Original Research Article

Empowering Futures: STEM Aspirations Among Bangladeshi Girls in Secondary Education

Abstract

This research examines the desire of the class nine and ten girls towards STEM education in Khulna and Rajshahi, Bangladesh. Despite growing awareness of gender parity, girls' STEM participation is little. This study surveys various socio-cultural, economic, and educational aspects to determine whether female students choose STEM streams in secondary school. This study has explored the unexplored aspirations of high school girls in these two areas of Bangladesh.

A mixed-methods approach was used to meet the objectives of this study. For this, researchers used a wide range of quantitative and qualitative data. Eight girls' high schools in Khulna and Rajshahi, Bangladesh, were studied using questionnaires in which 410 girls participated. The students were selected from ninth and tenth grades. In addition, 44 respondents shared their ideas, experiences, and observations in four focus group discussions (FGD) conducted at various schools. The data was collected from July 2021 to June 2023. STEM female students have been studied using descriptive statistics and qualitative methods. Some critical issues have been explored through this study. These include motivations for studying STEM, completion, desired degree, and chosen STEM higher education institutions. The present global STEM education scenario and STEM occupations largely influence female STEM students.

The results reveal that every respondent has well-defined STEM aspirations; nonetheless, the majority target the biological sciences. It also found that they have less interest in engineering, technology, and applied sciences. The earth, space, and physical science occupy a smaller subset in their chosen row. The girls also know local and global STEM education trends and actively seek knowledge to guide their academic and career paths. It is important to note that the students are ambitious and aware of STEM career opportunities despite their knowledge deficits.

The research suggested the need to provide additional assistance in a few areas, like providing high-quality teaching methods and materials for STEM girls, mentorship, organizing workshops for guardians, and offering scholarships and financial aid. If these suggestions are implemented, the girls' desires may be fulfilled.

1. INTRODUCTION

1.1 Background of the Study

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Bangladesh, a developing nation with a population of 169,828,909, exhibits a relatively balanced gender distribution, consisting of 84,077,203 males (49.51%), 85,653,120 females (50.43%), and 12,629 individuals identifying as transgender (0.01%) [1]. While literacy rates for males and females are fairly comparable, differences emerge at advanced educational levels, where female enrollment often falls short of that of males. The disparity is particularly noticeable in STEM education, a crucial sector within the scientific framework of the nation's educational system. In 2022, there were 3,750,218 students enrolled in classes nine and ten within the secondary education system of Bangladesh, including 2,051,109 female students. Upon analyzing students in the science stream, which serves as a pathway to future STEM education, a minor gender imbalance is observed. Among the 1,160,337 students enrolled in the science stream, there were 579,217 females (49.92%) and 581,120 males (50.08%) [2]. Although participation in secondary science education is almost balanced between genders, the disparity tends to increase as students advance to higher education, resulting in a lower number of women pursuing STEM fields. Upon entering class nine, students in Bangladesh's secondary education system must select an academic stream: Humanities, Business Studies, or Science. This decision is grounded in scholarly aptitude, enthusiasm, and skill. Only individuals who chosen the science stream are able to pursue STEM subjects in higher education later on. The decision regarding students' future academic and career trajectories is of utmost importance, and families, particularly guardians, significantly influence which stream girls choose to pursue. This choice is shaped by a variety of familial, cultural, academic, and social factors that impact educational aspirations and career objectives.

1.2 Statement of the Problem

STEM (Science, Technology, Engineer and Mathematics) education is crucial for national development, as it promotes innovation, economic growth, and social progress. However, in many developing countries like Bangladesh, girls' participation in STEM fields remains significantly lower than that of boys, particularly at the secondary school level. This disparity is especially pronounced among girls in classes nine and ten, an age group where educational and career aspirations begin to take shape. Several studies highlight the critical role these formative years play in shaping students' interest and confidence in STEM subjects, as well as the influence of societal and institutional factors that either encourage or discourage girls from pursuing these fields [3]. In Bangladesh, socio-cultural barriers such as gender stereotypes, societal expectations, and the lack of female role models in STEM professions contribute to the problem. Rahman and Panday (2020) find that girls are often perceived as less capable of technical subjects, which creates a sense of discouragement and lowers their confidence in pursuing STEM-related courses [4].

Additionally, the education system itself may inadvertently contribute to these issues, with teachers and curricula sometimes reinforcing gender biases that portray STEM as a male-dominated field. Studies show that when girls do not see themselves represented in STEM fields, their interest in these subjects tends to decline [5]. As a result, many girls in Bangladesh, despite having potential, feel discouraged or need more support to fully explore their interests in STEM.

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Moreover, economic factors and access to resources further exacerbate the situation. Mahmud and Kaiser (2021) argue that many students, particularly those from rural or lower-income backgrounds, need access to quality STEM education, including well-trained teachers, labs, and extracurricular activities that foster interest in STEM subjects [6]. These challenges are particularly detrimental for girls, who may face additional familial pressures to conform to traditional gender roles, limiting their aspirations in STEM education. This study aims to investigate the aspirations and attitudes of class nine and ten girls in Bangladesh toward STEM education, with a focus on identifying the key factors that influence their decisions to pursue or avoid STEM subjects. By understanding these challenges, the study hopes to contribute to strategies that can increase female participation in STEM, ultimately fostering gender equality in education and the workforce in Bangladesh.

1.3 Literature Review

The underrepresentation of females in STEM (Science, Technology, Engineer and Mathematics) disciplines is a widespread global concern, and Bangladesh is no exception. The ambitions of Bangladeshi girls in grades nine and ten about STEM education are shaped by a complex interaction of socio-cultural, institutional, and economic factors. This literature review analyzes the current research on STEM aspirations among adolescent girls, emphasizing the obstacles and facilitators that influence their involvement in these fields within the Bangladeshi setting. Socio-cultural norms and gender stereotypes profoundly affect girls' involvement in STEM education in Bangladesh. Research indicates that societal expectations significantly influence the educational and employment decisions of girls, frequently diverting them from STEM disciplines. Rahman and Panday (2020) contend that entrenched patriarchal norms in Bangladesh frequently designate STEM as a field predominantly appropriate for males, while females are anticipated to engage in disciplines deemed more congruent with conventional gender roles, such as humanities or social sciences [4]. Societal expectations diminish females' confidence in their capabilities in science and technology, thus perpetuating a cycle of underrepresentation in these domains. Dasgupta and Stout (2014) indicate that the lack of female role models in STEM professions intensifies the problem on a worldwide scale [3]. Girls are less inclined to engage in STEM disciplines if they lack visibility of successful women in these areas, as role models offer both motivation and a concrete demonstration that transcending gender conventions in STEM is achievable. This is especially pertinent in Bangladesh, where the representation of women in STEM fields is minimal. A UNESCO study (2017) indicates that public attitudes toward girls' education are gradually evolving; however, conventional perspectives remain prevalent, particularly in rural regions, where girls' education is frequently regarded as subordinate to their anticipated responsibilities as homemakers. The educational framework in Bangladesh significantly influences girls' ambitions in STEM fields. Numerous studies have identified institutional hurdles, such as gender-biased curricula, teacher attitudes, and school cultures, that do not promote girls' success in STEM disciplines. Mahmud and Kaiser (2021) contend that the national curriculum and textbooks in Bangladesh frequently perpetuate conventional gender stereotypes, featuring males as scientists, engineers, and mathematicians, while women are represented in more submissive ways. This depiction perpetuates the notion that STEM is not inherently suitable for girls, hence reducing their interest in these disciplines

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during their formative years. Furthermore, educators' perspectives significantly influence girls' engagement in STEM fields. A study by Ferdousi and Al-Mamun (2019) reveals that educators in Bangladesh frequently unwittingly reinforce gender prejudices by allocating more attention to male students in science and mathematics classes [8]. Boys are more frequently encouraged to engage in classroom discussions, lead group projects, and utilize laboratory equipment, whereas girls may be marginalized. This disparity in classroom treatment fosters a learning atmosphere in which girls experience diminished confidence in their STEM capabilities and are less inclined to pursue advanced studies in these disciplines. Institutional backing for extracurricular STEM initiatives is notably restricted, especially for female participants. Bairagi et al. (2020) indicate that there are limited formal initiatives in Bangladeshi schools aimed at encouraging girls to participate in STEM-related activities, such as science clubs or contests [7]. These activities are essential for fostering a lasting interest in STEM disciplines, yet the limited access for girls further constrains their exposure and aspirations in these areas. Economic issues significantly influence females' desires for STEM education. Bangladesh is a developing nation where financial constraints frequently determine educational prospects, especially for girls from economically disadvantaged backgrounds. A UNESCO report (2017) indicates that resource-constrained households frequently prioritize the education of boys over girls, perceiving boys as the principal future providers. This tendency is especially pronounced in rural regions, where the education of girls is sometimes regarded as subordinate to their preparation for early marriage or domestic duties [10]. The deficiency of access to high-quality STEM educational resources intensifies the issue. Mahmud and Kaiser (2021) emphasize that numerous schools, particularly in rural regions, are deficient in sufficient STEM resources, including well-equipped laboratories, current texts, and technological access [6]. This resource deficiency disproportionately impacts girls, who are less likely to obtain familial or institutional assistance for extracurricular educational endeavors, including scientific fairs or STEM workshops. The restricted access to resources substantially undermines girls' ambitions and prospects in STEM, as they lack the necessary tools and assistance to thoroughly realize their potential in these domains. Notwithstanding these limitations, numerous initiatives have been undertaken to enhance girls' involvement in STEM education in Bangladesh. Government initiatives, in conjunction with non-governmental organizations (NGOs), are striving to mitigate the gender disparity in STEM fields. Bairagi et al. (2020) observe that certain initiatives have concentrated on offering scholarships to girls in STEM education and presenting female STEM workers as role models via school visits and media campaigns [7]. Nonetheless, the efficacy of these initiatives has been constrained by the widespread socio-cultural and institutional obstacles that persistently dissuade girls from pursuing STEM jobs. Moreover, Dasgupta and Stout (2014) underscore the necessity for more specialized programs that tackle the distinct obstacles encountered by girls in secondary education [3]. These programs ought to concentrate on establishing supportive educational settings, providing mentorship opportunities, and formulating curricula that confront gender stereotypes. In the absence of these systemic modifications, the efficacy of current programs will persist and be constrained. Research indicates that a confluence of socio-cultural, institutional, and economic obstacles profoundly affects the ambitions of girls in grades nine and ten in Bangladesh regarding STEM education. Societal gender norms, prejudiced educational settings, and financial limitations restrict girls' abilities to investigate and

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participate in STEM disciplines. Despite efforts to tackle these challenges, additional focused interventions are necessary to foster an atmosphere conducive to girls pursuing STEM education and jobs. Overcoming these obstacles is essential for both gender equality and the sustainable advancement of Bangladesh's STEM workforce.

1.4 Objectives of the Study:

The general objective of this research is to explore the desire of the high school STEM girls in Khulna and Rajshahi districts. To this end, the research was accompanied with the following specific objectives:

I. To assess the current aspirations and attitudes of Class nine and ten girls in Khulna and Rajshahi districts towards STEM education.
II. To identify the socio-cultural, economic, and institutional barriers faced by girls in Khulna and Rajshahi districts in pursuing STEM education.
III. To evaluate the effectiveness of existing STEM-related programs and initiatives targeting girls in these districts.

1.5 Research Questions

In light of the study question, a sound research design is reasonable. The researcher should present evidence supporting the suitability of the chosen design [9]. This research has been conducted based on the following research questions:

I. What are the aspirations of Class nine and ten girls in Khulna and Rajshahi districts regarding STEM (Science, Technology, Engineering, and Mathematics) education and careers?
II. What socio-cultural, economic, and institutional factors influence the interest and participation of girls in Khulna and Rajshahi districts in STEM education?
III. What barriers do girls in Khulna and Rajshahi districts face in accessing STEM education, and how do these challenges differ based on socio-economic backgrounds?
IV. To what extent are existing STEM programs and initiatives in these districts effective in encouraging girls to pursue STEM subjects?

1.6 Scope and Justification

This study examines the aspirations and challenges faced by Class nine and ten girls across Bangladesh regarding STEM (Science, Technology, Engineering, and Mathematics) education. The scope includes exploring the factors that influence girls' interest in STEM, such as socio-cultural expectations, family dynamics, school environments, and economic conditions. By focusing on girls in these critical years of secondary education, the study aims to understand how their educational and career aspirations in STEM fields are shaped, particularly at a stage where decisions about future academic paths are made. The justification for this study lies in the underrepresentation of girls in STEM

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education in Bangladesh, a pattern that mirrors global trends but is exacerbated by local cultural, institutional, and economic barriers. Despite various initiatives to promote gender equality in education, girls in Bangladesh continue to face significant challenges in accessing STEM opportunities. Addressing this gender disparity is crucial for both individual empowerment and the nation's socio-economic development, as increasing female participation in STEM can contribute to innovation and economic growth. This research is timely and necessary for informing educational policy and program development aimed at fostering greater inclusion of girls in STEM fields. The insights gained from the study will help policymakers, educators, and stakeholders understand the barriers and potential motivators for girls, ultimately contributing to more gender-equitable education practices and the growth of a diverse STEM workforce in Bangladesh.

2. METHODOLOGY

2.1 Research Design

A large number of social scientists have offered competing definitions of study designs. According to Vogt et al., when we say "designs," we are referring to the most fundamental ways of gathering evidence, such as questionnaires, interviews, experiments, participant and naturalistic observations, data and textual archives, and hybrids of these [9]. Everything hinges on the design choice, which is also the one that has the closest relationship to the researcher's hypotheses and research questions [12]. Cresswell (2013) expresses that research designs are ways of looking at things that provide specific instructions for study methods in qualitative, quantitative, or mixed-methodologies approaches [12]. As per the classification provided by Vogt et al., there are essentially six distinct types of research designs: surveys, interviews, experiments, observational research, data and textual archives, and combining designs [12]."

This study will use a survey design due to its specific features and the following critical requirements. The most reliable sources of information are those directly from the respondents; concise responses to pre-designed questions yielded useful results, and the information supplied by respondents was accurate and reliable [12].

2.2 Participants and Sampling Technique

Researchers in Bangladesh's Khulna and Rajshahi regions surveyed 410 female students majoring in STEM from eight different girls' high schools. In Bangladesh, there are a total of eight divisions. The following cities are included: Mymensingh, Dhaka, Sylhet, Khulna, Rajshahi, Khulna, Barishal, and Rangpur. Of them, the divisions situated in the north-western portion of the nation and the south-western region of the country are Rajshahi and Khulna, respectively. When looking at the national socioeconomic position, STEM females in these two districts' high schools have a comparable socioeconomic level to girls throughout the nation. Therefore, the schools have been chosen on purpose, and the pupils have been chosen at random from grades nine and ten. To provide credibility to a nonprobability sample, judgment sampling is often used in survey research.

The study comprises eight schools, with three situated in rural areas and five in the urban areas of Khulna and Rajshahi. Forty-four individuals from four selected schools participated in the focus group discussions (FGDs) to express their views, experiences, feelings, and observations. In the rural areas

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two focus group discussion were conducted. The two other focus group discussions (FGDs) have been conducted in the schools of urban areas of Khulna and Rajshahi.

2.3 Research Instrument

This study employed a formal research questionnaire that included both closed and open-ended questions. The ability of respondents to comprehend open-ended questions is superior than that of closed-ended ones. On the other side, closed-ended questions, which tend to yield more pertinent information, are best compared in group settings. Focus group discussions (FGDs) have been conducted by following the checklist.

2.4 Data Collection Procedure

The STEM students were personally surveyed after the questionnaires had undergone pre-testing. Prior to it, the targeted respondents have provided their consent. Simultaneously, 44 FGD participants also gave their consent in this regard. Representatives from the science teachers attended Focus Group Discussions (FGDs), the school management committee, and the students' guardians. Everyone involved was speaking from their first-hand experience. In addition, they have provided their thoughts and recommendations in the areas where they are most comfortable expressing them.

2.5 Data Analysis Procedure and

By collecting data from a representative sample of a population, survey research can examine its demographics, culture, and socioeconomic standing and provide numerical assessments of societal trends, attitudes, and opinions [12]. This survey incorporates a focus group discussion into its design. Thus, the results and discussion sections involve massive amounts of qualitative data. The results of the questionnaire surveys and focus group discussions (FGDs) have been analyzed using the qualitative analysis approach. Descriptive statistics have been used to analyze both quantitative and qualitative data simultaneously. Tables, graphs, charts, diagrams, and mathematical equations are the many ways the findings are shown.

3. RESULTS AND DISCUSSION

3.1 Regarding completion of education in science or STEM

Students have been asked, "Are you interested in completing your education in science or STEM education?" In answer to this question, every respondent aspires that, they will complete their education in STEM. They have also explained four causes, for choosing STEM which is given below:

Figure 1: Causes for choosing STEM by the Respondents

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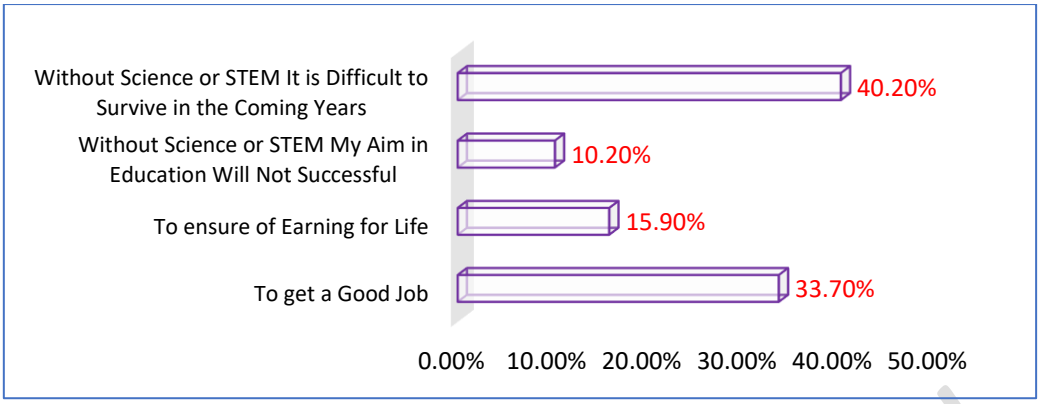

A popular slogan about the aims of education is “Learning for Earning.” Almost all of the students believe in this maxim. They have mentioned four reasons, why they have chosen STEM. All are directly related to earnings. Among the all, 165 respondents wrote that, without Science or STEM it is difficult to survive in the coming Years. The highest number of respondents perceive that, the world is changing very fast. So, cope with the changes, they have to study in STEM. STEM teachers expressed their view that,

> Today’s students are more concerned about the future of their education. They are interested in something other than education that will benefit them. They want an education that will enable them to build a bright future. The influence of science, technology, engineering, and mathematics in our daily lives is such that students feel that without STEM, it will be difficult for them to survive in the future. So, they want to take up STEM education to make themselves competent in the changing situation (KII STEMT 2, 3, 5 & 6).

The next highest number of respondents (33.7% or 138 students) opined that; STEM helps them to get a good job. There is a debate and confusion about the definition of a good job. It is an abstract idea. But the important thing is, by using the term ‘good job’, people simply believe that, it is one where you feel you are paid fairly for, and really good at, what you do [13]. But this definition not accepted all over the world. People now consider a job to be good if it not only pays fairly and enables the employee to do what they are good at but also makes them feel like their best selves are being recognized. If you have a decent job, you sense that your coworkers have your back; you do not encounter discrimination; you believe your position is secure, and you have faith that you will receive assistance navigating the constant changes in the workplace. In addition to gender and race, being on a team and how you react to stress can influence whether you experience these emotions [13]. From this definition, it is seen that some variables change over time. STEM respondents believe that if they receive STEM education, they can get a job where all the above variables will exist. So, it is assumed that the definition will change. By considering the changes and challenges of a good job, STEM students want to prepare themselves with STEM education.

The third reason they have mentioned is to ensure of earning for Life. In this group, 15.9 percent or 65 respondents opined that, STEM education ensure their earnings. Though they have judged the issue from narrow perspective, it is also important. It helps the overall scenario of employment in a particular area.

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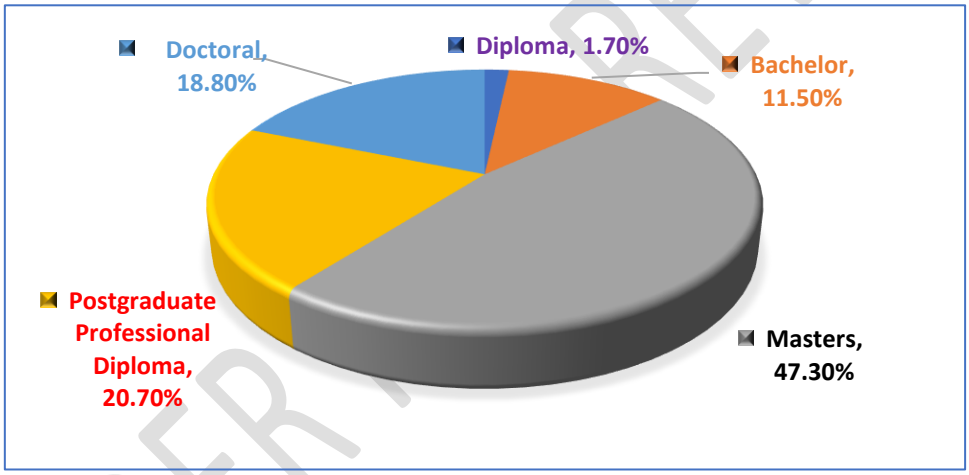
The last reason they have mentioned is that, without Science or STEM their aims in life will not fulfill. Only 10.2% or 42 respondents opined that, to bump into their aims in life, STEM is must. No other stream will meet their ambitions in life. Although many may try to narrow down their choice, everyone should think of that the larger goals of the country and the nation can be fulfilled by fulfilling the purposes of the individual. At the same time, respondents have been asked “Do you have any plans to study any other stream outside of science or STEM education, such as the arts, social sciences, or business progression at a higher level of education?” Nobody replied to this question positively. So, from the survey result it can be claimed that, current girl STEM students at high school level are very much aware of their education path in respect of choosing their stream. Everybody knows well that, why she has chosen STEM at high school level.

3.2 Desired level of STEM education

They were asked about their wished-for STEM education level. There have been given five options after pilot questionnaire survey. Everybody responded to the questions in the following ways:

Figure 2: Anticipated level of STEM education



The information obtained from the above figure shows that only an ignorant number of respondents are interested in completing a diploma, and the rest of them are determined to complete higher education. Almost half of the total respondents want to complete their master's. Significantly, almost one-fifth of them want to complete a doctoral degree. It indicates that many students want to engage in research or knowledge creation.

Generally, it is seen that, educational aspirations do not necessarily reflect specific socio-economic realities [11]. But is this study, it is found that respondents’ educational aspirations are to some extent different in considering their residential location. It is also found in this study that, socio-economic status of the respondents in the rural areas are comparatively weak in almost all kinds of variable, like, their parents’ monthly income, expenditure, educational qualification, profession etc.

Figure 3: Desired level of STEM Education between District Head Quarters and Rural Areas

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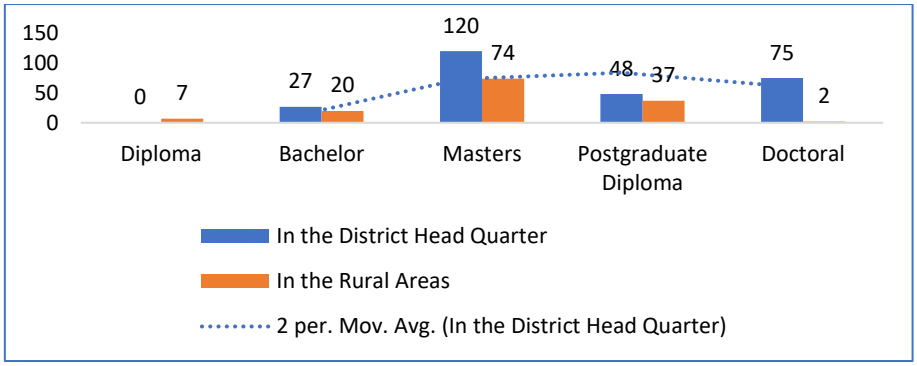


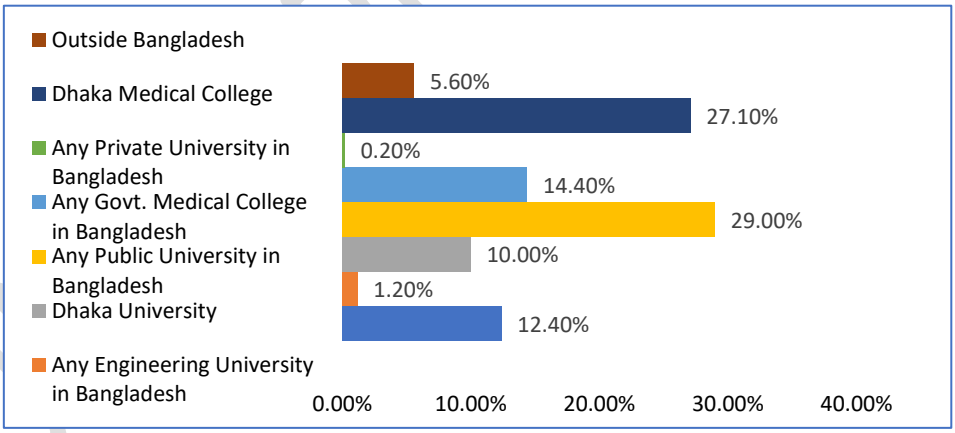
It is significantly noticed that, no student from district head quarter is interested in doing diploma. On the other hand, except two all of the respondents who desire to do doctoral degree have come from district head quarter. So, it can be claimed that, educational aspirations definitely reflected specific socio-economic realities. In this context, the guardians claim that,

> All education theories are incompatible in this country. Socio-economic inequality is widespread in this country. Socio-economically progressive groups want to retain their status, while deprived groups want to strengthen their socio-economic position. As a result, the achievement of goals in education is not what is supposed to be observed (FGD Khulna 1).

The expectation is that these girl students of the current generation believe that the existing social-economic inequality in this country will progressively diminish if they can become competent through STEM education.

3.3 Preferred Higher Educational Institutions and STEM domains

Figure 4: Desired Higher Educational Institutions of the Respondents



It is crucial to notice that a small segment of respondents' desire to study abroad. Because of that, they will not get to study in Bangladesh. Instead, they want to settle abroad. If admitted there at the undergraduate level, settling there will be easier than going there for a master's education. These respondents are from all levels of socio-economic background. Then it is found that only one respondent desires to study at a private university. Furthermore, the rest of the desire is to study at a public university, whether a medical college, an engineering university, or a general public university.

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The choice of STEM field or subfield in higher education depends on how STEM education is implemented at the high school level. It is not easy to implement STEM education at all the academic level specifically at pre higher education level. Because, there is no consensus regarding this. It totally depends on how a country or state sets up and implement STEM ideas. In recent days some developed countries are following the concept of National Academy of Sciences (USA). This organization has determined next generation science standards for Kindergarten to High School level students of USA (For States, By States) up to higher education (NGSS Lead States. 2013a). For this, the organization sets this standard according to disciplinary core ideas [15]. This organization has grouped disciplinary ideas into four major domains:

> The physical sciences; the life sciences; the earth and space sciences; and engineering, technology, and applications of science. At the same time, true to crosscutting concepts, we acknowledge the multiple connections among domains. Indeed, more and more frequently, scientists work in interdisciplinary teams that blur traditional boundaries. As a consequence, in some instances core ideas, or elements of core ideas, appear in several disciplines (e.g., energy, human impact on the planet [15].

Each fundamental concept and its constituents are introduced with a question that illustrates a facet of the world that this concept helps to explain. The question is followed by a description of the comprehension of the concept that students should have at the conclusion of high school. This structure is meant to emphasize that posing queries about the world and pursuing answers is fundamental to the scientific method [15].

The subsequent STEM field or sub-field of choice in higher education depends on which domains they know are weak or strong at high school. Their love or interest for specific STEM field or sub field is determined at the high school level. However, higher education institutions only sometimes follow the four STEM domains mentioned earlier. However, these four domains are considered important in most cases in higher education worldwide.

It is important to note that, in Bangladesh, STEM education is not provided according to the domain at secondary and higher secondary education levels. The subjects of science are taught here. So, even if they do not read according to the domain, students can learn about STEM education. Here is another debate about why science students are not taught according to the STEM domain. Therefore, in the existing system in this country, students know about STEM education, but their idea of the STEM domain needs to be clarified.

Regarding this, students have been asked, which of the following four domains of STEM education are you interested in pursuing in higher education (undergraduate and postgraduate)? They answered in the following way:

Figure 5: Respondents' Interest in STEM Domain

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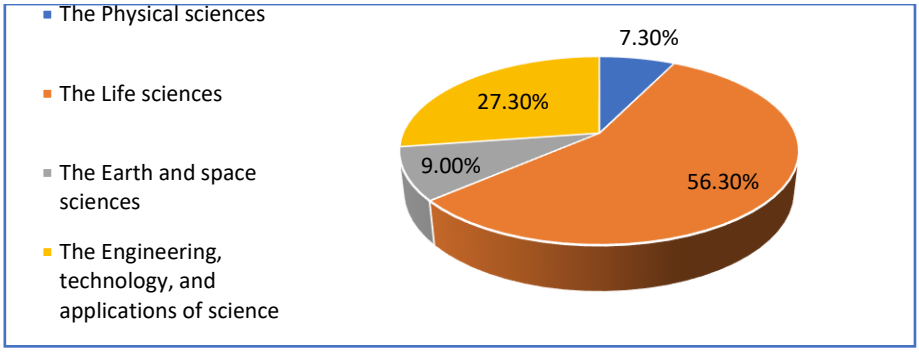

The above figure shows that, most of the respondents (231) tend to study the life sciences. The second largest group aspire to study the Engineering, technology, and applications of science. The third (37 respondents) and fourth (30 respondents) group choose to study the Earth and space sciences and the Physical sciences respectively. After this, respondents have been asked about STEM field or sub-field. But their ideas about this is very limited which has been presented below:

Table 1: Respondents' Preferred STEM Field or Sub-field

STEM Field or Sub-field	Frequency	Percent	Valid Percent
Medical Science	149	36.3	36.3
Biological Science	47	11.5	11.5
Computer Science & Engineering	62	15.1	15.1
Morphology	4	1.0	1.0
Cardiology	7	1.7	1.7
Physics or Mathematics	44	10.7	10.7
Aeronautical Engineering	32	7.8	7.8
Human Anatomy	1	.2	.2
Electrical and Electronics Engineering	14	3.4	3.4
Architecture	3	.7	.7
Medicine	13	3.2	3.2
Technology Related	20	4.9	4.9
Nuclear Science	3	.7	.7
Agriculture Related	9	2.2	2.2
Chemistry Related	2	.5	.5
Total	410	100.0	100.0

It can be seen from the table that their choices are limited to a few subjects. It indicates that they need to become better familiar with STEM or Science in general sense subjects. Parents and teachers present different views when asked about this kind of choice. Parents or guardians think Bangladesh's women's work field could be expanded. They or their guardian chose the life science domain for the right reasons. Some parents have opined that,

> Work fields of the life sciences domain are more secured that any other fields in Bangladesh. Though there are some fields in this domain, our daughters' choice for medical science gets first priority. Then they chose biology related fields or sub-fields. In the contest of Bangladesh, if a girl becomes a doctor (physician), she and her family's status reach higher in the society. At the same time, it ensures her earnings and job security. On the other hand, other STEM domains, fields or sub-fields did not catch the attention of the STEM girls. Because, the girls think that, it will be very challenging for them to get a good job by studying the subjects or sub-field except life sciences (FGD 1, SGR 1, 3; FGD 2, SGR 2, 5).

The teachers did not agree with them. According to teachers,

> Studying life sciences in Bangladesh has become a trend for women. They cannot think beyond that. Not that they can't do well in other domains. Family and society instill such

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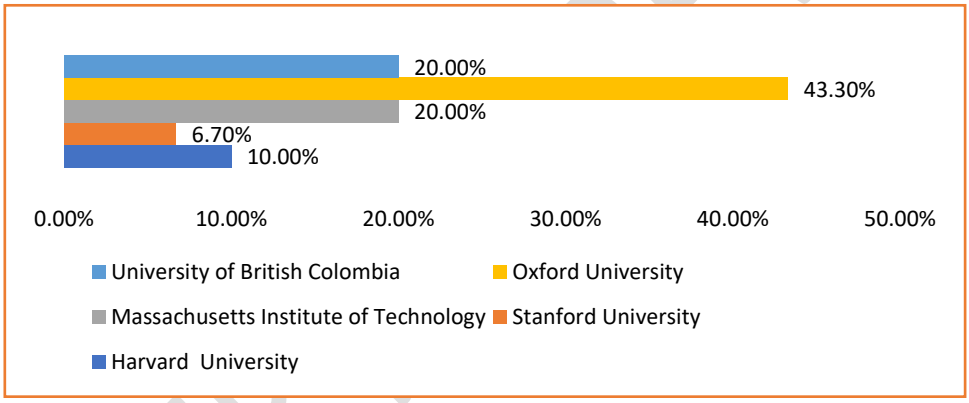
> a view that they do not learn to think outside of it. If we think about journalism in the non-STEM domain, we can see many women journalists working and succeeding there. So why are women only successful in the STEM domain of life sciences (KII STEMT 1, 4, 6, & 8)?

Now is the time for Bangladeshi female students to contemplate other STEM-related fields of study. Otherwise, limiting possibilities for education solely to life sciences can create a disproportion. Furthermore, women's participation is required in all STEM fields. Therefore, policymakers must consider it now. The relevant authorities should consider how to develop a proportionate education system by welcoming women in other STEM domains.

At this stage, students have been asked, "Does Bangladesh offer higher education at the undergraduate level in the subject or field you want to study?" Among all the respondents, 380 replied "yes" and only 3o responded "no". Further, they have been asked, "In which universities your preferred STEM field is taught?"

Figure 6: Respondents' Preferred Universities outside Bangladesh



The above figure shows that the respondents who chose to study abroad chose four North American universities and only one European university. In a greater sense, they have rightly chosen the continent of North America. However, when considering STEM-focused universities, they need to catch up and choose the right universities. In comparison with other universities, Oxford University is famous as a general university, though students have the opportunity to study STEM subjects. Nevertheless, the hope is that high school girls will know about these famous universities in Europe and North America. Not only that, they dream of studying there.

They have been requested to mention the STEM subject, field, or sub-field not taught in the universities of Bangladesh that must be taught in the universities of this country to meet the global challenges of the 21st century. Among all the respondents, 230 have expressed their view on it.

Figure 7: STEM subject, field, or sub-field must be taught in the Universities of Bangladesh

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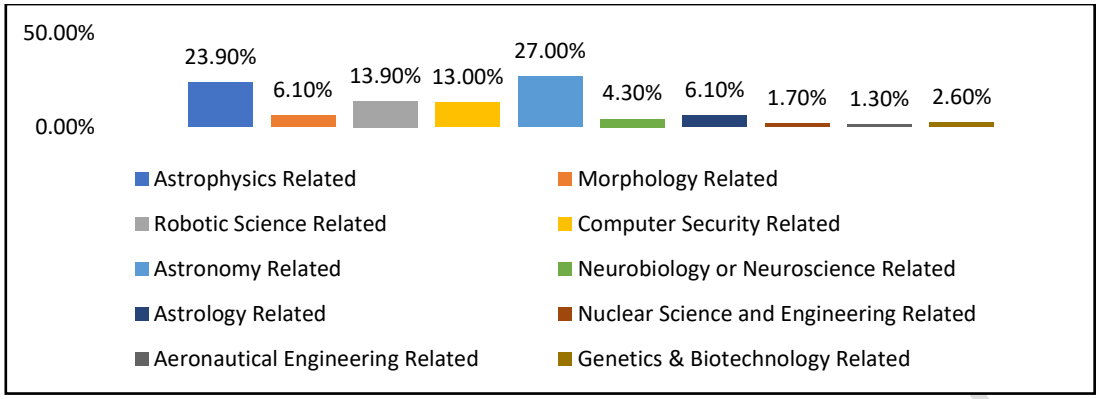

The above figure shows that Bangladeshi high school STEM girls are eager to know about the changes in the field of study at the higher education level. They feel that some fields of study must be added to the universities in Bangladesh. In considering the perspective of Bangladesh, their thinking is mostly correct. They also know that most of the fields they mentioned are already being taught in some universities. However, they expect that all the Science and Technology universities will open these fields of study at the undergraduate and graduate levels (Survey Respondent, Q-1, Govt. Coronation Secondary Girls High School). But they are not aware of the recent changes that have occurred in regards of STEM jobs and careers worldwide. Krutsch & Roderick have found that, there are ten STEM careers which are growing faster than any other jobs in the U.S. (2022) [16]. This has been presented below:

Table 2: Fastest Growing STEM Careers in the U.S

STEM Career	Number of jobs, 2021	Projected growth, 2021-2031	Occupational openings, 2021-2031 annual average
Data scientists	113,300	36%	$13,500
Information security analysts	163,000	35%	&19,500
Statisticians	34,200	33%	&3,900
Web developers	95,300	30%	&11,000
Software developers	1,425,900	26%	&143,400
Epidemiologists	8,600	26%	&800
Operations research analysts	104,200	23%	&10,300
Computer and information research scientists	33,500	21%	&3,300
Software quality assurance analysts and testers	196,300	21%	&19,500
Actuaries	28,300	21%	2,400

Source: Emily Krutsch, Victoria Roderick. (2022). STEM Day: Explore Growing Careers, U.S. Department of Labor Blog. https://blog.dol.gov/2022/11/04/stem-day-explore-growing-careers, accessed on 22nd May 2023 [16].

Analyzing the above table, among the ten careers or jobs, Statisticians, Web developers, and Software developers are familiar to the students of Bangladesh. However, most of the careers mentioned above need to be made familiar to the students. However, Bangladeshi universities can produce this kind of workforce. From an American perspective, the demand for these carriers is proliferating. However, there has yet to be a word that these careers will grow at the same rate in Bangladesh or everywhere. Therefore, considering the context of Bangladesh, those careers that may be required should be arranged for study in this country. However, the hope is that the recent steps taken by the government

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in higher education align with the times to some extent. Restructuring of the field of study, fields or sub-fields, reforms in the curriculum, and adjustments are needed in higher education in Bangladesh.

3.4 STEM Education Worldwide

Science-advanced nations aim to make education more useful. Therefore, they invented STEM education to apply knowledge in science more effectively. As a result, the USA led the way in the last decade of the 20th century in bringing about significant changes to the educational system. Following this, other developed countries introduced the STEM concept at all levels of education. There, they do not directly use STEM in the names of universities. They mention what the university is famous for or where there are study opportunities in STEM fields.

This analysis of STEM degree holders is based on a broad definition of a STEM degree, which includes degrees in the physical and earth sciences, engineering and architecture, computer and information sciences, math and statistics, and health-related fields. Using the six-digit Classification of Instructional Programs method from the National Centre for Education Statistics, U.S., 44 professional doctorate programs, 336 research doctorate programs, and 424 bachelor's, master's, and master's degree programs were identified as STEM programs in 2018. There is no universally accepted definition of the STEM workforce or STEM education sectors, even though there is frequently a great deal of overlap between definitions. Therefore, care should be taken when making direct comparisons with other studies [17].

It is pertinent to mention that the U.S. Department of Homeland Security (DHS) has made a list of STEM degrees [20]. This STEM Designated Degree Program List is a complete list of fields of study that DHS considers to be science, technology, engineering, and mathematics (STEM). It aims to “Attract the best and brightest international talent to our colleges and universities and enable them to contribute to their professional growth, which is an important part of our nation's economic, scientific, and technological competitiveness,” said Secretary of Homeland Security Janet Napolitano. "International students and exchange visitors bring invaluable contributions to our nation, and this helps empower the next generation of international entrepreneurs’ right here in America [20].

In order to increase the contributions of nonimmigrant students studying in STEM fields and support the expansion of the American economy and innovation, the Department of Homeland Security (DHS) announced on January 21, 2022, the addition of 22 new fields of study to the STEM Optional Practical Training (OPT) program.*

Secretary of the Department of Homeland Security (DHS) Mayorkas hoped that “STEM innovation allows us to solve the complex challenges we face today and make a difference in how we secure and protect our country.” In order to increase the number and variety of students who thrive in STEM education and contribute to the American economy, DHS expects to increase access to STEM education and training options [20]. If we count the DHS STEM Designated Degree, it is 530 (five

* To see the (DHS) STEM Designated Degree Program List, please visit the link: https:// www.ice.gov/ doclib/sevis/pdf/stemList2022.pdf., accessed on 25th May 2023.

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hundred and thirty) in numbers. So many new degrees are being added according to the needs of daily life. The 22 fields added in 2022 are: Bioenergy, Forestry, General, Forest Resources Production and Management, Human-Centered Technology Design, Anthrozoology, Climate Science, Earth Systems Science, Economics and Computer Science, Environmental Geosciences, Geobiology, Geography and Environmental Studies, Mathematical Economics, Mathematics and Atmospheric/Oceanic Science, Data Science, General, Data Analytics, General, Business Analytics, Data Visualization , Financial Analytics, Data Analytics, Other, Industrial and Organizational Psychology, and Social Sciences, Research Methodology and Quantitative Methods.

If we compare the (DHS) STEM Designated Degree Program List with the STEM Designated Degrees are taught in the universities of Bangladesh, we see that there is extensive gap. There are very few opportunities of studying STEM fields or degrees in Bangladesh, and most of the STEM fields or degrees are not taught here. To join the ranks of the developed world, the STEM fields or degrees studied in the U.S. or other developed countries must also be studied in Bangladesh. In this regard, Bangladesh is lagging, which is easily understood. If Bangladesh falls behind the developed world in this regard, it will be difficult for this country to face the challenges of the 21st century, which can be said undoubtedly.

3.5 STEM Jobs, Workforce and Career in and Outside Bangladesh

Globally, there is an increasing focus on building technological and scientific skills. Science and Engineering (S&E) work takes place all around the world and is not only limited to wealthy economies. However, the majority of the activity is concentrated in industrialized countries, where a sizable amount of research and development (R&D) is also conducted. Where firms choose to place S&E work is significantly influenced by the availability of a qualified labor force [21]. Highly trained S&E workforces are moving around more and more, and governments have changed their immigration laws to make it simpler for them to do so and work in their country. These adjustments signal an intensifying battle for highly mobile talent around the world [22]. But it is challenging to determine the accurate size and features of this specialist labor due to the dearth of data on the worldwide S&E workforce. Data that can be compared across borders are only available from business establishment surveys of the industry, which give a basic profile of the S&E workforce. Despite the limitations on determining the number of S&T researchers globally, the OECD figures offer a suitable starting point for calculating the pace of the global increase in researchers in these fields. From the following table, it may be assumed that the world's scientific and engineering workforce is expanding.

Table 3: Estimated number (Thousands) of researchers in selected Regions, Countries, or Economies: 2012–17

Year	United States	European Union	Japan	South Korea	China	Russia
2012	1,253.2	1,687.7	646.3	315.6	1,404.0	443.3
2013	1,294.4	1,736.9	660.5	321.8	1,484.0	440.6
2014	1,340.1	1,772.5	682.9	345.5	1,524.3	444.9
2015	1,369.5	1,845.9	662.1	356.4	1,619.0	449.2
2016	1,372.1	1,898.5	665.6	361.3	1,692.2	428.9

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2017	1,434.4	1,999.9	676.3	383.1	1,740.4	410.7

Source(s): Organisation for Economic Co-operation and Development, Main Science and Technology Indicators, 2020/1 (August 2020).

It is seen from the table that, in every country, except Russia researchers in science and engineering have been increasing constantly.

Since it is impossible to get an accurate global picture of the STEM workforce, U.S. STEM workforce statistics can be presented to comprehend the global STEM workforce scenario. A view of the STEM workforce can be assumed here. With the passage of time, definition of STEM workforce has been changed. Individuals with at least a bachelor's degree who work in S&E occupations are the subject of past and present Indicator's assessments. S&E occupations include five major categories: (1) computer and mathematics scientists; (2) biological, agricultural, and environmental life scientists; (3) physical scientists; (4) social scientists, and (5) engineers. Analyses of workers who also apply science and technological expertise may embrace those employed in S&E-related occupations, including doctors, nurses, engineering managers, computer programmers, and biological technologists [23]. But this definition has changed over time.

The present STEM workforce definition to include individuals at all education levels and in middle-skill occupations is a major change for this report. According to the U.S. Census Bureau's (2020a) 2019 American Community Survey (ACS), the number of STEM workers in middle-skill occupations is nearly the same as the number of workers in S&E and S&E-related occupations combined. Most of the nearly 20 million STEM workers without a bachelor's degree work in middle-skill occupations (12.7 million), followed by S&E-related occupations (5.2 million) and S&E occupations (2 million) (Figure LBR-2). Most of the middle-skill occupations are held by nearly 13 million STEM workers who make up the STW. Of the more than 16 million STEM workers with a bachelor's degree or higher, most work in S&E or S&E-related occupations [23].

Table 4: U.S. workforce, by STEM occupational group and education level: 2019

Education level and STEM occupational group	Total (Thousands)
Total	**155,423**
STEM workforce	**36,094**
Bachelor's degree or higher	16,241
S&E occupations	6,559
S&E-related occupations	7,917
Middle-skill occupations	1,765
Without a bachelor's degree	19,853
S&E occupations	2,017
S&E-related occupations	5,180
Middle-skill occupations	12,657
Non-STEM workforce	**119,329**
Bachelor's degree or higher	40,287
Without a bachelor's degree	79,042

Note(s): Data include workers ages 16–75 and exclude those in military occupations or currently enrolled in primary or secondary school. The STEM workforce without a bachelor's degree is also known as the skilled technical workforce (STW). S&E occupations include computer and mathematical scientists; biological, agricultural, and environmental life scientists; physical scientists; social scientists; and engineers. S&E-related occupations include health-related occupations (e.g., health practitioners and health technicians); S&E managers; S&E teachers;

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and S&E technologists. Middle-skill occupations include those in construction and extraction; installation, maintenance, and repair; production; and other middle-skill occupations. Middle-skill occupations include the STW and STEM workers with a bachelor's degree or higher. Numbers are rounded to the nearest 1,000.

Source(s): U.S. Census Bureau, American Community Survey (ACS), 2019, Public Use Microdata Sample (PUMS), data as of 25 October 2020. Science and Engineering Indicators [23].

Table 5: Employment in STEM occupations, 2021 and projected 2031 (Numbers in Thousands)

Occupations	Employment, 2021	Employment, 2031	Employment change, 2021-31	Percent employment change, 2021-31	Median annual wage, 2021 (1)
Total, all occupations	158,134.70	166,452.10	8,317.40	5.3	$45,760
STEM occupations (2)	9,880.20	10,944.20	1,064.00	10.8	$95,420
Non-STEM occupations	148,254.50	155,508.00	7,253.50	4.9	$40,120

(1) Data are from the Occupational Employment and Wage Statistics program, U.S. Bureau of Labor Statistics. Wage data cover non-farm wage and salary workers and do not cover the self-employed, owners and partners in unincorporated firms, or household workers.

(2) Science, technology, engineering, and math (STEM) occupations include computer and mathematical, architecture and engineering, and life and physical science occupations, as well as managerial and postsecondary teaching occupations related to these functional areas and sales occupations requiring scientific or technical knowledge at the postsecondary level. For more information, see https://www.bls.gov/oes/topics.htm#stem.

Source: Employment Projections program, U.S. Bureau of Labor Statistics.

Since Bangladesh gained its independence, there have been significant developments in the economic, social, industrial, service, and agricultural sectors, which have led to the formation of new jobs and occupations in the country's labor market. This is why the Bangladesh Standard Classification of Occupations 2020 (BSCO-2020) is being established in accordance with the most recent ISCO-2008 criteria and guidelines [25]. In BSCO-2020, the first level, which is the broadest, has 10 major groups that are identified by a one-digit code; the second level, which is more specific, has 43 sub-major groups that are identified by a two-digit code; the third level, which has 137 minor groups; the fourth level, which has 464-unit groups; and the fifth level, which has 5460 occupations/sub-unit groups [25]. 10 major groups are Managers, Professionals, Technicians and Associate Professionals, Clerical Support Workers, Service and Sales Workers, Skilled Agricultural, Forestry and Fishery Workers, Craft and Related Trades Workers, Plant and Machine Operators, and Assemblers, Elementary Occupations, Armed Forces Occupations (BSCO-2020, 11) [25]. The total labor force aged 15 years or older by Sex for the year 2022 is 73.41 million. Among them, males are 47.48 million and females are 25.93 million (Bangladesh Bureau of Statistics, 2023). The report also needs to detail how many people work in any major occupational group. Even if given, it would not be possible to determine how many people are working in STEM occupations. However, it does not classify STEM occupations separately. As a result, it is not easy to get an accurate estimate of how many people are doing STEM jobs in Bangladesh. However, the large number of foreigners who work in this country can be estimated to be the demand for the STEM workforce here because almost all foreigners here belong to the STEM workforce. There needs to be an accurate count of how many STEM foreign workers work in Bangladesh. As a result, a database has yet to be created in the country about the number of foreigners in any sector. Hence,

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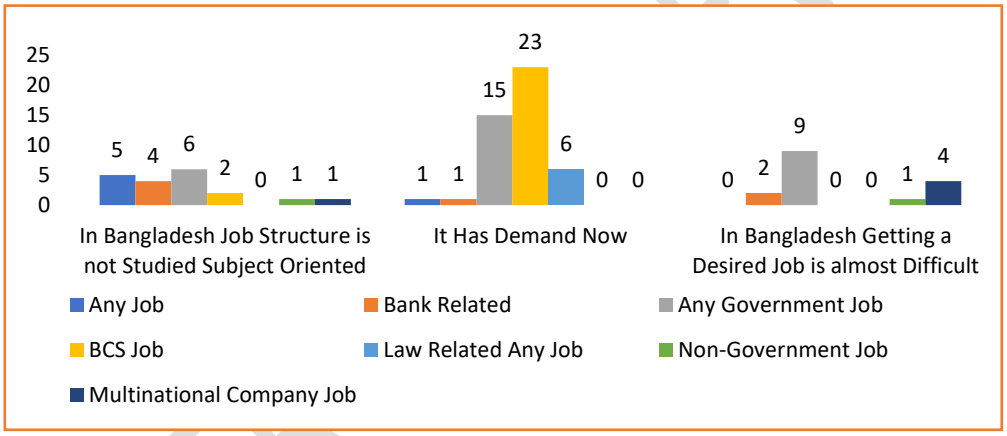
specific information regarding the STEM workforce has not been found yet, which creates problems in mapping the need for occupational fields.

In this regard, students have been asked, what is the current status and future of STEM jobs in Bangladesh? In answer to this question, 290 respondents relied on 'satisfactory,' and 120 replied 'unsatisfactory.' However, what is noticeable is that those who replied satisfactorily say that Bangladesh has much to do. Regarding students' attitudes towards STEM education, Science Teachers say that,

> Students studying in class nine or ten cannot know more than this. What they think of higher education at this time is admirable. If teachers, educational institutions, society, and the state can create a space for them, they can do good things in STEM education in the coming days (STEMT 1, 4, 6 & 8).

The last question has been asked to the students about their job aspiration, are you interested in a non-STEM job after studying a STEM subject? Eighty-one responded 'Yes'. They have also explained, what types of job they want to do and why.

Figure 8: Respondents' Non-STEM Job Interest



The above figure shows that, among all the respondents, eighty-one want to do non-STEM jobs if required. They have categorized jobs into seven classes. Among this category, the highest number (30) of respondents will want to do any government job, and the second largest group (25) will try to do a BCS job. Moreover, the rest of the respondents have chosen the jobs mentioned above. They desire to do a bank job, considered a STEM job, but they wrongly judge it. Any citizen of Bangladesh has the right to do any job. However, in recent years, many academics have questioned how students from science backgrounds, or STEM, have entered the general cadre of the Bangladesh Civil Service (BCS). In that case, teaching and learning these specialized subjects is very expensive. The government has to spend much money to build them. The main objective is to provide services to the country's people through medical care, technical skills in developmental work, agricultural research or extension, or such specialized knowledge [19]. Therefore, if they enter the BCS general cadre or try to enter, if there is a demand in society, power can be exercised, and status can be obtained without specialized knowledge. The main goal of STEM education can be misguided. However, there are opinions against it. The country has so many specialized subjects that so many students study those subjects that a few will

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not harm the BCS general cadre but enrich it. There will be variations in thought, skill, and ways of working. Furthermore, some parents argue that,

> Students in developing countries like Bangladesh get different facilities than in developed countries. Talents educated in specialized education in this country do not get a proper evaluation of their merits, so they go or try to go to administration, police, or foreign affairs cadres by participating in exams like BCS. So now is the time to radically reform science or STEM education. Otherwise, the country will suffer (FGD 1, SGR; FGD 3 SGR).

Bangladesh has great prospects for STEM jobs, the workforce, and careers. High school STEM girls are very aware of this prospect. They desire to do STEM jobs, though they have some exceptions. Though the STEM workforce still needs to be defined correctly in Bangladesh, if the government takes proper steps, Bangladeshi girls can take on the challenges. In Bangladesh, some STEM careers have social dignity and status. Moreover, girls can prove themselves as STEM professionals abroad if they get proper support and guidelines.

4. Conclusion

In Bangladesh, meritorious students are expected to study in the science stream or STEM. So, those girls whose aspirations are high are studying STEM education. From the analysis mentioned above, it is found that all the respondents desired to complete their education in STEM. They have already set their goal about the level of education. Then, they have already set up their mind in choosing the STEM domains in which they want to study. Most of the respondents (231) tend to study the life sciences. The second largest group aspires to study the Engineering, technology, and applications of science. The third (37 respondents) and fourth (30 respondents) groups chose to study the Earth, space, and Physical sciences, respectively. They dream of studying in the STEM field or sub-field.

Meanwhile, they have targeted an institution either in Bangladesh or abroad. In this case, they know and try to learn something about global STEM education trends. They are already aware of building their dream career. In this case, they may have limitations in thinking or knowing. They are also aware of domestic and global STEM careers. In this case, they are also interested and aware of future changes. So, their aspiration for STEM education is realistic, ambitious, and achievable.

5. Recommendations

I. Increase Awareness and Mentorship: Implement mentorship programs featuring successful women in STEM to inspire and guide Class nine & ten girls toward STEM careers.
II. Promote Gender-Sensitive STEM Curriculum: Ensure teaching methods and materials are free from gender biases to create an encouraging learning environment for girls.
III. Parental and Career Counseling: Organize workshops to inform parents about the opportunities in STEM fields, encouraging them to support their daughters' aspirations.
IV. Financial Incentives: Offer scholarships and financial aid specifically for girls pursuing STEM subjects to reduce economic barriers and motivate participation.

CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the authors.

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