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A reflexive thematic analysis exploring the experiences of undergraduate women in STEM in Bangladesh

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Abstract
Globally, a significant gender gap is reported in the enrolment of women in Science, Technology, Engineering, and Mathematics (STEM). Bangladesh reports one of the lowest female stakeholder percentages in STEM but has increased demand for skilled STEM professionals. Therefore, this qualitative study explores the experiences of undergraduate women in STEM in Bangladesh. Seven female undergraduate students were recruited using purposeful sampling, and a semi-structured interview was conducted. Reflexive thematic analysis, along with a phenomenological approach, was utilized for data analysis to gain a better understanding of their experiences. The four key themes that emerged were the gendered nature of interactions, the impact of societal barriers, underrepresentation and role models, self-identity, and psychological outcomes. The findings suggested multiple factors like gender-biased interactions in classrooms, lack of access to STEM resources, and lack of female role models negatively impacted students' academic experiences. Moreover, poor self-esteem in female students contributed to imposter syndrome and heightened career anxiety.

Keywords Science · Technology · Women · Education · STEM

1 Introduction

The rapid advances in science and technology have increased the demand for skilled professionals in Science, Technology, Engineering, and Mathematics (STEM) [1]. Despite the increase in STEM enrolment, women enroll at lower rates than males across all educational levels, and there is a significant gender gap in the workforce [2]. However, to secure economic strength, a workforce of skilled STEM graduates is required [3]; as a result, women's participation is essential to raising productivity and boosting the economy. Moreover, without the inclusion of women innovation will be limited, and diverse perspectives will be missing from research. More importantly, the inclusion of women in STEM will foster an equitable and equal society, enabling people to reach their potential. Over the past few decades, researchers and policymakers have been working to address this global issue and mitigate the gender gap [4].

Addressing this gender gap, previous studies have investigated the causes behind the lack of women pursuing STEM education. The findings suggested that the underrepresentation of women in STEM has resulted in a decreased sense of belonging [5] which causes fewer women to enter the STEM education pipeline. The feeling of exclusion is further fueled by the lack of female role models such as female professors, and industry professionals according to a study by González-Pérez et al. [6]. The social role theory states that people perceive certain roles to be more or less suited to their gender [7]. Since women are exposed to the unequal representation of men and women in STEM roles, they attribute stereotypic gender beliefs to those roles. Moreover, empirical evidence also supports the theory because countries with

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low representation of women in STEM show greater gender-science stereotypes [8]. Another study also suggests that preexisting assumptions regarding the nature of STEM and the intrinsic qualities of men and women propel women's STEM avoidance and cause gendered aspirations [9]. However, the study by González-Pérez et al. [6] is a quantitative study that utilizes a questionnaire modeled on the social role theory therefore other external sociocultural factors such as sexual harassment and the effect of classroom interactions are not considered [10]. One of the key limitations of the social role theory is that it does not consider gender differences in values and personality, specific to a culture or region. Thébaud and Charles [9] reviewed previous literature and suggested that their study focused on Western cultural stereotypes as the majority of the literature reviewed had participants from Western cultures. Therefore, a qualitative approach is required to provide a more holistic understanding of the combined impact of underrepresentation as well as other factors such as classroom interactions with women in STEM. Additionally, a focus on Asian stereotypes in the underrepresentation of women in STEM can address a key research gap.

Greater representation of women in life science fields is often seen as a positive gain [11]. However, this representation does not necessarily indicate equality because of biased gender interactions in academic settings. In the study by Grunspan et al. [12] women in undergraduate biology classes felt that their performance was underestimated by men despite having greater representation. Another study that reviewed literature and statistical data from 2007–2017 concluded that gender biases through classroom interactions, and identity are key factors that contribute to the gender gap [13]. While the study by Blackburn [13] depicted the changes in interactions over time, it did not focus on women at a particular educational or professional level. One of the strengths of the study by Grunspan et al. [12] is that it focused on undergraduate students. This is particularly important because fewer women complete higher education in STEM [14] therefore, the perspective of undergraduate students can provide more appropriate insight. However, the study provides a subject-specific insight particular to US universities which may not apply to other fields within STEM education in other countries. The study also utilizes a survey and uses a quantitative approach to mathematically draw correlation among the variables which does not consider the thoughts and feelings of women in classroom settings. Therefore, this suggests that exploring the interactions of students at different timelines of their education from a qualitative perspective is crucial to enhancing the understanding of their struggles.

Biased classroom interactions often contribute to one's perception of self. A study investigated the experiences of undergraduate women in STEM in the US using a survey approach [15]. The findings suggested that the interactions with peers during the courses had gender biases which caused women to lose interest and believe that they lacked the ability resulting in imposter syndrome. Imposter syndrome can be defined as self-doubt of intellect, skills, or accomplishments [16]. Moreover, another study showed that women felt incompetent and were more insecure in disciplines with mathematical load compared to men [17]. Low self-efficacy in the long term can affect women's academic attainment and can lead to dropouts [18]. This is consistent with Beck's cognitive theory [19], which suggested that negative interactions may cause the relevant schema to be activated, which results in negative inferences about the self. The strength of the study by Bloodhart et al. [15] is that it focused on undergraduate students since this educational period is when the influence of peers is most significant, and it can change a woman's choice of major and job [20]. However, it did not investigate the differences or similarities between male and female peer interactions because interactions can be ambiguous. Since linear multilevel models assume linearity and have risks of overfitting, the differences could not be modeled. However, that was considered in the study by Sáinz et al. [17] from a qualitative perspective, which is a key strength. One key limitation of the study by Sáinz et al. [17] is that it focuses on secondary school students because notable gender difference in the students' perceived competence in science and math was found during college in comparison to school [21–23].

The negative self-perception from biased interactions consequently affects women's career choices. High levels of intellectual brilliance are frequently connected with STEM careers, and brilliance is stereotypically associated with masculinity [24]. Additionally, college experiences of women, such as group favoritism and explicit gender-STEM stereotypes, deter women's aspirations to pursue a career in STEM [25], particularly in subjects like Computer Science and Engineering [26]. As a result, women experience career anxiety when starting their careers in a male-dominated environment and mid-career when they are transitioning into leadership roles that require them to be more confident [27]. This is consistent with the social cognitive theory of career development (SCCT) [28]. According to SCCT, people who have high levels of self-efficacy, which are influenced by external circumstances, are more likely to get interested in, choose to pursue, and perform well in careers. STEM's perceived unwelcoming nature to women leads to gendered attribution of skills, reducing women's sense of interest and reinforcing the belief that their failures stem from internal abilities, which heightens career anxiety [29]. While the theoretical framework of the SCCT applies to women in STEM, there is a lack of empirical evidence that correlates the impact of college experiences on women's career motivations.

Additionally, women's STEM avoidance and career anxiety are affected by sociocultural factors such as family, workplace bias, sexual harassment, societal perception of STEM, and access to STEM resources [10]. These sociocultural factors require a country-specific approach which was present in the study by Sáinz et al. [24], which investigated the perception of STEM roles among Spanish women. While its qualitative approach provided in-depth insights into gender role stereotypes, the research questions focused only on the differences in perception of people working in technological STEM fields and non-technological STEM. The study by [30] took a quantitative approach and illustrated the negative impacts of sexual harassment and the positive impacts of STEM encouragement from family. However, the participants were enrolled in a biology class at a US university where there is more gender equality and less prevalence of sexual harassment in comparison to South Asian countries. Moreover, subjects such as biology, which are not purely mathematical are a highly female-dominated STEM field [31]. García-Holgado et al. [32] emphasized the importance of access to resources required for STEM education to retain more women in STEM higher education. However, this is a challenge for students from low socioeconomic backgrounds in developing countries in Asia and Africa. A study by the World Bank illustrates that compared to other regions, the barrier to accessing STEM education and the gender pay disparity is higher in South Asia [33]

Despite being a global issue that is heavily influenced by sociocultural factors, most of the research for women in STEM that was discussed above was on participants in developed Western countries. Therefore, there is a gap in research that explores the experiences of women in South Asian patriarchal societies such as India and Bangladesh. Among South Asian countries, Bangladesh has one of the lowest female stakeholder percentages in STEM [34]. After completing secondary education, most women give up on pursuing higher education in STEM. Only 9% of female college students in Bangladesh take STEM courses, and 21% of female tertiary graduates are unemployed, which is three times that of males [33]. Numerous factors contribute to this, including poverty [35], early marriage, parental illiteracy, gender pay gap, and many others [36]. In addition, Bangladesh's heavily patriarchal society's biased treatment of women deters female students from choosing a demanding degree in STEM areas [37]. As Bangladesh faces a wave of digitization and the government's Digital Bangladesh project aims to increase the STEM population from 17 to 30 percent by 2030 [38], gaining more country-specific insights on the discrepancy is imperative.

There are a few relevant pieces of literature on women in STEM in Bangladesh. In a quantitative study by Naher et al. [39] that analyzed statistical data, it was observed that in top positions in academic and scientific institutes in Bangladesh, women are significantly underrepresented. While this study depicts the problem, the causes behind the discrepancy were not explored. Among the very few qualitative studies with Bangladeshi women, the study by conducted focus group discussions with female school students participating in the math Olympiad, their parents, and their mentors. The study shed light on the issue of sexual harassment in Bangladesh. The focus group approach provided a varied perspective from many stakeholders, such as parents and mentors, which is a key strength of the study since positive reinforcement from significant people (family, mentors, friends) can motivate students to pursue STEM education [40]. One of the potential limitations of the study is the quantity and quality of data from the student's perspective might be affected due to varied communication styles among children [41]. Moreover, Bangladesh has a prevalence of authoritarian parenting, which might have affected the emotional expression of children in the presence of their parents [42]. This study also focuses on students in high school; however, previous literature proves that investigating undergraduate student experiences can be more effective in finding out why students drop out of the STEM pipeline at higher educational levels or in their careers.

2 Methodology

2.1 Design

This is a qualitative online study where data was collected using semi-structured interviews and analyzed using reflexive thematic analysis [43]. The ethical clearance for this study was provided by The University of Derby [Study Reference Number: ETH2223-3549]. As this study focuses on the experiences of Bangladeshi female undergraduate students in STEM a qualitative approach is necessary to gain an in-depth understanding of the country-specific context. This is because the qualitative method allows participants to describe how, why, or what participants were feeling, thinking, and experiencing in a specific context, time, or during an event of interest [44].

Semi-structured interviews were used in this study. Since the experiences of undergraduate women in STEM, a subjective lived experiences influenced by factors such as type of university, family support, and individual differences in

personality semi-structured interviews are the most appropriate method of data collection. This method enabled the researcher to explore the personal feelings of the participant due to its informal nature [45] which is crucial for understanding of women's thought processes. The ethical approval secured by the ethics committee of the University of Derby conforms with the principles laid out in other relevant policies, guidelines, and codes of conduct, including those of funding bodies such as the UK Concordat to Support Research Integrity and the British Psychological Society.

Due to the lack of research on women in STEM in Bangladesh, studies with a country-specific approach were explored to establish methodological rationale. One study explores the experience of professional Spanish women in STEM through a phenomenological approach using interviews as a data collection method [46], and another research investigates imposter syndrome among Ph.D. students in STEM using thematic analysis [47]. This suggests that a qualitative approach with a phenomenological standpoint is an effective methodology for analyzing specific societal experiences as well as emotional states in adult participants. Moreover, a quantitative approach is unsuitable since there is a lack of background research in Bangladesh for the development of hypotheses, and in-depth insights from experiences cannot be drawn. Therefore, this research aims to contribute to the gap in the literature by qualitatively exploring the experiences of undergraduate women in STEM in Bangladesh. The study focuses on the nature of interactions between peers, potential societal barriers, underrepresentation, and psychological outcomes such as career anxiety or imposter syndrome.

For analyzing the data, reflexive thematic analysis (RTA) was used because it links theory, evidence, and interpretation by focusing on the subjectivity of the researcher and their reflexive participation [48]. In this method, meaning is derived from the data through the identification of repetitive patterns [49]. A specific pattern is referred to as a theme, which can be explicit or implicit. This provides a scope for the interpretation of the data as this technique can be modified according to the requirements of the study [50]. The focus on reflexive involvement in RTA might enhance the rigor and validity of the research and more effectively examine and confront their assumptions, and potential biases because the researcher of this study was a Bangladeshi undergraduate woman in STEM.

2.2 Participants

There were 7 participants in the study since participant ranges for phenomenological studies usually include approximately 6–10 participants [51]. Moreover, the participants were an underrepresented demographic therefore recruiting more participants was a challenge. Guest [52] suggested that in exploratory studies with underrepresented participants, a small sample size can provide valuable insights. Participants were female, between the ages of 18 and 24, and located in Dhaka the capital city of Bangladesh. One person studied mechanical engineering, three individuals studied computer science and engineering, two people studied electrical and electronic engineering, and one participant majored in microbiology. All participants were enrolled in their undergraduate degrees for at least a year. The participants were recruited through the circulation of the invitation to participate across personal social media accounts online and student community Facebook groups upon receiving permission from the moderator of the group. The interested participants filled out the Qualtrics form and participants were selected on a first come first serve basis. The participants were recruited through purposeful sampling as specific groups present in the Facebook communities accessible to the researcher were targeted. This sampling technique is favored as it is one of the least expensive options for student researchers [53]. All participants provided informed consent to participate in the study.

2.3 Materials

In order to recruit participants a participant invitation was circulated. A Qualtrics form was used to hold the participant information sheet, informed consent form, and privacy notice. The interview was conducted on a secure password-protected laptop using Microsoft Teams following an interview schedule The Microsoft Teams Transcription service was utilized to transcribe the interview in chat. The transcripts were read and manually checked for any discrepancies. Afterward, the University OneDrive was used to store data. The interview schedule was prepared based on previous literature. A study by Ahmed et al. [34] and a study by Chakraverty [47] were considered during the design of the interview schedule. "*Did you feel that there was a lack of female representation in STEM? If so, how do you think that impacted your academic experience?*" is an example of an interview question based on Bangladesh's low percentage of female stakeholders in STEM which was reported by Ahmed et al. [34]. After the interview, a debrief form was distributed using Qualtrics to the participants, and the form restated the objectives of the research and the procedure to withdraw.

2.4 Procedure

For recruitment of participants, the invitation to participate was circulated to prospective participants through social media accounts, and student community Facebook groups upon receiving written permission from the moderator. Brief information about the study and Qualtrics Link containing the participant information sheet, informed consent form, and privacy notice was shared. The Qualtrics form collected some additional information such as age range, undergraduate major, email address, and preferred time slots for the interview. Upon receiving informed consent, an interview was scheduled on Microsoft Teams. The interviews were initiated with an introduction about the researcher, brief information about the study, and statements regarding confidentiality and options to withdraw. This was done to establish an initial rapport with the participant and to be clear because building trust during an interview is crucial to its success [54]. Afterward, the Microsoft Teams transcription feature was turned on and the interview was transcribed in chat. While interacting with the participant, interview strategies such as attentiveness, acknowledgment of the participants, and adopting a friendly approach with an informal tone of voice [55] were used. As these techniques strengthened the respect for participant situations and gratefulness for the opportunity to learn about participants' lives through their experiences and points of view [56], the dialogical flow in the interview was improved. Following the discussions, a link was provided to the participants via email, which will lead the participants to Qualtrics where the debrief form was housed. The transcript of the interview was downloaded and stored in OneDrive. All participant data was anonymized to ensure privacy.

2.5 Analytical strategy for data analysis

The data analysis was conducted using reflexive thematic analysis (RTA) which consisted of six phases [43]. Immersion in the transcript and repeated readings of it were part of the initial step. The method of coding was used to identify important features from the responses to each question in the following stage. During this stage, the author used reflexivity to think about how their viewpoints, and areas of knowledge might have affected the comprehension and interpretation of the data [48]. The code was then utilized to find overarching subthemes or patterns and similar subthemes were combined to create themes. After that, the themes were checked to ensure consistency with the research questions. Finally, names for the themes were created, and contextual analysis was documented in connection to pertinent literature. The research aimed to explore the experiences of undergraduate women in STEM in Bangladesh with a focus on exploring the nature of interactions between peers, potential societal barriers, underrepresentation, and psychological outcomes such as career anxiety or imposter syndrome. Since the reflexivity in thematic analysis allows researchers to draw from experiences, innate knowledge, and social position such as gender, the analytical strategy is consistent with the research questions [57]. Moreover, previous literature by Kilby et al. [58] uses RTA to explore imposter syndrome in postgraduate students who are racial minorities. Therefore, it suggests that RTA is an effective strategy for this study due to the similar nature of participants since women are gender minorities. The research questions used in the study by Kilby et al. [58] are also consistent with one of the research aims of this study. The epistemological position used in this study is inductive phenomenology. Phenomenology aims to gain an understanding of people's experiences [59]. The focus of the inductive phenomenological approach to investigate, describe, analyze, and contextualize participants' sense-making of their experiences [60] makes it especially appropriate for this study. Moreover, this epistemology is complimentary to reflexive thematic analysis as the language used to describe experiences assists in the identification of themes [61]. In previous literature, reflexive thematic analysis and an interpretative phenomenological epistemology are used to investigate the lived experiences of women with high-risk pregnancies [62]. In this study, the author's methodology of coding the themes provided crucial insights. Therefore, it is suggestive that this combination is effective in analyzing lived experiences, which is the focus of this study.

3 Results

This analysis of the data revealed several key themes. Firstly, it reflected the presence of gender-biased interactions among students and the societal barriers that affect women's participation in STEM education. Secondly, the impact of women's underrepresentation was explored. Another emergent theme was the impact of women's experiences on their self-perception, as well as the psychological outcomes they face, including career anxiety and imposter syndrome.

3.1 Gender-biased interactions

In the following extract, Susan reflects on their social interaction with male peers for the creation of group project teams and the evidence is suggestive of group favoritism and gender stereotyping.

> *"Maybe uh, if I talk about forming a group of friends so I think. They just assume that if female classmates maybe will not that much compatible as them so they usually take the male group mates in their group. If they choose a classmate they think that she's not capable to be on their group because she's a female, or she can be there group not because her capabilities, maybe because she's female or she's beautiful."*

In this extract by using the word "usually" Susan highlights that group favoritism behavior is the norm in classroom interactions. Susan reflects on the thought process of male peers and suggests that it is caused by the perceived lack of competence of women. This is demonstrated by the terms "not capable" and "not compatible." Moreover, it was suggested that beauty was a positive quality attributed to women's gender roles; therefore, it is a prerequisite for group formation. It is also illustrated that the interactions of women with their male peers are heavily influenced by the preexisting assumptions regarding the intrinsic qualities of men and women. Additionally, the inclusion of women in a group may be due to ulterior motives such as their beauty as opposed to competence.

In the following extract Nancy illustrates that in classroom interactions women's performance is underestimated by their male peers.

> *"At least for my major, most of us are women. So in lab, the environment between my peers just became a lot more evident that a lot of the men, even people who were on the same sort of educational level in the sense that they were all undergrads in their last semester, especially the guys they have this like air of superiority and I just don't know why they think that it is ok to keep saying, you're doing this wrong."*

The word "air of superiority" was used to describe the underlying biased tone of the conversation and the phrase "they think that it is ok" was used to indicate that this tone is the norm in conversations. This suggests that women's voices are usually undermined and ignored because of the perceived superiority among men despite being at the same educational level. This behavior is further explained using the phrase "keep saying, you're doing this wrong" and it shows that women's knowledge is invalidated which makes them feel incompetent. Nancy reports greater female representation using the term "most of us are women". This suggests that greater representation is not enough to remove a sense of superiority among men which is an internalized gender role belief. Additionally, the usage of the word "especially the guys" indicated the prominence of this attitude among men. However, it also indicated that some women had this attitude, suggesting that they had internalized misogyny.

In this account, Nancy reflects on stereotyping by their teacher and shares the nature of interaction with female peers.

> *"The teacher like jokingly would make comments about how like you know, he doesn't expect a lot of the female students to be really good at math because that's not the kind of thing that he generally sees girls excelling at. Faculties, making jokes about how women are not very good at subjects like biostats and whatnot, it's really distasteful. A lot of my female peers, most of them actually have been very friendly. Again, a lot of them are hyper over competitive to the point where they feel like they constantly need to prove something."*

The use of the phrase "generally sees girls excelling" indicates that there was a lack of portrayal of successful women in mathematical subjects. As a result, women are more focused on trying to outdo other women as opposed to supporting women to achieve more in these fields as a group. The competition can pit women against each other.

This is supported using the word "over competitive". Although most interactions with female peers were reported to be positive, the participant used both the terms "hyper" and "over" to suggest the extreme nature of competition. Moreover, the competitiveness stemmed from low self-worth which was emphasized using the words "constant" and "prove themselves". Women feel an added burden to prove their competence and feel a sense of belonging. Moreover, it was suggested that misogynistic jokes from people in mentorship roles such as teachers had a significant impact on women's self-worth and hypercompetitive behavior because the participant used the word "distasteful" to express frustration. As a result, misogynistic commentary may fuel more toxic competition in women as their self-esteem decreases.

3.2 Societal barriers and its impact

This account depicts a concern for the safety for women working on projects that affect active participation of women in Bangladesh.

> *"if we have pending deadlines, we might have to stay back late. It's a thinking matter for like every girl that had to like. So it was the same for me. I had to, like, tell my parents about it and they were kind of iffy. I also felt a bit iffy because traveling at night is kind of a, I mean. Like it's just not safe."*

The gravity of the concern regarding harassment was emphasized using the phrase "for every girl." Moreover, this normalizes parental restrictions across the gender since it is a common experience. Parental concerns, as well as the participants' hesitancy, were reflected with the word "iffy". The word "iffy" was used twice when describing traveling at night which indicates that the concerns of harassment and safety at night prevented women from choosing to participate in many activities. This indicates that women need to choose between safety and learning. Moreover, the phrase "Like it's just not safe" suggests that the concerns are legitimate, and the restrictions are required to ensure safety for girls.

In this extract, Isabel shares the restrictive university policies that prevent female students from accessing STEM educational resources.

> *"The male students in my uni, they get a lot more exposure to say events and Workshops compared to us because, umm, I think it's a special case in my uni because we have like a sunset rule where the female students cannot go out of their dorms after past sunset. So, like your activities outside the outside class gets restricted to the sunset. And also in terms of when it comes to events or networking."*

Isabel uses the phrase "gets restricted to sunset" to express her frustration regarding unequal access. Women don't receive equal access to academia due to a rule causing an inability to attend events. This suggests that university policy has a direct impact on women's ability to achieve. Moreover, women's career opportunities are significantly curtailed because participation in events often provides networking opportunities that women are deprived of. The participant also highlights this discrepancy by describing that men get "more exposure".

The next extract presents a discussion regarding the lack of support from families for women pursuing STEM. Moreover, the extract provides insights regarding the societal exclusion of women from STEM jobs.

> *"So, I started my undergrad having this broken heart because my parents were not OK with that decision. They they thought that it's not the best place for a female. They pay the full amount, and they get out of the university with a degree maybe having better skills then the men but then again in some particular field they. They strictly look for males."*

Selena used the word "broken heart" to describe the impact of unsupportive family members. The word "broken heart" is an extremely emotive word that emphasizes the negative impact of unsupportive families on their mental health and indicates that pursuing STEM becomes more challenging for women with unsupportive families. No support from family can demotivate women and reduce the emotional strength required to survive in male-dominated STEM fields. Selena uses the phrase "degree maybe having better skills than the men" to depict that the hiring culture focuses more on the person's gender identity as opposed to their competence. The use of the word "strictly" to describe the preference towards men adds weight to the problem. Therefore, it is suggestive that the stereotypical gender role bias in the hiring process prevents skilled women from excelling in their careers because of the barrier to entry. Moreover, discouragement from parents also prevents women from entering the STEM pipeline. This is caused as a result of stereotypes that portray women to be incompatible and incompetent for the STEM field as well as fear regarding STEM. The participant depicts the internalized bias of her parents using the phrase "It's not the best place for a female".

3.3 Underrepresentation and role models

In this extract Isabel reflects on the struggles of participating in STEM activities by focusing on the negative impact of underrepresentation on the academic experience for women.

> *"there were very few female seniors who participated in such activities because of the restrictions, of course. So that's why this junior, they don't have much inspiration to take from. So I didn't have anyone to look up to any female representative to look up to actually and like had to figure out most of the things myself or had to like push through, put myself in some uncomfortable situations to learn from."*

The severity of the underrepresentation was showcased using the words "very few" and "any female representative." Moreover, the challenge of Isabel to pursue these activities was emphasized using the phrases "push through" and "put myself in some uncomfortable situations." This indicates that women experience greater discomfort in accessing the same opportunities as men. Moreover, the Isabel suggests that greater representation motivates women to take up challenging activities as visibility creates an increased sense of belonging and confidence. The use of the word "inspiration" and "look up to" emphasizes that greater representation of women in mentorship roles is a key motivating factor for increasing women's participation in STEM.

This extract reflects on the lack of female teachers in STEM and its negative impact on students. *"we barely had any good uh female professors. One female professor but I would really look up to her because I felt like she was doing amazing work in in this field, and I just felt so much so inspired by her. But I feel like if we had more representation like that, it's just it just gives you more hope. you know the hope of thinking that, OK, maybe I could do that someday. Maybe I have more options than I think I do."*

The positive influence of role models was expressed using the word "so much inspired by her". Senior successful women help students feel a sense of enthusiasm and influence their actions. This indicated that more representation could increase confidence in women's abilities to succeed in STEM. Moreover, the visibility of women succeeding in various fields also shaped women's aspirations and motivated women to be ambitious in STEM. As a result, it is suggestive that women are more prone to excel academically in the presence of female role models. The word "hope" in the phrase "hope of thinking that, OK, maybe I could do that someday" is a strongly emotive phrase that emphasized the positive impact of role models on women's educational experience. Michelle's account describing the female-faculty ratio also supports the social role theory suggesting that exposure to unequal representation causes stereotypic gender beliefs about those roles. Therefore, equal representation in the teaching faculty can challenge stereotypic gender beliefs and provide students confidence which can enhance their academic experience.

The following extract depicts the unequal gender ratio in classrooms and its negative impact on students.

> *"When I actually went to class, we have like 86 students in our class and out of the 86, only 16 are females, so it's like it can be very isolating, and like you have very few people to ask for help because the male students like when the ratio is so, so small, the male students form their own group and the female students for form their own group. So there is no like the there's a lack of collaboration which effects, the academic environment in the class"*

Sifa describes the classroom experience using the term 'very isolating' as they point out the gender ratio in class. The lack of female students is illustrated by the term "the ratio is so so small" where the word "so" was repeated to create emphasis on underrepresentation. This means that women are significantly more challenged academically in STEM as they receive no support from peers, and they are forced to feel alone. In classrooms, group formation is heavily impacted by gender decreasing women's sense of belonging. Phrases such as "very few people to ask for help" and "lack of collaboration" indicates that the lack of collaborative efforts between both genders weakens the support structure for women. This means that the underrepresentation in classrooms causes more segregation among genders and reinforces internalized gender biases among peers. This is a barrier to women who have no support from peers because they are ostracised in the classroom causing an "isolating" academic experience. As a result, these experiences can reinforce fear regarding STEM majors and careers for women.

3.4 Self-identity and psychological outcomes

In this extract, Anna's feelings of incompetence and potential ways to combat it are discussed.

"I think I have a quite good CGPA. But still, I feel very low and sometimes and I think all my peers are doing better than me and I feel and I suffer from inferiority complex. So yes that even I think I'm better than my male classmates but still I feel that Umm that inferiority complex in me and I think I'm not enough. We can combat it by talking about it more and also by asking for help from our seniors, our professors asking for feedback."

Anna uses the phrase "inferiority complex" to describe their feelings in the classroom. This reflects the feeling of being belittled by peers. Additionally, this showcases that women internally attribute superiority to men which could be due to social conditioning and discriminatory treatment in classrooms. Other external evidence and validation such as good academic performance is unable to alleviate the feeling of inferiority as it is internalized. The participant uses the phrase "I'm not enough" which indicates that classroom interactions have resulted in a negative self-image. Therefore, it is suggestive that Anna suffers from imposter syndrome and has low self-worth. Positive reinforcement from seniors and teachers improves self-esteem and can be used to combat insecure feelings. The usage of the word "combat" portrays that imposter syndrome is a key hurdle for women that requires it to be overcome. However, there is a lack of senior female role models who can provide support and help counteract the bias therefore seeking help from male seniors is unlikely to alleviate this feeling of inferiority.

In this extract, the feeling of inferiority in mathematics and engineering is reported by the Susan.

"We always think that boys are boys are better than female, the males are better in mathematics or engineering. And this is what in our minds and we couldn't really get out of it. And some of us couldn't really believe that a girl is capable of. Even pursing those, That lets us the females to, uh, stop believing our capabilities and stop going for the STEM."

Susan reflects on the failure to get past stereotypical beliefs and emphasizes the self-doubt surrounding their capability by using phrases like "couldn't really believe". This means that women in STEM are less likely to attribute their success to their competence and merit. Women themselves associates strong mathematical ability to men and mathematical incompetence to females which causes them to not pursue STEM. This belief is internalized by women which is depicted by the phrase "couldn't really get out of it". This leads to the avoidance of math-based subjects like Computer Science and Engineering propelling the stereotype by associating specific gender roles to certain careers or subjects. The imposter syndrome and inferiority regarding math's competence is reflected in the word "better" in the phrase "males are better in mathematics". As a result, the pursuit of STEM for men is thought as the norm, decreasing women's belongingness and dismissing their ability.

In this extract Sifa shares their anxiety about starting a career in a male dominated industry. *"Even the thought of entering into a job with very few female representatives makes me very anxious. Because In university, that is how I feel most of the time. Uh, I don't know what to do. The male students here, they aren't the most helpful, and I know that it's only going to get harder. When I get into the job sector I don't. I I don't believe that my male colleagues would be very helpful."*

Sifa used the word "I don't believe" to show skepticism regarding the helpfulness of male colleagues in her workplace. This means that she is less likely to seek support in workplaces and will feel alone. Therefore, negative classroom experiences cause avoidant behavior which reinforces STEM's perceived unwelcoming nature toward women. Sifa uses the words "very anxious" and "going to get harder" to describe her career prospects. The isolating academic experience and the lack of support cause women to feel inferior and doubtful of their abilities increasing career anxiety. Moreover, Sifa uses the term "I don't know what to do" indicating uncertainty and a lack of confidence regarding starting a career. This means that to excel in STEM careers, there is an onus on women to be resilient and continue to have strong will power despite the exclusionary experiences in STEM. As a result, some women who are not thick-skinned are systematically excluded from STEM careers.

4 Discussion

The purpose of the research questions was to explore the experiences of undergraduate female STEM students in Bangladesh. It focused on the nature of interactions, societal barriers, underrepresentation, and the impact of college experiences on career anxiety or imposter syndrome. One of the themes explored in the study was gender-biased interactions. It was found that stereotypical beliefs about women's STEM competence resulted in biased classroom interactions, such as group favouritism among male peers and teachers which was highlighted in reference to jokes

made by teachers. Another theme explored the impacts of societal barriers. During discussions, participants in Bangladesh expressed concerns about the safety of women, particularly regarding harassment while traveling alone at night. They also highlighted challenges related to accessing STEM resources, such as university policies like the "sunset rule," which restrict participation in STEM events and networking opportunities. Furthermore, participants noted the lack of family support, as evidenced by negative attitudes and conversations within families, which can impede women's ability to participate and excel in college-level STEM education. Underrepresentation and the lack of role models were also a key theme, and it was found that the underrepresentation demotivated undergraduate women. Additionally, the self-identity of the students and their psychological outcomes were explored as a theme. It was found that low self-esteem shaped by experiences in college resulted in imposter syndrome and career anxiety among female students.

Previous literature supports a majority of the findings. Leaper & Starr [25] reports biased interactions among students that caused group favoritism. This is consistent with the findings of the theme where the participant reports male favoritism for group projects. Another study by Grunspan et al. [12] found that gender stereotypes and underestimation of female students' abilities were prevalent among men. Moreover, a study by Hill et al. [10] reported that societal barriers such as decreased access to STEM resources prevented women from pursuing STEM education, and the findings were consistent. The participant's account reported the "sunset rule" in Bangladeshi universities that forces women to stay indoors past sunset preventing access to STEM workshops which supports the findings of Hill et al. [10]. This is a huge barrier to success, for women in countries like Bangladesh. Universities should provide alternatives to ensure women have the same access to opportunities as men. This can be done by ensuring events and workshops are arranged at a convenient time that is accessible to women. One of the key focuses of Ahmed et al. [34]'s study was the prevalence of sexual harassment in Bangladesh that negatively impacted young learners' STEM participation. Even among undergraduate women, safety concerns were prevalent, supporting the findings of this study. The findings suggested that students were aware of the rampant gender discrimination in workplaces, and hesitancy to hire females in STEM roles was suggested. While this is consistent with the study by Hahn et al. [36], it reported the gender gap in pay as the leading cause as opposed to preferential hiring. Accounts from participants provided insights into the positive impact of family support which is consistent with Johnson et al. [40]'s study. Additionally, multiple studies reported that positive reinforcement from role models such as female professors and more representation encouraged women's STEM participation [5, 6]. Although the findings were consistent, these studies did not correlate the impact of role models on academic experiences such as participation in competitions and a sense of belonging in classrooms. It was found that the lack of role models negatively impacted academic experience as well as self-confidence among participants. This is consistent with the social role theory [7] that states exposure to different roles in society shapes individuals' behavior and identity. Lastly, findings reported low self-competence belief among female students. This is consistent with the finding of Sáinz et al. [17]. However, the participants reported a higher lack of confidence in their mathematical abilities which was not investigated in the study by Sáinz et al. [17]. This is also consistent with Beck's cognitive theory [19] that suggested changes occur in self-inferential schema due to negative experiences. Moreover, participants reported increased career anxiety in male-dominated industries due to the unwelcoming nature of men. LaCosse et al. [29]'s study supports this finding.

The study possesses both strengths and limitations. One of the primary strengths of the study is that it is a qualitative study that provides in-depth insights into the experiences of women as opposed to the previous quantitative literature. Moreover, the study focused on undergraduate students, which is a significant educational period as it affects a woman's choice of major and job [15]. A limitation of the study is that there was no distinction between male- dominated STEM fields and non-male-dominated stem fields such as Biology. Grunspan et al. [12] report significant differences between the experiences of students in the two different categories. Although the study explored societal barriers, information regarding the participants' socioeconomic backgrounds was not collected. Factors such as family support and access to STEM resources are heavily influenced by socioeconomic status [63]. Moreover, the researcher's background of being a Bangladeshi undergraduate woman in STEM might have influenced the analysis of the data. Reflexive thematic analysis was employed to offset this bias and enable a more impartial interpretation of the results. However, more techniques like reflexive journaling and reflexive interviews could have been used to counteract the bias [64]. The findings can be utilized by policymakers to implement strategies for the inclusion of more women in STEM. Mentorship programs from successful women in STEM can be organized by leading STEM companies for students to build confidence and extend support. Moreover, restrictive policies such as the sunset rule should be abolished as it puts the onus on preventing harassment of women and hinders academic development. Universities should adopt policies to ensure equal access to opportunities such as workshops or events in accordance with the sunset rule. Additionally, peer support groups and clubs involving women in STEM can help students vocalize their concerns.

5 Conclusion

In conclusion, the research aimed to explore the experiences of Bangladeshi undergraduate women in STEM. Stereotypes in interaction, societal barriers such as concerns with safety, and lack of access to STEM resources affect women's STEM education in Bangladesh. Furthermore, women experience imposter syndrome and career anxiety because of their systemic underrepresentation and low self-esteem. In today's fast-paced world, active participation for both men and women is crucial to the economic advancement of a developing country like Bangladesh. Therefore, further research is necessary to increase participation and retain more women in STEM education. Moreover, it is imperative to employ policies and extend support to disenfranchised STEM women in Bangladesh. Increased research involving all relevant stakeholders from various socio-economic brackets may result in the formulation of effective strategies for universities. Governments and policy officials should work towards promoting equality and equity for women in STEM in Bangladesh.

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Declarations

Ethics approval and consent to participate Ethics approval was received from the research ethics committee of the University of Derby which is by principles laid out in other relevant policies, guidelines, and codes of conduct, including those of funding bodies such as the Research Councils and the UK Concordat to Support Research Integrity. The study reference number is ETH2223-3549. All participants provided informed consent and all data was pseudonymized for anonymity.

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