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STATUS OF FEMALE REPRESENTATION IN STEM FIELDS: A FOCUS ON ENROLLMENT IN HIGHER EDUCATION IN BANGLADESH

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ABSTRACT
This study explores the status, challenges, and prospects of women's participation in Science, Technology, Engineering, and Mathematics (STEM) education in Bangladesh. Despite achieving near gender parity at the primary and secondary levels, female representation in STEM disciplines remains disproportionately low at higher secondary and tertiary education levels. Analysis of enrollment and dropout trends, supported by primary data collected from 200 female students across 10 universities, reveals structural, socio-cultural, and economic barriers that limit women's participation in STEM. Findings indicate that financial constraints, gendered subject selection, lack of role models, and cultural expectations surrounding marriage contribute to persistent underrepresentation. While female enrollment exceeds 60% in health-related fields, participation remains below 26% in engineering and technology programs. Comparative insights from Asian countries such as Malaysia highlight the importance of early STEM integration, mentorship, and policy support. The study underscores the need for systemic interventions, including gender-sensitive curricula, targeted scholarships, mentorship programs, and institutional reforms, to foster equitable access and encourage women's engagement in STEM. These measures are essential for developing a skilled workforce aligned with the demands of the Fourth Industrial Revolution and achieving the Sustainable Development Goals (SDG 4 and SDG 5).

KEYWORDS: STEM education, gender equity, higher education, Bangladesh, women in STEM, educational policy

INTRODUCTION
Bangladesh has achieved remarkable economic progress over the past three decades, driven primarily by agriculture, the ready-made garment (RMG) sector, and remittances. Between 2010 and 2019, GDP expanded at an average annual rate of 6.6 percent, placing Bangladesh among the fastest-growing economies in South Asia (World Bank, 2024). This growth has been accompanied by gains in human development, particularly in education and gender parity at the primary and secondary levels. Women have played a crucial role in these achievements. Yet, despite these advances, their representation in Science, Technology, Engineering, and Mathematics (STEM) education and careers remains disproportionately low, especially in higher education.

STEM—an integrated approach to science, technology, engineering, and mathematics—extends beyond technical expertise to encompass problem-solving, critical thinking, creativity, and collaboration. Globally, STEM is recognized as the foundation of the Fourth Industrial Revolution, driving innovation in artificial intelligence, biotechnology, climate adaptation, and digital economies (Schwab, 2017; OECD, 2022). Countries such as Malaysia, Singapore, and South Korea have embedded STEM into mainstream curricula, fostering highly skilled workforces that power their innovation-driven growth (Ng, 2013; KWDI & UNESCO, 2015).

In contrast, Bangladesh's education system still relies heavily on rote memorization, which undermines inquiry-based learning and limits students' ability to engage with STEM disciplines (UNICEF, 2010). Although gender parity has been achieved in primary and secondary enrollment, female participation drops significantly at higher levels, particularly in engineering, physics, and information technology (BANBEIS, 2022). Global data reflect similar patterns: women constitute only 35 percent of higher education enrollments in STEM, with the lowest representation in ICT and engineering (UNESCO, 2017). This underrepresentation is not simply a matter of choice but reflects systemic barriers, including restrictive social norms, lack of female role models, limited career counseling, and institutional biases (Brotman & Mensah, 2008; Scantlebury & Baker, 2007).

The urgency of addressing these gaps lies in the future of work. Projections show that STEM-related employment will grow at nearly twice the rate of non-STEM jobs over the coming decade (Bureau of Labor Statistics, 2021). For Bangladesh to realize its Vision 2041 goal of becoming a high-income country, it must build a workforce equipped with STEM competencies. Excluding women from these fields not only perpetuates inequality but also denies the nation access to half of its potential innovators, scientists, and leaders.

Grounded in this context, this study investigates the status of female participation in STEM higher education in Bangladesh. It examines enrollment trends across public and private universities, compares Bangladesh's situation with other Asian countries, and explores the socio-cultural and institutional factors shaping women's educational choices. By situating the issue within both national development priorities and global debates on gender equity in STEM, the study highlights the urgency of designing gender-responsive policies and programs that foster inclusive participation in science and technology.

MATERIALS AND METHODS

Research Design

This study adopted a mixed-methods design to comprehensively assess the status of female representation in STEM fields within higher education in Bangladesh. A combination of quantitative and qualitative approaches was used to capture enrollment trends, institutional variations, and perceptions regarding STEM participation. Mixed methods were selected because they allow for both statistical generalization and in-depth exploration of socio-cultural dynamics influencing educational choices (Creswell & Plano Clark, 2018).

Study Population and Sampling

The research focused on female students enrolled in tertiary-level institutions offering STEM programs across Bangladesh. A purposive sampling technique was employed to ensure inclusion of students from both public and private universities, reflecting diversity in institutional contexts and socioeconomic backgrounds.Primary data were collected from 200 female students enrolled in STEM-related programs. The selection included students from 10 universities distributed across different regions to ensure geographical and institutional representation:

Dhaka University	Patuakhali University of Science & Technology
North South University	Khulna University
Southeast University	BRAC University
Jahangirnagar University	Shanto-Mariam University of Creative Technology
Begum Rokeya University (Rangpur)	Chattogram Veterinary and Animal Sciences University

Data Sources

Two types of data were utilized:

Secondary Data: Statistical data were gathered from the Bangladesh Bureau of Educational Information and Statistics (BANBEIS), University Grants Commission (UGC) reports, and UNESCO databases. Additional references included the Annual Primary School Census, Bangladesh Education Statistics 2022, and international datasets for comparative analysis with other Asian countries (UNESCO, 2017).

Primary Data: Collected through surveys, interviews, focus group discussions (FGDs), and classroom observations. These methods provided insights into enrollment challenges, motivational factors, and institutional support for female students in STEM disciplines.

Data Collection Methods

Questionnaire Survey: A structured questionnaire captured demographic information, academic background, motivations for choosing STEM, perceived barriers, and suggested interventions. The instrument was designed based on previous studies on gender and STEM participation (Brotman & Mensah, 2008; UNESCO, 2017).

Interviews: Semi-structured interviews with selected students provided qualitative insights into their personal experiences, aspirations, and challenges in pursuing STEM education.

Focus Group Discussions (FGDs): Conducted with groups of 8–10 participants to facilitate open dialogue about institutional practices, societal attitudes, and support mechanisms influencing female participation.

Classroom Observations: Undertaken in selected institutions to examine teaching practices, classroom interactions, and gender dynamics in STEM learning environments.

Ethical Considerations

Participation was voluntary, and informed consent was obtained from all respondents. Confidentiality was maintained by anonymizing participant identities during data recording and reporting. Ethical guidelines for social science research were followed in line with the Declaration of Helsinki principles.

Data Analysis

Quantitative data from the survey were coded and analyzed using descriptive statistics, including frequency distributions and percentages, to identify trends in enrollment and perceptions. For qualitative data, thematic analysis was employed, following Braun and Clarke's (2006) framework, to categorize responses into major themes such as motivation, institutional barriers, and gender stereotypes. Triangulation of data sources was applied to enhance validity and reliability.

RESULTS AND DISCUSSION

Enrollment Trends and Gender Disparities

Analysis of enrollment data reveals significant progress in achieving gender parity at the primary and secondary education levels in Bangladesh. Between 2010 and 2023, the Gross Enrollment Ratio (GER) and Net Enrollment Ratio (NER) for girls at the primary level consistently exceeded those of boys, reflecting policy efforts to improve female access to education (BANBEIS, 2022). At the secondary level, the trend remains favorable for girls; however, this parity does not translate into sustained participation in STEM disciplines. (Table 1 & 2).

Table 1: Trend of GER and NER by Gender during 2010-2023 in Primary Level

Year	GER (%)			NER (%)		
	Boys	Girls	Both	Boys	Girls	Both
2010	103.20	112.40	107.70	92.20	97.60	94.80
2011	97.50	105.60	101.50	92.70	97.30	94.90
2012	101.30	107.60	104.40	95.40	98.10	97.70
2013	106.80	110.50	108.60	96.20	98.40	97.30
2014	104.60	112.30	108.40	96.60	98.80	97.70
2015	105.00	113.40	109.20	97.09	98.79	97.94
2016	109.30	115.00	112.10	97.01	98.80	97.96
2017	108.10	115.40	111.70	97.66	98.29	97.97
2018	110.32	118.30	114.23	97.55	98.16	97.85
2019	104.49	114.93	109.60	97.65	98.01	97.74
2020	100.87	108.95	104.85	97.37	98.25	97.81
2021	105.32	106.14	105.72	97.39	97.44	97.42
2022	103.16	118.46	110.48	97.52	97.81	97.56
2023	100.71	109.83	104.53	97.68	97.84	97.76

Source: Directorate of Primary Education (Annual Primary School Census 2023)

Table 2: Trend of GER and NER by Gender during 2010-2022 in Secondary Level

Year	GER (%)			NER (%)		
	Boys	Girls	Both	Boys	Girls	Both
2010	49.59	62.62	55.81	44.45	55.09	49.53
2011	57.04	66.91	61.89	51.94	59.94	56.50
2012	57.37	71.31	64.05	51.64	63.58	57.37
2013	59.63	71.86	65.58	54.05	64.16	58.97
2014	62.94	75.88	69.23	57.04	67.74	62.25
2015	67.75	77.84	72.78	62.16	71.85	67.00
2016	67.11	81.74	74.23	63.85	73.10	67.84
2017	68.60	81.90	74.64	63.59	74.38	68.78
2018	69.56	82.50	75.32	64.47	74.68	69.38
2019	67.83	83.36	75.62	60.11	74.47	67.30
2020	67.13	85.19	76.38	62.89	80.62	71.89
2021	66.40	83.15	75.52	63.29	79.09	70.25
2022	69.10	83.20	76.10	67.60	80.02	73.76

Source: Pocket Book on Bangladesh Education Statistics 2022

Despite these gains, dropout rates remain a concern. In 2022, **40.78% of girls** at the secondary level and **22.6% at the higher secondary level** discontinued their studies compared to **33.25% and 21.59% for boys**, respectively (Table 3) (BANBEIS, 2022). These attrition patterns, often linked to socio-economic constraints, early marriage, and limited institutional support, reduce the pool of female students eligible for tertiary STEM education.

Table 3: Dropout Rate in Secondary and Higher Secondary Level 2009-2022

Year	**Secondary Level**		**Upper Secondary Level**	
	Boys	Girls	Boys	Girls
2009	42.15	64.93	42.23	42.48
2010	57.29	53.57	36.67	37.88
2011	46.73	56.43	33.5	34.8
2012	34.9	52.36	20.31	23.29
2013	34.18	48.89	21.28	23.16
2014	34.52	47.67	25.32	17.05
2015	33.72	45.92	16.83	24.6
2016	33.88	42.19	16.55	23.83
2017	33.43	41.52	16.44	22.99
2018	36.01	40.19	18.02	21.21
2019	35.52	37.67	17.28	19.66

2020	36.80	34.86	20.57	22.02
2021	32.50	40.29	20.74	21.56
2022	33.25	40.78	21.59	22.60

Source: Pocket Book on Bangladesh Education Statistics 2022

The cycle dropout rate for girls in secondary education decreased from approximately 65% in 2009 to below 41% in 2012 (Figure 1 & 2). A similar trend was observed at the upper secondary level, where the rate declined from nearly 43% to around 23%. Although the dropout rate for girls has consistently been higher than for boys over the years, the gap between the two is converging.

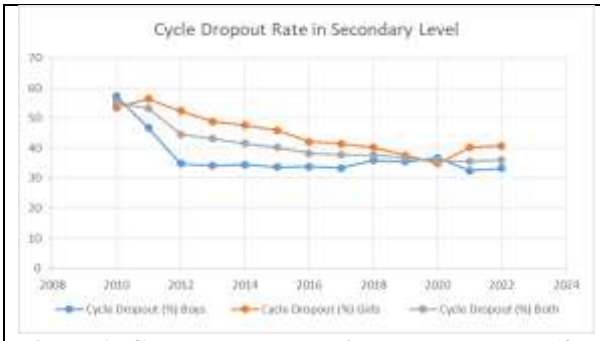

Figure 1: Cycle dropout rate in secondary level (for boys, for girls, and for both combined)
Source: Bangladesh Education Statistics 2022, BANBEIS

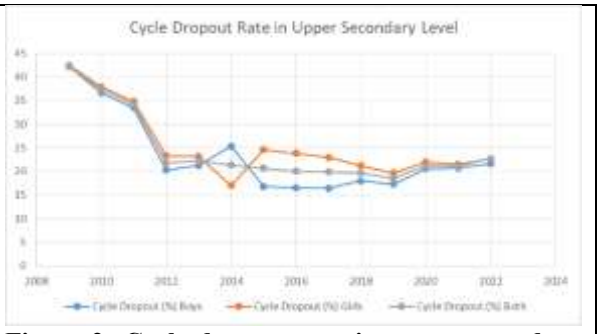

Figure 2: Cycle dropout rate in upper secondary level (for boys, for girls, and for both combined)
Source: Bangladesh Education Statistics 2022, BANBEIS

Participation in STEM at the School Level

Data from the Secondary School Certificate (SSC) and Higher Secondary Certificate (HSC) examinations indicate persistent gender disparities in subject selection. Between 2018 and 2020, the proportion of female examinees in the science stream remained significantly lower than that of males, with most girls opting for humanities (Figure 3). At the higher secondary level, a marginal increase of about **1%** was observed in the share of female students in science between 2017 and 2019 (Table 5), but the overall representation remains low. These patterns suggest that gendered subject choices emerge early, constraining later STEM participation.

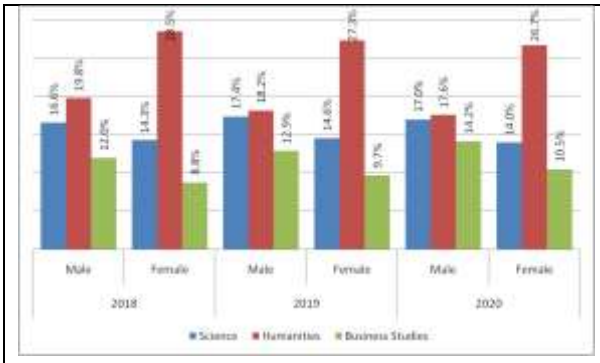

Figure 3: Percentage of Examinee by Steam and Gender for SSC 2018 - 2020
Source: Author's calculation using SSC results of Education Board 2018 – 2020

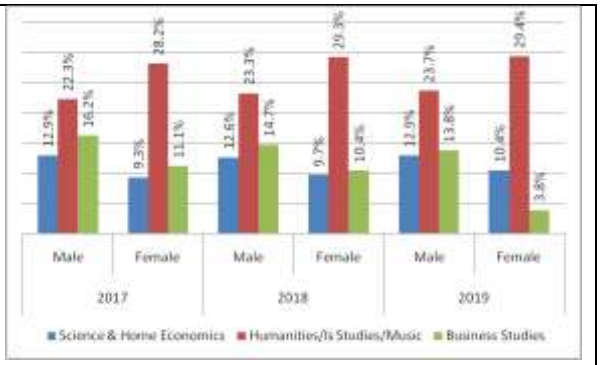

Figure 4: Percentage of Examinee by Steam and Gender for HSC 2017 - 2019
Source: Author's calculation using HSC results of Education Board 2017 – 2019

Female Enrollment in Tertiary STEM Programs

At the tertiary level, the situation is more critical. Although women account for roughly 50.3% of total college enrollments across general streams, their participation in STEM-focused programs is disproportionately low. For instance, in engineering universities such as BUET, only 22.26% of students are female, while female representation in textile and leather technology institutes is below 26% (BANBEIS, 2022). Conversely, female enrollment is higher in health-related fields such as nursing and midwifery (90%) and medical colleges (62.77%)**,** reflecting entrenched gender norms that associate women with caregiving roles (Table 4 & 5).

Table 4: Number of Girls' Enrollment in Tertiary Level for College Education

Type of College	**Enrollment**		
	Total	Girls	% of Girls
School & College (College Section)	444165	236678	53.29
Higher Secondary College	427362	219700	51.41
Degree (Pass) College	864869	465473	53.82
Degree (Honors) College	1417259	702674	49.58

Master's College	1678515	804703	47.94
Total (College Education)	4832170	2429228	50.27

Source: Pocket Book on Bangladesh Education Statistics 2022, BANBEIS

Table 5: Enrollment in STEM-based tertiary level institutions by gender type 2022

Sl. No.	Type of Institute	Total	Girls	% of Girls
1	Medical College	50594	31757	62.77
2	Armed Forces & Army Medical College	1875	675	36.00
3	Dental College & Dental Unit	7186	4480	62.34
4	Nursing & Midwifery College and Institution	42410	38169	90.00
5	Bangladesh University of Engineering & Technology (BUET)	7420	1652	22.26
6	Homeopathic College	45482	22699	49.52
7	Unani/Ayurbedic College	3467	911	26.28
8	Textile Technology College	1210	236	19.73
9	Leather Technology	786	201	25.57
10	Agriculture College	1891	733	38.76

Source: Bangladesh Education Statistics 2022, BANBEIS

A UGC report (2016) further highlights that only 21% of all tertiary-level students in Bangladesh are enrolled in STEM courses, with stark gender disparities (Table 6). This underrepresentation not only limits women's career opportunities in high-demand sectors but also undermines national efforts to build a skilled workforce aligned with the Fourth Industrial Revolution.

Table 6: Proportion of enrolment in STEM courses in tertiary level in 2015

	Public University	Private University	Tertiary Colleges	Total Tertiary
Total Enrolment (in millions)	0.49	0.38	1.7	2.75
Enrolment in STEM (in millions)	0.24	0.17	0.16	0.56
Enrollment in STEM (%)	48	44	9	21

Source: UGC Bangladesh 2016

From the survey in 30 schools at Gazipur district, it was found that in only 4 schools' girls share the majority in science group whereas humanities and commerce are dominating groups in other 25 schools and no efficient data was found in one school. (Figure 5)

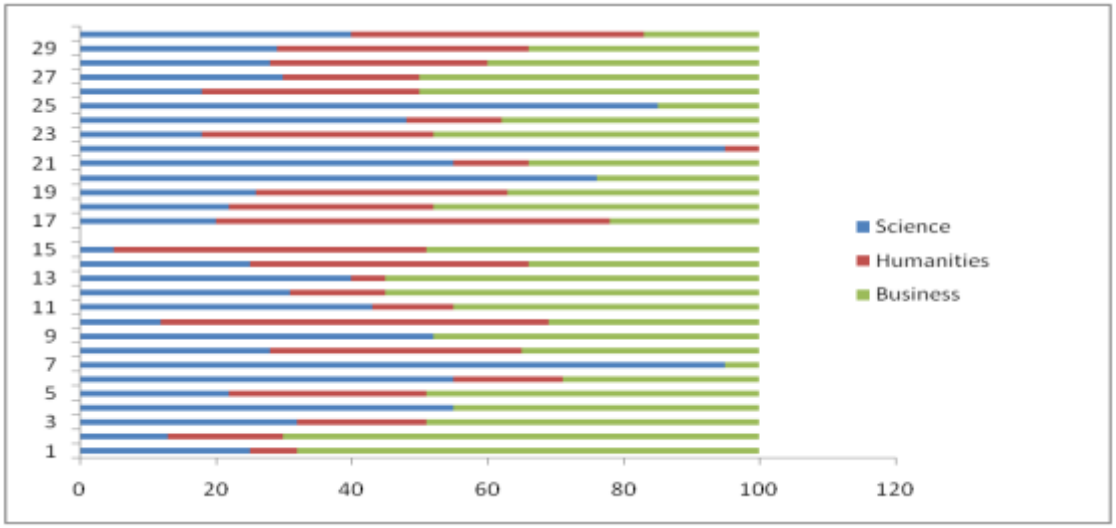

Figure 5: Percentage of groups in secondary level at Gazipur district

Source: Survey of female secondary school students conducted in Gazipur district, Bangladesh
Note: Survey respondents (n=400).

Comparative Perspective with Other Asian Countries

Compared to regional peers, Bangladesh lags in female participation in STEM. Countries like Malaysia have implemented integrated STEM education in mainstream curricula, resulting in more balanced gender representation in higher education (Ng, 2013; KWDI & UNESCO, 2015). In contrast, Bangladesh's progress is hindered by systemic challenges, including

limited female role models in STEM, insufficient mentorship programs, and persistent cultural stereotypes that discourage girls from pursuing technical fields. Table 7 shows the comparative studies of secondary education of South and West Asia countries. It shows that in Bangladesh and Maldives highest percent of female are enrolled in the secondary level (51.9%) whereas Net Enrolment Rate (NER) is highest in Iran (72.7%) followed by India (66.7%).

Table 7: Comparison of Education Statistics of Secondary Education of South and West Asian Countries (6-12)

Country	Year	Students in Secondary Education		Students in Secondary TVE Education			Teacher in total Secondary	GER in Total Secondary	NER in Total Secondary
		Total	% Female	Total	% Female	% TVE to total students in secondary			
Bangladesh	2015	14,566,771	51.9	602,080	27.4	4.13	378,209	63.52	52.24
India	2014	129,438,989	47.6	1,590,879	16.9	1.23	4,073,937	74.28	66.70
Pakistan	2015	12,077,917	42.3	329,562	34.3	2.73	571,685	44.53	43.96
Afghanistan	2015	2,698,816	34.7	26,986	9.7	1.00	71,547	55.64	48.88
Maldives	2004	28,878	51.9	1,115	30.0	3.86		69.82	
Nepal	2016	3,277,231	50.6				113,385	69.57	54.43
Sri Lanka	2013	2,605,597	50.9	149,818	45.2	5.75		99.72	
Iran	2015	5,712,478	47.6	832,083	34.5	14.57	335,686	89.17	72.70

Source: UNESCO Institute Statistics

Globally, data shows that despite increased parity in enrolment at the Bachelor's level (or equivalent) in higher education, in STEM disciplines, male students outnumber female students in 91 percent of countries with available data (UNESCO, 2010b, p. 5). According to the UNESCO report, only 35% of STEM students in higher education globally are women, and differences are observed within STEM disciplines. For example, only 3% of female students in higher education choose information and communication technologies (ICT) studies. This gender disparity is alarming, especially as STEM careers are often referred to as the jobs of the future, driving innovation, social wellbeing, inclusive growth and sustainable development.[2]

In others, a higher proportion of enrolled females might remain the minority in specific disciplines within the STEM, such as physics, mathematics, and engineering in Malaysia, Mongolia, and Indonesia (Figure 6, 7 & 8).

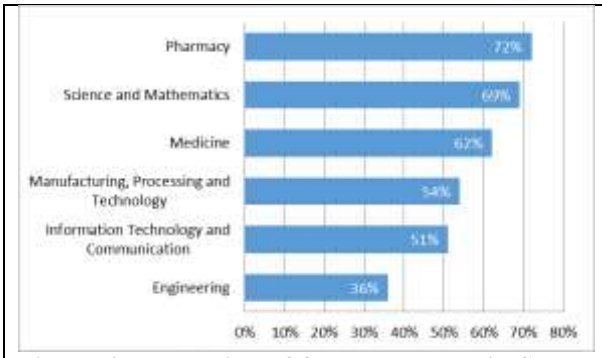

Figure 6: Proportion of female students in STEM disciplines in higher education in Malaysia in 2012 (%)
Source: Adapted from MoHE, 2013

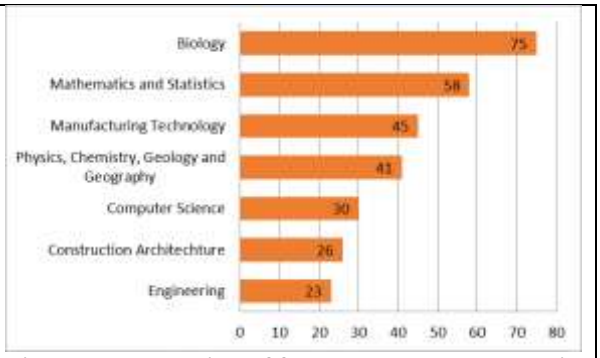

Figure 7: Proportion of female students enrolled in STEM disciplines in higher education in Mongolia as of 2013 (%)
Source: MEDS, 2013

[2] Book - Cracking the code: Girls' and women's education in science, technology, engineering, and mathematics (STEM)

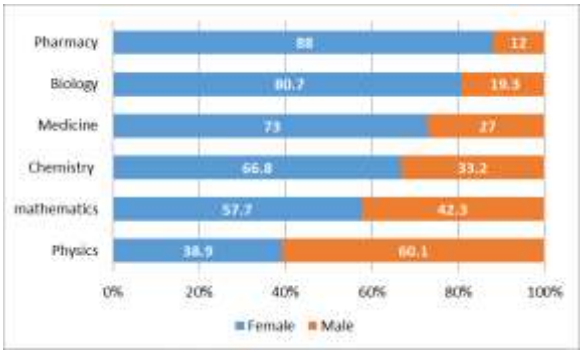

Figure 8: Proportion of students enrolled in STEM disciplines in selected universities in Indonesia by sex (%)
Source: DoHE, 2014; Yogyakarta Statistics, 2013

Perceptions and Challenges from Primary Data

Primary data collected from 200 female students across 10 universities reveal motivational and structural factors influencing STEM choices. Among respondents from private universities, 41% cited personal interest as their primary motivation, whereas 39% of public university students emphasized career opportunities (Figure 9). However, financial barriers emerged as a significant constraint for students in public institutions, with 88% advocating for scholarships as the most effective intervention (Figure 10). Respondents from private universities prioritized mentorship programs and exposure to role models in STEM professions (Figure 11).

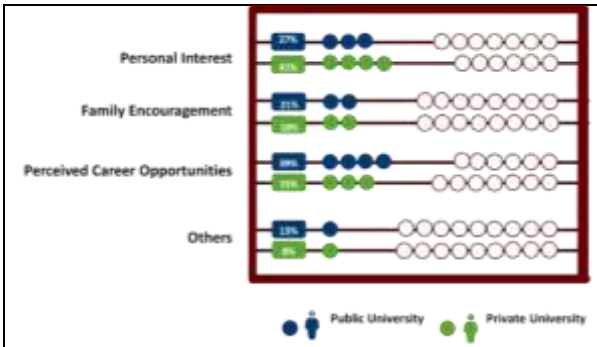

Figure 9: Factors Influencing Female Students' Decision to Pursue STEM Education at the University Level

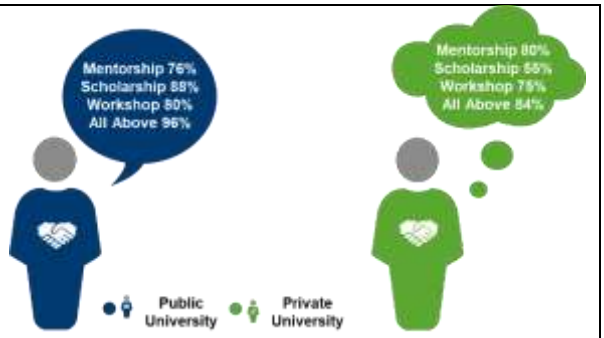

Figure 10: Support and Resources to Enhance Female Students' Experience in STEM Programs

When asked about representation in STEM-related leadership roles, 56% of public university students reported inadequate female representation, while 48% of private university respondents emphasized limited opportunities for active participation (Figure 12). These findings align with global research suggesting that visibility of women in leadership fosters aspirational pathways for female students (UNESCO, 2017).

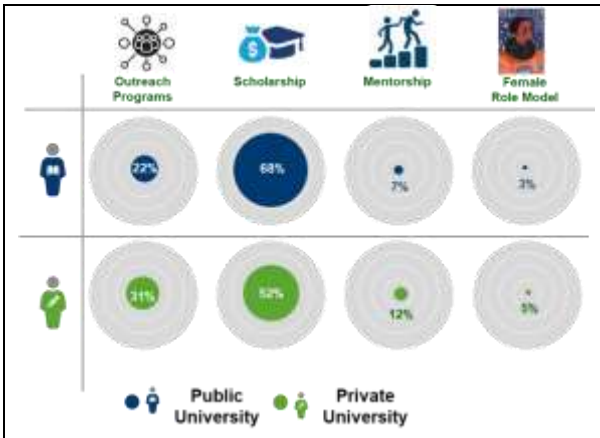

Figure 11: Effective Initiatives to Encourage Female Enrollment in STEM Fields at Universities in Bangladesh

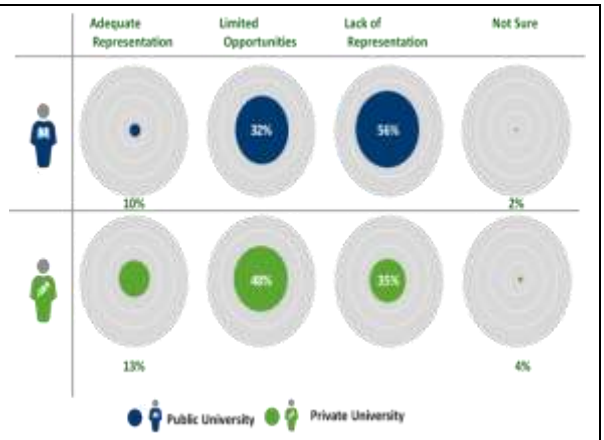

Figure 12: Perceptions of Female Representation in STEM Activities and Leadership Roles at Universities

DISCUSSION

The findings of this study underscore the persistent gender gap in STEM education in Bangladesh, despite significant progress in achieving gender parity at the primary and secondary levels. While enrollment figures for girls in early education reflect near parity or even higher ratios than boys, this trend does not sustain into higher secondary and tertiary

education, particularly in STEM disciplines. The high dropout rates among female students—40.78% at secondary and 22.6% at higher secondary compared to 33.25% and 21.59% for boys (BANBEIS, 2022)—suggest that socio-economic pressures, early marriage, and gendered expectations continue to limit girls' educational continuity.

The underrepresentation of women in STEM-related higher education programs is particularly concerning. Although women constitute more than half of general tertiary enrollments, their participation in STEM programs remains disproportionately low. For example, only 22.26% of BUET students are female, and representation in textile and leather technology institutes is below 26% (BANBEIS, 2022). Conversely, female participation in nursing and medical fields is significantly higher, reinforcing traditional gender norms that associate women with caregiving roles. These patterns are consistent with findings from other Asian countries, where cultural stereotypes, limited role models, and financial constraints have been identified as key barriers to women's STEM participation (UNESCO, 2017; KWDI & UNESCO, 2015).

The qualitative data highlight similar structural and cultural barriers. While many students cited personal interest and career prospects as motivations for pursuing STEM, financial limitations and lack of institutional support were dominant themes, especially among public university respondents. Additionally, limited exposure to female role models and minimal representation of women in STEM leadership positions were noted as factors reducing motivation for aspiring students. These challenges collectively point to a cumulative disadvantage for women, starting from early educational choices through to career pathways.

To mitigate these barriers, several strategies emerge from the findings and comparative analysis with global best practices. Integrating gender-sensitive STEM curricula at early education levels can help normalize girls' participation in science and technology fields. Similarly, providing targeted scholarships and stipends for women in STEM, particularly in engineering and ICT, is crucial for reducing economic constraints. The establishment of mentorship programs and networking opportunities featuring female STEM professionals can address the lack of role models and enhance career confidence. Moreover, institutional policies promoting gender equity, such as safe campus environments and inclusive support services, are essential for retaining female students.

The experience of countries like Malaysia demonstrates that early interventions—through STEM-focused programs, parental engagement, and public-private partnerships—can significantly improve female representation in technical fields (Ng, 2013; OECD, 2022). Implementing such measures in Bangladesh would not only enhance women's educational and career outcomes but also contribute to the national ambition of developing a skilled workforce aligned with the demands of the Fourth Industrial Revolution and the Sustainable Development Goals (SDGs).

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