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Empowering Women for Sustainable Social Change through STEAM Education: An Overview

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Abstract

It is impossible to imagine a world where women do not exist. However, it is unfortunate that our Society still considers women inferior and incapable of making their own decisions. The government, lawmakers, scholars, and social activists must take steps to support women's empowerment, sustainability, and emancipation. India needs to give this ongoing issue more careful consideration. Despite the government's best efforts to prevent female feticide, promote women rights education, and enforce relevant legislation, the situation remains alarming. This article reviewed the literature and collected information from numerous journals. Google Scholar, Science Direct, Elsevier, and SSRN were used to collect the necessary information. The study highlights the importance of Education in empowering women to create long-term social change. The study examines how STEAM education can empower women with the skills and knowledge needed to succeed in traditionally male-dominated industries. Women with equal access to Education and training in STEAM fields can achieve leadership positions and significantly contribute to innovation and problem-solving. Women who have received training in STEAM subjects are more likely to think creatively and develop original solutions to challenging issues. The paper concludes that investing in women's Education catalyzes positive social change while addressing the barriers women face in accessing Education and offering solutions to overcome these challenges. Additionally, the article draws attention to the links between Education, gender equality, and sustainable development.

Keywords: *Women's Empowerment, Sustainable development, STEAM, Women's Education, Gender equality*

Introduction

"A woman can create, nurture, and transform the world around her."-Diane Mariechild. One's gender at birth should not determine their rights or opportunities (OSAGI, 2021). The EU policy supports women's empowerment and gender equality globally by promoting and financially supporting it as a pillar. Higher Education Institutions (HEIs) formulate internal policies that endorse the Sustainable Development Goals (SDGs) and are crucial in equipping students with the requisite skills to address the problems of the 21st century. The Global Gender Gap Report reveals that no nation has attained gender equality. In 2021, the worldwide gender gap score was 67.7%, indicating that 32.3% remains to be addressed (World Economic Forum, 2021). Due to the identification of gender-related traits in educational materials, there is a lack of institutional

initiatives to promote gender equality in schools (Reyes & Alvarez, 2018). It also tracks progress in bridging these gaps over time and computes a gender equality score for each sub-index. Educational attainment has significantly improved, with 95% of the gender gap already being addressed. Regardless, gender gaps persist in higher education around the world, even though tertiary enrollment rates have reached parity in the majority of nations (UIS Stat in 2016). STEAM education is vital for developing technological skills and empowering individuals, particularly women. Research shows that women in STEAM careers tend to have higher earning potential, greater job satisfaction, and more leadership opportunities (Kanta et al., 2024). Despite these advantages, women remain underrepresented in STEAM fields. According to UNESCO, only 30% of global science, technology, engineering, and mathematics researchers are women. The STEAM industries exacerbate this issue, potentially discouraging young girls from pursuing careers in these areas (Custódio et al., 2024).

The Western Australian Department of Education (2019) defines STEM as an educational strategy that promotes creativity, inquiry, communication, teamwork, and critical thinking (EducationCloset, 2019). STEAM with A for the arts has emerged as an alternative to traditional STEM education to prepare today's students for the future as leaders, innovators, scientists, engineers, educators, entrepreneurs, and learners. This approach emphasizes creativity, risk-taking, collaborative and experiential learning, and perseverance in problem-solving. (Education Closet, 2019). STEAM combines science, technology, engineering, arts, and mathematics. It involves using design thinking and an investigative process to integrate ideas from these disciplines, focusing on interdisciplinary learning (Belbase et al., 2022). This approach is being promoted in various parts of the world, including African regions and Latin America, and through partnership and collaboration initiatives in European nations (Belbase et al., 2022). The STEAM approach requires a deliberate connection between standards, assessments, and lesson design/implementation (Education Closet, 2019). This approach highlights learning experiences in two or more strands through interaction. By investigating and collaborating with integrity, ethics, cohabitation, and mutual respect, trans-disciplinary knowledge and skills complement each other (EducationCloset, 2019). Therefore, through trans-disciplinary consciousness and conscience, STEAM provides a new vision to encourage student creativity, collaboration, and community building (All Education Schools.com, 2019). The Bridges Conference Proceedings offer several examples demonstrating mathematics and the arts close relationship and their

complementary nature (Belbase et al., 2022). In this scenario, STEAM education plays a vital role in breaking down and transcending the boundaries of disciplines, providing a new interface between theory and practice (Connor et al., 2015; Quigley et al., 2019). The arts help unite the disciplines into a cohesive whole with a more expansive scope and disciplinary identity, as well as imitate real-world difficulties and problems by fencing in the fundamental elements of the entire (Quigley & Herro, 2019). The shift from STEM to STEAM has brought about a paradigm change in Education (Yakman, 2019). More specifically, this study explores how STEAM education can serve as a solid tool to equip women with the knowledge, skills, and abilities needed to succeed in fields that men have traditionally dominated. Providing women with equal opportunities for STEAM education and training can empower them to become leaders and contribute significantly to creativity and problem-solving. The underrepresentation of women in STEAM fields is a global issue (Rahman & Halim, 2022). Empowerment is a crucial aspect of leadership in management and Education (Battel et al., 2021). A lack of female involvement in critical STEM fields can hinder innovation and impede global progress. At worst, it may have potentially dire consequences (Wajngurt et al., 2019). A study conducted by Zeng et al. (2023) through semi-structured interviews revealed that learning approaches differ within the context of STEAM pedagogy. The aim is to promote an inquiry-based, transdisciplinary educational approach to develop future innovators and business owners (Kumar & Deák, 2024). According to a study conducted by Wajngurt and Sloan (2019) with American university students, women are more likely to pursue STEM fields if they have previously taken courses that integrate the arts into STEM, as opposed to traditional STEM courses. These findings highlight the importance of incorporating the arts into STEM education to attract more women and support the idea that female students are more interested in pursuing a STEM degree when they attend STEAM courses. The paper examines various strategies and solutions related to education. It highlights the importance of gender-responsive educational policies and practices that challenge stereotypes and promote equal opportunities for girls and boys. The review emphasizes integrating gender perspectives into curricula and textbooks to create inclusive and equitable educational environments.

Additionally, it analyzes initiatives to empower girls in STEM education and address the barriers that hinder their participation. The assessment also examines efforts to improve women's representation in higher education and leadership roles. The review presents practical examples

of actions that have successfully advanced gender equality in education. It critically evaluates the effectiveness of these interventions and identifies areas for improvement. Incorporating Science, Technology, Engineering, Arts, and Mathematics (STEAM) into educational and professional trajectories is vital for advancing gender equality and empowering women worldwide. Despite the increasing demand for STEAM competencies in the contemporary labor market, women remain underrepresented in these domains. This underrepresentation is due to multiple systemic obstacles, such as gender stereotypes, the absence of role models, and insufficient support networks. This article examines the convergence of STEAM education with women's empowerment, emphasizing the obstacles, tactics, and practical efforts established to tackle these gaps.

Rationale of the study

The purpose of this study is to highlight the significance of empowering women through STEAM education to bring about long-term social change, promote gender equality, and establish communities that are both inclusive and innovative. Women have historically been underrepresented in STEM professions, which has resulted in persistent gender discrepancies in employment, wealth, and influence. Historically, this has continued to be the case. Therefore, educating women and encouraging their participation in STEAM professions is necessary to bridge this discrepancy and create gender equality in these many fields. Empowering women benefits society by encouraging creative expression, economic expansion, and social advancement. Early intervention initiatives that engage girls in STEAM disciplines from an early age can foster their curiosity and self-assurance. Initiatives like the Creative Coding initiative, which amalgamates coding with art, have demonstrated favorable results in enhancing girls' engagement in STEAM disciplines (Maric & Rani, 2024). To achieve social justice and equality between the sexes, empowering women is necessary. Empowering women is most effectively achieved through education, especially in STEM (science, technology, engineering, and mathematics) fields.

As a result of having a high level of STEAM education, women are more equipped to defy gender stereotypes, seek employment in these disciplines, and create positive societal change. The study emphasizes the significance of social transformation and sustainability, highlighting the connections between gender equality, STEAM education, and broader societal challenges. To bring about a long-lasting societal change, it is essential to eliminate the structural hurdles that

impede women's empowerment and establish an atmosphere that supports women working in STEAM professions. The purpose of this study is to provide a comprehensive review of the numerous approaches and strategies that may be utilized to empower women through STEAM education.

Research Question

- What are the most effective techniques and strategies for promoting gender equality in STEAM education?
- What is the impact of sociocultural variables on women's success and involvement in STEAM education programs that promote long-term social change?

Methodology

This study utilized various platforms such as SSRN, Science Direct, Elsevier, and Google Scholar to conduct a literature review and gather data from multiple journals. The report outlines the selection criteria for the Empowering Women for Sustainable Social Change initiative via STEAM education that was selected for the study. It also explains the methodology used to collect information and data for the report.

Empowering Women through STEAM Education for Social Change

STEAM Education to empower women for social change is a crucial and multifaceted project with far-reaching effects. STEAM professions not only offer excellent job opportunities but also encourage creativity and contribute to the advancement of Society. However, due to various challenges, such as systemic barriers, lack of motivation, stereotypes, and societal norms, women have historically been underrepresented in these fields. Empowering women through STEAM education not only promotes gender equality but also unlocks untapped potential, bringing diverse skills and perspectives to the workforce. The female literacy rate in India has been increasing, but it remains lower than that of males (Census of India, 2011). This gender disparity in Education is particularly noticeable in the northern states of India. Although there may be a higher number of female students enrolled in schools in these states, many girls drop out after only a few years of study. The progress towards women's emancipation in India is noteworthy, although much work still needs to be done. Women's roles in higher Education have undergone a significant transformation globally. To empower women, there is a growing awareness about the importance of incorporating gender perspectives in formulating public policies and adopting gender-inclusive strategies to achieve development objectives. In India, the issue of women's

empowerment through higher Education depends on a just distribution of resources, both presently and in the future. It should be a fundamental principle of all programs and initiatives aimed at establishing a society based on liberty and democracy and upholding fundamental rights while promoting equal opportunities and intergenerational harmony. The literature review focused on students' evolving attitudes and opinions towards including the arts in STEAM subjects. In addition to art, the skills required to promote entrepreneurship and creativity are also required (Nakano & Wechsler, 2018).

Furthermore, it explores the most effective instructional methods for students to navigate the complexities of this innovative pedagogy. This approach can equip students with the necessary skills to become adaptive innovators and business owners. The focus of Education has shifted from a one-size-fits-all approach to a more inclusive, personalized, and creative learning experience (Kumar & Deák, 2024). This approach is essential to provide students with the necessary skills and mindsets to succeed in a changing world and contribute to future social and economic progress. Teachers play an indispensable role in helping female students acquire these critical skills by adopting innovative teaching strategies and providing flexibility in the curriculum (Litz, D. 2011). The STEAM framework includes a variety of creative learning approaches that have been integrated into the education systems of several European countries, which enhance students' skills (Jesionkowska et al., 2020). However, many obstacles exist in our country's STEAM framework of various creative learning methods in educational institutions. To overcome that, we must advance in women's Education and empowerment (Liao, 2016). It is essential to examine these stories from a broader perspective to see how different pedagogical learning methods can shape the skills of women for future innovators and entrepreneurs. Inclusive pedagogical techniques that address the varied needs of students can foster a helpful learning environment. These methodologies encompass adaptable learning trajectories, peer-to-peer education, and cooperative initiatives that promote involvement and engagement (Sánchez-Soriano et al., 2024).

Additionally, the Telesecundaria Rural initiative in Mexico sought to dismantle gender stereotypes and empower girls in rural regions by offering them the opportunity to cultivate STEAM competencies. The project encompassed practical activities and coaching, resulting in favorable shifts in the girls' perspectives of their capabilities and future ambitions (Hernández et al., 2024). In India, economic empowerment via financial inclusion has been a significant

technique for enhancing women's involvement in STEAM. Strategic governmental measures, accessible banking services, and focused financial education have promoted women's economic autonomy and ability to engage in STEAM professions (Ramya & Deepak, 2024).

Challenges and Opportunities

Empowering women through STEAM education can lead to significant social change. They can succeed in various fields by providing women with the necessary skills, confidence, and opportunities. However, several challenges and opportunities are associated with using STEAM education to empower women and effect long-lasting social change. Notwithstanding advancements, women continue to be underrepresented in STEAM fields. The World Economic Forum (2021) reports that merely 28% of engineering professionals and 32% of IT professionals worldwide are women. The gender gap is exacerbated by systemic obstacles, such as gender stereotypes, insufficient female role models, and implicit bias (UNESCO, 2019). The involvement of women in STEAM is essential for attaining gender equality and fostering innovation while effectively tackling global concerns. Professions in STEAM disciplines typically provide substantial remuneration and enhanced work security. STEAM education empowers women with technical and artistic abilities, facilitating access to lucrative careers in artificial intelligence, biotechnology, and digital design (Li et al., 2022). Facilitating women's entry into these sectors elevates their economic standing and bolsters their financial autonomy. STEAM education can aid in dismantling entrenched gender stereotypes by motivating girls to engage in occupations previously dominated by males. Initial engagement with STEAM disciplines in a nurturing, inclusive setting has demonstrated an enhancement of girls' self-assurance in their competencies and a challenge to societal conventions (Master et al., 2017). Women who thrive in STEAM disciplines frequently evolve into leaders, entrepreneurs, and agents of change. They enhance innovation by providing varied views on problem-solving. Studies indicate that diversity within STEAM teams fosters more innovative and efficient solutions (Phillips, 2014).

Challenges

Our goal should be to guarantee women and girls access to high-quality STEAM education, especially in rural and impoverished areas, and to address prejudices and cultural norms that could prevent or limit women from seeking professions in STEAM education. Raising the profile of accomplished women in STEAM disciplines can help guide and motivate the upcoming

generation of female leaders. It is also crucial to supply materials and assistance to help women overcome impostor syndrome and develop self-assurance in their STEAM-related skills.

Opportunities

Mentorship programs and STEAM outreach initiatives can help young girls get interested in STEAM fields at a young age. Pairing women and girls with accomplished STEAM professionals can offer advice, encouragement, and inspiration. Schools should also incorporate inclusive, gender-sensitive STEAM curricula to foster diversity and motivate female involvement in STEM fields. Women entrepreneurs in STEAM disciplines also need help with their businesses, such as networking, getting money, and getting training. Encouraging STEAM organizations to adopt diversity and inclusion policies can assist in creating welcoming and helpful environments for women, which will keep women working in these fields. Advocacy and Changing Policies It is important to support programs that encourage girls and women to study and work in STEAM fields and laws that promote gender equality in schools and workplaces. By providing women greater power through STEAM education, we can solve these problems and take advantage of opportunities. This will lead to lasting societal changes and a better future for everyone. Get girls interested in STEM-related activities and fields early to get them interested and excited. This might include scientific festivals, robotics workshops, coding clubs, and other STEM-related activities that let people do things. Promoting early engagement of girls in STEM disciplines dismantles gender stereotypes and cultivates a favourable disposition towards STEM (Buenestado-Fernández et al., 2023). After all, Various international initiatives seek to mitigate the gender disparity in STEAM. For instance, the Girls Can Code program from UNESCO educates young girls on using computers, while groups like Girls Who Code and Women in STEM offer mentoring, training, and networking opportunities (UNESCO, 2019). These programs have successfully gotten more women involved in STEAM professions by tackling problems like access to resources and mentorship.

Education

1. To break down myths about gender inequalities in STEAM professions and promote advocacy based on data. This will make women more likely to apply for STEAM programs. Also, discussing affirmative action programs can help people understand why STEAM needs more women and people of colour.

2. Create specific measures to support women in STEAM fields. For example, implementing supernumerary programs, like those in IITs, can increase the proportion of female students enrolled in STEAM programs. Public and private educational institutions should implement more such policies to encourage women to pursue STEAM degrees.
3. To get more girls to sign up for STEAM-related programs, make coaching programs less expensive and give scholarships only to girls. This will help close the gender gap in STEAM professions.
4. Encourage investment in STEAM programs by the public and private sectors so that governments, businesses, and civil society organizations can collaborate to create and fund projects that support women's early STEAM education. Financially incentivized initiatives can be particularly advantageous. Programs for sponsored apprenticeships that offer on-the-job training can help women enter the workforce. For instance, Microsoft's Tech-Saksham initiative supports women engineers in finding employment by providing them with skill training.
5. Implement interventions in the educational ecosystem, such as enhanced teacher preparation programs that educate educators to reject gendered norms. Government programs that assist young children in achieving better reading and numeracy outcomes can also contribute to the readiness of the future workforce for STEM fields. To ensure equal opportunities for all students to pursue STEM education, schools should incorporate gender equity into the curriculum.

Employment

1. Women who have succeeded in their fields can help younger women by offering guidance and networking opportunities through mentoring programs, conferences, events, and talks. Creating such initiatives can promote a sense of community and reduce loneliness at work. For example, Vigyan-Shaala's "Kalpana" program helps women in STEAM who are not well represented by building networks to help them find mentors and make connections.
2. It is important for STEAM workplaces to give diversity and inclusion training to both managers and employees. This training will help them better understand and meet the demands of their female workers.
3. Reducing the age limit on research grants and fellowships could get more women to apply, especially those returning to work after a sabbatical.

Retention

1. The gender salary gap is one of the many reasons women are discouraged from pursuing careers in STEAM. Gender-responsive evaluation policies must be implemented to encourage women's participation.
2. Flexible and gender-sensitive policies, such as making workplaces more welcoming, offering family support, helping with childcare, and allowing employees to set their hours, can help keep women in the workforce. IBM and Unilever are two companies that have made headway towards creating a flexible work culture by putting gender equality first.

Interpretation

Empowering women through STEAM education profoundly impacts individuals, communities, and cultures while promoting gender equality. Here are a few ways that this empowerment can appear:

- STEAM professions often provide better-paying employment with more growth opportunities. Women's empowerment in these areas can increase financial stability and autonomy for them and their families, which can lower poverty rates and help close the gender pay gap.
- Women's different experiences and points of view help the STEAM fields come up with new ideas and ways of doing things. Getting more women to work in these areas can help society advance by creating new and better products, services, and technologies.
- Women have not been well represented in several STEAM sectors in the past, which has led to a significant disparity between the sexes. Bridging this gap and giving women more power via education and support will help make many jobs more equal for men and women. When more women in STEAM fields can be role models and mentors, women are more likely to follow their interests in science, technology, engineering, arts, and math. This circle of positive feedback encourages more women to work in these fields and do well.
- Giving women in STEAM greater influence may help create a more diverse and welcoming workforce by challenging traditional gender-role ideas. It might also lead to bigger societal changes, like changing how people think about gender roles and giving women more chances in all industries.
- In a world where technology rules, providing women in STEAM fields additional support and chances to succeed is important. Utilized on top in science and technology, countries need to use all of their skills and different points of view to encourage new ideas.

- Many of the world's problems, like poverty, healthcare, and climate change, need solutions from multiple STEAM disciplines. Giving women more authority in these areas can help find long-term answers to these problems and improve the future for future generations.

Educating women in STEAM fields is ultimately empowering for them on a personal level, and it has a significant positive impact on communities, societies, and the world. It is crucial to achieving gender parity and building a more prosperous and inclusive future for everyone.

Futuristic paradigm

The article examines women's problems in STEAM fields and how they might be empowered. It shows how important STEAM education is for empowering women and how important it is to close the gender gap in STEAM fields. We need to do more studies right away on what works to help women overcome problems in school and at work. Looking at how things like mentorship programs and outreach are practical, analyzing the creation of an inclusive curriculum and how it affects women's participation in STEAM will help us understand how to get more women involved in these fields. Also, looking into how rules and norms in the workplace encourage gender diversity in STEAM fields will help address organizational problems better. Comparative studies in different countries and areas could show how cultural variations and other variables affect women's engagement in STEAM. Focusing on these areas will help future research make a big difference in the fight for gender equality and empowerment in STEAM. We need complete monitoring and evaluation mechanisms to determine how well specific programs and initiatives work. This includes gathering data that is broken down by sex, checking how well students are learning, keeping an eye on retention rates, and looking at the long-term effects on girls' lives. Consistent evaluation makes it easier to find problems, improve techniques, and make sure people are held accountable. Also, it is important to look at gender gaps in education, how well interventions work, and the best ways to do things. Sharing information and evidence-based methods can help make policies, improve program design, and help people better understand the factors that affect gender equality in education.

Conclusion

Women's empowerment is an important part of the future of STEAM education. To reach its full potential, lawmakers, teachers, communities, and business leaders must work together. A future where everyone, regardless of gender, can contribute to and benefit from a knowledge-based society will make it easier to achieve investments in education, changes in cultural attitudes, and

a shared commitment to gender equality. STEAM education goes beyond the classroom; it may also be a powerful tool for changing society. It speeds up innovation, economic growth, social justice, and women's empowerment. We move closer to a dynamic, equal future where everyone can do well and prosper, regardless of gender, by breaking down barriers and encouraging inclusive learning environments. Educating women in STEAM (science, technology, engineering, arts, and mathematics) is essential for making permanent societal changes. We can close the gender gap and use different points of view to solve complex global problems by making STEAM education available to everyone. We can create a dynamic ecosystem where women are encouraged to lead and develop new ideas by putting in place programs that support diversity, mentorship, and support systems. By pushing for STEAM education to be included in different communities, women may be catalysts for meaningful social change and help create a fairer and lasting future. Let us stay committed to using women's latent creativity and potential in STEAM subjects for the greater good of society. The study implies that paying for women's education can help them overcome the obstacles that make it hard to learn and provide them with the tools they need to make positive societal changes. STEAM is important for scientific research, technical progress, and industrial growth. They deal with complex problems and significantly impact how the modern world is made. To give women and girls more power through STEM education, teachers, legislators, and society need to work together. Creating inclusive learning environments, fighting gender bias, and offering mentorship and networking opportunities are all important parts of this project. Making connections between schools, teachers, businesses, and community partners is important for boosting STEM results for kids because it gives them real-world examples of how STEM areas work. Focusing on these school years is important to raise awareness and get more girls involved in STEM and business courses. A collaborative approach is necessary for bringing together different skills and experiences in problem-solving, including those from different groups. This strategy lets more people help shape the future of humanity. Encouraging girls and women to work in STEM will lead to a more egalitarian and prosperous society in the long run. However, we need to look at successful programs, best practices, challenges, and chances to get more women involved and in charge of STEAM disciplines. The study suggests that paying for women's education can help them overcome obstacles and improve society.

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