Shodh Sari-An International Multidisciplinary Journal

2025, Vol. 04, Issue 03, 28-45
ISSN: 2959-1376
DOI: https://doi.org/10.59231/SARI7835

Empowering Women and Girls in Science by Integrating Humanities Perspectives into STEM Education

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Abstract

This paper examines the integration of humanities perspectives into STEM education as a means of empowering women and girls and addressing persistent gender inequities. It acknowledges the historical underrepresentation of women in STEM due to stereotypes, biases, and systemic issues. This tackles the historical context of gender inequity concerning STEM, and issues such as the role stereotypes propagate biases about women's participation and success in these fields. This study advocates for an interdisciplinary pedagogy incorporating feminist principles to create inclusive spaces, questions of relation and power in the classroom. Key empowerment strategies include creating supportive environments, mentorship programs, collaborative learning opportunities, defining open communication channels, technologists locating and mobilizing community voices. This paper highlights challenges such as representation and lack of stereotypes, threat, and climate of the classroom. Case studies and success stories show the impact inclusive pedagogy programs, workshops, service-learning, and mentorship initiatives have on women's persistence in STEM. It is suggested to take a progressive interdisciplinary learning approach towards global issues and all its equitability and accessibility facets, so that budding innovations enter the STEM culture, innovatively equipping to face the contemporary complex dilemmas.

@2025 International Council for Education Research and Training 2025, Vol. 04, Issue 03, 28-45
ISSN: 2959-1376 DOI: https://doi.org/10.59231/SARI7835
Keywords: STEM education, women in STEM, gender equity, interdisciplinary pedagogy, feminist pedagogy, empowerment

Introduction:

Therefore, the inclusion of humanities perspectives in STEM education is to empower women and girls through addressing the gender inequities that hitherto tend to marginalize women and girls in these fields.

Despite the advancement in eliminating gender biases regarding equality, women are still underrepresented across the fields of STEM, facing systemic issues ranging from stereotypes, lack of role models, and institutional biases, to a struggle for equity in participation and success. [1][2]Introducing the humanities into STEM curricula, these educational initiatives attempt to provide a more inclusive and holistic approach to learning that emphasizes the relevance of cultural and ethical contexts in scientific inquiry and technology development.[3][4]

These include debates over whether traditional STEM curricula are effective enough, as opposed to integrated models that emphasize the humanities. Proponents suggest that integrating different perspectives encourages critical thinking, enhances engagement of students, and prepares future scientists and engineers to tackle the complex challenges faced within society[7]. Critics, though, argue that blending these disciplines results in a loss of key technical rigor needed to succeed in STEM fields. However, evidence suggests that such integration can enhance educational outcomes and create more opportunities for long-term success and retention of women in the STEM pipeline. [8][9]

The critical strategies for building manpower in STEM that spur women and girls through this integrated approach have developed supportive environments, setting up mentorship programs, and creating collaborative learning opportunities. Further actions such as all-girls clubs and community partnerships have proven effective in raising confidence and engagement among female students.[10][11]. An educator can dismantle the very barriers that propagate gender inequities in STEM fields through the intentional design and implementation of learning communities that recognize and celebrate their varied experiences.[12]

In conclusion, sciences' and humanities' integration in education may help improve

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ISSN: 2959-1376
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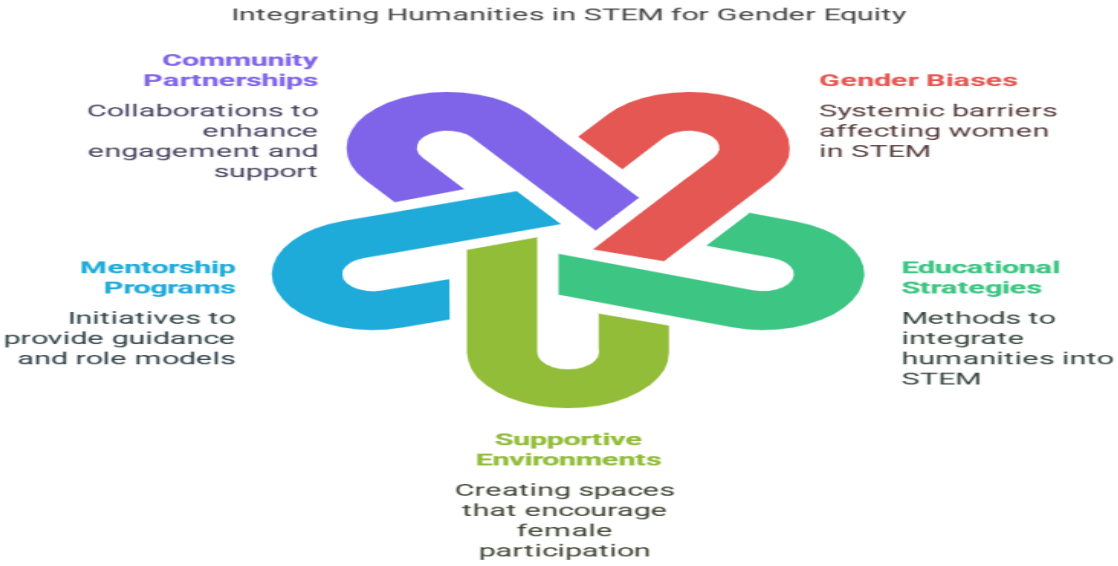
gender equity in fields where, historically, women's presence is not comparatively greater. By stressing contextual understanding and critical engagement, this approach will not only enhance students' experiences but will also nurture new generations of innovators capable of approaching the urgent issues of the contemporary world.[13][14]



Historical Context

Since the 18th century, when they were emerging as significant sciences in the context of the Age of Enlightenment, the involvement of the women within STEM has been exposed as predestined to a long history of a gender gap.[1] Even if have made countless strides toward achieving gender equality, the underrepresentation of women in different STEM fields confronts them with obstacles of navigating these traditionally male-dominated arenas. One of them is the influence of gender stereotypes and biases in the form that STEM fields tend to be seen as men's sphere; these stereotypes still shape educational and career paths for women and girls.[2]

In the past few decades, academic researchers and policymakers alike have endeavored to explain the existing gender gaps in STEM. They then posit that women have historically been discriminated against and hence persistently underrepresented in these fields.[3] As an example, studies have

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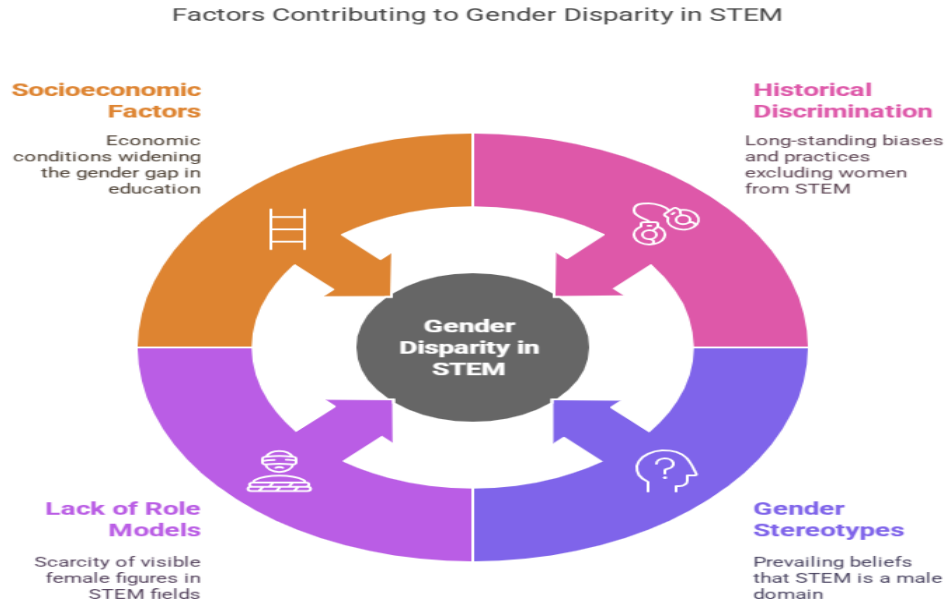
suggested that the lack of visible female role models in STEM creates an environment that discourages girls from aspiring to succeed in these habits.[2]

Further economic growth of particular nations has also widened the gender disparity in STEM education, particularly among upper-middle-income and high-income nations, indicating that socioeconomic factors are also of critical importance in maintaining this gap. Economic context and gender stereotypes reveal that just having access to education does not suffice; systemic changes are critical in fostering an inclusive environment that will sustain and promote the participation of women in the demanding STEM fields.

In spite of these challenges, initiatives have begun to grow to empower women and girls in STEM fields with a focus on integrating humanities perspectives into STEM education. These interdisciplinary approaches show how cultural and historical contexts need to be understood to develop solutions to the problems women in these fields often face.[4][6]

The development of public recognition for the contributions of female historians and educators, thus advancing public policy, holds hope for any generation of women in STEM.[6]



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Integrated STEM Education

The introducing conceptual framework caters to the secondary education paradigm, focusing particularly on high school teachers and students on how to integrate an integrated, horizontally-integrated STEM approach into actual practice. The framework purposefully incorporates interdisciplinary connection of STEM disciplines with predecessor fields of knowledge, such as humanities education, for creating a truly integrative learning experience. In a sense, it provides a space where the teachers can apply their knowledge of integrated STEM directives and practices [7].

Inter disciplinary Pedagogy

Furthermore, this framework provides an interdisciplinary approach that can incorporate the realms of STEM, agriculture sciences, humanities, and quantitative mathematics. A synthesis of the humanities with STEM education should exhort teachers to integrate teaching methods that would allow students to understand the cultural, social, and historical contexts necessary for tackling contemporary challenges. Such an approach strives to develop a learning environment that focuses on the interconnections of real-world contexts to the reactive relevance of STEM education.

Feminist Pedagogies

Above all other modes and recognized methods, feminist pedagogies remain a vital feature of the suggested theoretical framework that set out to empower the learners through inclusiveness in STEM education and pedagogical practice. These pedagogies have designed a new way of looking at power dynamics in the classroom, a collaborative teaching space where teaching and learning processes shared by learners would enable them to hold themselves responsible for others as well. It fosters a culture of self and collective empowerment that rejects oppressive structures of power, engendering equitable, socially responsible commitments on the part of educators and students alike to decreasing the reality and recognition of under-representation-fighting for social justice education in STEM [8].

Key Principles of Feminist Pedagogies

Empowerment implies the provision for pupils to express their views and their experiences in the learning process through democratic processes within classrooms.

Community Building defines inclusivity,

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respecting and valuing the differing backgrounds and experiences of all students. Critical Reflection stands for encouraging self-analysis of thought processes while engaging in debate to develop scientific communication skills and delve into ethical issues stemming from STEM[8]

Implementation Strategies

In order to successfully render to educational practice, the integration of the theoretical frame, various major organizational strategies must be implemented. These include uniformity of goals across different disciplines, the assembling of an interdisciplinary team, and the employment of structured frameworks such as design thinking or project-based learning. This likewise entails overcoming communication barriers and cultural divides potentially involved in working between the STEM and humanities domains [9].

By supporting interdisciplinary teaching and providing ongoing support for teachers and students, the framework aims to establish an interactive learning space that values diversity and stimulates creativity. Ultimately, this theoretical framework aims at not just knowledge transfer but also a sense of empowerment and social responsibility, including ethical training that guides learners to address global challenges[4][10].

Strategies for Empowerment

Creating Supportive Environments

An empowering atmosphere for girls and women in STEM commences through an environment of support. This involves creating spaces where girls feel valued, secure, and are willing to express themselves. A very good strategy could be the provision of "all-girls" clubs in STEM-practical pursuits so as to enhance self-esteem and confidence among participants [11]. Such initiatives should also tie with fun-haired and colorful promotions, using girl empowerment slogans like "Code like a Girl" and "Girl Powered Robotics" to engage young women and stir their interests to participate in such spheres.

Role Models and Mentorship

An inspiring factor propelling women and girls into STEM careers, role models succeed by being centered on demonstrating what can be attained and providing advice from their own experiences in an effort to inspire the next generation to approach their processes with confidence available [12]. Programs that connect young women with mentors in STEM can provide essential direction and

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support toward overcoming obstacles and allowing for successful future endeavors. Positive encounters with role models serve to open possibilities, many women stating that seeing someone so much like themselves strive and succeed truly made a huge difference for their confidence and motivation [12].

Collaborative Learning Opportunities

Opportunities for collaborative learning are imperative in enhancing engagement in STEM education. Through teamwork and group projects, the perspectives of other people can be brought into play in such ways that the mood set for the class fosters problem-solving skills and understanding of STEM concepts. Spaces in which girls feel comfortable sharing will be essential for reshaping participation barriers [13]. To bolster confidence and promote active involvement in STEM, it can include hands-on activities and peer-led discussion.

Promoting Open Communication

Establishing continuing open communication is like a right path to follow: this practice entails an honest exchange of ideas and opinions by the students, educator, and parents to create an inclusion culture [13]. If and when educators see vocal support from female students, this validates the students' input and will point them toward a world of possibilities in STEM. Parents can drive little STEM discussions in their homes with their daughters, instilling the right kind of curiosity and a good outlook towards such careers.

Leveraging Technology for Empowerment

According to a recent publication, the advancements in industries have brought technology into the background, for the purpose of creating empowerment strategies. It must be the other hand that prospects will be laid out for women to acquire knowledge and skills in rising career fields, such as artificial intelligence and data science. For instance, mentorship programs can use technology to pair mentors with mentees based on their mutual interests that support useful relations with the goal of encouraging personal and professional growth [14]. This can provide the women with the navigation through the potential difficulties associated with contemporary STEM careers and encourage collaborative efforts in technology advancement.

Community Involvement

Thus, community partnerships create avenues for young women into STEM.

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Participation in local competitions, workshops, and hands-on learning initiatives exposes girls to various disciplines within the STEM field, promoting their appreciation of difficult subjects [15]. Such collaborative ventures enable girls to compete, create, and develop self-belief along the way; it is in this environment of engagement and cooperation that the community has the power to change the course of the future for women in STEM. In these ways, we can arise to find ways to open up a better route for women and girls in STEM so that they can embrace leadership roles in what are otherwise crucial fields.

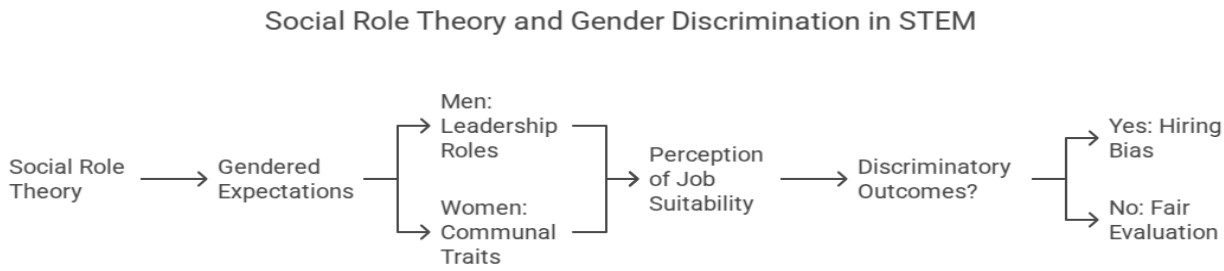
Challenges and Barriers

Despite notable advancement in increasing female participation in STEM, gaps and barriers exist which continue to inhibit women's full engagement and ensuing success.

Underrepresentation and Gender Stereotypes

Women are frequently underrepresented in STEM careers due to long-standing social norms and gender stereotypes that imply that certain roles were meant for men only. For example, women are denied traditional entry into a male-dominated field because of the absence of female role models combined with the lack of family-friendly environments [16][17].

This is explained further by Social Role Theory which shows that individuals are expected to show certain qualities that reinforce gender roles, that is, men are seen to be better suited for the exercise of leadership and agentic roles while communal traits are assigned more often than not to women. These perceptions of job suitability led to discriminatory outcomes against women in the hiring or evaluation processes in STEM-related careers [17][18].



Stereo type Threat

It complicates the entirety of the case for

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women in STEM since, when women are aware of negative stereotypes about their quantitative abilities; they risk negatively affecting their performance and confidence. Oftentimes senior members in STEM fields tend to ignore or devalue women who do not conform to the stereotypical image of a scientist, engineer, or mathematician [18]. Stereotypes have been shown to lead to negative evaluations and also discourage women from ever considering careers in those fields [18][19].

Classroom and Institutional Environment

The educational setting also plays a very important role in shaping the experiences of women in STEM. Inclusive, equity-minded teaching practices must be followed if students should feel welcome. Yet many educators are not adequately trained to create inclusive spaces, and/or would have various concepts that would further promote inequities in higher education [19][7]. Implicit biases, microaggressions, and a fixed mindset can create a classroom climate that is not at all welcoming to women but nonetheless has a great effect on their persistence and success in STEM fields [19].

Cross-Disciplinary Integration

The traditional siloed approach to STEM education may evoke lack of interest from the part of students, especially if the purposefulness of the learning cannot be seen in the real world. An integrated approach connecting STEM to the humanities will engage students further and open their minds to new perspectives on problem-solving leading to effective ways of finding solutions to global problems [4][9][7]. Emphasis on interdisciplinary projects can be skill-certifiers for prospective students: advanced critical thinking and communication skills are prized by employers [9].

Progress toward the introduction of reforms at several levels in order to make improvements to classroom instruction is bound to impress those contending for reform toward inclusivity and diversity within all spectrums of STEM education and practice in general.

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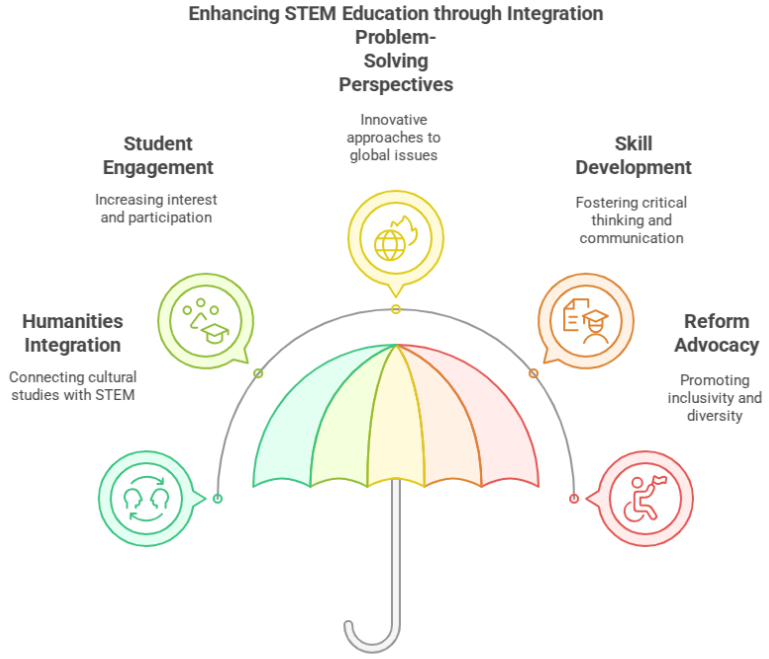

Women in STEM Persistence

A study published in the Journal of Technology Management & Innovation scanned the experiences of seven female engineering students entering college with a major in sciences. The aim of the study was to illuminate factors triggering either persistence or departure from their course of study.

Major predictive variables included parental support, pre-college preparation, and the identification with the culture of science and engineering. Findings indicated that the existing literature on persistence did not adequately capture the specific experiences of women in STEM, which emphasizes the need to further research the different interpretations of women's open responses about their academic paths and decisions-making about persistence [18].

Integrating Humanities into STEM Education

A case study was designed to illustrate the integration of humanities into STEM education through the mathematical modeling and presence of artificial intelligence. This innovative approach enhances traditional models of education and satisfies the changing demands of the twenty-

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ISSN: 2959-1376
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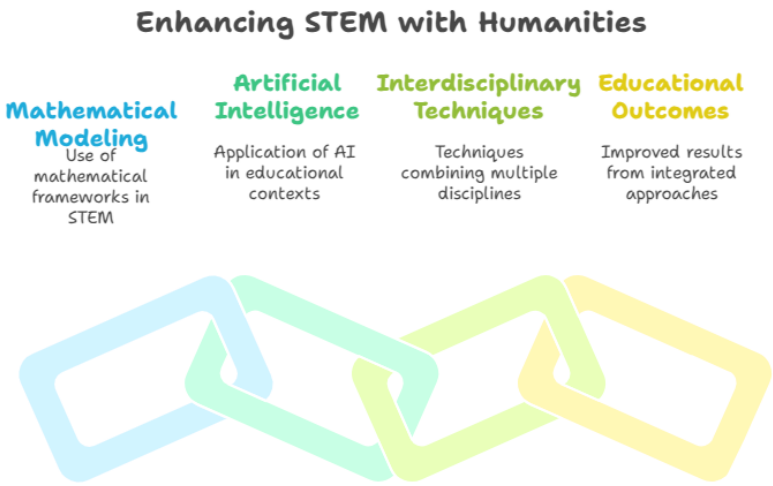
first century. By applying interdisciplinary techniques, they are better prepared to engage the critical problems awaiting their professional and global destinies. The study provides concrete evidence that the joining together of such STEM areas with humanities leads to thoroughly informed framing of problems, hence culminating into superior education outcomes for students [4].



Impact of Inclusive Pedagogy Workshops

These surveys reveal the clearest picture yet of changes in faculty attitudes toward diversity among students, influenced by workshops aimed at inclusive pedagogy. Pre- and post-workshop surveys indicated that 85.8% of respondents noted an improved understanding of student challenges in the STEM area, while 96.6% no longer objected to the workshops having provided them with an insight on how best to relate to student issues. The workshops increased interest in how such factors as race, ethnicity, and gender could impact the interactions of science classrooms, which indicates a positive avenue toward culturally responsive instructional practices [19].

Service-Learning Experiences

This ground- breaking research has shown that service-learning can positively impact students' perspectives based on the experiences and stories shared in the study by students from a premier STEM University. Participants, used to highly urban contexts,

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worked in the rural educational settings that opened up their minds to teaching challenges in diverse settings. Qualitative analyses showed that students' narrative accounts were stored-of-the-marathon type in the form of imaginable reports and bore high social desirability bias; however, it specifically noted dominant themes related to their preparation for the teaching role and the effects of their service-learning on their vision toward a profession [10].

Mentorship Programs and Initiatives

Other such programs and initiatives are hammering towards the empowerment of women and young girls in the STEM fields. The initiative includes Tech Girls and Tech Women through which the U.S. government wishes to produce young women in the Middle East and North Africa with STEM skills. In addition, the Teacher Initiative seeks to lessen the gender gap in STEAM curriculum and organizes girls' after-school activities and clubs. One of the significant programs, Girls Who Game, developed in collaboration with Dell Technologies, Microsoft, and Intel, is teaching useful skills such as communication and collaboration to young women and underserved K-12 students through My craft: Education Edition [17][20]. These initiatives offer helpful examples of the central elements necessary to put the foundation for creating a welcoming environment, as best practices to improve mentorship and education in STEM fields.

Future Directions

The merging of humanities perspectives into STEM education is set to affect the future directions of curriculum and teaching methods. With the interdisciplinary framework being pushed by educational institutions, there is rising emphasis on blending technical skills with the ethical and cultural insights offered by the humanities. This holistic approach prepares future engineers and scientists to tackle complex and evolving global challenges in an ethical and inclusive way [22][9].

Evolving Interdisciplinary Learning Approaches

Staying up-to-date on emerging trends in collaborative cross-disciplinary education reveals other insightful strategies that would improve the effectiveness of STEM and humanitarian collaboration. For example, using high-tech methodologies such as artificial intelligence and virtual reality in educational projects is believed to not only furnish an increase in student engagement but

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will also give them a peek of what it is like in real-life applications so that there is more relevance to learning [9]. Also becoming important are focused sustainable recommendations as these cater to the collaborative efforts that address urgent societal crises and foster collective problem-solving among students [9].

Structural and Pedagogical Considerations

In interdisciplinary education, careful consideration should be given to structural and interactional aspects such as culturally relevant pedagogy. Successful integration will occur in an environment where the curriculum contains both the need for technical competency and a moral conscience, permitting the student to respond with some competence to societal issues [4]. Given this research results to have greater implications in broader applications of the models, it needs to be properly done as a longitudinal study adopting a more diverse demographic sample. It would be necessary to ascertain how the integration of humanities into STEM curricula affects learners' long term [4]

Multi-disciplinary Academia to Tackle Global Challenges Engineering education must echo some grand challenges that were identified by bodies like the National Academy of Engineering, including critically important issues such as sustainable clean water supplies and troubled urban infrastructure restoration [4]. With the integration of a broader societal context, literary and philosophical disciplines provide strong introductions to issues relating to human values and ethics that will enhance students' faculties for understanding the many-faceted problems and challenges facing the inhabitants of our modern world [4].

Equity and Accessibility

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@2025 International Council for Education Research and Training
ISSN: 2959-1376
2025, Vol. 04, Issue 03, 28-45
DOI: https://doi.org/10.59231/SARI7835

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Received on March 01, 2025
Accepted on May 07, 2025
Published on July 01, 2025