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Barriers to STEM education for rural girls: A missing link to innovation for a better Bangladesh

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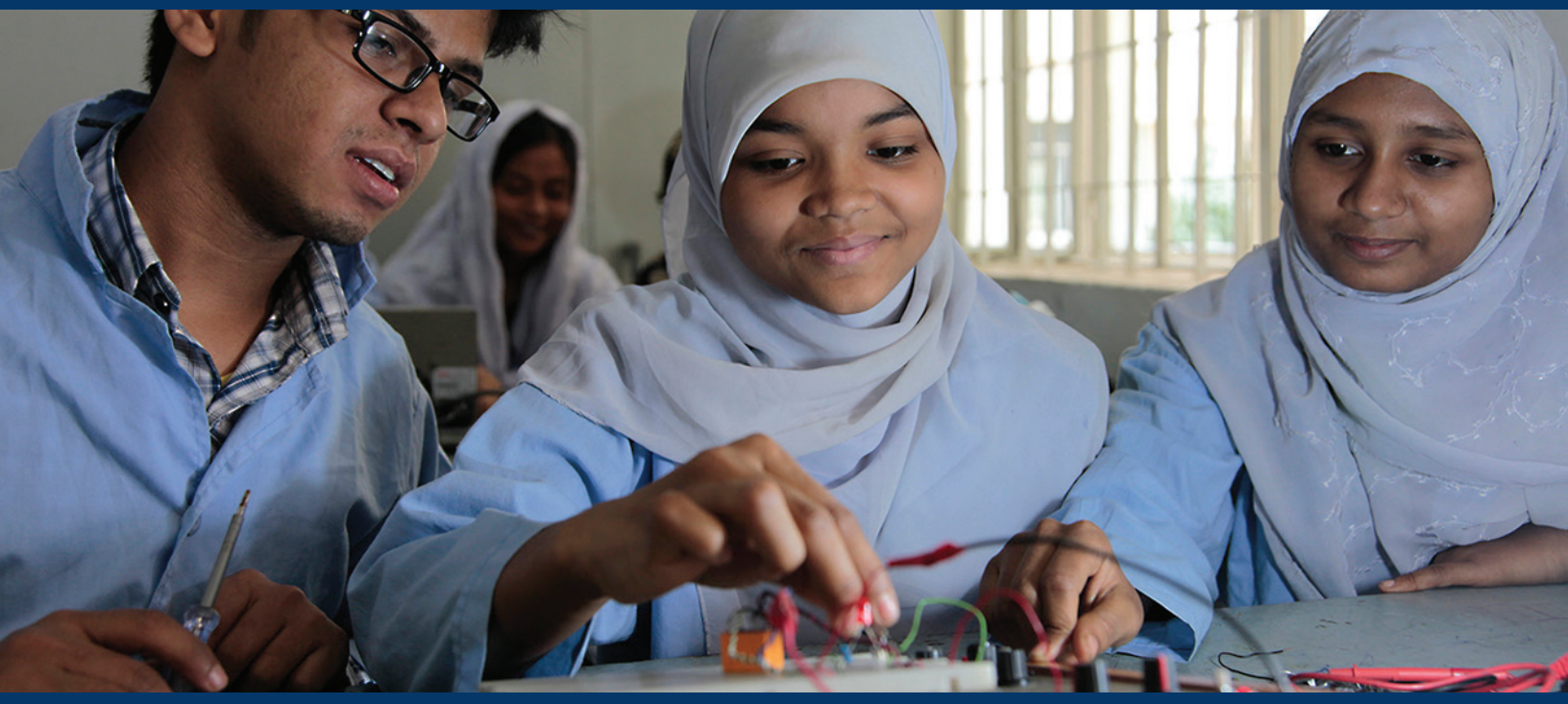
co-authored with Amanda Braga



Center for Universal Education at BROOKINGS

Nasrin Siddiqa has worked for nearly 20 years in schools and nongovernmental organizations (NGOs) to promote gender equity and access to quality education in Bangladesh, focusing on barriers to girls' education such as child marriage and gender violence. In 2010, Nasrin founded the Education & Cultural Society (ECS), a Dhaka-based NGO, and currently serves as its president and CEO. Noticing the lack of science, technology, engineering, and mathematics (STEM) education for girls in Bangladesh, Nasrin launched a flagship project to expand rural girls' access to STEM education opportunities. Through this project, ECS established 30 science and environmental clubs in rural Bangladeshi schools and trained nearly 1,000 teachers to create gender-sensitive classroom environments. Nasrin holds master's degrees in Japanese studies and botany from the University of Dhaka.

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Contents

ABBREVIATIONS

FDI	foreign direct investment
ICT	information and communication technology
NGO	nongovernmental organization
RMG	ready-made garment (industry)
STEM	science, technology, engineering, and mathematics

ABSTRACT

As one of the world's fastest-growing economies, Bangladesh aims to become a middle-income country by 2021 and a high-income country by 2041. To attain these goals, the country must face global challenges head on by strengthening existing industries and preparing itself for industries that have yet to emerge. To do this, it must tap the full potential of its human capital. Although Bangladesh made strides in access to education during the Millennium Development Goals era, poor girls continue to fall behind despite their ambitions to lead the country to change—a gap that affects their work outcomes once they leave school. The skills that Bangladesh's youth need to thrive in a world of rapid technological advancement will require a response by policymakers and practitioners alike.

This policy paper unveils the barriers to educational opportunities for rural girls in Bangladesh, focusing specifically on science, technology, engineering, and mathematics (STEM) education. It reflects upon a survey of 500 rural secondary-level schoolgirls, 100 parents, and 75 teachers from 30 rural schools of the district of Gazipur. The study identified barriers to STEM education at three levels—individual, institutional, and societal—that revealed both systemic and socio-cultural issues that actors in policy and practice can tackle. It provides clear recommendations for action and examples of practices that have started to fill the gap globally. If Bangladesh is to accomplish its goals and tap the potential of all its youth for rapid development, breaking the barriers to STEM education for all children is a key place to start.

INTRODUCTION

As the Fourth Industrial Revolution shifts the way the world communicates, learns, and works,[1] global education actors are concerned about how industries increasingly driven by robotics, artificial intelligence, machine learning, and other disruptive technologies will affect the world's youth and their future livelihoods. For low-income countries whose economies have rapidly grown because of foreign direct investment (FDI), the prospect of automation threatens to devastate their workforces.

This is especially true in Bangladesh, one of the world's five fastest-growing economies (World Bank 2019b). For example, the ready-made garment (RMG) industry has transformed Bangladesh's economy, lifting the economic status of millions of young women in the process, and is set to help lead Bangladesh to middle-income country status (Ambastha 2018). But the increased global competition for cheap labor and increasing industrial automation place at risk not only the future of the Bangladesh RMG industry but also the realization of gender equality through women's economic empowerment (Mahmud 2018; Obe 2018; Ovi 2018; Roberts-Islam 2019).

To get ahead of the threat of automation, place Bangladesh at the forefront of the global RMG industry, and thus help to secure the country's economic future, the education community must focus on increasing the skills of the RMG industry's female, largely rural, workforce. But this doesn't just mean providing female garment workers with upskilling training; it also means going to the root of the problem: barriers to educational opportunities that will give rural girls the foundation to lead innovation in the industry—most crucially, education in science, technology, engineering, and mathematics (STEM).[2] This paper examines the nature of those barriers.

To take stock of the status of STEM education in Bangladesh and to highlight the improvements needed for Bangladesh's female workforce to thrive, new research was conducted in Gazipur district outside of the capital city of Dhaka.[3] This fieldwork sought the perspectives of 500 female students, 75 parents, 100 STEM teachers, and 30 school administrators through interviews, focus group discussions, observations, and a survey of the STEM facilities of 30 rural secondary schools.

This research illuminated several major barriers and policy-relevant areas at three key levels: individual, institutional, and societal. Some barriers affected all children, including boys, whereas the barriers at the societal level demonstrated how girls are further disadvantaged. By bringing these to the fore of policymakers' agendas, we can ensure that rural girls gain the quality education needed to help Bangladesh meet its 21st-century challenges, not only in the RMG industry but also in other sectors of Bangladesh's economy.

The rest of this paper includes a discussion of the crucial role that the RMG industry plays in the Bangladeshi economy and labor force and explains why STEM education is key to achieving the country's economic goals. It then presents the findings from Gazipur district, starting with six thematic "buckets" of barriers to STEM education for girls that the research participants identified: safety, poverty, teacher quality, infrastructure and resources, early marriage and motherhood, and social norms. These findings are further broken down by challenges at the individual, institutional, and societal levels. The paper concludes by discussing the policy implications of these findings and recommendations for improving girls' access to high-quality STEM education.

Box 1. Women's employment in the RMG industry of Bangladesh

Although women make up 80-85 percent of the RMG workforce (Sikdar, Sarkar, and Sadeka 2014; World Bank 2017)—92.5 percent of whom are under the age of 30 and 46 percent of whom come from rural areas—men continue to dominate leadership of the industry, which has resulted in unsafe work environments ridden with sexual violence and exploitation of women at work.[a]

When women come to urban centers from rural Bangladesh to join garment factories, they often lack digital, communication, or math skills, keeping them stuck in the lowest-wage positions. And, although some garment factory owners report having female staff at all levels to foster safer, more productive work environments (Labowitz and Baumann-Pauly 2015; Paul-Majumber and Begum 2000), most of the industry continues to operate under male-dominated management. Moreover, the tasks that women predominantly perform in garment factories are the ones at greatest risk of automation. A recent International Labour Organization study suggests that automation of "sewbots" could lead countries like Bangladesh to lose more than 80 percent of their RMG sector jobs (Chang, Rynhart, and Hyunh 2016).

But automation of the RMG industry is not Bangladesh's only concern. An enormous gap remains between male and female youth unemployment overall. Four times as many young women as young men are not in education, employed, or training (NEET) (World Bank 2019b). Today, Bangladesh faces a demographic dividend—a working-age population larger than its non-working-age population. This can fast-track the country's economic growth if youth are skilled and can help spur innovation to enhance the economy. But it can also mean that if unemployment persists—and if youth are not supported to meet this challenge—the country will lose a key opportunity to accelerate its development (Matin et al. 2019).

a. "Bangladesh," Where We Work, ActionAid UK (website), accessed July 2019, https://www.actionaid.org.uk/about-us/where-we-work/bangladesh.

WHY STEM?

The Bangladesh government's strategy to achieve the United Nations' Sustainable Development Goals by 2030 and to become a high-income country by 2041 hinges on human capital investment and technological innovation. Encouraging FDI has immense potential to create jobs and hence to achieve these goals, but investors report concern about the low-skilled labor force and technological challenges like a high risk of cyberattacks—gaps that the education sector has an obligation to help fill (World Bank 2019b).

To understand why the STEM field is vital to the future of work, we must also understand that the latest technological revolution presents an immense opportunity to create jobs. Although research shows that many jobs will undoubtedly be lost, many new ones requiring new skills will emerge (CNES 2018). To that end, the technical skills associated with STEM subjects are crucial not only to acquiring specific jobs that already exist but also to building the transferable skills underlying the ability to innovate—skills that will become even more crucial to Bangladesh's future workforce.

Experts concerned with the impact of automation predict that the world will continue to rely on innovative technologies to transform economies. The World Economic Forum's Center for the New Economy and Society has projected that the most in-demand jobs globally will be intertwined with technology and digital skills (CNES 2018). And because technology changes constantly, many of those future skills are likely unknown to us today.

Important transferable skills that research has identified as key for the future of work are creative problem solving, communication, self-organization, and adaptability, among others (OECD 2017). In many ways, these amount to one's ability to *learn to learn*. These soft skills might not fall squarely within any given subject, but the STEM subjects are particularly useful to pushing skills acquisition beyond literacy and numeracy. For instance, one study showed that robotics can teach students a range of competencies related to communication and teamwork, particularly because it is so difficult to build a robotics system by oneself (Ospennikova, Ershov, and Iljin 2015). Another study showed that STEM-related activities had the potential to develop 21st-century skills because of their emphasis on open-ended, collaborative investigations (Sahin, Ayar, and Adiguzel 2014).

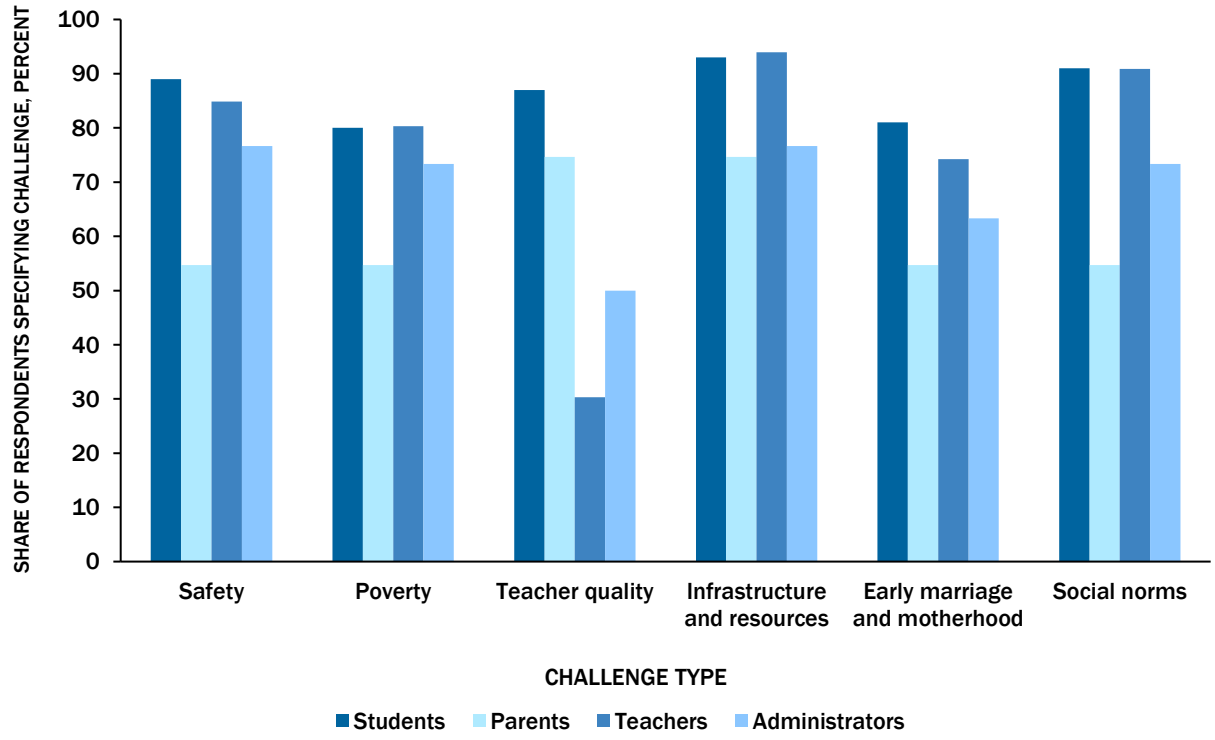
Fearing technological progress makes sense if we cannot rise to the challenge of teaching youth to lead that progress. Just as we have adapted to learn, for instance, digital skills that increase daily productivity, if girls can *learn to learn* the skills of the future—particularly those that may be unknown to us today—they, too, can be part of the solution.

FINDINGS: BARRIERS TO STEM EDUCATION FOR GIRLS

So, if providing girls with a quality STEM education is key to Bangladesh's ability to innovate in the 21st century, what is keeping girls from attaining these skills?

In the survey, focus groups, and interviews conducted for this paper, stakeholders in Gazipur district overall identified barriers to girls' STEM education within six thematic buckets: safety, poverty, quality of teachers, infrastructure and resources, early marriage and motherhood, and social norms. However, different types of stakeholders—students, parents, teachers, and administrators—prioritized these challenges differently (Figure 1).

Figure 1. Stakeholders' view of challenges to girls' STEM education, by type, in Gazipur district, Bangladesh



Source: Survey conducted March 1 to April 30, 2019, Gazipur district, Bangladesh.

Note: STEM = science, technology, engineering, and mathematics. Survey respondents were asked, "What challenges have you observed for girls in STEM education?" Responses were then systematically analyzed and categorized by challenge type. Results represent responses from 100 of 500 interviewed female students from grades 9-10 (random selection), 100 parents, 75 secondary school STEM teachers, and 30 school administrators.

At least 50 percent of all groups identified all these areas as key barriers, with one exception: only 30 percent of teachers identified teacher quality as a barrier, perhaps indicating a lack of awareness of their role in the challenges that hinder girls from obtaining STEM education. That only half of school administrators identified teacher quality as an issue, given their active role in this area, means it may be necessary to foster greater reflection across these two groups. However, nearly 80 percent of administrators and 90 percent of teachers classified infrastructure and resources as key barriers, which demonstrated a common understanding of the role of schools. Parents were broadly critical of those two school realms as well, but they were less likely than

all other groups to identify as key barriers the broader socio-economic conditions in the students' lives (reflected by safety, poverty, early marriage and motherhood, and social norms)—areas in which the parents are likely to play active roles.

Despite the differences, the large consensus across the groups—that numerous barriers impede STEM education for girls—shows a promising step toward getting stakeholder buy-in for solutions that tackle these areas. The following findings demonstrate how these challenges play out across the individual, institutional, and societal levels.

Individual-level barriers

Girls are confident and interested in STEM subjects, but teacher quality and infrastructural challenges keep them from reaching their full potential.

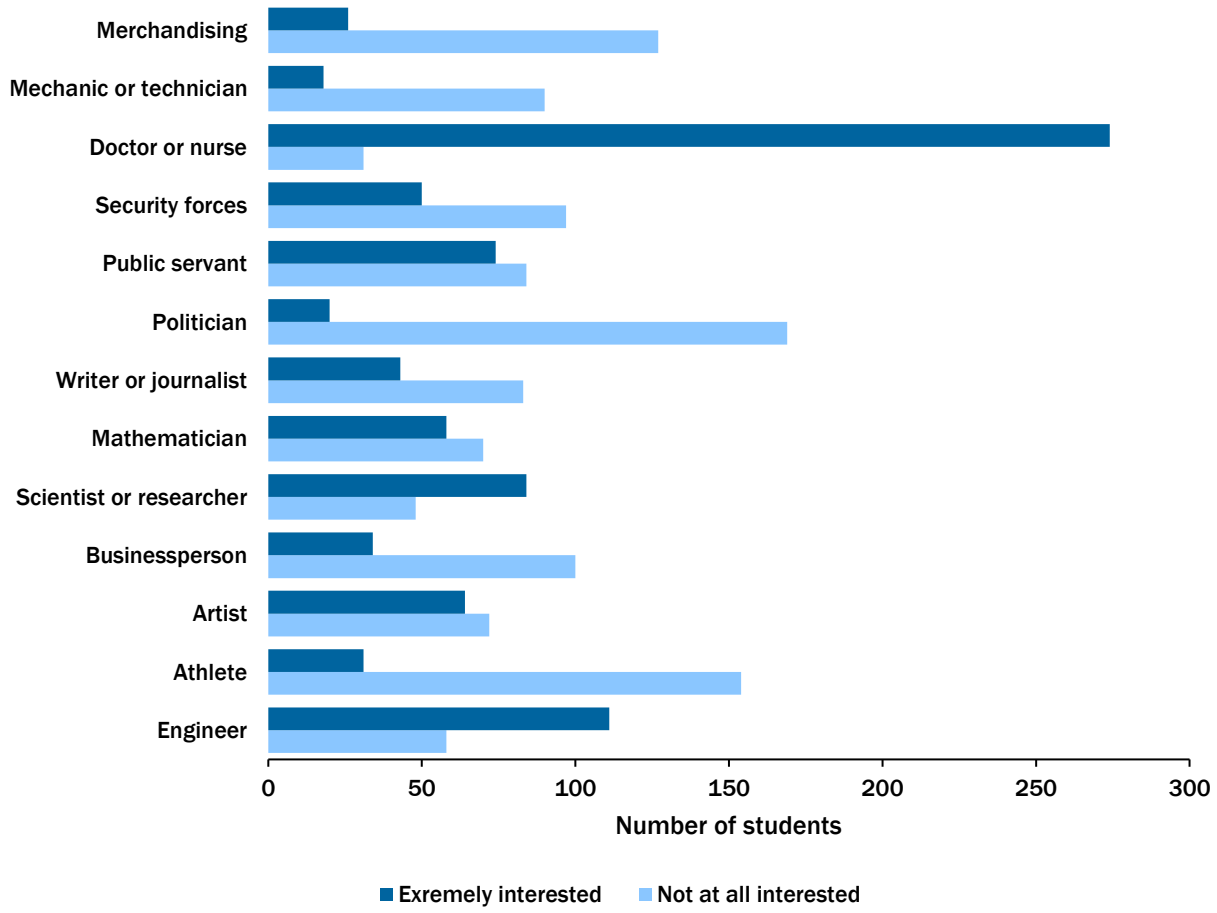
Contrary to research that indicates that girls are not as drawn to STEM subjects as their male counterparts (Choudhury 2014), the interviews and focus group discussions conducted for this study demonstrated the opposite. Girls showed a keen interest in STEM fields and an appetite for learning about other women in science they can look up to. One participant remarked, "I want to know more and more about STEM, wish to know the contribution of world women scientists, want to know about NASA, space, technology, [and] robotics!"

Girls collaborating on science experiments

Asked about their confidence levels across various subjects, most of the students reported mid-to-high levels of confidence throughout. Girls were most confident in biology (60 percent reporting the maximum level of confidence on the 1-5 point Likert scale); followed by mathematics (35 percent reported 5, and 31 percent reported 4); chemistry (21 percent reported 5, and 31 percent reported 4); and technology (22 percent reported 5, and 24 percent reported 4). The girls reported the lowest confidence in physics (16 percent reported 5, and 29 percent reported 4). For a depiction of data from this survey, see Annex A.

Given the prevailing discourse around girls' low levels of confidence in the STEM fields, this was a somewhat surprising but encouraging finding. In general, girls do have high aspirations for their future, and they look forward to getting good jobs. When responding to specific occupations that they see themselves working in, 274 students said that they would like to be a doctor or a nurse, and 111 students described wanting to be an engineer (Figure 2).

Figure 2. Attitudes of female secondary school students toward prospective occupations, Gazipur district, Bangladesh

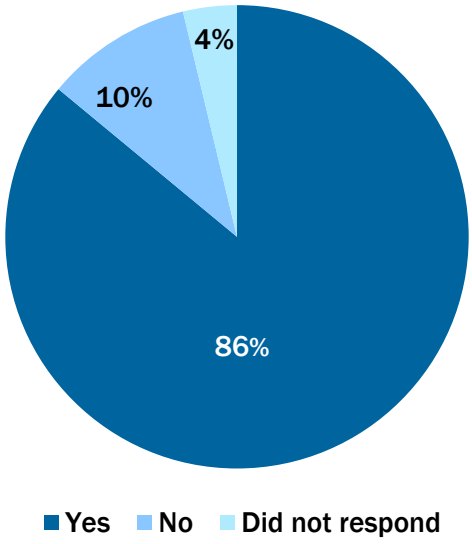


Source: Survey conducted March 1 to April 30, 2019, Gazipur district, Bangladesh.

Note: Survey respondents (n=300) were asked, "From the following occupations, rank those which you think you would enjoy working in?" Respondents scored each occupation on the 1-5 point Likert scale (5 being most favorable, 1 being least favorable, and N/A being indicated when students did not respond or were not familiar with the profession). "Extremely interested" corresponds to responses of 5 on the scale. "Not at all interested" corresponds to responses of 1 on the scale.

Unfortunately, despite girls' individual interest in STEM fields and their internal confidence, they often encounter barriers at institutional and societal levels that keep them from fulfilling their individual potential. It is at those levels that the research uncovered gender-specific barriers. All levels of barriers intersected in ways that limit the individual girl's ability to actualize her confidence and aspirations in STEM. In interviews, 86 percent of girls told the same story: teachers often save effective teaching methods for their private tutoring businesses, leaving lessons incomplete in the classroom (Figure 3). One girl explained that students don't have the right to ask questions a second time in the classrooms, even when they don't understand the material or a given part of a lesson. Another reported that teachers use different teaching methods in the private coaching sessions that make the content easier to grasp.

Figure 3. Reported need for private coaching for STEM education, Gazipur district, Bangladesh



Source: Survey conducted March 1 to April 30, 2019, Gazipur district, Bangladesh.

Note: Female secondary school students (n=500) were asked, "Do you need to seek private coaching after school for STEM subjects?"

Students in focus group discussions agreed that, in the classroom, teachers seldom completed a lesson, leaving them confused and forcing parents to pay for additional tutoring outside of the classroom. "Our teachers are so clever that they start a topic and never finish it," one girl said. "They start a new one the next day. Not a single chapter is finished in the classroom. They mentally force us to go to the coaching center. They finish the rest of the lesson there." But the cost burden of private courses is particularly difficult for poor families, who already struggle to pay for their children's school tuition, let alone for private lessons.

The second barrier that came out strongly in girls' interviews concerns the poor infrastructure and policy system, further elaborated below. Girls mentioned the desire for a library and the fact that they cannot borrow books from their teachers (most of which aren't even science books). In addition, there is little coordination at the school level for extracurricular activities that encourage girls' creativity and participation in science. For instance, one girl reported, "We participated in a science fair seven years back. It was a huge gathering … afterwards it just stopped."

Speaking to and surveying the girls illuminated many of the key challenges that keep their goals from becoming a reality. Based on their experiences, which reflected issues across many levels of the education ecosystem, it was key to also speak to school administrators, teachers, and parents as well as to visit schools to better understand the state of their facilities.

Institutional-level barriers

Teachers are largely unmotivated and lacking in support, but administrators have little agency to change school conditions in an uncertain environment.

As the girls reported, quality teachers who specialize in STEM are scarce, and, in rural areas where investment in education is lower, they are even harder to find. The dream of project-based learning, life-skills-infused curricula, and learner-centered classrooms is still distant for poor girls in Bangladesh. To start with, of the 75 interviewed STEM teachers, only 10 were female. Frequent changes in education policies, curricula, and examination systems proved to be a burden to both students and teachers. This leaves little time for the extracurricular activities that students desired, like STEM clubs or science and technology fairs.

Further compounding this issue is teachers' lack of confidence. They reported feeling humiliated in their role, and administrators confirmed that they go up to five months without being able to pay their teachers. With

Bangladesh spending only 2 percent of gross domestic product on education—the second-lowest level in South Asia—teachers' inability to support themselves with their salaries alone is unsurprising (World Bank 2016). This unstable system keeps teachers dependent on their private coaching businesses all over Bangladesh (Mahmud 2019; Mahmud and Bray 2017). One teacher told us that he was formerly a banker and came into teaching as a math teacher so that he could earn more through his private coaching center, further substantiating girls' perception that teachers have an incentive to lead students into tutoring services.

A corrupt education system underlies many of the challenges at the school level (Mulcahy 2015). Teachers are overburdened with teaching multiple subjects across various ages and lack adequate resources. For instance, when surveyed, school administrators reported needing more support for STEM teachers through higher salaries, more classroom equipment, and stipends to teachers for good performance. In addition, to keep their jobs, teachers have an incentive to feed students their examination questions before taking exams. Physics teachers may be teaching agriculture, languages, geography, and art, leaving them stretched too thin and enabling little specialization in any given area.

Teachers also reported that decisionmakers in the managing committees of rural schools and in the Ministry of Education lack an understanding of their environment. One teacher pointed out that the ministry tries to adapt a more creative curriculum into textbooks but that it doesn't translate to the realities of his classrooms. Teachers also explained that when they have 120 students in a classroom and must teach up to seven periods—particularly when they are not specialized in the subject—those new curricula are not feasible to implement given their day-to-day realities.

Further, both teachers and administrators described the burden of the examination system and the importance of rote memorization to pass with good scores. Interviews with teachers and administrators revealed an unmotivated, cynical outlook throughout the system. For instance, when one teacher was asked about giving students answers to exams, he replied, "Who cares whether students have learned or not? Ask them any basic science question three months after their exam and none of them can answer." And, when an administrator was asked about early marriage among her students, she replied, "I got a lot of brilliant girls in my lifetime, but none of them could establish a career or profession." A concern for safety was also expressed by one teacher when asked about the corrupt examination practices, stating that if teachers protest they risk being harassed or losing their jobs.

Although the quality of teaching is clearly a large part of the equation, more rudimentary infrastructural issues are also key. In Bangladesh's "7th Five Year Plan, FY2016-FY2020," the government included human resource development and information and communication technology (ICT) development among its 10 development goals (Government of Bangladesh 2015). Its ICT development goals include promises that all primary schools will have one multimedia classroom and that all secondary schools will have three multimedia classrooms. In addition, it commits to equipping 30 percent and 100 percent of primary and secondary schools, respectively, with an ICT laboratory. Three-and-a-half years into this government commitment, this study found that, in rural schools, little progress has been made.

Basic infrastructure challenges plague the schools visited. One administrator reported that, although his school had a laboratory, the government had provided the equipment in 1985. Another explained that, because classes didn't use the laboratory, the equipment remained locked up for years. Some teachers ironically rely on books to teach technology subjects, reporting that their students must use their imaginations in those classes. And, despite the government commitment to all schools, only 5 out of the 30 secondary schools visited in Gazipur district had a computer lab. These basic challenges, coupled with the teaching crisis, paint a dismal picture and demonstrate just how far the public education system needs to go to deliver on its promises.

Societal-level barriers

From the home to the community, economic, safety, and cultural barriers keep girls from participating fully in STEM education.

Some of the socio-cultural findings of this research pointed to reasons why girls don't participate in STEM specifically, whereas others revealed barriers that keep girls from receiving any education at all. And although some of the above findings paint a dismal picture of the system writ large—for boys and girls—barriers in the

home and social spheres were the most gender-specific. For one, the pervasive belief that STEM fields were a male realm led even the most confident and motivated girls to perceive barriers ahead of them.

Much of this belief starts in the home. Most of the parents with whom we spoke were uneducated, often to the point of illiteracy, and severely plagued by poverty. They reported that STEM education is more important for boys because, they believe, girls will eventually join their in-laws' households, but boys will help provide for them. Among the few mothers who worked outside the home, earning an income, many were garment workers. Those who worked appeared to have a vision for their daughters' careers. But most mothers were housewives, with fathers working as day laborers in small temporary businesses and often under poor conditions. For these poor families, whose daughters go to free government schools, there are remaining expenses in indirect school fees, transportation costs, and uniforms. Parents reported feeling helpless, because good facilities were limited to urban or private wealthy rural schools. The private coaching system proves another barrier for them, because they find it challenging to afford.

Cultural and social barriers can keep girls out of school altogether. Even leaving the home to go to school can pose a significant constraint. Parents reported being afraid of sending girls to school because of the prevalence of gender-based violence and rape in rural Bangladesh (Fattah and Kabir 2013).

Early marriage and early pregnancy are among the other issues that can take a girl out of school. One teacher remarked, "Every year, we lose talented girls who cannot continue further studies." Bangladesh has the fourth-highest rate of child marriage in the world (Girls Not Brides 2019), and this research showed no different. Sixty percent of girls reported feeling pressure from their families, relatives, or society to marry early, often starting in early adolescence (ages 13-14). Sometimes families reported feeling the need to invest in their daughter's education to attract a suitor for marriage so that "she can be a good housewife and maintain the family intellectually."[4]

Girls presenting a project on harvesting rainwater for safe drinking

A slew of additional barriers such as fundamental religious beliefs, trauma, and social prejudice might also keep girls out of school as well as seep into the classroom. In contrast to girls' high self-esteem in STEM, some of the interviewed teachers expressed a lack of confidence in girls' abilities in those subjects while perceiving boys to be stronger. And in the home a heavy burden on girls to perform domestic chores also reportedly contributed to their inability to study or even stay in school.

Despite many of these challenges in the home sphere (as shown earlier in Figure 1), the parents who were surveyed perceived teacher quality and infrastructure and resource issues as being the key challenges that keep girls out of STEM education. Fewer parents reported early marriage and motherhood, safety, social norms, and poverty as being key challenges. Although teacher quality was a highly reported area of concern in surveys, focus groups, and parent interviews, they did not mention gender sensitivity as being a problem of teacher quality.

Box 2. Hope ahead: Successful school models in Gazipur district, Bangladesh

Although this study focuses on barriers that keep girls from reaching their full potential in schools, we also came across school models that worked for rural girls' STEM education. The most promising examples came from three rural secondary schools in Gazipur district where we found a core of enthusiastic, helpful teachers and administrators with a sound commitment to STEM education.

There, communication between educators and school governing bodies enables teachers to receive adequate salaries and access basic infrastructure for their classrooms. As a result, educators successfully weave art and design thinking into curricula, and staff use technology to foster digital skills. Teachers also provide practical, hands-on learning opportunities in school laboratories. Staff showed a keen interest in starting STEM clubs, hosting trainings, and otherwise identifying opportunities to ramp up girls' STEM education.

Notably, these three schools are religious, military, or private institutions that received private donor support, which bolstered their success. However, these examples illustrate the transformative effect that investment in teacher training, school facilities, and STEM-based learning can have on students, teachers, and administrators alike.

RECOMMENDATIONS FOR GOVERNMENT AND CIVIL SOCIETY

Without engaging the skills of its full population, Bangladesh will be unable to attain its economic development goals, particularly those most severely threatened by automation. To transition Bangladesh into a high-income country by 2041, policymakers must keep progress for girls at the center of their strategies for a better Bangladesh. Bangladesh made a tremendous start by getting most previously out-of-school children enrolled in school during the Millennium Development Goal era. Now, the task is to leverage the leaps in education access toward building quality learning across all subjects and moving beyond literacy and numeracy to ensure more meaningful life and work outcomes for all youth. The public sector and nonformal sectors alike have roles to play in moving the country forward in time to meet its goals.

As discussed in the findings, the most crucial factors affecting a girl's ability to reach her full potential occur on the individual, institutional, and societal levels. Consequently, these recommendations focus on the concrete steps that the public and nonformal sectors can take to break down the barriers identified in the research.

Individual-level recommendations

Public school curricula should integrate STEM activities for 21st-century skills development, whereas nonformal programming can cultivate socio-emotional skills like leadership and confidence through girl-specific curricula.

One of the biggest threats to Bangladesh's development is that its workforce of approximately 87 million people is predominately uneducated, and only 4 percent of workers have moved past secondary education (World Bank 2016). As such, foreign direct investors that can help Bangladesh continue its development journey may be deterred by the state of its human capital (World Bank 2019a): 75 percent of Bangladeshi business leaders report that skilled workers are few and far between (BRAC 2016).

This research paper has called for a broad application of STEM activities to cultivate skills that may apply both within and outside of STEM fields in a changing work landscape. STEM curricula, if delivered experientially, promise to develop the crucial transferable skills that the 21st century demands (Wan Nor Fadzilah et al. 2016). Those skills—creative thinking, problem solving, adaptability, and communication—have been deemed key for successful employment and adaptability to today's workforce demands (Casner-Lotto and Barrington 2006).

Socio-emotional skills like confidence and leadership skills can also be cultivated as girls are integrated into STEM fields. Nongovernmental organizations (NGOs), particularly those concerned with girls' life skills and gender equality, are well positioned to support girls in developing their socio-emotional skills through initiatives

like STEM and girls' clubs across Bangladesh. Organizations like mine—the Education & Cultural Society—have started doing this work after school hours, and we are seeing meaningful results in girls' aspirations and determination to pursue STEM careers.

A complete evaluation would be useful to generate much-needed evidence on the importance of lifting girls up through girls' club settings, particularly in the Global South. Examples of successful implementation of such clubs all over the world abound.[5] They have provided positive learning environments around the STEM subjects and cultivated confidence and positive identification with the field through girls' exposure to role models and community building (McCreedy and Dierking 2013).

Institutional-level recommendations

Increase investment in school infrastructure and teacher training to eradicate the underlying systemic issues that affect all children's learning outcomes. Partnerships between NGOs and teacher training institutions can help accelerate the process, and advocacy organizations can launch campaigns to support accountability against corruption.

The research revealed a weakened public school system, with outdated infrastructure and a corrupt human resource base. Despite these systemic failures, students remain committed to leading the country into development and still dream of a prosperous future. The results were unsurprising given Bangladesh's low levels of investment in education (World Bank 2016).

Researchers concerned with STEM education for successful youth development indicate that STEM should also incorporate increased technology in schools and learning experiences (Bybee 2010). In 2011, the Prime Minister's Office launched the strategic priorities of Digital Bangladesh—the government vision and policy initiative to integrate ICT across all realms of Bangladeshi life by 2021 (Government of Bangladesh 2011). For the country more broadly, this ambitious policy moved the needle in the right direction. For instance, by establishing digital centers and streamlining services, delivery times for public services in general were cut by 83 percent across the country (GCPSE 2018). But this research showed that these positive outcomes have yet to reach classrooms as successfully as they have elsewhere. Further, focusing only on computer labs and neglecting simpler materials that build skills could be a mistake. Students need not only the experience with digital tools but also the transferable skills that might stem from, for instance, a chemistry experiment just using household kitchen items like table salt or indigenous plants like hibiscus. Though ICT has become a compulsory subject in secondary schools and more teacher training institutions now have computer labs (ADB 2017), poor learning outcomes demonstrate that infrastructure and materials are only one part of the puzzle.

As the data showed, teacher quality must also be a prime investment area for the public sector. In this space, education NGOs as well as multilateral and bilateral organizations can all partner with government to ensure adequate preservice training—not only on the STEM subject matter but also in gender-sensitive pedagogy—and, perhaps more important, continuing education for teachers. If the country places the burden of its future workforce on the shoulders of teachers, it must provide the necessary support.

One organization that illustrates this recommendation in action is STiR (Schools and Teachers Innovating for Results) Education, an NGO operating in India and Uganda at the district, state, and national levels to create teacher support networks by working directly with government officials. Its approach focuses on reigniting teachers' passion and motivation for teaching and providing local teacher networks. Issues that are rampant in Bangladesh like absenteeism and test score manipulation need models that leverage the power of teachers and change the culture surrounding these corrupt behaviors. But without government support these networks can only go so far. STiR's model is rooted in government buy-in and ownership, which helps to ensure buy-in, sustainability, and scalability (Robinson and Winthrop 2016).

At the Education & Cultural Society, we have also engaged in teacher training activities, including exchange programs for urban and rural teachers to ensure that teachers learn from one another and through each other's environments. Such training also means being attuned to creating gender-sensitive environments that promote girls' engagement. In addition, these efforts have provided us with insights around the importance of exposing teachers from low-resource schools to high-quality schools to motivate and reignite their love for learning. However, NGOs can't do this alone. Through partnerships with the Global Partnership for Education

(GPE) and other multilaterals like the United Nations Girls' Education Initiative (UNGEI), government resources can be allocated for more gender-responsive education budgeting and planning to ensure widespread support.

Societal-level recommendations

Launch public education campaigns and engage key leaders to break the socio-cultural barriers surrounding girls.

Across all education initiatives, particularly those that increase girls' empowerment and life skills, it is key to engage local leaders—namely community leaders and parents. In traditional communities being transformed by shifting economic and legal systems, it is particularly important to garner support and buy-in diplomatically (Parsitau 2017). Religious organizations and governments, as well as organizations working on gender and education issues, must work to find common ground as initiatives take place in such communities. Because Bangladesh anticipates increased urbanization, with rural migrants moving to urban centers, it is more important than ever to prepare rural girls for urban jobs. But, to break down the social barriers that keep girls from progressing, the gatekeepers of those traditions and long-held beliefs must also buy into these efforts.

Although research reveals mixed evidence around the efficacy of public information campaigns (Weiss and Tschirhart 1994), some promising initiatives delivered through entertainment have proven key to successfully shifting mindsets. Governments and NGOs alike can successfully disseminate socially powerful messages and leverage entertainment value for good. For instance, Sesame Workshop has worked through radio programming and television to teach children values that are oriented toward gender equality and empowerment. But, importantly, it has also worked to develop open-mindedness among key actors in a girl's life. For instance, in Afghanistan, Sesame introduced a new character—a young boy who looks up to his educated older sister. And, in India, Sesame Workshop's *Galli Galli Sim Sim* Radiophone Project successfully prompted parents and local leaders to prioritize girls' education alongside other community concerns (Sesame Workshop India, n.d.).

Other organizations, like the Population Media Center (PMC), work on television and radio drama series to support social change. The PMC prioritizes entertaining its audience and working with local actors and staff to develop compelling stories. By doing so, it cultivates empathy for marginalized groups or adds nuance to a given social issue. As a result, it has seen successful mindset shifts that have applied to gender issues and beyond.[6]

CONCLUSION

Bangladesh's young girls are eager to provide innovative solutions that will meet the challenges threatening the country's economic development. This research found that they want to do so through the STEM fields but that their systems and environments are failing them and thwarting their ambitions for a better Bangladesh. The gap in the STEM field can only be reduced if barriers at all levels—individual, institutional, and socio-cultural—are addressed by policymakers and practitioners alike (Table 1).

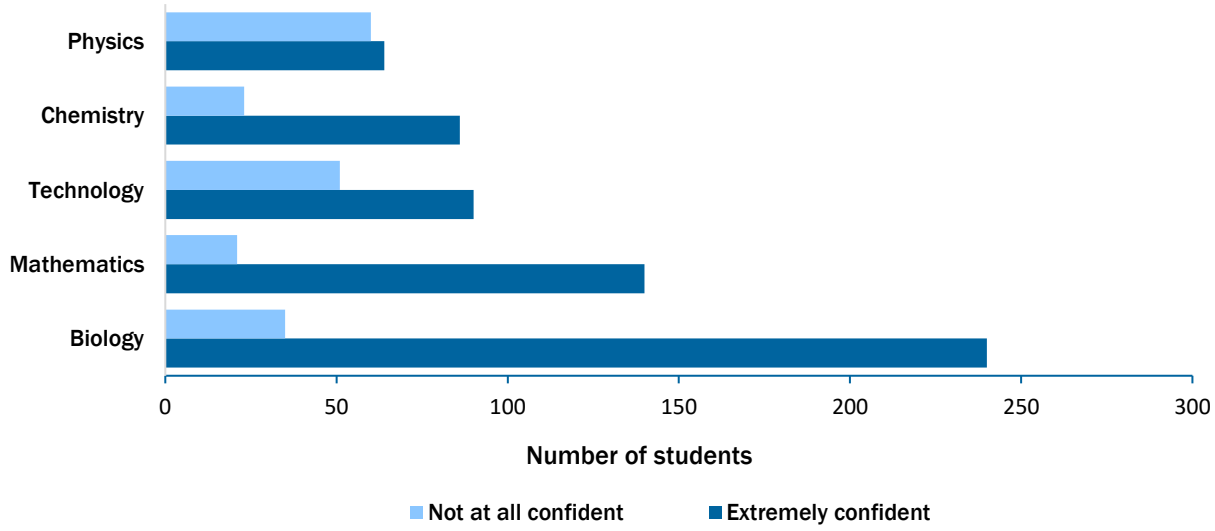
Table 1. Summary of recommendations, by level, for overcoming barriers to STEM education for rural girls in Bangladesh

Level	Government (education ministries and public school decisionmakers)	Civil society (NGOs and private sector social responsibility actors)
Individual level: Both public and nonformal sectors can build human capital by supporting girls' skills development.	• Leverage STEM classes to develop the critical skills that students need to thrive in a 21st-century world.	• Support girls' leadership and empowerment through after-school programs.
Institutional level: Although the public sector is mainly responsible for successful reform, nongovernmental institutions may also help to develop a more qualified workforce.	• Allocate investments toward infrastructural challenges to deliver on the promise of technical resources for all schools while also not neglecting the basic lower-tech investments that help students build skills through project-based learning.	• Promote external accountability mechanisms to address the deep-seated corruption exposed in fieldwork interviews and other research. • Exert healthy pressure by nongovernmental advocacy bodies on government systems to ensure greater transparency and teachers' accountability to students.
	• Develop partnerships between NGOs and preservice training institutions to create professional learning communities around gender-sensitive STEM education. • Develop partnerships between NGOs and public schools to create ongoing learning opportunities for in-service teachers around gender-sensitive STEM education.	
Societal level: Government and civil society can each play a role in the long process of changing social norms by engaging the right actors.	• Launch public education campaigns to accelerate changes in social norms, particularly around barriers like early marriage and beliefs that girls don't belong in STEM. • Engage religious and community leaders as well as parents in informational sessions for greater engagement in their daughters' education.	

Note: NGO = nongovernmental organization. STEM = science, technology, engineering, and mathematics.

Without delay, stakeholders—from ministry-level government officials to community-based organizations—must help equip young women with the core STEM skills necessary to face existing and emerging challenges. At a systems level, a high-quality education curriculum, systemic accountability, and teacher support are urgently needed to develop the type of education that will help girls face real-world problems. Government and nonformal initiatives can target changes in social norms to allow girls to lead industries and workplaces in the future. If Bangladesh wishes to transition into a high-income country by 2041, the time to invest in STEM education is now.

ANNEX A. FEMALE STUDENTS' SELF-REPORTED LEVELS OF CONFIDENCE ACROSS STEM SUBJECTS, GAZIPUR DISTRICT, BANGLADESH



Source: Survey of female secondary school students conducted March 1 to April 30, 2019, Gazipur district, Bangladesh.

Note: STEM = science, technology, engineering, and mathematics. Survey respondents (n=400) were asked, "Think about your science, technology, mathematics subjects. To which extent do you feel capable of studying these types of subjects in the future?" Respondents scored their confidence in each subject on the 1-5 point Likert scale (5 being most confident, 1 being least confident). "Extremely confident" corresponds to responses of 5 on the scale. "Not at all confident" corresponds to responses of 1 on the scale.

NOTES

[1] The Fourth Industrial Revolution is the current industrial revolution, which, according to the World Economic Forum, is defined by its ability to fuse the physical, digital, and biological spheres (Schwab 2016).

[2] For definitions and descriptions of STEM education, see "Science, Technology, Engineering, and Math," U.S. Department of Education (web page), https://www.ed.gov/stem; "Why STEM? What Is STEM?" Arizona STEM Network (web page), Science Foundation Arizona, http://www.sfaz.org/stem-stem/; and UNESCO 2017.

[3] Gazipur district is north of Dhaka, Bangladesh, and was previously a subdivision of Dhaka district before becoming a district in 1984. In 2011 (latest data found), the literacy rate in the district was 62.6 percent, and average school attendance for ages 5-24 was 42.5 percent (BBS 2013).

[4] Teacher interview, Gazipur district, Bangladesh. Interviews were conducted March 1 to April 30, 2019.

[5] See, for instance, Teach for All's STEM bootcamp in Kathmandu (Teach for All 2019).

[6] For an evaluation of the PMC's approach, see "How Do We Know If We Succeed?" on the PMC website: https://www.populationmedia.org/our-approach/evaluation/.

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