanding the evolution of instructional programs designed to promote gender diversity in STEM, and proposing policies and strategies to enhance gender parity in the field constituted the majority of STEM research. Following an exhaustive examination of the extant body of literature, a multitude of research domains have been identified that warrant additional inquiry in subsequent investigations. An area that requires significant attention is the creation of STEM curricula specifically designed for elementary school students, given the critical role that this grade level assumes in reducing gender inequalities within STEM disciplines. Therefore, the findings of this research can serve as a benchmark for scholars seeking to identify relevant STEM topics in the current environment. However, it is imperative to recognize that this research has limitations, as the analysis was conducted exclusively using the database of materials indexed in Scopus that commenced from 2013 to 2023; hence the number of articles is limited. No other sources or studies from earlier years were considered. Therefore, the generalizability of the research results is not significant.

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