SOUTH ASIA DEVELOPMENT FORUM

Engendering Access to STEM Education and Careers in South Asia

Shobhana Sosale, Graham Mark Harrison,
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Abbreviations

ICT	information and communication technology
ILO	International Labour Organization
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
PISA	Program for International Student Assessment
SAARC	South Asian Association for Regional Cooperation
SAGE II	Asia Gender and Energy Facility II
STEM	science, technology, engineering, and mathematics
TIMSS	Trends in International Mathematics and Science Study
TVET	technical and vocational education and training
UNESCO	United Nations Educational, Scientific and Cultural Organization
PhD	doctoral degree
MA	master of arts degree

Executive Summary

Introduction

Globally, about 80 percent of men and more than half of women are in the workforce. Countries with larger shares of workers trained in science, technology, engineering, and mathematics (STEM) grow faster and advance more quickly, enabling opportunities for and benefiting all members of society. Countries that invest in STEM education and skills expand talents that contribute to social, economic, and technological advancements, facilitating growth and supporting progress toward the Sustainable Development Goals.

STEM investments also pay rich dividends to countries at every stage of development. For South Asian countries – Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka – investments in STEM, from basic education to expanding STEM opportunities in the workforce, can enhance human capital accumulation and contribute to economic development.

For many reasons, policy makers should care about STEM education for girls and women. Societies that understand STEM-related topics—such as climate change, clean water, and sustainability—are better able to respond to global challenges. Inclusive economic growth makes countries more likely to achieve the Sustainable Development Goals. To realize their potential, countries must make available and pursue opportunities for as many of their people as possible. And governments and their development partners should strengthen STEM education and advance women's participation in the workforce. It is also imperative that STEM stakeholders—a diverse group from the public and private sectors—build a culture of inclusion and diversity to foster women's advancement in STEM.

STEM skills and experiences, coupled with a diversity of perspectives, are integral to building South Asia's STEM workforce in research and in developing new products and ideas. Thus, inclusion and diversity must be championed by governments and by STEM stakeholders that stand to benefit from more diverse workforces. Though women themselves would likely be credible champions, in South Asia they are often constrained by a range of factors. This report addresses those factors.

Focus and Goals of This Report

This report aims to improve the understanding of the barriers to, and ultimately address, the gender segregation in access to and participation in STEM in South Asia. To that end, it applies a hybrid multidimensional framework to help explain the motivations for access to STEM education. This framework is used to assess how South Asian countries fare on access to STEM education, identify gaps, and offer recommendations for how access challenges can be addressed. Of note are the multidimensional elements and influencers:

- The key elements affecting *learners* are language and spatial skills, self-efficacy, self-perception, stereotypes and STEM identities, interest, engagement, motivation, and enjoyment.
- The role of *family and peers* combines peer relations, parental beliefs and expectations, household assets and support, and family characteristics.
- The role of *schools* combines psychological factors linked to assessments, STEM equipment, materials, and resources, student interactions, teacher-student interactions, teacher perceptions, female teachers, teaching quality and subject expertise, teaching strategies, textbooks and learning materials, and assessment procedures and tools.
- The role of *society* encompasses equal pay legislation, gender equality policies and laws, mass and social media, sex-disaggregated data for policy making, societal and cultural norms, and inclusive gender norms.

The methodology first considers the participation and performance of females in STEM subjects in primary, secondary, and tertiary education, including technical and vocational education and training. Female participation in the labor force is then reviewed, with a focus on STEM careers. The framework and a situational analysis of access to STEM education in South Asia are summarized. It is envisaged that applying the multidimensional framework and status analysis will help initiate dialogue within and among South Asian countries to explore areas for collaboration and potential investments in this important area.

The report also highlights growth in STEM sectors as part of the transition to green economies and identifies options for improving the representation of women in these sectors. The World Bank proposes that countries follow six "adaptation pillars" to build resilience to climate change (World Bank 2022), four of which are directly relevant to STEM education:

- *Pillar 1*: Ensure development is rapid, inclusive, and offers protection against shocks
- *Pillar 2*: Facilitate the adaptation of firms and people
- *Pillar 3*: Adapt land use and protect critical public assets and services
- *Pillar 4*: Help firms and people cope with and recover from disasters and shocks
- *Pillar 5*: Anticipate and manage macroeconomic and fiscal risks
- *Pillar 6*: Prioritize, implement, and monitor interventions.

Increasing access to education and opportunities for girls and women is among the most critical issues to consider in advancing the Sustainable Development Goals. Education and opportunities are essential foundations on which countries can strengthen society and address other challenges identified by the goals, including good health and well-being and decent work and economic growth.

Interventions can be tailored to local audiences and circumstances and to individual firms, nonprofits, nongovernmental organizations, and governments. Regardless of the types of STEM stakeholders, the education of students and the imparting of skills to them—and the STEM opportunities made available to women and men entering the workforce—are crucial.

This report recognizes the importance of health care workers. Its focus, however, is on other STEM professions—such as engineering and information technology—in which women are underrepresented. The report delves into the performance and records of countries in South Asia. Within the region there are success stories as well as some common and some specific challenges. Based on available data on STEM participation in the region, the report draws conclusions and offers recommendations for actions that might encourage more girls and women in South Asia to pursue STEM education and careers—while at the same time strengthening societies.

Education's Evolution—and Stagnation

Around the world, significant advances have been made in increasing access to education. Yet many challenges remain, at all levels of education systems, in offering quality education to all children and imparting the skills needed. To fully benefit from the advances that STEM can bring, all of society must be represented. Diversity in genders,

backgrounds, perspectives, and countries of origin is a strength in STEM and in the concepts, ideas, products, and solutions that scientific and technological knowledge deliver to society. Yet globally, including in South Asia, the following apply:

- Girls—especially poorer, rural ones—are underrepresented in science programs in secondary schools.
- Young women are not engaged in most technical and vocational education and training programs and in most STEM disciplines in tertiary education.
- A lower share of female STEM graduates work in STEM jobs.
- Women often do not hold senior positions in STEM industries.

Girls and women lose their potential for STEM talent in education systems and labor markets if they are not nurtured in STEM subjects from a young age. Primary and secondary education must provide the foundations for children to participate in and contribute to society. A critical component of that education is STEM, where girls' participation and continuation rates fall with age and education in South Asia and around the world. This "leaky pipeline" results in girls and women showing increasing disengagement from STEM in secondary and postsecondary education—and ultimately in jobs and careers. As a result there is less diversity in perspectives and insights that drive technical progress and economic development.

In South Asia, the main leaks in the pipeline for females occur as a result of the following:

- *Not enrolling in science in upper secondary education.* It is here that the STEM gender gap becomes evident.
- *Not entering STEM programs in postsecondary education*. About three-quarters of STEM students are male. Among the remaining quarter, 70 percent of female undergraduate STEM students are in health sciences.
- *Not joining the workforce.* In many South Asian countries, women's participation in the labor force is much lower than men's participation. Moreover, educated women are more likely to be unemployed.

Participation in Education by South Asian Girls and Women

South Asian girls and women face challenges in pursuing STEM at all levels of education. Though the region has made great advances in enrollment, secondary enrollment and learning achievement lag behind those of leading economies. And by the time they reach upper secondary education, male and female students have different perceptions of STEM careers.

The transition to upper secondary school might be the biggest indicator of the gender gap in STEM. Though this transition might not reflect the different attitudes toward

STEM among boys and girls—and their parents—specific tracks for STEM, arts, and commerce become available only at this point. Thus, the data clearly show the point at which girls become underrepresented in STEM subjects. Accordingly, this demarcation point is not when interventions should be targeted since attitudes are already set. Instead, STEM education interventions need to happen much earlier, in primary education. The report presents data and analysis by level of education, highlighting the significant variations in national enrollment data. Country examples of interventions to address the challenges are also presented. A key finding is that female students do well in STEM studies around the world and in South Asia. But their participation progressively declines through the levels of education, especially from upper secondary education onward—the leaky pipeline.

Gender disparities prevail in labor force participation. Women's participation rates in STEM careers are low in South Asia, whereas those of men are much more likely to reflect global rates. Unemployment rates also provide insights into the labor market for women and those with more advanced qualifications. Unemployment intensifies the underrepresentation of women in the workforce, including in STEM disciplines. The underrepresentation of women in the labor force, especially highly educated women, exacerbates the STEM leaky pipeline observed in education.

What Kind of STEM Interventions Does South Asia Need?

As access to all levels of education increases in South Asia—especially for females—the expectation is that more women will enter the workforce. Specifically, more women are expected to pursue jobs and careers that require more advanced skills, including those associated with STEM, and to advance to leadership positions in the STEM workplace. But that will take time. And policy interventions and cultural shifts will be needed to bring greater balance to gender representation in STEM and other career fields.

The report outlines the types of interventions that can limit attrition in STEM subjects as girls and young women choose their education, careers, and personal life paths. It shows how interventions can be pursued by engaging stakeholders that support inclusion in STEM, whether in a specific country or in all of South Asia and offers recommendations that can be adapted to any aspect of STEM or by any interested stakeholder. For example, South Asia's WePOWER initiative has a diverse network of public and private stakeholders and emphasizes locally driven initiatives (World Bank, n.d.). Some interventions will require the full engagement of governments. Though these interventions might be larger in scope and demand fuller policy discussions, they can build on stakeholder interventions, evidence from actions by stakeholders, and global good practices.

This report provides potential investment options for South Asia. The priority placed on these options will vary by countries' aspirations, development levels, ability to invest (whether through public or private financing), capacity to secure financing

from development partners, and commitment to promoting girls' and women's STEM education and careers. To be more effective, interventions should be combined. For instance, STEM and tertiary education outreach should always be combined with the provision of support to women in STEM. The report also provides recommendations in the key aspects of the hybrid multidimensional model applicable to South Asia in secondary education, technical and vocational education and training, and higher education—specifically, on gender stereotyping, role models, and trained teachers. The report concludes with recommendations for fostering regional integration, outlining goals based on observed collaborations and interventions in South Asia between partners, and recommendations for advancing the goals.

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CHAPTER 1

Access to STEM: Gender Dimensions and Challenges

Introduction

To fully benefit from the advances that science, technology, engineering, and mathematics (STEM) can bring to socioeconomic development, STEM fields must be inclusive and fully represent all of society. Diversity—in genders, backgrounds, perspectives, countries of origin—is a strength in STEM and in the concepts, ideas, products, and solutions that scientific and technological knowledge bring to society. However, the following still apply:

- Girls are generally underrepresented in science education in secondary schools.
- Young women are significantly underrepresented in most technical and vocational education and training (TVET) programs and in most STEM disciplines in tertiary education.
- Women are underrepresented in the STEM workforce.
- Women are underrepresented in senior positions in STEM industries and organizations (UNESCO 2017).

The statements above apply to girls and women everywhere and often to other groups, including rural residents and poorer people. In South Asia, women are generally underrepresented in the workforce and specifically in STEM, as with women in other parts of the world.

Performance differences in STEM education at primary and lower secondary school levels have implications for girls' enrollment in upper secondary school, STEM education at the TVET and university levels, and the transition from school to work. Social norms also play a major role in influencing the types of programs open to girls, directly affecting their labor market choices and options and likelihood of engaging in nontraditional technical jobs and academic careers.

However, digital developments have opened doors for acquiring new skills and gender-neutral jobs. STEM education could produce a new workforce with the tools and knowledge needed to harness innovative solutions to development, growth, and climate change problems. STEM education provides a bedrock for deploying renewable energy, for new green jobs, and for climate-sensitive solutions.

This report is intended to encourage policy makers and development partners to consider the importance of investing in STEM education and to influence thinking about the importance of preparing larger, better-skilled workforces around the world. The World Bank's South Asia Region Education Global Practice, WePOWER, and South Asia Gender and Energy Facility II (SAGE II) collaborated to examine how access to and the choice to pursue a STEM education affect enrollment in upper secondary, TVET, and higher education in South Asia. The goal of their new research and policy initiative is to improve access to and participation in STEM programs and careers. Previous work by WePOWER and SAGE indicates systematic underrepresentation of girls and women more broadly, but specifically of girls pursuing STEM education and careers (box 1.1). This shortfall is due to factors such as education experiences in school, choices embedded in social norms, teacher behaviors, parents' expectations, information asymmetries, institutional and structural barriers, and so on.

BOX 1.1 South Asia's WePOWER Network: A Success Story

Launched in 2018, WePOWER is a voluntary women's professional network in South Asia. It has two main goals: supporting women's participation in energy projects and institutions and promoting normative changes for girls and women in STEM education. WePOWER has grown exponentially, by the end of 2021 having completed nearly 1,400 gender-driven activities positively affecting more than 28,000 female students and professionals and forming 28 partnerships. With a network comprising a diverse group of public and private stakeholders and an emphasis on locally driven initiatives, WePOWER has had an impressive reach. Its accomplishments include the following:

- Job placement for 328 women through job fairs, career counseling, mentorship programs, and the like
- Recruitment of 690 interns and enrollment of 652 female students in study tours
- Participation by 11,156 female professionals in workshops and training.

WePOWER's program has also led to infrastructure enhancements, with 233 women-friendly facilities being built and services provided. Workshops and seminars for returning mothers are also an important area of focus for WePOWER, to promote retention.

Source: South Asia WePOWER Network, www.wepowernetwork.org.

Gender and STEM is not a new topic; a wealth of resources provide detailed data for specific countries and the world. One reason for the interest in it is that growth in STEM professionals in a country positively correlates with societal advancement and economic growth.[1] Giving all segments of society the opportunity to pursue a quality STEM education strengthens human capital and broadens the pool of potential STEM professionals.

By investing in STEM education and skills, a country expands the range of talent available to contribute to the technological, economic, and societal advancements that facilitate growth and support progress toward the Sustainable Development Goals. In recent years, inclusivity coupled with a diversity of perspectives, experiences, and skills has emerged as integral to STEM workforces engaged in research and in conceiving of and developing new products and ideas. Thus, inclusion and diversity must be championed not just by women and governments, but by the STEM sectors that stand to gain from a more diverse workforce.

Highlights of the Literature on Gender and STEM

A vast literature covers gender and STEM in both academic and nonacademic settings. Though women have achieved parity in life sciences in many countries, they still trail men in engineering and computer science (UNESCO 2015). South Asia is lowest among all regions, with women accounting for just 17 percent of researchers.[2] There is variation across STEM subjects, with women tending to be more concentrated in some subjects, such as biology and chemistry, rather than in computer science, engineering, and physics.

Though most of the literature has focused on Europe and the United States, the findings are still relevant to South Asia. Decades of research and hundreds of journal articles on engineering, sociology, psychology, economics, and business highlight the diverse interest in the topic. Various themes have emerged to explain both the low number of women studying engineering and the low number staying in the profession.

Achievement gaps are slowly narrowing, but despite having the ability and appropriate academic preparation, women are still less likely to pursue education pathways that lead to engineering degrees. The cultural biases and structural barriers that divert young women from pursuing engineering (and other STEM fields) begin in early childhood, and engineering workplaces, both in industry and academia, inhibit participation by female engineers. Indeed, cultural biases and underrepresentation of women—leading to a lack of role models—are the main obstacles hindering the advancement of girls and women in these fields (NCWGE 2012). Gender has no influence on academic ability, including in STEM subjects.

Early interventions are essential to cultivating children's interest in STEM. However, many social, familial, and developmental behaviors do the opposite, resulting in gendered differences in interests. Consider the stereotype that, from a young age, boys are more oriented to STEM than girls or the ways that adults—consciously or unconsciously— contribute to and reinforce this stereotype. A wealth of research has examined why few women choose to enter engineering programs, as well as the gendered

dynamics of such programs. Even textbooks can convey implicit and explicit bias in regard to gender roles and capabilities in STEM—for example, that doctors are male and nurses are female (box 1.2).

What happens in college is a continuation of processes that began much earlier in students' lives. First, some fields are typified by a masculine culture that inhibits a sense of belonging for women. Second, women often do not get enough early education in fields such as physics, engineering, and computer science. Some researchers have found large gender gaps in self-efficacy in those three fields, which can help explain why women do not pursue them (Cheryan et al. 2017). In the United States, women who are candidates for engineering faculty face more questions and scrutiny during hiring—and just 16 percent of faculty are women, while only 11 percent of professors are women (National Academy of Engineering and National Research Council 2014; Yoder 2016).

The situation in South Asia for women in STEM is not dissimilar to that in the United States. A 2015 study explored why enrollment of female researchers was low in the region's postgraduate degree programs (Economist Intelligence Unit 2015). In India, almost half of postgraduate candidates were women (39 percent for PhDs, 54 percent for master's degrees), yet few pursued a career in research. Indeed, the proportion of South Asian women researchers to men by subject was quite low, at just 15 percent in engineering and 16 percent in energy.

As one would expect, the share of female researchers varied by country, from 8 percent in Nepal to 37 percent in Sri Lanka. In Sri Lanka, a larger portion of women researchers were engaged in "softer" sciences and social sciences (30 percent) than in engineering and technology (27 percent). In India, the share of women in research and science and engineering roles stood at just 15 percent. Interviews with global experts conducted for this report indicate that in South Asia, cultural restrictions and a lack of career opportunities play major roles in the decrease in women researchers after the PhD level. The main barriers identified were women's lack of mobility, networks, and recognition. These findings were reaffirmed by a 2019 World Bank assessment of

BOX 1.2 Gender Bias in Textbooks

Increasing girls' interest and achievement in STEM requires ensuring that curricula accommodate their perspectives and avoid gender stereotypes. However, a review covering more than 110 national curriculum frameworks for primary and secondary education in 78 countries found that many math and science textbooks and learning materials contained gender bias.

For example, in India, more than half the illustrations in math and science textbooks at the primary level portrayed only male characters. Just 6 percent showed only female figures. In math textbooks, only men appeared in commercial, occupational, and marketing situations. No women were depicted as engineers, executives, or merchants.

Source: UNESCO 2017.

South Asia's power sector that interviewed engineering students (WePOWER, World Bank Group, and ESMAP 2019).

To support girls and women in STEM, encouraging participation in STEM activities from an early age is essential (Hammond et al. 2020). Spatial play and extracurricular activities outside the classroom—such as museum visits, competitions, clubs, and robotics and coding camps—foster interest in STEM among girls. Combining efforts such as mentoring and outreach, including contests and professional development programs, can dispel stereotypes about who can do STEM and what may result from STEM studies and careers. Actively combating stereotypes in curricula and textbooks and educating teachers on implicit bias can also help.

A key area identified for closing STEM gender gaps at universities is exposure to female experts, faculty, and peers to enhance social belonging (Fiske, Dasgupta, and Stout 2014). Studies of tertiary education point to the importance of mentors and role models to augment women's participation in STEM. However, further research is needed to understand STEM gaps in education and careers and what works to close them.

As noted, STEM is vital to a country's economic and social prosperity (Hammond et al. 2020). STEM fields produce thinkers, researchers, and technicians who advance progress in health, energy, nutrition, education, food security, transportation, infrastructure, communications, and other areas. STEM innovations play a central role in solving global challenges such as overcoming disease, protecting the environment, increasing energy access and efficiency, and enhancing education (UNESCO 2017).

Moreover, STEM jobs are often good jobs. Demand for STEM workers is rising, and such jobs pay more (Aktakke, Aran, and Munoz Boudet 2019; Rothwell 2013; World Bank Group 2016). The gender gap in STEM careers contributes to large disparities in pay between women and men (ILO 2018). Moreover, the gender gap in STEM is a missed opportunity for economies and an inefficient allocation of labor and talent. Shortages of STEM workers threaten economies, compromising their potential to reap the benefits from advances in STEM (Cedefop 2016; Freeman, Marginson, and Tytler 2015).

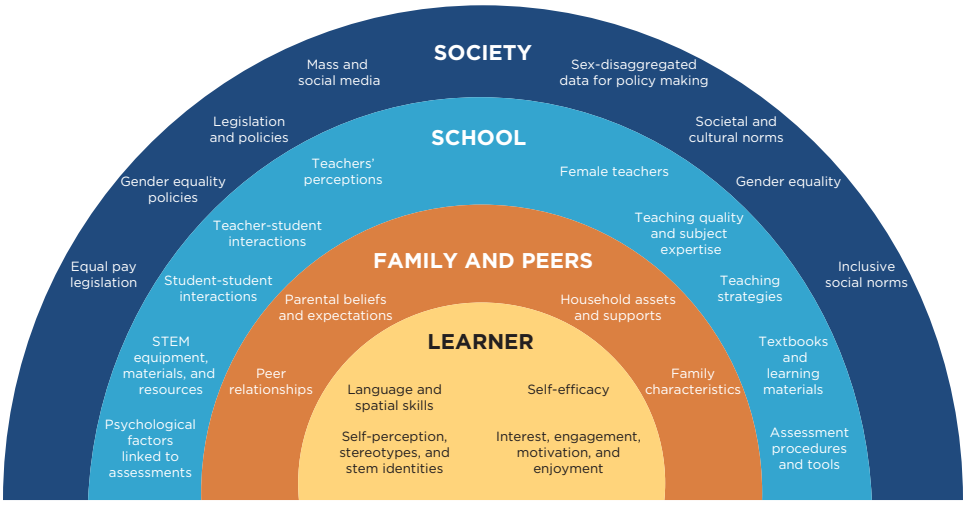
This Report's Focus and Goals

This report aims to improve the understanding of the barriers at play and ultimately mitigate gender disparities in access to and participation in STEM across South Asia. It applies a hybrid multidimensional framework to define what access to quality STEM education entails (figure 1.1). This framework is used to assess how South Asian countries fare in access to STEM education, identify gaps, and offer recommendations for how access can be improved. In addition, it is hoped that the framework and status analysis will help initiate dialogue among South Asian countries to explore areas for collaboration and potential future investments in this important area.

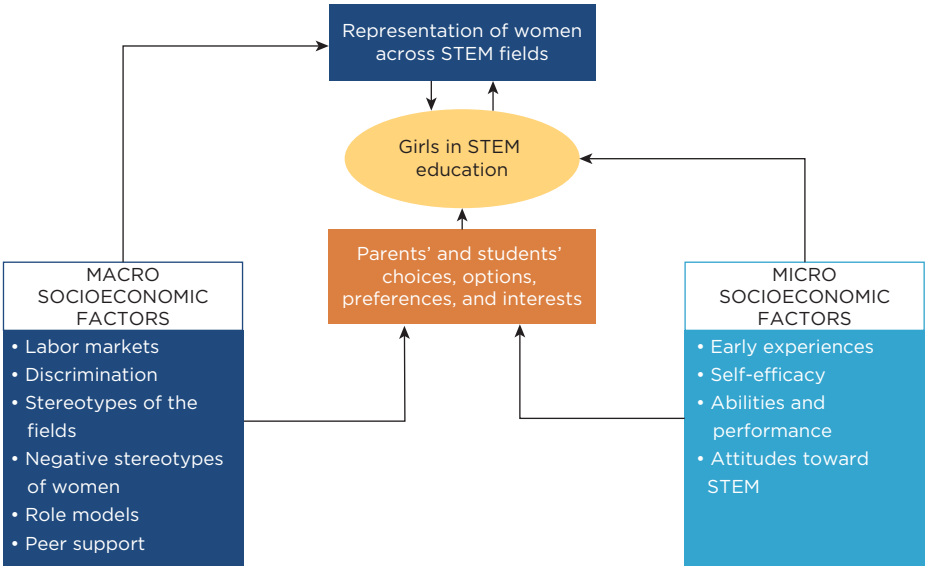
The hybrid multidimensional framework helps visualize and conceptualize the ecological and socioemotional aspects of access to STEM education and careers in South Asia. It combines elements of a global framework, developed by the

FIGURE 1.1 A Multidimensional Framework for Increasing Access to STEM Education and Careers in South Asia

a. Ecological framework of factors influencing girls' and women's participation, achievement, and progression in STEM studies



b. Macro and micro socioeconomic framework of factors influencing girls' and women's participation, achievement, and progression in STEM studies



Sources: Panel a, UNESCO 2017; panel b, adapted from NYAS 2016.
Note: Key aspects applicable to South Asia—gender stereotyping, absence of role models, and lack of trained teachers—apply to secondary education, technical and vocational education and training, and higher education. STEM = science, technology, engineering, and mathematics.

United Nations Educational, Scientific and Cultural Organization (UNESCO), and a US framework, created by the New York Academy of Sciences, and weaves in dimensions unique to South Asia. Global frameworks assess the range of factors that influence girls' and women's participation, achievement, and progress in STEM studies. The UNESCO framework does so while putting the learner at the center, with family and peers, school, and society as the main influencers. (Additional frameworks are presented in annex 1A.)

The hybrid multidimensional framework is applied here to assess STEM access by education level. Though quality is just as important, data constraints and assessment complexities at the country level have been barriers to assessing quality. The quality dimension warrants separate research—as do governance, institutional management, and financing.

This report addresses gender and STEM education from national and regional perspectives, identifying common themes along with recommendations and interventions that could be considered and implemented across South Asia to boost girls' and women's participation in STEM education and careers. It focuses on sectors where STEM-educated and -trained women are already present, as their contributions there could be enhanced through exposure to new skills, careers, and workforces.

There are some limitations to the report. In considering topics such as access to and quality of education, access to STEM curricula, and resources for teaching and learning, certain challenges go beyond the sole consideration of gender. Similarly, some South Asian countries have limited demand for STEM workforces. Although that might affect women workers, an assessment of the broader expansion of STEM in the economy is beyond the scope of the analysis here.

The report's methodology first considers the participation and performance of females in STEM subjects in primary, secondary, and tertiary education, including TVET. Female participation in the labor force is then reviewed, with a focus on STEM careers. The framework and a situational analysis of access to STEM education in South Asia are summarized.

The report highlights growth in STEM fields as part of the transition to green economies and identifies options for increasing the representation of women in these areas. The World Bank proposes that countries follow six "adaptation pillars" to build resilience to climate change (World Bank 2022). Four are directly relevant to STEM education:

- *Pillar 1*: Ensure development is rapid, inclusive, and offers protection against shocks
- *Pillar 2*: Facilitate the adaptation of firms and people
- *Pillar 3*: Adapt land use and protect critical public assets and services
- *Pillar 4*: Help firms and people cope with and recover from disasters and shocks
- *Pillar 5*: Anticipate and manage macroeconomic and fiscal risks
- *Pillar 6*: Prioritize, implement, and monitor interventions.

Increasing access to education and opportunities for girls and women is among the most critical issues to consider in advancing the Sustainable Development Goals. Education and opportunities are essential foundations on which countries can strengthen society and address other challenges identified by the goals, including good health and well-being and decent work and economic growth.

Interventions can be tailored to local audiences and circumstances and to individual firms, nonprofits, nongovernmental organizations, and governments. Regardless of the types of STEM stakeholders, the education of students and the imparting of skills to them—and the STEM opportunities made available to women and men entering the workforce—are crucial.

This report recognizes the importance of health care workers. Its focus, however, is on other STEM professions—such as science, research, engineering, and information technology—in which women are underrepresented. It delves into the performance and records of countries in South Asia. Within the region, there are success stories as well as some common and some specific challenges. Using available data on STEM participation in the region, it draws conclusions and offers recommendations for actions that might encourage more girls and women in South Asia to pursue STEM education and careers—while at the same time strengthening societies.

The report is organized in four chapters. Chapter 2 traces STEM trends, globally and in South Asia. Chapter 3 sets out key observations from South Asia, and traces the "leaky pipeline" based on trends and observations discussed in the previous chapters. Chapter 4 outlines potential interventions for South Asia and offers considerations for regional integration.

Defining STEM in School and Careers

Despite significant attention to science, technology, engineering, and mathematics (STEM) in education, workforce development, and the economy, there is no universal definition for and understanding of what STEM means. Science, technology, engineering, and mathematics are typically viewed as distinct topics, especially for children, with the focus on providing the fundamentals of education and separate classes and curricula for each topic.

DEFINING STEM IN SCHOOL

Education systems worldwide prioritize different aspects of STEM, such as engineering, technology, or environmental themes. Although labor markets more fully acknowledge the interconnections between the elements of STEM, even here a consistent definition of a STEM career does not exist. For example, the International Labour Organization (ILO) defines 10 major groups of occupations: managers; professionals; technicians and associate professionals; clerical support workers; service and sales workers; skilled agricultural, forestry, and fishery workers; craft and related

trade workers; plant and machine operators and assemblers; elementary occupations; and armed forces occupations (ILO 2012).

Although each of these occupation groups (including those focused on STEM) has underlying subgroups, countries often report employment data at the major group level. Even for this group, however, countries use descriptions that differ from those of the ILO. For example, Sri Lanka indicates that more than 50 percent of women are skilled agricultural, forestry, and fishery workers, while only 16 percent of them are in elementary occupations—which might be expected to include most agricultural labor. For the purposes of this report, STEM is considered in the following ways:

- At the *primary level,* STEM is represented globally mainly by the study of general science and mathematics. National and international benchmarks tend to focus on these two disciplines. Some countries place increasing emphasis on technological (or digital) skills and literacy, but those tend to be viewed as tools rather than as formal elements of the curriculum.
- At the *secondary and upper secondary levels,* STEM focuses on science and mathematics and on acquiring the foundations of knowledge in core subjects. There are often also opportunities for differentiation based on students' interests and abilities. For example, a science focus may be offered in addition to, for instance, an arts and humanities or commerce focus. Science might be split into biology, chemistry, earth science, and physics and perhaps include elements of environmental studies, design, and engineering (among other fields). According to the National Science Teaching Association, STEM "is not a single subject" and "is also not a curriculum, but rather a way of organizing and delivering instruction." Furthermore, STEM "is identified in many different ways" (NSTA 2020). Technology plays a growing role in secondary education, both as a tool for teaching and learning and as a distinct discipline in such classes as computer science and coding.
- At the *technical and vocational education and training* (TVET) level, STEM is reflected in the programs designed to provide the skills required for employment. At its best, TVET integrates classwork with practical applications of STEM to solve problems and find solutions. The focus on TVET is growing worldwide, and many programs are geared toward technology-driven careers. TVET programs frequently concentrate on trades and in some cases require the development of applied skills that build on the foundations of science and mathematics gained in basic and secondary education.

The idea that a high-end STEM education is essential for professional qualifications requires reexamination. For example, STEM workers were documented in the early 2010s as playing a direct role in driving economic growth in the United States (Rothwell 2013). Further, there are STEM requirements in many non-STEM jobs (Grinis 2019). However, the excessively professional definition of the STEM economy as requiring at least a bachelor's degree has resulted in policy makers' overlooking the strong potential of workers with less than a bachelor's degree but some STEM education.

- At the *university level,* STEM programs build on the separate foundations of science and mathematics to prepare graduates to pursue STEM-related careers where solutions to problems might not be immediately known. Many engineering and technology programs include problem-solving and design classes in the first year to teach students how to solve practical problems. For example, engineering, chemistry, and biology disciplines might require physics and calculus (problem-solving) in the first year, then use these core subjects—together with digital technology—as tools to find solutions. Moreover, STEM disciplines at the university level are increasingly interconnected and multidisciplinary; biology, chemistry, and physics share common underpinnings, and bioengineering, materials engineering, and environmental science and engineering developed from the intersection of previously distinct disciplines. In response to demands from employers, as part of the curriculum, more STEM programs expect students to master so-called soft skills, such as teamwork, time management, decision-making, and written and oral communications.
- Though not analyzed in this report, at the *postgraduate and research levels,* the blurring of distinctions between STEM disciplines becomes even more pronounced. STEM master's degrees, and especially doctoral degrees, focus on training students how to solve problems using a STEM "toolkit." As with undergraduate degree programs, problem definition and communication skills are essential.

DEFINING STEM IN CAREERS

Describing STEM careers can be even more challenging. Some STEM-focused companies employ a STEM workforce as well as myriad business, administrative, and other staff. Similarly, many non-STEM-focused companies have STEM employees essential to their operations, such as information technology staff. As STEM workers advance in their careers, they may move out of STEM-focused jobs into managerial or leadership positions. Many graduates of university STEM programs never enter STEM careers at all, choosing instead to use the skills they obtain in their education and training to contribute to other sectors of the economy.

Annex 1A: Alternative Frameworks for Assessing Girls' and Women's Progress in STEM Education and Careers

This section highlights several frameworks that have been used to assess girls' and women's progress in STEM education and careers in country-specific contexts. Although elements of each framework could be directly relevant to South Asia, the hybrid multidimensional framework used for this report combines ecological frameworks developed by UNESCO (for global analysis) and the New York Academy of Sciences (for the United States) as most applicable to global and South Asia–specific contexts (figure 1.1).

Cheryan and associates (2017) offer a dynamic framework based on the gender system in the United States. Congruent to the multidimensional framework, it centers choices, preferences, and interests as influencers, which in turn draw from (a) variability in micro-level factors, such as early experience, self-efficacy, abilities and performance, and attitudes toward STEM; (b) variability in macro-level factors, such as stereotypes of the fields, negative stereotypes of women, role models, discrimination, labor market, and peer support; and (c) variability in how women are represented across STEM fields, such as through beliefs, prescriptions, and roles.

An alternative framework by Jackson and her associates (2021) proposes ecological dimensions at the individual, family, school, and societal levels and identifies roles that stakeholders—students, parents, peers, policymakers, teachers, private sector, and the media—can play to support various aspects, including the following:

- Ensuring early care, play, and learning opportunities to (i) cultivate girls' interest, confidence, and engagement, (ii) avoid discrimination in care, play, and recreational experiences, and (iii) build children's spatial skills and self-efficacy in science and math.
- Providing good-quality, inclusive, and gender-responsive STEM education to (i) mainstream gender equality in STEM education laws and policies, (ii) hire and train male and female STEM-specialized teachers in gender-responsive pedagogy and classroom management, (iii) remove stereotypes and biases in STEM textbooks and learning materials, and expand opportunities for inquiry-based learning, (iv) create safe and inclusive STEM learning environments, (v) provide authentic opportunities for STEM learning and practice inside and outside the classroom, (vi) expand access to mentoring, apprenticeship, and career counselling to improve orientation on STEM studies and careers, (vii) facilitate contact with female role models, and (viii) provide incentives (scholarships, fellowships) in areas where girls and women are significantly underrepresented.
- Addressing social and cultural norms and practices impeding STEM participation, learning achievement, and progression to (i) mainstream gender equality in public policies and programs across sectors, including education, social, labor, (ii) reach out to and engage with parents to counter common misconceptions about STEM education and encourage dialogue, (iii) challenge discriminatory social and cultural norms and practices, (iv) raise awareness of the importance of STEM and women's achievements, (v) expand access to media literacy to promote critical thinking, (vi) help recognize gender stereotypes in the media, and promote positive representation of women in STEM, and (vii) promote and facilitate multisectoral collaboration and partnerships.

The STEM Opportunity Index, developed by the National Math and Science Initiative (NMSI n.d.), includes two broad classifications–system contributors and conditions and practices—and outlines underlying variables. The definitions are largely qualitative. System contributors include students, pre-K through 12 school systems, families and

parents, STEM-rich institutions, the business community, out-of-school programs, higher education institutions, policy makers, not-for-profit organizations (such as nongovernmental organizations), and researchers. Conditions and practices include policies and funding, district infrastructures, school contexts, educator preparation, educator quality, instructional resources, and STEM learning opportunities. STEM outcomes include education, societal, and broader impacts. These and other variables and factors are implicitly or explicitly included in this report.

The seeds of gender-based bias in STEM are often sown at an early age and manifest at elementary school level (Ford, Usher, and Mohr-Schroeder 2019). The belief that girls are less capable in STEM leads them to focus more on the humanities. The bias that boys are deemed smarter than girls in STEM (Bian, Leslie, and Cimpian 2018) encourages boys to pursue STEM at a young age. It is more difficult to spark girl's interest in STEM at later stages in their academics and in their choice of career.

The National Research Council (2011) links the roles of various actors, institutions, and actions in creating opportunities to promote STEM education, in particular the following:

- Students who had research experiences in high school, who undertook an apprenticed mentorship or internship, and whose teachers connected the content across different STEM courses were more likely to complete a STEM major than their peers who did not report these experiences.
- Research in STEM teaching and learning since 2000 has shown that it is possible to characterize what could be termed "effective" STEM education. Briefly, effective instruction capitalizes on students' early interest and experiences, identifies and builds on what they know, and provides them with experiences to engage them in the practices of science and sustain their interest. The research shows a clear link between what students are expected to learn and mathematics achievement: at a given grade level, greater achievement is associated with covering fewer topics in greater depth.

Key elements to fostering STEM education include the following:

- *Teachers with high capacity to teach in their discipline.* However, the evidence of their effects on student achievement is more tenuous because very little research traces the causal pathway from professional development to student achievement.
- *Adequate instructional time.* Overall, interest in science education and careers can be best developed during elementary school years. However, bias against girls taking up STEM learning opportunities leads to unequal access to high-quality STEM learning opportunities.
- *Reduction in the time for science education for girls.* Teacher expectations, school- and classroom-level factors such as access to adequate laboratory facilities, resources, and supplies compound the problem, increasing the disparity in science achievement for girls.

- *Teacher education and qualifications.* Fostering science and math learning during elementary school requires qualified and competent teachers who can inculcate a culture and appropriate conditions for science and math learning equally among girls and boys. Critical factors include school leadership, professional capacity of faculty, shared base beliefs about change and transformation, and collaborative work among staff to drive change.
- *School environment.* Attractive facilities and safe and welcoming school environments support intellectual stimulation.
- *Support for qualified science and mathematics teachers.* Mentoring, networking, instructional guidance and advanced tools to develop instructional materials, active discussions on academic demands and challenges comprise the ingredients for inspiring change.
- *Community support.* Involving parents and communities in children's academic success and strengthening school and institutions actively employing and applying science and mathematics knowledge help to build the bridges to serve as conduits for change.

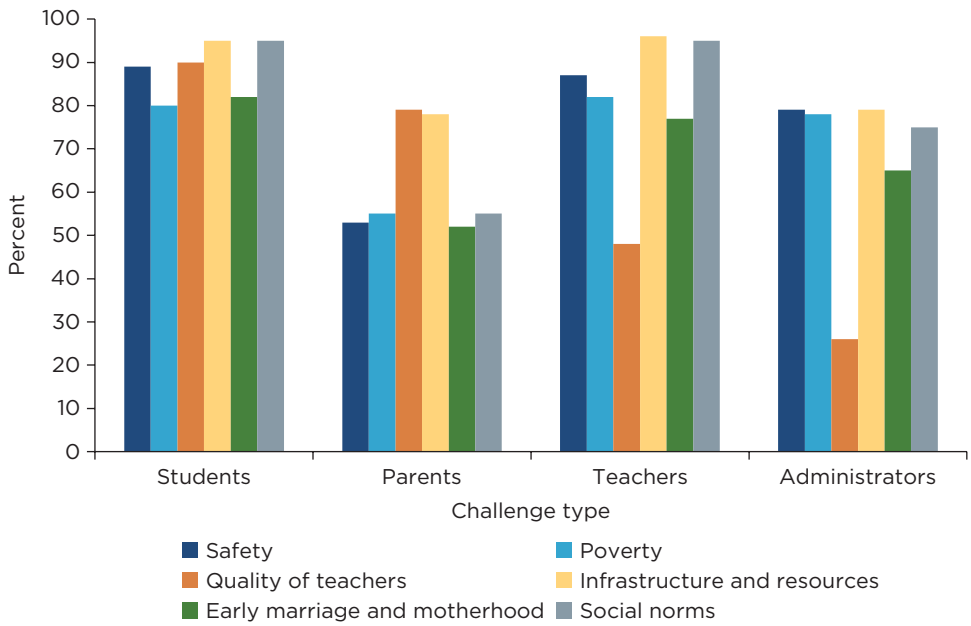
Gender equality is central to the World Bank's twin goals of ending extreme poverty and boosting shared prosperity in a sustainable manner. Advancing the participation of women and girls in STEM will require concerted focus on equality (Hammond et al. 2020). The STEM fields are vital to the economic and social prosperity of countries. These fields produce thinkers, researchers, and technicians who advance progress in health, education, food security, nutrition, transportation, infrastructure, energy, communications, and other sectors. STEM innovations play a central role in solving global challenges, such as overcoming disease, protecting the environment, increasing energy access and efficiency, and enhancing education (UNESCO 2017).

Moreover, STEM jobs are often good jobs for workers. Demand for workers in STEM is rising, and these jobs pay more (Rothwell 2013; for evidence on Europe and Central Asian countries, see Munoz Boudet et al. 2021; for evidence on digital and information and communication technology jobs, see World Bank Group 2016). Women and girls continue to be underrepresented in STEM careers, with wide variation among countries and across STEM fields.

The gender gap in STEM careers contributes to overall larger gender pay gaps (ILO 2018). Beyond income disadvantages for women because they have less access to STEM careers, the gender gap in STEM is also a missed opportunity for economies and an inefficient allocation of labor and talent. Shortages of STEM workers are a threat to economies, compromising the potential to reap the benefits of advances in STEM (Cedefop 2016; Dobson 2013).

For example, Siddiqa and Braga (2019) surveyed barriers to STEM education for girls in Gazipur District, Bangladesh (figure 1A.1). Their research reveals the challenges that various actors face with respect to STEM education for girls. The data

FIGURE 1A.1 Challenges to STEM Education for Girls in Gazipur District, Bangladesh



Source: Siddiqa and Braga 2019.

show that there is no congruence between what students and parents are seeking from the education system, and what administrators and teachers consider to be challenges. Infrastructure and resources are common challenges for all stakeholders. However, for administrators and teachers, the quality of teachers is of least concern. The key reason could be that administrators and/or teachers are parents, too. Their concerns depend on their position in the household or in the workplace (school). Addressing the barriers to STEM education for girls requires concerted efforts at individual, institutional, and societal levels from government, public school decision makers, and civil society (including nongovernmental organizations and private sector social responsibility actors).

Notes

1. See EIGE (2022) for analysis of this correlation in the European Union.
2. See UNESCO (2015, 88–89, fig. 3.2), https://en.unesco.org/sites/default/files/usr15_fig_3-2_female_researchers.pdf.

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CHAPTER 2

STEM Trends—Globally and in South Asia

Introduction

This chapter provides insights into global trends in enrollment and achievement in science, technology engineering, and mathematics (STEM) subjects, with comparisons for South Asia. Data and results are included for Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. STEM is considered a key element in socioeconomic development, and in recent years these countries have made rapid advances in access to basic and secondary education and strengthened higher education. Still, challenges remain in addressing the "leaky pipeline"—that is, girls' attrition from lower secondary education onward—to ensure greater inclusion in STEM education and careers. Moreover, COVID-19 (coronavirus) has significantly disrupted schooling and learning everywhere. Learning loss is measured by the number of days of school closures, the reduced contact hours and time spent on topics, and the availability of remote learning.

Primary Education

In primary (basic) education, children in all countries typically learn from standard curricula. For STEM, these curricula include mathematics and general science, and boys and girls have similar educational experiences. Globally, between 2000 and 2015 the number of children of primary school age (6–11) out of school nearly halved—from 100 million to 52 million—with a 44 percent drop in the number of girls out of primary school (UNESCO 2017). Since 2008, about 8.8 percent of children around the world have been out of school (9.7 percent of girls). In 2019 and 2020, gross primary enrollment ratios in South Asia were similar to those in richer countries (table 2.1).

TABLE 2.1 Gross Enrollment Ratios in Primary School in Global and South Asian Economies, 2019 and 2020

Percent

a. Global economies			b. South Asian economies		
Economy	**Total**	**Female**	**Economy**	**Total**	**Female**
Canada	101	101	Afghanistan	107	85
China	103	104	Bangladesh	120	125
France	103	102	Bhutan	106	107
Germany	103	103	India	100	101
Italy	101	100	Maldives	98	99
Japan	98	98	Nepal	142	143
United Kingdom	100	100	Pakistan	95	89
United States	101	101	Sri Lanka	100	100
Global average	**102**	**101**	**South Asian average**	**99**	**99**

Source: World Bank, World Development Indicators, https://datatopics.worldbank.org/world-development-indicators.
Note: The gross enrollment ratio is the number of students enrolled in a given level of education, regardless of age, expressed as a percentage of the official school-age population corresponding to that level of education.

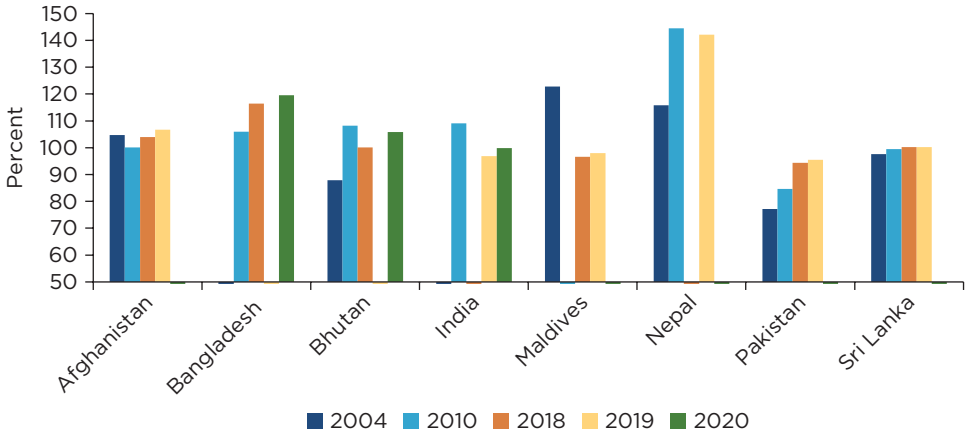
Over the past two decades, most South Asian countries achieved rapid increases in basic education enrollment (figure 2.1). The number of primary schools grew substantially, making boys and girls closer to schools, especially in rural areas. In recent years, the gender parity index for primary education has reached or exceeded 1 in all South Asian countries except Afghanistan and Pakistan, indicating that boys and girls are participating in equal numbers.

Still, the out-of-school rate for Central Asia and South Asia was 5.9 percent—meaning that 11 million children still do not receive a basic education (UNESCO Institute for Statistics 2017). Most South Asian countries retain disparities in primary education between urban and rural areas (figure 2.2), and poorer children have fewer opportunities for a quality education.

As in most countries, primary school students in South Asia are required to take mathematics and general science. In India and Sri Lanka, science is taught within the framework of environmental science, giving students a context in which to learn the fundamentals and potentially providing practical, real-world applications that could benefit society and point to future careers. In Bhutan, science is structured around agriculture, health and hygiene, and population education. However, across South Asia, there are concerns about the quality of teaching in basic education and about the resources available specifically for science labs and experiments.

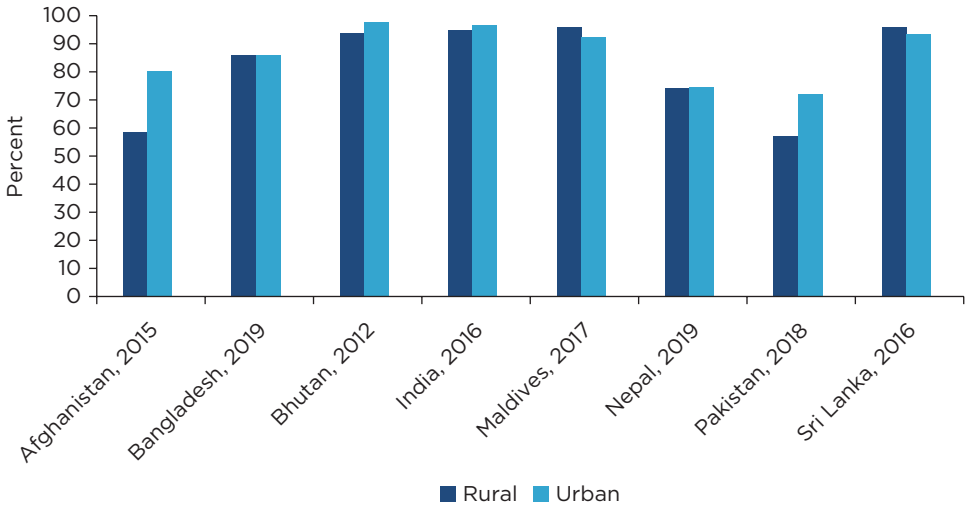
Benchmarking the achievement levels of South Asian students against their global peers is difficult because most countries in the region do not participate in international assessments, such as the Program for International Student Assessment or the Trends

FIGURE 2.1 Gross Enrollment Ratios in Primary School in South Asia



Source: World Bank, World Development Indicators, https://datatopics.worldbank.org/world-development-indicators.
Note: Data are not available for all years in all countries. Missing bars = missing data.

FIGURE 2.2 Net Enrollment in Primary School in South Asia

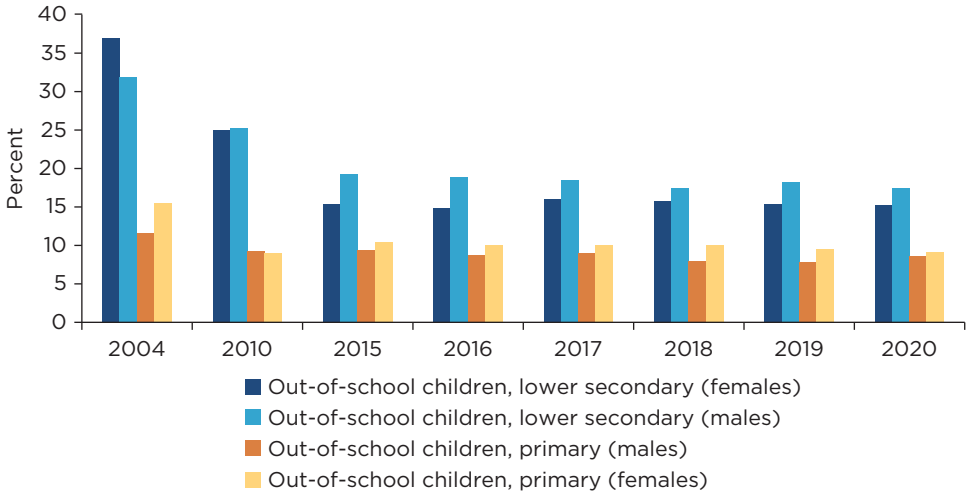


Source: World Bank, World Development Indicators, https://datatopics.worldbank.org/world-development-indicators.

in International Mathematics and Science Study (TIMSS). Since 1995, TIMSS has provided comparative international data every four years on mathematics and science achievement in grades 4 and 8 (figure 2.3). Pakistan is the only South Asian country that takes part in TIMSS, but only for grade 4.

TIMSS and similar studies measure performance based on gender for each participating country and also provide comparisons between countries. In 2019, 58 countries participated in the TIMSS grade 4 assessment. In mathematics, 27 countries showed

FIGURE 2.3 Out-of-School Ratios in South Asia



Source: World Bank, World Development Indicators, https://datatopics.worldbank.org/world-development-indicators.
Note: The countries of South Asia are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

gender parity, boys outperformed girls in 27, and girls outperformed boys in 4. For science, 33 countries had no gender gap, girls outperformed boys in 18, and boys outperformed girls in 7. (Although Pakistan's overall performance was near the bottom of the rankings, girls outperformed boys in science.)

In the absence of international benchmarking of performance in South Asia, national assessments provide some measure of the relative performance of boys and girls. In Nepal, grade 5 girls do slightly better than boys in mathematics. In Sri Lanka, too, grade 5 girls outperform boys, and performance for 2018–19 of both boys and girls was a 60 percent improvement over 2002. Sri Lanka's results indicate that performance is correlated with reading comprehension and literacy, subjects in which girls globally tend to do better than boys.

South Asia's impressive gains in enrollment and access to primary education need to be maintained to bring the entire region up to global averages. In addition, efforts should be made to improve science and mathematics education and to benchmark science and mathematics education outcomes against global peers. For students to receive quality instruction in primary education and potentially pursue STEM-related careers, they need to have the STEM education and skills necessary to succeed in the global economy.

Lower Secondary Education

Globally, there is typically a standard series of required classes for students in lower secondary education, though there may be some differentiation in level. Again, STEM curricula usually include mathematics and science.

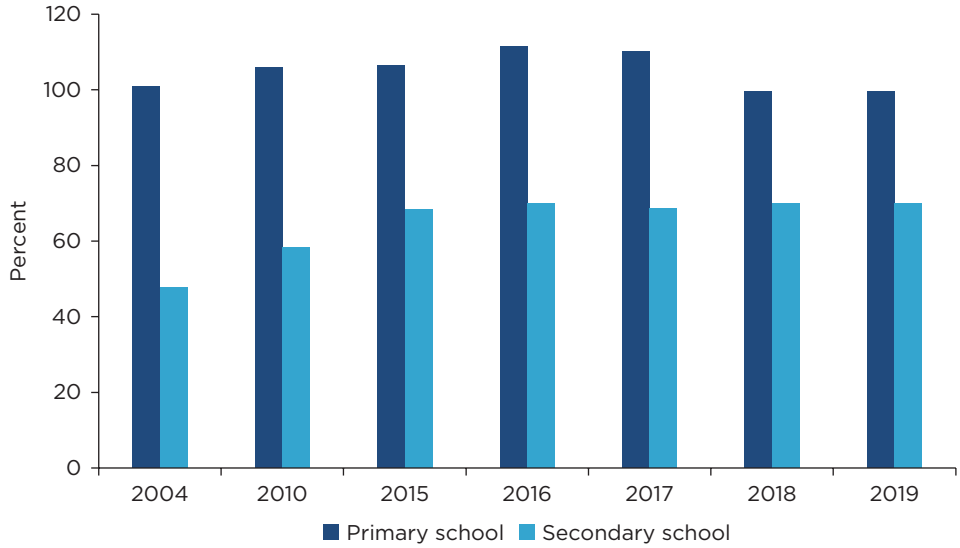
Between 2000 and 2015, the number of children of lower secondary school age (12–14) out of school fell 37 percent around the world. In 2000, there were 15 percent more out-of-school girls than boys, but by 2015 that trend had reversed—with 7 percent fewer lower-secondary-age girls out of school than boys. In 2020, 16.4 percent of lower-secondary-age children were not in school,[1] indicating significant attrition between primary and lower secondary schooling for boys and girls (figure 2.3).

In general, in South Asia, through about age 15, there is a common mathematics and science curriculum for all students in a given country. Beyond general science, this curriculum often includes the foundational disciplines of biology, chemistry, and physics.

In Sri Lanka, lower secondary school science includes practical skills, and where available, includes a laboratory focused on digital skills.[2] Middle secondary schools (for ages 14–16) may provide additional options, such as health, agriculture and food technology, and design—topics that give students an early view of a broader, integrated approach to STEM topics and potential opportunities, as well as a practical approach to science education. In Bhutan, there is an opportunity to focus on computer applications in some places. These examples of application-driven STEM education, while also delivering on the fundamentals, improve learning outcomes and provide real-world examples that could inspire students to pursue further STEM education and ultimately opt for STEM careers.

South Asia suffers from a significant drop in secondary enrollment relative to primary enrollment (figure 2.4). In 2020, the out-of-school rate in South Asia for lower secondary

FIGURE 2.4 Gross Enrollment in Primary and Secondary School in South Asia



Source: World Bank, World Development Indicators, https://datatopics.worldbank.org/world-development-indicators.
Note: The countries of South Asia are Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

education was 16.4 percent—nearly twice the rate for primary education (UNESCO Institute for Statistics 2021b). The region's adjusted gender parity index of 0.86 indicates that the gender disparity favors boys' enrollment at this age. The drivers of enrollment in lower secondary school are complex both across and within countries in South Asia.

In 2019, net secondary enrollment ratios were equal for boys and girls in some of the world's leading economies, above 90 (except in Germany), and significantly above the global average (table 2.2). In South Asia, these ratios were close to the global averages, although Sri Lanka's approached that of the leading economies.

Country specifics shine some light on South Asia's variations in net secondary enrollment ratios:

- In Bangladesh, the net secondary enrollment ratio for females exceeds that for males. For females, the ratio rose from 50 percent in 2010 to 72 percent in 2018, and for males from 45 percent in 2004 to 69 percent in 2016. But females appear to drop out of secondary education more, perhaps reflecting issues beyond academic ability and performance.
- In Bhutan, the enrollment ratios are closer, at 77 percent for females and 64 percent for males,[3] with relatively even enrollment and transition rates for males and females in lower and middle secondary school.
- In India, as with many other countries in the region, there is some variation (Bhog, Ghose, and Mullick, 2011). For example, 80 percent of villages with small scheduled caste or scheduled tribe communities have access to a secondary school—compared

TABLE 2.2 Net Enrollment Ratios in Secondary School in Global and South Asian Economies, 2019 and 2020

Percent

a. Global economies			b. South Asian economies		
Economy	**Total**	**Female**	**Economy**	**Total**	**Female**
Canada	100	100	Afghanistan	50	37
France	95	95	Bangladesh	65	72
Germany	85	85	Bhutan	70	77
Italy	95	95	India	62	62
Russian Federation	91	91	Maldives	47	51
United Kingdom	97	97	Nepal	62	63
United States	92	93	Pakistan	37	34
Global average	**66**	**66**	Sri Lanka	91	92
			South Asian average	**60**	**61**

Source: World Bank, World Development Indicators, https://datatopics.worldbank.org/world-development-indicators.
Note: The net enrollment ratio is the number of children of official school age who are enrolled in school relative to the population of the corresponding official school age.

with 4 percent to 6 percent where such communities comprise the majority. Nationwide, school enrollment decreases substantially from age 14 onward, especially in rural districts. Overall, the net secondary enrollment ratio is 62 percent.

- In Afghanistan and Pakistan, secondary school enrollment is low, especially for females.
- In Sri Lanka, the net secondary enrollment ratio is 91–92 percent, with no significant gender differences. Still, there are differences by region and income group, with males from the poorest quintile having a notably higher dropout rate than females. Males also tend to repeat secondary school grades more often.

The 2019 TIMSS assessment also considered mathematics and science achievement in grade 8 for 39 countries. For mathematics, 26 countries had no gender difference, males outperformed females in 6 countries, and females outperformed males in 7 countries. For science, 18 countries had no gender gap, while in 15 countries, girls outperformed boys and in 6 boys outperformed girls. These results indicate that relative to grade 4, girls maintain or even increase their performance relative to boys as they progress through the education system.

The TIMSS assessment also investigated access to and use of technology in mathematics and science education. Access to computers measurably improved performance, although such access might indicate access to other resources that can also affect performance (Mullis et al. 2020). Use of computers in the classroom had a small impact on achievement, although most students reported that teachers never or almost never used computers in the classroom.

Across South Asia, limited data on mathematics and science achievement are available at the lower secondary level, that is, for ages with a common science curriculum for all students:

- In India in grades 8 and 10, males and females appear to perform equivalently on mathematics and science, but scores for both are below those for other subjects (National Council of Educational Research and Training, 2020 and 2021).
- In Nepal, males outperform females in mathematics and science in grades 8 and 10, reversing the results seen in grade 5.
- In Sri Lanka, females in grade 8 outperform males on mathematics and science, though both have improved since 2012. At the General Certificate of Education Ordinary Level, typically taken at ages 15–16, 76 percent of females received a passing grade compared with just 58 percent of males. For science, the pass rates are 69 percent for females and 63 percent for males, and for mathematics 56 percent and 47 percent, respectively. Pass rates for both subjects are lower than for other subjects. Given that Sri Lankan students must pass the General Certificate of Education Ordinary Level to advance to the collegiate (upper secondary) level, these results indicate that more females are eligible to pursue STEM tracks as they progress through the education system.

TABLE 2.3 Normalized Education Data in South Asia, 2020

	Expected years of schooling		Harmonized test scores		Learning-adjusted years of schooling	
Country	Total	Girls	Total	Girls	Total	Girls
Afghanistan	8.9	6.9	355	350	5.1	3.9
Bangladesh	10.2	10.5	368	370	6.0	6.2
Bhutan	10.2	10.7	387	370	6.3	6.3
India	11.1	11.2	399	399	7.1	7.2
Nepal	12.3	12.2	369	—	7.2	—
Pakistan	9.4	8.7	339	343	5.1	4.8
Sri Lanka	13.2	13.2	400	—	8.5	—

Source: World Bank, Human Capital Index, 2020.
Note: — = not available. No data are available for Maldives on harmonized test scores and learning-adjusted years of schooling.

- In Bhutan in 2017, females outperformed males in reading, males outperformed females in mathematics, and there were no significant differences in science according to PISA for Development (PISA-D), the initiative by the Program for International Student Assessment that evaluates education systems in low- and middle-income countries, focusing on 15-year-old students and their knowledge of reading, mathematics, and science. Although Bhutan's scores were below the averages for the regular PISA, in which no South Asian country has participated in recent years, they exceeded the averages for the eight other countries participating in the PISA-D. In mathematics and science, Bhutan's scores were the second highest, trailing only Ecuador (Bhutan Council for School Examinations and Assessment and OECD 2019).

Before focusing on STEM opportunities at the upper secondary level, it is worthwhile to consider general learning within the South Asia region. The education data underpinning the World Bank Human Capital Index[4] provide important insights with respect to the expected years of schooling, harmonized test scores calculated to provide a global measure of achievement, and learning-adjusted years of school (table 2.3).[4] The results indicate that although there has been substantial progress in school enrollment, there is considerable room for improvement in teaching and learning across the region.

Upper Secondary Education

Globally, students in upper secondary education (age 12–17) often begin to focus on pursuing higher education or entering the workforce. Many countries offer some choice between an arts and humanities, commerce, or science stream. Some countries encourage students to choose from a more diverse set of individual classes.

Mathematics education typically varies based on progress toward calculus classes. Education can also focus on science areas, such as biology, chemistry, and physics, but also extend to more interdisciplinary studies, such as environmental science. For STEM, some countries also offer such classes as computer science, design, and engineering.

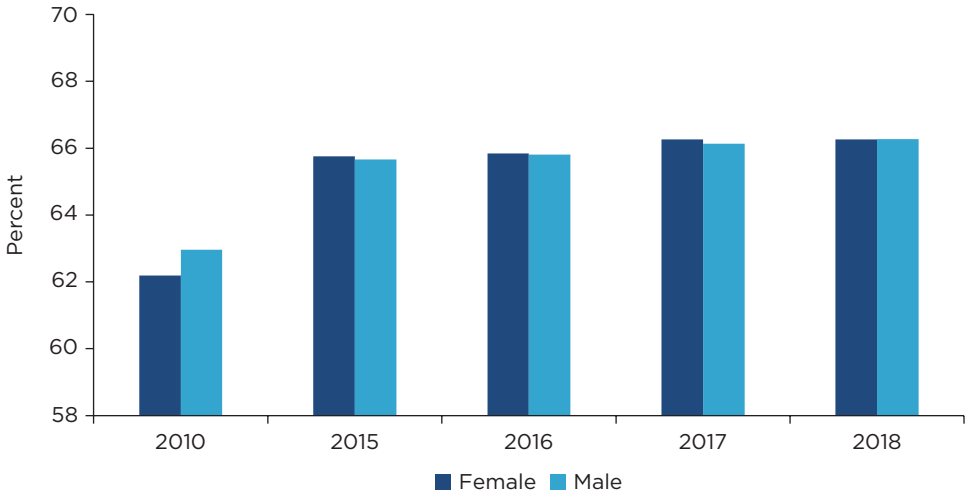
Moreover, many countries allow interested students to enroll in vocational training at ages associated with upper secondary education. For instance, in Nepal grade 10 graduates can take a year and a half to two years of vocational training. Bhutan also introduces students to a technical and vocational education and training (TVET) curriculum in its mainstream education system, from pre-primary to grade 12.

Given the range of offerings, enrollment data for upper secondary education are hard to generalize. Globally, the number of out-of-school children at this age (12–17) dropped from 175 million in 2000 to 132 million in 2020 (UNICEF 2022). During this period, upper secondary enrollment for females increased substantially, and globally it is now on par with that of males (figure 2.5).

Completion rates are an important indicator of achievement. Globally, just 72 percent of students who start an upper secondary education program complete it on time (OECD 2020). The completion rate rises to 81 percent two years after the on-time completion date. Students in general academic programs have a much higher completion rate than those in vocational programs, perhaps indicating that students tracked to vocational education are less academically inclined or prepared because of inequities at lower education levels. In addition, females are more likely to complete upper secondary education.

By the time students reach upper secondary education, males and females have different perceptions about STEM careers, though perceptions of gender, science, and even

FIGURE 2.5 Net Enrollment in Upper Secondary School, Global



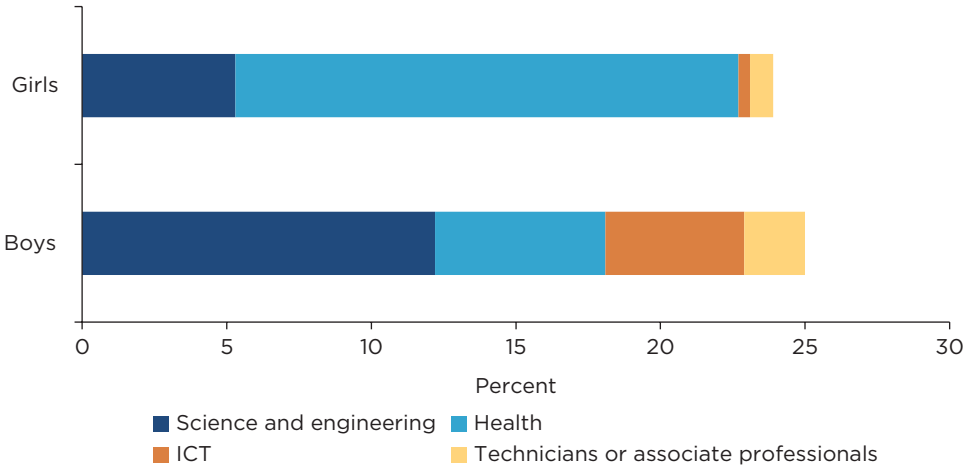
Source: UNESCO Institute for Statistics 2020.

potential STEM careers start much earlier in childhood. A 2015 survey (OECD 2016) found that a quarter of 15-year-old boys and girls anticipated a career in a science-related discipline (figure 2.6), but there was a stark breakdown in the types of careers envisioned. Nearly three-quarters of girls anticipated a career in health care, whereas fewer than a quarter were focused on science or engineering. By contrast, nearly half of boys anticipated a career in science or engineering, a quarter in health care, and a fifth in information and communication technology. (Interest in information and communication technology has likely increased since the onset of COVID-19 in 2020.) These numbers are reflected in STEM enrollment in higher education. In TVET, 8 percent of males were focused on STEM positions—nearly three times the share of females (OECD 2016).

The TIMSS advanced assessment provides one, albeit limited, global analysis of enrollment and achievement in advanced mathematics and advanced physics in the final year of upper secondary school in nine countries. In mathematics, six countries had more males enrolled; just two had more females. In six countries, males outperformed females. Similar trends were observed for physics, where more males were enrolled in all nine countries, and males outperformed females in eight (Meinck and Brese 2019).

In 2019, for the first time, more females than males in the United Kingdom took A-level science examinations (conducted in the final years of upper secondary school) (Guardian News and Media 2019). Upon closer examination, however, 63 percent of those females took biology and chemistry examinations—likely reflecting a preference for health care careers—whereas only 23 percent took physics examinations (typically associated with engineering). Similar trends are evident with advanced placement examinations in the United States.

FIGURE 2.6 Differences between Girls and Boys in Expected Careers in South Asia, 2014



Source: Adapted from World Bank, World Development Indicators, https://datatopics.worldbank.org/world-development-indicators.
Note: The countries of South Asia are: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. ICT = information and communication technology.

South Asia's enrollment for upper secondary education shows a continued, accelerated decline relative to lower secondary enrollment across the countries (Government of India Ministry of Education, 2017). In Central Asia and South Asia, half of young people of upper secondary age—69 million potential students—are out of school.[5] National enrollment in the region also shows significant variation:

- In Bangladesh in 2018, there were 7.1 million out-of-school youth of upper secondary age, or 3.5 times the number out of lower secondary school. About a fifth of females and males dropped out of upper secondary school; the share has halved in the past decade.
- In Bhutan in 2019, 5 percent more girls than boys were enrolled in upper secondary school.
- In India, in rural areas, the number of primary to upper secondary level schools is decreasing, while the distance to schools is increasing. However, school enrollment is also increasing.
- In Maldives, a reflection of enrollment in STEM disciplines is that some 7,200 boys and girls took A-level examinations after grade 12 in 2019, yet only 676 took the mathematics examination and 613 took the physics examination. This indicates limited emphasis on STEM disciplines.
- In Nepal in 2019, 54 percent of the nearly 600,000 students in grades 11–12 were girls, up from 47 percent in 2015.
- In Pakistan in 2017, there were 9.8 million out-of-school youth of upper secondary age, almost twice the number not enrolled in lower secondary school.
- In Sri Lanka in 2019, 56 percent of females were enrolled at the upper secondary level (grades 12–13).

Across South Asia, upper secondary school is where students approach their studies based on their interests and skills. Upper secondary grades offer tracks that may include STEM, arts and humanities, and commerce. Some countries in the region also have tracks dedicated to vocational training at this age.

The transition to upper secondary school is perhaps indicative of the biggest gender gap in STEM. However, this transition might not reflect a divergence in attitudes toward STEM among females and males—and their parents—because tracks for STEM, arts and humanities, and commerce only become available at this point. The data clearly show that upper secondary school is the point at which females are underrepresented in STEM subjects, but interventions for STEM education need to happen much earlier, at the primary level. Moreover, because females interested in health careers are likely to pursue the science stream, the female talent pool available for nonhealth STEM higher education and careers is probably much smaller.

The underrepresentation of girls in upper secondary science streams across South Asia is a concern because, as noted, most females pursuing STEM fields are interested in health careers—amplifying the leaky pipeline in engineering.

Female enrollment in upper secondary education shows the following:

- In Bangladesh in 2019, 20 percent of females took the Higher Secondary Certificate Science and Home Economics examination, compared with 26 percent of males. Between 2018 and 2020, there was a 10 percent increase in the number of females taking the examination. More data are needed to assess whether this increase can be maintained.
- In Bhutan in 2021, 16 percent of females and 21 percent of males (of 1,138 students) chose the science stream. Female enrollment in STEM courses was higher than male enrollment in biology (767 girls enrolled) and environmental science (225 girls enrolled); the higher enrollment in biology reflects a preference for health-related careers.
- In India, upper secondary schools exhibit significant variations in STEM streams (Ramachandran and Shukla 2021). Across the country, 30 percent of upper secondary students choose the science stream. Science streams are often oversubscribed, and access depends on interest and examination scores. Coupled with a lack of science tracks in many secondary schools and extensive private coaching for students who can afford it, access to science in upper secondary education is heavily dependent on students' location (urban or rural) and socioeconomic status. These challenges significantly affect diversity in STEM education and careers for both sexes. Box 2.1 provides an example from the state of Tamil Nadu.
- In Maldives, on average 10 percent of graduates take the mathematics and physics A-level examination.
- In Nepal, on average females account for 38 percent of the science stream.
- In Sri Lanka, extensive data have been collected on STEM tracks at the upper secondary (collegiate) level. In 2019, a third of students pursued such tracks (biological science, physical science, biotechnology, and engineering technology), with 41 percent of males and 27 percent of females doing so. Of the 62,000 females

BOX 2.1 Access to Science Track in Tamil Nadu, India

The state government of Tamil Nadu, India, provides greater access to science tracks compared to other states in India. Unlike some other states in India—and countries in South Asia and around the world—admission is based not on examination results but on student preferences. As a result, 60 percent of upper secondary students in Tamil Nadu choose a science track, with a larger share of females doing so. This access-driven model could increase the number of girls who pursue STEM careers.

Source: Ramachandran and Shukla 2021.

who chose STEM tracks, half pursued biological science—2.5 times the number of males. Many of these students will likely choose further study (and careers) in health. Another 17,200 females chose physical science, 9,300 selected biotechnology, and just 4,000 (fewer than 2 percent of female enrollees) preferred engineering technology. These data demonstrate the leaky pipeline for females with the prerequisites to pursue, for example, engineering degrees at university, but do not do so. By contrast, 52 percent of females chose the arts track.

Students who choose or are admitted to a STEM track in upper secondary school would generally be expected to be high achieving. Though limited data are available across South Asia, secondary school exit examinations provide insights for some countries:

- In Bhutan in 2021, 97 percent of students in the science stream passed final examinations, including 98 percent of females and 96 percent of males—exceeding the 90 percent national average passing rate, which included arts and commerce. For individual STEM subjects, pass rates for males and females exceeded 94 percent for biology, chemistry, physics, computer studies, and environmental science. The pass rates were lower for mathematics: 79 percent for males and 81 percent for females.
- In Sri Lanka, students can sign up for the General Certificate in Education Advanced Level examinations after two years of the collegiate track. Students take three subject matter examinations. Nationally, 40 percent more females pass all three examinations, more females obtain three A scores, and more males fail all three examinations. STEM pass rates are typically lower than for non-STEM courses. A slightly larger share of males pass the chemistry and physics examinations, whereas females do much better on the biology and combined mathematics examinations.

Tertiary Education

Over the next few years, about half of people under age 25 will begin tertiary education in Organisation for Economic Co-operation and Development (OECD) countries. Most will enter programs for bachelor's degrees, followed by short-cycle programs (OECD, European Union, and UNESCO Institute for Statistics 2015).[6] In OECD countries where short-cycle programs provide training for health and education, most enrollees are women. Conversely, where most labor market demand for short-cycle training is in nonhealth STEM disciplines—such as engineering, manufacturing, and construction—men account for the majority of enrollees (OECD 2021). But about 58 percent of first-time tertiary graduates in OECD countries are women, and women have higher graduation rates.

Globally, 37 percent of university students pursue STEM degrees, with nearly 40 percent of those in health-related courses (UNECE 2022). Male and female enrollment in the broad STEM classifications have varied widely (table 2.4). The fact that

many women are pursuing university degrees in health disciplines is a success story, but they are underrepresented in nonhealth STEM programs; overall, women's enrollment in STEM is relatively small. These global trends reinforce the need for early interventions to foster females' interest in engineering.

It is hard to estimate national data on the number of graduates in engineering disciplines, including women, but US data provide a reference point. The 10 disciplines shown in table 2.5 cover 90 percent of female engineering graduates in the United States in 2019. Engineering disciplines associated with health and environmental careers

TABLE 2.4 University Enrollment in STEM, by Total and Female, Global

Percentage of female enrollment

Discipline	Category	World	Canada	France	Germany	United Kingdom
Engineering, manufacturing, and construction	Total	13	11.3	13.6	20.7	9.2
	Female	*8*	*4.4*	*6.4*	*9.2*	*3.4*
Health and welfare	Total	14	15.1	15.5	7.3	16.2
	Female	*15*	*21.4*	*20.7*	*10.3*	*21.6*
ICT	Total	5	4.0	2.8	6.5	4.3
	Female	*3*	*1.3*	*0.8*	*2.7*	*1.3*
Natural sciences, mathematics, and statistics	Total	5	11.0	9.7	10.2	14.9
	Female	*13*	*10.5*	*7.6*	*9.6*	*14.0*

Source: UNECE 2015.
Note: STEM = science, technology, engineering, and mathematics; ICT = information and communication technology.

TABLE 2.5 Share of Female Graduates at the Bachelor's Level in Engineering in the United States, 2019

Discipline	Total	Share of engineering (%)	Share that is female (%)
Biomedical	7,130	5.2	45.4
Chemical	11,586	8.5	35.4
Civil	12,221	9.0	25.9
Computer engineering	7,906	5.8	13.3
Computer science	10,398	7.6	18.5
Computer science (in engineering)	19,082	14.0	17.4
Electrical	13,767	10.1	14.2
Environmental	1,288	0.9	50.6
Industrial	6,690	4.9	32.3
Mechanical	31,936	23.4	14.8

Source: ASEE 2020.

had the highest shares of female students. About 22 percent of engineering graduates with bachelor's degrees were female. The share of females enrolled in undergraduate engineering and technology programs is 29 percent (Government of India Ministry of Education, 2020, 2021)—but just 12 percent in Japan and 13 percent in Taiwan, China.

Technical and Vocational Education and Training

Skills training is an essential part of education opportunities around the world. However, implementation varies dramatically, and there are substantial age variations and educational backgrounds among those who enroll in these programs. In many countries, TVET is considered less desirable than traditional upper secondary or university education, especially for wealthier individuals. It is often viewed as being geared toward males and trades. Entrance requirements vary substantially, and the variation in types of programs—certificate, diploma, and so on—makes them difficult to compare or determine equivalence.

In many countries, TVET offerings include a number of technical and STEM-based programs. For that reason, TVET is important in the education value chain and for gender-based consideration in STEM education and employment.

In South Asia, the opportunities available through TVET programs vary dramatically. Students can enroll in TVET instead of attending upper secondary school or return to training programs later in life.

- In Bangladesh, the number of TVET institutions and overall enrollment has more than doubled since 2010. The government aims to increase female enrollment in TVET programs to 40 percent of the total, but in 2019 there were approximately 280,000 women in such programs—about 25 percent of the total.
- In Bhutan most TVET programs focus on STEM disciplines, often for students who do not receive scholarships for university. The country's six technical training institutes and two institutes for traditional arts offer 86 courses; the top 3 involve electrical, masonry, and automobile subjects. Nearly a third of the 1,700 TVET students are female.
- In India which has extensive TVET, between 2000 and 2019, the number of industrial training institutes almost quadrupled, to 16,000, with 80 percent of them private. Some 3.4 million students are enrolled in the institutes, though only 11 percent are female (Government of India, 2016).
- In Nepal, the TVET system caters primarily to young people and to adult workers who were unable to attend formal schooling or are out of the system. TVET is seen as a less attractive choice rather than as an integral part of a diverse education portfolio. In recent years, the system's capacity has increased, and although enrollment numbers have grown, enrollment as a share of capacity has lagged. In engineering diploma programs, enrollment more than doubled between 2015 and 2019, reaching 8,655. During this period, the share of women in engineering programs rose from 12.5 percent to 17.5 percent—equivalent to an additional 1,000 enrollees.

- In Sri Lanka, the TVET system jumped from 140,000 students in 2016 to more than 250,000 in 2019, reflecting the government's new policy, beginning in 2018, of free TVET education. STEM programs accounted for more than 60 percent of TVET enrollment in 2019, but women accounted for just 38 percent of STEM enrollment. Still, overall, 53 percent of women enrolled in TVET are in STEM programs.

University Education

University graduates in STEM fields, particularly engineers, are essential for strong socioeconomic development. However, there is significant unmet demand for engineers across disciplines and countries (Royal Academy of Engineering 2019). Further, employers bemoan the lack of preparedness of graduates to fill open STEM positions.

The quality of STEM graduates depends on the quality of their university programs, and their preparedness for university education depends on their primary and secondary education. Although not all STEM university graduates end up in STEM careers, there is often an imbalance between the number of available STEM graduates and a greater number of STEM positions in a country. Further, the graduates who are available lack the quality of education that would ensure their retention. University STEM programs also need to develop in students both the STEM and the soft skills needed to succeed in the STEM workplace:

- Bangladesh, where higher education includes universities and tertiary colleges affiliated with universities, had 135 universities enrolling 860,000 students and 1,862 tertiary colleges enrolling 1.8 million students in 2017, a sharp increase from 2010, when enrollment totaled 1.47 million students. Though the gender parity index improved from 0.39 in 2010 to 0.49 in 2015 for universities, and from 0.68 to 0.77 for tertiary colleges, these ratios are still far below parity. Given the strong performance of girls in higher secondary education, significant barriers to female participation remain in higher education. Nearly half of university students study STEM disciplines, including those related to health. In tertiary colleges that share is just 9 percent.
- Bhutan had about 13,000 students enrolled in colleges and universities in 2019, up 40 percent from 2014. In recent years, the gender parity index has approached 1. In addition, many students pursue degrees overseas. About 40 percent of upper secondary graduates enroll in higher education, but disparities are found in STEM disciplines, where 41 percent of students are female (when health disciplines are subtracted). In engineering and construction, 32 percent of 2,832 students are female. In mathematics and statistics, 55 percent of 110 students are female, and in natural sciences, 56 percent of 111 students are female.
- India has 27.2 million undergraduates in higher education, 47 percent of whom are women. About 17 percent of undergraduates are studying science disciplines (48 percent of them women), 15 percent engineering and technology (28 percent

women), and 2 percent information technology and computer science (42 percent women) (Government of India Ministry of Education, 2019a). These are huge numbers. After China, India graduates the most engineers in the world, and its percentages of women are comparable to STEM powerhouses among them Japan; Taiwan, China; and the United States—and better than global averages (National Science Board 2018). India also maintains data on engineering disciplines. Whereas 52 percent of males study the traditional disciplines of mechanical, civil, and electrical engineering, just 24 percent of females do. However, whereas about 36 percent of males study electronics engineering, computer engineering, and information technology, 63 percent of females focus on these disciplines (Government of India Ministry of Education, 2017).

- Maldives, through Maldives National University, offers undergraduate degrees in civil engineering, computer science, information technology, marine science, and environmental management.
- Nepal has about 400,000 undergraduates, and 54 percent are female. However, of the nearly 30,000 students studying engineering, only 17 percent are female. In science and technology disciplines, that share is 36 percent. One of the factors contributing to this gender imbalance is that many female students attend community campuses in rural locations, most of which do not offer STEM disciplines. But even at constituent and private universities, female participation in STEM significantly lags behind that of males.
- Pakistan has about 1.6 million students enrolled in higher education, 44 percent of whom are female. Some 133,000 are studying engineering and technology at the undergraduate level—just 12 percent of whom are female. Computing enrolls 137,000 students, 25 percent of them female. By contrast, of the 100,000 studying medical subjects, 63 percent are female. These trends are representative of South Asia as a whole.
- Sri Lanka has 128,000 undergraduates enrolled in 15 state-supported universities. Another 21 nonstate higher education institutions offer programs. Nearly half of all students in both state- and nonstate-supported institutions study STEM courses (including in health) at state universities, of which 22 percent are males and 27 percent are females. Most nonstate institutions focus on information and communication technology, health sciences, and other STEM disciplines.

Higher education is increasingly a global endeavor for South Asian students, who often pursue degrees overseas. The region has relatively few incoming university students, with only India (49,348) and Sri Lanka (1,306) having measurable numbers. However, student outflow is considerable. Top destinations include Australia, Canada, Japan, Malaysia, the United Kingdom, and the United States. Not surprisingly, India has the largest outflow of students (461,792), followed by Nepal (93,921), Pakistan (59,784), and Bangladesh (44,338) (UNESCO Institute for Statistics 2021a).

The Global STEM Labor Market

Globally, three-quarters of men and just under half of women were participating in the labor force (ILO 2017). Unemployment rates for women have been consistently above those for men. In 2017, the global share of women in wage and salaried employment marginally exceeded that of men. That share, however, is highly dependent on economic development, with developing countries having much lower wage and salaried employment, especially for women (14 percent versus 24 percent of men), and the gap is widening in developing countries. Though part-time employment may offer flexibility, women are more likely to be employed part-time both by choice and involuntarily. Gender-based pay gaps persist, and in developed countries this gap widens at higher levels.

There is no consistent definition of what a "STEM career" is, making it especially hard to assess women's representation in the STEM workforce and draw broad conclusions. Despite the availability of some national data, there are few national, regional, or global research reports on STEM employment.

About 5 percent of the US workforce is in science and engineering jobs that require at least a bachelor's STEM degree, and many other laborers with science and engineering training work outside STEM fields. Another 20 percent of the workforce without a bachelor's degree works in science and engineering fields (box 2.2).

Though 52 percent of the US college-educated workforce is female, only 30 percent of the STEM workforce is. In 2017, women in the United States accounted for 29 percent of physical scientists, 27 percent of computer and mathematical scientists, and just 16 percent of engineers. By contrast, women make up 70 percent of the health workforce and 48 percent of workers in life sciences with a bachelor's or higher degree (National Science Board 2018).

In Europe, about only about 2 percent of jobs in 2014 required a science and engineering professional degree, and another 5 percent an associate professional degree. About 41 percent of scientists and engineers in Europe were women (EU Skills Panorama 2014). However, the current growth rate exceeds that for men. In both Europe and the United States, the growth rates for jobs requiring STEM capabilities exceed those for non-STEM employment.

BOX 2.2 STEM Workers without Bachelor's Degrees

The US National Science Foundation has proposed greater reporting on STEM workers who do not have a STEM bachelor's (or higher) degree. Skilled technical workers require extensive technical knowledge but not a bachelor's degree. These include mechanics; construction, extraction, and production workers; and installation, maintenance, and repair workers.

Source: National Science Board 2018.

In most countries, the majority of STEM workers do not have a bachelor's (or higher) degree. Skilled STEM workers, many with TVET credentials, are essential for any science- and technology-driven economy.

Beyond the traditional scope of a STEM career, the need for digital skills at work has received increased attention. Most new jobs will require such skills, and even existing ones require digital competence. Regardless of actual capability, women usually report less confidence and ability in their information and communication technology skills (Gebhardt et al. 2019).

Globally, there is broad interest in strengthening female representation in STEM careers, as manifested through extensive research and activities in the European Union, the United States, and many other regions and countries. In South Asia, too, there is growing interest among girls and women in participating in STEM education, but again, it is difficult to obtain detailed data on types of STEM work, levels of education acquired and required, age, seniority, and management levels.

The South Asian STEM Labor Market

As elsewhere, in South Asia a smaller share of working-age women than men is in the STEM workforce even though females do well in STEM-related studies. Indeed, gender disparities in labor force participation tend to be wider in the region (table 2.6).

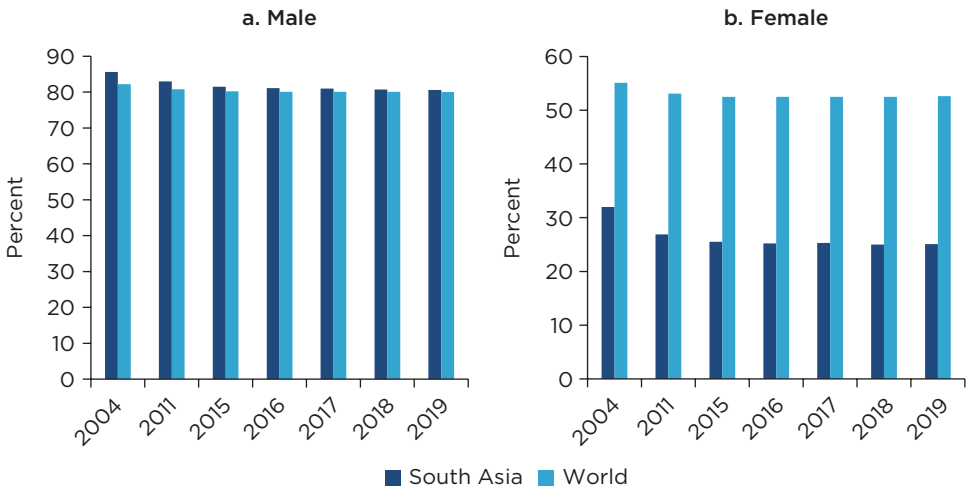
In general, men's participation in South Asia's labor force mirrors global trends (figure 2.7, panel a). However, other than in Bhutan and Maldives, female participation rates in the region are far below the global average (figure 2.7, panel b). Although the

TABLE 2.6 Labor Force Participation Rate in Countries in South Asia and the World, 2019

Place	Male (%)	Female (%)
Afghanistan	66.8	22.0
Bangladesh	80.7	36.0
Bhutan	71.2	61.0
India	74.4	23.0
Maldives	78.5	46.8
Nepal	53.8	26.0
Pakistan	80.3	22.0
Sri Lanka	72.9	35.0
World	75.8	47.3

Source: International Labour Organization, ILOSTAT database, https://ilostat.ilo.org/data.
Note: The latest data for Maldives are for 2014.

FIGURE 2.7 Labor Force Participation Rate in South Asia and the World



Source: International Labour Organization, ILOSTAT database, https://ilostat.ilo.org/data.
Note: The figures show the labor force participation rate as the share of the male and female population age 15–64 (modeled ILO estimate).

female participation rate has increased in recent years for most countries in the region, in India and Sri Lanka it is low.

Unemployment rates also provide insights into the labor market and further reflect the underrepresentation of women in the workforce, including in STEM disciplines:

- For 2017, Bangladesh's overall unemployment rate was 4.2 percent; however, it was 14.9 percent for people with higher secondary qualifications and 11.2 percent for those with tertiary degrees. At all levels, unemployment rates were higher for women: 26.2 percent for higher secondary graduates and 21.4 percent for those with tertiary degrees.
- For 2018–19, Bhutan's overall unemployment rate was 3.4 percent. For people with upper secondary qualifications, however, it was 8.9 percent, and for those with a bachelor's degree, 13 percent. Whereas 70 percent of men with TVET credentials were employed, only 39 percent of similarly qualified women were—a stark difference.
- For 2019–20, India's unemployment rate was 5 percent for men and 4.2 percent for women (Wheebox, 2021). For all levels of education, a larger share of men were employed. For example, 56 percent of men with a higher secondary education were in the labor force compared with 16 percent of women. Among those with undergraduate degrees, 70 percent of men were in the labor force compared with just 24 percent of women. The differences were smaller for TVET, with 73 percent of men and 38 percent of women in the workforce.

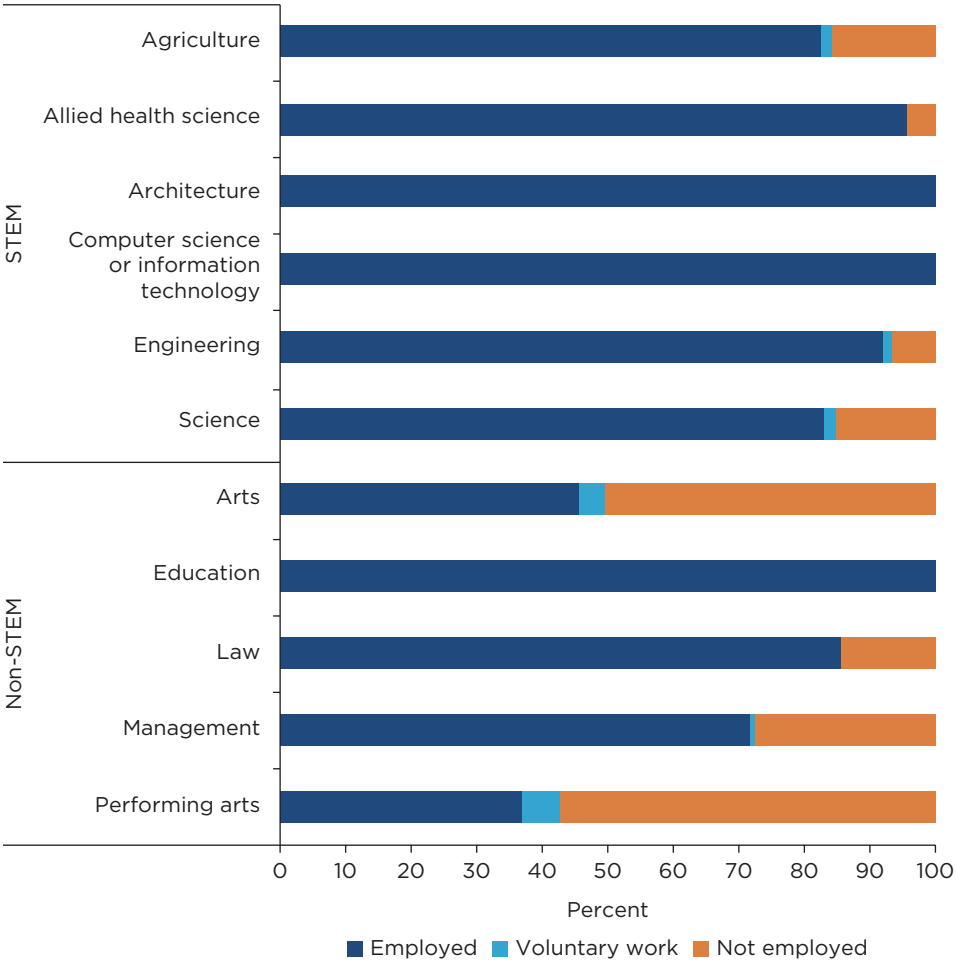
- For 2014, Maldives' unemployment rate was 5.9 percent for women and 4.8 percent for men. However, the unemployment rate for women was a vast improvement from 2009, when it stood at 23.7 percent.
- In 2018, Nepal's unemployment rate was 13.1 percent for women and 10.3 percent for men.

Although consistent, detailed data on employment and the level of education associated with jobs in specific sectors are difficult to find globally and across South Asia, some insights can be gleaned from available data in some countries:

- Bangladesh, a national labor market survey revealed, has a larger share of women than men work in STEM-focused careers. Sixty percent of them, however, work in skilled agriculture, forestry, and fishing, which often might not require formal credentials, would not typically be classified as STEM or skilled technical employment, and includes market-oriented agricultural workers and subsistence farmers. About 15 percent of employed women work in manufacturing, primarily in the ready-made garment sector. Women account for just 15 percent of "technicians and associates" and 35 percent of "professionals," which includes both STEM and non-STEM careers.
- Bhutan had 340,000 workers in 2017, with 50 percent in agriculture, 12 percent in industry, and 37 percent in services. The government employs about a fifth of the workforce. Just 6 percent of the labor force holds university degrees, 35 percent of which are women. About 8,000 people are projected to enter the workforce each year, most of them better educated than previous generations. However, with 4,000 tertiary graduates a year, there is a significant mismatch between qualifications and available positions for Bhutan's most highly educated. This disparity is likely to affect women university graduates more than men. And though Bhutan has South Asia's highest share of women in the workforce, women remain underrepresented in managerial, professional, and technical occupations—those most likely to include STEM fields. In 2020, about 1,100 women with a bachelor's degree or higher were employed in STEM jobs, along with 765 employed in wholesale and retail trade and repair of motor vehicles and motorcycles.
- India, commensurate with its population and size, has South Asia's largest labor market. Every year, a large number of people graduate from vocational and university STEM programs. However, the share of those 15 years and over with technical credentials is small given the size of the country and is lower in rural areas relative to urban areas. Indeed, even in the information technology field, Indian companies were unable to recruit 140,000 graduates in 2018, equivalent to 30 percent of the need (Jaffrelot and Jumle, 2019).

- Maldives had a workforce of 145,000 in 2014, but expatriates—primarily from Bangladesh, India, and Sri Lanka—accounted for a large share of this workforce. For example, 40,000–50,000 expatriates were working in construction. The travel and tourism sector provided 34,500 jobs, but the lack of highly skilled Maldivians threatens long-term economic development (ILO, n.d.).
- Nepal has a relatively low overall labor force participation rate, and women account for only about a third of the labor force. Three-quarters of men age 25–45 are in the labor force, compared with just one-fifth of women age 25–34. This is especially

FIGURE 2.8 Employment of STEM and Non-STEM University Graduates in Sri Lanka, 2018



Source: Democratic Socialist Republic of Sri Lanka 2018.
Note: STEM = science, technology, engineering, and mathematics.

striking given that more women (229,961) than men (211,858) are enrolled in the country's tertiary education system. Although perhaps partly due to family considerations, the lack of workforce participation by highly educated women represents a significant deadweight loss for the economy; even though about 37 percent of women age 35–44 are in the workforce, many university graduates do not take up long-term careers. About 8 percent of the population in the workforce works in STEM fields, and 27 percent of STEM jobs are held by university graduates compared with 11 percent for non-STEM jobs. But women make up just 22 percent of the STEM workforce. Nepal's data on gender differences in salaries show that, on average, women earn 70 percent of what men do, even among highly skilled STEM workers.[7] The data indicate that advanced skills do not pay off in higher wages for highly educated women interested in STEM careers.

- In 2019, Sri Lanka had a workforce of 8.1 million women, constituting one-third of the total labor force. About 45 percent of the workforce is in STEM careers (30 percent of males and 15 percent of females), and the gender ratio equals that of the overall workforce. Data from 2018 indicate that university graduates in STEM and education disciplines had higher employment rates than those in non-STEM disciplines (figure 2.8).

Notes

1. UNESCO Institute for Statistics (UIS) database, data as of September 2021, http://data.uis.unesco.org/.
2. Here and throughout this chapter, unless otherwise indicated, all country data for South Asia are drawn from the country background papers prepared for this report. Summary notes and infographics for each country are presented in the appendix.
3. UIS database, data as of February 2020.
4. Human Capital Index, https://data.worldbank.org/indicator/HD.HCI.OVRL.
5. UIS database, data as of September 2021.
6. "*ISCED 2011 Level 5*: Short-cycle tertiary education. The content of ISCED level 5 programmes is noticeably more complex than in upper secondary programme(s) giving access to this level. ISCED level 5 programmes serve to deepen knowledge by imparting new techniques, concepts and ideas not generally covered in upper secondary education (whereas ISCED level 4 programmes serve to broaden knowledge and are typically not significantly more advanced than programmes at ISCED level 3). Programmes classified at ISCED level 5 may be referred in many ways, for example: higher education, community college education, technician or advanced/higher vocational training, associate degree, back+2. For international comparability purposes, the term 'short-cycle tertiary education' is used to label ISCED level 5" (OECD 2015).
7. Calculations for this publication used data from the 2017/18 national labor force survey.

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CHAPTER 3

Key Observations from South Asia

Introduction

This chapter summarizes key observations on science, technology, engineering, and mathematics (STEM) education and employment in South Asia, with a focus on gender considerations.

Primary and Secondary Education

- South Asian countries have made major advances in school enrollment in recent decades, and the gap in the gender parity index has narrowed significantly.
- Though there continues to be attrition in enrollment as children reach secondary school age, girls' dropout rates have fallen substantially.
- Boys and girls perform at similar levels academically, including in mathematics and science for all age groups in many countries in South Asia.
- Focused science and mathematics tracks typically become available in upper secondary education, but the availability and quality of these tracks vary considerably by country.
- Girls are underrepresented in science and mathematics tracks in upper secondary education, reflecting a lack of access to and less interest than boys in STEM education and future careers. This phenomenon, observed globally, is sometimes referred to as the "leaky pipeline."
- Girls in science tracks often focus on health careers, shrinking the female talent pool available for other STEM disciplines.

- Girls' performance in science tracks is similar to that of boys.
- The quality of teaching and learning—especially in science and mathematics—remains a concern. Where data are available, science and mathematics performance in South Asia lags behind global averages.

Technical and Vocational Education and Training

- Females are significantly underrepresented in technical and vocational education and training (TVET) programs in South Asia, as they are globally, with even wider disparities in STEM offerings across countries in the region.
- STEM-focused TVET is generally perceived as being geared toward males.
- A perception remains that TVET programs are a second-choice option for further education, yet globally, many STEM jobs require TVET skills.

University Education

- University enrollment in South Asia has jumped in recent years, and the region's gender parity index for universities is increasing.
- Women are underrepresented in engineering and technology disciplines. This trend continues the leaky pipeline observed in science tracks in upper secondary education and is coupled with large shares of female STEM undergraduates pursuing health-related degrees.
- Female enrollment in STEM fields varies by country in the region, but the overall trends are consistent with global trends.
- The quality of STEM education available to many university students is a concern to potential employers.
- Employers note a gap between the skills of university graduates and job requirements.

The Labor Market

- Significant disparity persists between South Asia and leading global economies in female labor force participation.
- The underrepresentation of females in the workforce exacerbates the STEM leaky pipeline observed in education.

- Better-educated women are less likely to work than those with less formal education. This indicates that fewer highly educated STEM graduates are working and amplifies the effect and implications of the leaky pipeline in South Asia.

A host of socioeconomic reasons explain why South Asian girls and women do not or cannot pursue STEM-related upper secondary, TVET, and university educations and careers. Those identified in annex 3A are drawn from the country notes prepared for this report, which assembled data based on secondary sources (see appendix). In some cases, the secondary sources represent data from primary sources. Thus, the data are the most proximately representative.

The Leaky Pipeline

The "leaky pipeline"—the consistent loss of girls' and women's potential STEM talent throughout the education system and continuing into the labor market—occurs globally, including in South Asia. It reduces the diversity of perspectives and insights that drive technical progress and economic development. In South Asia, the main leaks result from the following:

- *Low enrollment in science tracks in upper secondary education.* Girl's lower participation becomes evident here.
- *Limited pursuit of STEM programs in postsecondary education.* Men account for 75 percent of technical and vocational education and training students in STEM, and 70 percent of female undergraduate STEM students are in health sciences.
- *Poor workforce outcomes.* In many South Asian countries, women's labor force participation rates are much lower than men's. Similarly, South Asian women—especially more educated ones—tend to have higher unemployment rates.

Data for Bhutan, for example, demonstrate the leaky pipeline throughout undergraduate education as well as for employment in STEM disciplines requiring a bachelor's degree or higher (tables 3.1 and 3.2). At every transition point, the available talent pool shrinks considerably for both males and females, but for nonhealth STEM paths, it is especially clear for females beginning in upper secondary education. From then on, the attrition rate for females in STEM fields exceeds that for males.

Women are also significantly underrepresented in employment in Bhutan; labor force participation rates are 71 percent for men and 61 percent for women. In addition, there appears to be a mismatch between graduates and demand in several fields, as shown by a comparison of the number of bachelor's-level graduates with current employment in, for example, electrical engineering and information and communication technology. This mismatch has implications for retaining STEM workers, and especially for women's employment opportunities.

TABLE 3.1 STEM Education in Bhutan, by Gender, 2019

Level	Males	Females	Share male (%)	Share female (%)
Prior to university				
Entering primary school	6,500	6,500	50.0	50.0
Year 12 enrollment	6,200	6,700	48.1	51.9
Science track, upper secondary	1,301	1,138	53.3	46.7
Annual university degree				
Nonhealth	590	334	63.9	36.1
Health	225	210	51.7	48.3
Bachelor's degree				
Electrical engineering	24	12	66.7	33.3
Engineering	170	59	74.2	25.8
ICT	70	40	63.6	36.4
Power engineering	36	10	78.3	21.7

Source: World Bank data.
Note: ICT = information and communication technology; STEM = science, technology, engineering, and mathematics.

TABLE 3.2 STEM Careers Requiring a Bachelor's Degree in Bhutan, by Gender, 2019

STEM career	Males	Females	Share male (%)	Share female (%)
Construction	785	229	77.4	22.6
Electricity, gas, steam, air conditioning	372	130	74.1	25.9
Information and communication technology	517	189	73.2	26.8
Manufacturing	740	326	69.4	30.6
Mining	100	84	54.3	45.7
Professional, scientific, technical activities	424	131	76.4	23.6
Transportation	119	119	50.0	50.0
Water supply, sewers and waste management	60	25	70.6	29.4
Wholesale / retail trade, repair of motor vehicles	1,113	765	59.3	40.7

Source: World Bank data.

Annex 3A: Barriers to STEM Education and Careers for Girls and Women in South Asia

BANGLADESH

- Girls have a higher dropout rate after secondary school because of poverty, early marriage, and motherhood.
- The wide gap in the quality and accessibility of rural and urban schools means that rural girls have the fewest opportunities and lack the confidence to pursue science, technology, engineering, and mathematics (STEM).
- Fear of gender-based violence keeps girls out of school, especially in rural areas.
- There is a perception that even if girls are educated, they would still have limited livelihood opportunities, such as farming and manual labor.
- There are more male than female teachers, leaving a dearth of role models for girls and women. In technical and vocational education and training (TVET), male teachers are about four times more common.
- The shortage of teachers trained in STEM renders school lessons insufficient. Hence, some students turn to private coaching, an additional expense that most families are unable or unwilling to bear.
- There is a difference in competencies between urban and rural teachers, especially in STEM.
- Even though there are STEM jop opportunities, women make up only a small portion of the labor force, and unemployment is high among graduates.
- The cost of higher education is considered a major barrier to pursuing STEM.

BHUTAN

- Issues such as childbearing and child-rearing as well as perceptions that women are inferior deter women from joining STEM fields.
- Teenage pregnancy is high, preventing girls from taking up STEM education and careers.
- The absence of female teachers in rural schools adds to impediments to girls' STEM education.
- Rural schools have a limited supply of well-trained teachers.
- There are few STEM jobs in the labor market, so not many people choose to take STEM courses.
- Parents' economic status is a determining factor in girls' ability to pursue education, especially if they do not receive state-sponsored scholarships.

INDIA

- In rural areas, the challenges of fewer schools, increasing school size, and increasing travel distance to schools from primary to upper secondary levels are barriers to STEM education.
- In states where the government does not provide higher secondary schools, education is often too costly to permit matriculation.
- The low percentage of women professors in universities discourages women from enrolling.
- Subject specialist teachers are in short supply, especially in science and mathematics.
- Many students enroll in university, but mostly male students attend coaching centers that prepare students for the terminal examinations and also help them get ready for entrance examinations for professional courses in engineering, medicine, nursing, and teacher training. Such centers are not accessible to lower- and middle-income students, affecting their ability to pursue STEM.
- Few schools in tribal areas offer STEM courses in higher secondary education.
- Education is costly, especially extra coaching when government-supported schools are unavailable. These costs are decisive barriers for certain groups and marginalized populations.

NEPAL

- STEM institutions and opportunities in the labor market are dominated by males.
- Parents tend to withdraw support from women's pursuit of higher education because women are expected to marry early.
- Girls are not encouraged to pursue STEM because parents aspire to find highly educated men as husbands for their daughters, which might lead to higher dowries.
- Girls pursuing STEM education are considered a financial burden for the family.
- Female teachers being outnumbered by male teachers, particularly in STEM subjects, discourages girls from taking up certain subjects.
- Teachers are less well-trained in science and computer education than in other subject areas.
- Rural schools lack resources relative to urban schools.
- Most rural women attend higher education at community campuses near their villages, and these campuses do not offer STEM subjects.
- Parents' different social and economic expectations for girls and boys favor education for boys and a different path for girls.

MALDIVES

- Sociocultural factors, among them early marriage, limit women's pursuit of STEM educations and careers.
- The lack of role models in STEM fields discourages women from pursuing STEM when they enter tertiary education.
- Teachers are not sufficiently qualified and lack information related to STEM education.
- A lack of STEM teachers in general impedes females' access to STEM educations and careeers.
- Higher education opportunities and job opportunities in STEM fields are lacking.
- The cost of living forces young adults to enter the workforce as early as possible, making the pursuit of a full-time higher education degree an impossibility.

PAKISTAN

- Gender stereotypes mean that access to STEM education and certain trades are not acceptable for girls and women, especially in TVET.
- The absence of guidance and female role models, and dominance of male-centric values and sociocultural biases, hinder women from opting for STEM education.
- Insufficient numbers of teachers are trained in STEM subjects.
- Not having appropriate higher education institutions nearby means that girls, who are not allowed to travel far from home, cannot pursue STEM education.
- Enrollment in higher education decreases because it is unaffordable.

SRI LANKA

- Women's childcare and eldercare responsibilities hinder their participation in the labor force.
- Women lack role models who might encourage them and promote female participation in TVET.
- Low pay and limited career development opportunities have led to a serious shortage of TVET teachers, limiting role models for girls and career options for women.
- Female enrollment in STEM courses is often low because there is a perception that some occupations and trades are better suited to men.
- High enrollment costs for STEM education and high institutional energy costs reduce options offered to students.

CHAPTER 4

Potential Interventions for South Asia

Introduction

As female access to primary, secondary, and tertiary education increases across South Asia, the expectation is that more women will enter the workforce and pursue careers requiring more advanced skills—including those associated with science, technology, engineering, and mathematics (STEM)—and advance to leadership positions. It will, however, take time for that to happen. Moreover, the gender disparities between higher education enrollment and labor force participation rates indicate that deliberate policy interventions and cultural shifts will be required to bring greater balance to gender representation in STEM and other career fields.

Globally, several factors have been identified as contributing to female underrepresentation in STEM education and the STEM workforce, including family and peers, societal norms and pressures, and education considerations (UNESCO 2017). In many cases these factors are amplified in South Asia.

This report focuses on a more limited set of potential interventions for South Asia based on the analysis of regional trends, challenges, and capabilities covered in previous chapters. A strong pathway from STEM education to careers inherently depends on an integrated, systematic approach that provides students with the skills and motivations to pursue STEM fields and that explicitly focuses on addressing the "leaky pipeline" for girls and women that hinders the diversity crucial to a robust STEM sector. Education is assessed at different levels, from the basic level to the university level, and for underrepresented groups, including but not limited to gender. Further, suggestions are made for interventions regarding the labor market to strengthen female participation in STEM careers.

The three intervention points—designed for maximum impact to ease the attrition observed as girls and young women make decisions about their education, career, and life paths—are enrolling in upper primary and lower secondary education, planning for and enrolling in tertiary education, and entering and navigating their early years in the labor force.

Two types of interventions can be considered. First are those that can be implemented by interested stakeholders and that support inclusion in the STEM enterprise broadly, either in a particular country or across South Asia as a whole. One such stakeholder is the WePOWER initiative (see box 1.1); the recommendations can be adapted to any STEM sector or any interested stakeholder or actor. Second are those interventions that generally require the fuller engagement of governments than those by stakeholders. Though, in some instances, these interventions may be larger in scope and demand a fuller policy discussion requiring the involvement of stakeholders' interventions, they can build on stakeholder interventions, evidence developed from actions in the sector, and on global good practices.

Stakeholder Interventions

Stakeholder interventions can be executed at different scales, including by firms, nonprofits, nongovernmental organizations, and governments, and implemented locally, nationally, or regionally. Interventions around the world can be tailored to local audiences and circumstances.

Some versions of these actions are frequently attempted, including in South, but a coordinated intervention, with well-designed materials and evaluation processes, significantly increases the potential impact and the likelihood of adoption by stakeholders, STEM sectors, and even governments. Though the cost might be higher in financial and staff support, the resulting broader, more inclusive STEM workforce offers considerable benefits.

CORPORATE AND SECTORAL OUTREACH

At all levels of the education system, outreach from different actors in STEM can shape perceptions of STEM activities and careers for students and their parents. Health sciences, a readily acknowledged STEM career field, attracts a large number of women, but others do not. Systematic and standardized resources on STEM education, jobs, and careers, coupled with well-designed dissemination of them, can help develop female interest in STEM overall. Examples of such resources include the following:

- Multimedia aids, on STEM jobs and economic and societal benefits, developed by educators

- Role models, to offer guidance to students on topics such as educational expectations of potential employers, corporate benefits, and career paths
- Open houses and tours, showcasing local facilities, such as factories and power plants.

SUPPORT FOR STEM OUTREACH

By building relationships with students, stakeholders can build knowledge and human capacity in STEM by raising awareness of it outside the formal academic environment. Activities can include the following:

- After-school programs focused on STEM problem-solving
- Science fairs and competitions with coordination and judges provided by STEM stakeholders
- Summer camps and programs offering extracurricular STEM programs to interested and talented students.

SUPPORT FOR STEM IN PRIMARY AND SECONDARY EDUCATION

Although education and curricula are generally a government responsibility (see the example from Singapore in box 4.1), interested stakeholders can provide additional resources that support learning and align with teaching goals. Local and regional challenges offer a concrete path to teaching the importance and relevance of STEM to daily life. Examples include the following:

- Problem-based learning examples from STEM sectors and stakeholders
- Practical and lab exercises
- Field trips to demonstrate concepts taught in the classroom
- Science museums that connect classroom concepts to careers, business sectors, and societal challenges.

BOX 4.1 Singapore's Applied Learning Programme

In 2013, Singapore's Ministry of Education launched the science, technology, engineering, and mathematics–focused Applied Learning Programme, which encourages practical learning experiences and connects to current and anticipated societal and business needs. Schools can work with businesses to design curricula.

Source: Science Centre Singapore, https://www.science.edu.sg/stem-inc/applied-learning-programme/about-our-applied-learning-programme.

SUPPORT FOR STEM TEACHERS

High teacher quality and female STEM teachers help retain girls in STEM subjects. In addition to providing supplementary classroom materials as described in earlier chapters, stakeholders can provide resources and support teachers by doing the following:

- Offering mini-internships so teachers can learn more about STEM careers and stakeholders can showcase STEM applications and experiential learning
- Mentoring teachers on STEM subjects and curricula.

OUTREACH TO TERTIARY EDUCATION

STEM stakeholders must encourage women studying STEM at universities and technical and vocational education and training (TVET) institutions to complete their studies and enter the workforce. Dedicated actions are needed to ensure that female students are aware that the full participation of women in employment is encouraged and facilitated. Opportunities for outreach by stakeholders include the following:

- Participating on advisory boards at universities, faculties, and departments
- Organizing or taking part in targeted career fairs
- Offering internships in STEM fields
- Delivering departmental seminars and lectures
- Speaking about careers and corporate cultures
- Becoming a role model, including by speaking with female STEM professionals
- Organizing and leading tours of facilities
- Providing support through strategic finance and activities, extracurricular clubs, and Women in Engineering chapters.

SUPPORT FOR FEMALE STEM STUDENTS

Efforts to recruit a diverse workforce can benefit from identifying potential employees well before the students complete tertiary education. Offering scholarships to strong students ensures that financial constraints are not a burden to finishing a program and can build an early rapport. Paid internships provide practical experience and introductions to potential employers as well as opportunities for companies to benefit from paid interns.

STRENGTHEN STEM CURRICULA

Every STEM discipline in tertiary education benefits from associated sectors' contributions to the development and delivery of the curricula offered to students. Sector stakeholders—ranging from global entities to local employers—are expected to provide guidance on the design of courses, lab design and equipment, and course work. Additional ways to strengthen STEM curricula and links to students are for STEM academics to: participate on advisory boards; respond to employer surveys based on experience and discussions with their students; and regularly engage with STEM departments strengthens academic offerings and should strengthen links between students and STEM stakeholders.

BUILD THE CAPACITY OF STEM FACULTY, INCLUDING WOMEN

Though stakeholders should engage with all faculty to build capacity, working specifically with female faculty can play a critical role in the retention, success, and careers of female STEM students. To strengthen STEM teacher and research capacity in higher education, stakeholders may consider doing the following:

- Offering and delivering guest lectures to students
- Providing internships to faculty
- Offering research funding and consulting opportunities
- Sharing equipment, either through donations or access, to build partnerships.

CORPORATE AND SECTOR OUTREACH

To recruit and retain workers, employers must show that they value the contributions of females and that they take seriously their commitment to an inclusive work environment (see examples in box 4.2). A global nonprofit could be a catalyst—supported by

BOX 4.2 Organizations Commit to Building Inclusive Work Environments

The Women into Science and Engineering (WISE) Campaign works with STEM businesses, policy makers, schools, and other organizations to encourage women and girls to pursue STEM careers. It also engages directly to improve the gender balance in STEM roles.

Chevron Corporation, the global energy giant, developed *The Chevron Way: Engineering Opportunities for Women* in 2015 to focus on recruiting, retaining, and advancing women in the company.

Sources: WISE Campaign, https://www.wisecampaign.org.uk/; Chevron Corporation, "The Chevron Way: Engineering Opportunities for Women," https://www.youtube.com/watch?v=2jzaHNfNWWM.

top CEOs and companies—that seeks to develop more inclusive workplaces for women. It could provide workshops, diagnostic tools, good practices, and advisory services to build organizations committed to advancing women in the workplace. Potential corporate initiatives include the following:

- Equal pay for women
- Access to childcare facilities
- Formal maternity and family leave policies
- Professional networking opportunities
- Corporate data on retention and advancement rates for women employees
- Commitments to female representation on major committees
- Targeted training and mentoring for women employees on leadership and technical skills
- Policies and actions supporting women in leadership roles and career advancement opportunities.

Government Interventions

Governments (see box 4.3 for an example) could implement specific interventions to support the broader STEM enterprise in South Asia and the increased participation of girls and women in STEM education and careers. The interventions proposed here focus on strengthening the pipeline of talented females for STEM education and careers, as well as on building the knowledge and data needed to retain women in STEM at all levels.

PRIMARY AND SECONDARY EDUCATION STEM TEACHERS

Without a strong cohort of properly trained teachers for students at all levels, STEM sectors will suffer from a weaker workforce. Though credentials do not guarantee

BOX 4.3 Example of a US Government Intervention

In 2021, the United States Office of Science and Technology Policy released *Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide by and for Federal Agencies*, a publication that summarizes good practices, provides extensive recommendations for government, and offers important guidance and options for policy interventions.

Source: United States Office of Science and Technology Policy 2021.

better teaching, in Organisation for Economic Co-operation and Development countries, about half of lower secondary mathematics and science teachers have master's degrees. About two-thirds of these teachers are women, providing mentors and role models to students in their classrooms.

Strengthening teacher training and providing the resources to enable schools to have qualified, dedicated mathematics and science teachers for all students is critical to building the STEM workforce of the future and ensuring that all segments of society—including women and underrepresented groups—contribute to STEM-based economic development.

TERTIARY EDUCATION STEM TEACHERS

A vibrant STEM sector requires a strong STEM higher education sector. As tertiary education continues to expand and to enroll more women, there must be continuous improvement in the quality and quantity of faculty. Initiatives should include the following:

- Increasing the share of faculty and lecturers with PhDs
- Increasing the number and proportion of female faculty in STEM disciplines
- Reducing student-to-faculty ratios to improve teaching and mentoring and to facilitate opportunities for more extensive research
- Providing ongoing support for professional development to ensure that STEM faculty remain at the forefront of knowledge generation and dissemination.

BASIC AND SECONDARY STEM EDUCATION

With increasing enrollment and increased demand for STEM education, education systems must invest in the techniques needed to teach to a global standard to develop a STEM-competent labor force. This includes the following:

- Benchmarking academic performance against international standards
- Ensuring sufficient local capacity for upper secondary students interested in STEM tracks
- Prioritizing the availability and accessibility of appropriate water, sanitation, and hygiene facilities for girls and women in all schools and education facilities
- Providing dormitories at schools for female students who cannot live at home
- Incorporating problem-based learning into curricula
- Creating resilient, sustainable laboratory and information technology facilities in schools at all grade levels

- Supporting science fairs and competitions for interested students
- Constructing, where appropriate, dedicated science-focused schools to facilitate access for interested and qualified students.

TERTIARY STEM EDUCATION

For most STEM disciplines, academic programs should combine international standards with local considerations. In addition, targeted interventions to recruit and retain talented women and other underrepresented groups strengthen STEM programs. Initiatives can include the following:

- International benchmarking and accreditation for STEM programs
- Problem-based learning for national accreditation
- Resilient and sustainable teaching, laboratory, and information technology facilities
- Strong public funding for research and development, with links to industry partnerships
- Dedicated dormitories and learning communities for female STEM students
- Dedicated scholarship and fellowship programs for female STEM students
- Internship opportunities for all STEM students, especially female students.

Enhanced Gender-Disaggregated Data on STEM Education, with a Focus on Upper Secondary, TVET, and University Programs

Completely disaggregated data on STEM education at all levels are urgently needed. Readily available data would enable better interventions and stronger alignment between education outcomes (graduates) and employment. Specific data to consider include the following:

- Enrollment data for STEM tracks in upper secondary schools
- Disaggregated, cumulative enrollment and completion data for STEM programs in TVET
- Disaggregated, cumulative enrollment, and completion data on STEM programs in higher education

- Graduation data for TVET and undergraduate students for each STEM discipline
- Disaggregated data on female teachers and university academic staff in STEM disciplines.

Enhanced Data on Women in the Workforce

There is a strong need globally, including in South Asia, for better disaggregated data that provide a more complete picture of women in the labor market (box 4.4 provides an example from Norway), especially in STEM careers. Better data would enable additional, evidence-based interventions to be considered. Though the employment categories defined by the International Labour Organization (ILO) are useful, they can be too broad to provide detailed information on, for example, the different types of STEM careers and the training required to best contribute to the workforce. To effectively benchmark national performance in STEM, labor market surveys must do the following:

- Consider sector-based employment in STEM disciplines
- Distinguish between and report on STEM careers requiring bachelor's degrees and above and those requiring TVET credentials or apprenticeships
- Consider age and educational attainment in STEM career progression
- Provide longitudinal data reflecting changes in the educational background of the workforce
- Track considerations such as maternity and family leave and time away from the labor force, issues that are especially important for women entering the labor market force.
- Conduct tracer studies of student cohorts, including those with upper secondary credentials, TVET credentials, and university degrees.

Finally, individual and coordinated policy efforts and actions that could address the socioeconomic challenges identified in table 4.1 are explained in table 4.1.

BOX 4.4 Use of Data in Norway

In 2007, Norway began requiring boards of listed companies to have a 60/40 gender balanc at the least. Within 10 years, female board membership rose from 6 percent to 42 percent; the average in Europe is 22 percent.

Source: Chang 2020.

TABLE 4.1 Recommendations to Help Girls and Women Pursue STEM Education and Careers in South Asia

All education levels
Data
• Complete disaggregated data on STEM education at all levels are necessary. Readily available data will enable better-designed interventions and stronger alignment between education outcomes (graduates) and employment.
• There is a need—globally, including in the South Asia region—for better disaggregated data that provide a more complete picture of women in the labor market, especially in STEM careers. With better data, additional interventions can be considered that are evidence based. Although International Labour Organization categories are useful, they can be too broad to provide detailed information on, for example, the different types of STEM careers and the training required to best contribute to building a STEM workforce.
Curricula
• To harness contributions from associated sectors, develop and deliver curricula linked to every STEM discipline in tertiary education. Entities from global bodies to local employers can provide formal and informal guidance on course work, lab design and equipment, and even the design of courses, strengthening academic offerings and creating stronger links between students and the sector.
• Although education, and curricula, are generally the responsibility of the government, interested stakeholders can provide additional resources that support learning and that are aligned with curricula objectives. Local and regional challenges offer a concrete path to teaching the importance and relevance of STEM to daily life.
Teachers
• Strengthen teacher training programs and provide the resources to enable schools to have dedicated, qualified science and mathematics teachers so that all students have access to STEM education. This is critical to building the STEM workforce of the future and to ensuring that all segments of society, including women and underrepresented groups, contribute to STEM-based economic development.
• Require training for teachers handling STEM subjects and deploy only these trained teachers to teach the curricula.
• Stipulate that all teachers desiring to teach STEM subjects have a master's-level degree. While acknowledging that credentials are not a guarantee of better teaching, it is noteworthy that in Organisation for Economic Co-operation and Development countries, 47 percent of mathematics teachers and 52 percent of science teachers in lower secondary schools have a master's-level degree. At the same level, approximately two-thirds of mathematics and science teachers are women, providing mentors and role models to students in their classrooms.
• When possible, permit and arrange short-term internships with employers so teachers can learn more about STEM careers and showcase STEM applications and experiential learning
• Mentor teachers on STEM subjects and curricula
• Deliver guest lectures on campus and invite professionals from STEM areas to provide lectures
• Provide internships to faculty members
• Offer research funding and consulting opportunities
• Share equipment, either through donations or access, to build collaborations.

(continued)

TABLE 4.1 Recommendations to Help Girls and Women Pursue STEM Education and Careers in South Asia *(continued)*

Secondary, technical and vocational education and training (TVET), higher education, and TVET
Gender stereotyping
• Undertake activities in rural schools to give girls the confidence to pursue STEM education
• Adopt strategic communication strategies to diffuse positive messages about women pursuing STEM fields
• Frame female-friendly policies that enable women to fulfill their professional responsibilities along with their reproductive responsibilities
• Promote a communications strategy about hopes and aspirations of girls and the value of girls pursuing STEM education for higher income generation within families; discourage early marriage and motherhood; discourage the payment of dowries
• Establish a functional body to address cases of sexual harassment
• Nurture the application of STEM education in fields that are perceived to be women friendly; facilitate women's pursuit of home-based work, such as providing ICT-related services
• Introduce innovative measures, such as feminization of STEM subjects and their application to reduce stigma and societal stereotypes attached to STEM subjects.
Role models
• Create strategic communications around the positive role of women in STEM by bringing in role models to diffuse the messages
• Promote career counseling and guidance and facilitate exchange of information by role models to dispel the perception that even if girls are educated, they would have limited livelihood opportunities, such as farming and manual labor.
• Develop STEM- and values-based strategic communications against cultural biases
• Create awareness sessions targeting students, parents, and communities by highlighting female role models, case studies, and job opportunities in TVET institutions
• Set up STEM-focused colleges specifically for women and hire women teachers trained in STEM subjects
• Foster real-life applications of STEM problem-solving and critical thinking among teachers, trainers, and students by using the demonstration effects of women in STEM subjects
• Feminize certain streams to encourage girls and women to enter certain fields, for example, home-based work with ICT-related services
• Provide incentives for STEM-related organizations to increase representation by women, especially at the upper management level, and institute policies to improve the gender composition of upper management in organizations.
Teachers
• Prioritize and focus on teacher training for women in STEM education
• Equalize urban-rural competencies in STEM teacher training through real-life applications of STEM according to the urban or rural environment
• Consider introducing a digital literacy and technology curriculum
• Foster learning and blended teaching-learning in STEM-related subjects
• Create a cadre of subject specialists (women teachers) in science and mathematics at higher education levels

(continued)

TABLE 4.1 Recommendations to Help Girls and Women Pursue STEM Education and Careers in South Asia *(continued)*

Teachers

- Offer subsidized—even free—training for women teachers in science and mathematics
- Prioritize and focus on teacher training in STEM subjects with incentives for taking up STEM education
- Prioritize and focus on teacher training in science and mathematics with incentives for urban teachers to teach in rural areas for short periods
- Develop science and computer laboratories in rural schools
- Focus teacher training in STEM subjects to foster technical knowledge and problem-solving skills
- Invest in female teachers and educators to ensure that they have the right knowledge and tools to inspire and help girls who are interested and already enrolled in schools.

STEM educational institutions and career opportunities

- Facilitate the upgrading of teacher training and classroom teaching and learning of STEM to reduce dependence on external coaching centers—which are not accessible to students from the middle class or of lower income status—and to positively influence women's decisions to pursue higher education in STEM
- Focus on STEM teacher training and school subject areas through STEM-related courses at upper or higher secondary education in tribal areas
- Consider setting up "centers of excellence" that include career counseling and assistance to facilitate opportunities in the STEM fields in catchment islands
- Reassess the catchment areas of upper secondary schools to review the distance from home to school for girls and consider options to increase attendance, such as busing girls to school
- Increase the number of upper secondary schools in rural areas
- Offer STEM-related subjects at community campuses, where most girls in rural areas opt to attend higher education
- Introduce incentive schemes to draw young women into STEM education
- Consider the feminization of some of the occupations or trades that are considered to be more "masculine"
- Increase security for girls and women by creating safe schools to stem the fear of gender-based violence
- Promote the establishment of early childhood development centers to provide girls and women with secure options for pursuing their education
- Advocate the recruitment of females to the labor market
- Prioritize career counseling on the importance of STEM
- Ensure greater focus on women and inclusion throughout secondary and higher education policy documents
- Develop family- and female-friendly benefits to retain employees
- Consider accommodating the needs of young people who are working by convening classes in the evenings or on weekends
- Review labor market policies and laws in the medium and long terms to make them more female friendly and with equal wages for similar occupations
- Introduce diverse trades in TVET institutions to complement STEM-related subjects so that women and men can acquire the skills needed to keep up with technological innovation and make the transition to the labor market

(continued)

TABLE 4.1 Recommendations to Help Girls and Women Pursue STEM Education and Careers in South Asia *(continued)*

Cost of education
• Consider combinations of subsidies and incentives to address the high cost of higher education, for instance, a menu of options to combine tuition waivers with scholarships, internships with stipends, and low-interest loans with appropriate loan-recovery or waiver options
• Provide targeted state-sponsored scholarships and internships with stipends
• Promote targeted, subsidized additional tutoring for girls from vulnerable social groups and for marginalized populations
• Consider increasing scholarships and freeships for students to encourage students to take science courses and participate in science-related national competitions and exhibitions.
• Undertake a more comprehensive gender review to reform grants, placements, salary scales, and promotions in the labor market
• Introduce female-specific incentive schemes to draw young women into STEM education
• Develop a policy in the long term to offer high TVET-related stipends for female students.

Source: World Bank, based on country background papers prepared for this report.
Note: ICT = information and communication technology; STEM = science, technology, engineering, and mathematics; TVET = technical and vocational education and training.

Considerations for Regional Integration

Policy makers should care about science, technology, engineering, and mathematics (STEM) education for girls and women for many reasons. Societies that understand STEM-related topics—such as climate change, clean water, and sustainability—are better able to respond to global challenges. Inclusive economic growth makes countries more likely to achieve the Sustainable Development Goals. To realize their potential, countries must make available and pursue opportunities for as many of their people as possible. Governments and their development partners should strengthen STEM education and advance women's participation in the workforce.

Countries with larger shares of workers trained in STEM grow faster and advance more quickly, enabling opportunities for and benefiting all members of society. Countries that invest in STEM education and skills expand talents that contribute to social, economic, and technological advancements, facilitating growth and supporting progress toward the Sustainable Development Goals.

STEM investments also pay rich dividends to countries at every stage of development. For South Asian countries—Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka—a foundation of development is enhancing the education and skills of girls and boys and expanding STEM opportunities for women and men entering the workforce.

STEM education and careers in South Asia offer potential for regional cooperation provided the challenges can be constructively addressed. Regionally, the sharing of waterways, roadways, railways, and technology have a direct bearing on countries' welfare. Further, as part of growing efforts to foster a green economy, the application of STEM education and skills from the upper secondary school, technical and vocational

education and training, and university levels will take on new meaning. Women are disproportionately affected by climate change, especially in fragile environments where livelihoods are directly affected by weather patterns.

With the migration of workers across countries in South Asia, STEM education, skills, and careers are critical ingredients for cross-border trade. Thus, new ways of defining STEM occupations are required in South Asia to enhance STEM education, knowledge, and portability. Preparing a critical mass of semiskilled and skilled STEM migrant workers would have cross-border value, especially for migrants from smaller to larger economies.

South Asian countries could collaborate on preferential trade through the South Asian Association for Regional Cooperation (SAARC) to assess the prospects, challenges, and solutions for STEM education and careers and reap the dividends of collective action—whether in trade, tourism, or telemedicine—through the rotating chairpersonship of the SAARC, or by instituting fellowship and scholarship schemes, youth volunteer programs, visa exemption reciprocity agreements, and more communication networks for journalists. Science and technology is one of the 12 areas of collaboration in the SAARC Integrated Program of Action. There are opportunities for deeper integration through science congresses for solving climate challenges and advancing agriculture technology solutions, and through facilitating the exchange of students, professors, and professionals.

Digital connectivity has also brought rapprochement between nations. SAARC member countries are harnessing this comity for telemedicine networking. Other knowledge networking and exchange areas in science and technology could support green jobs.

Other opportunities for the application of STEM education, knowledge, and skills to foster regional integration include the following:

- Collaborating to create cross-border accreditation of programs and developing equivalence credits across STEM programs
- Providing skills passports to facilitate portability of STEM skills with equivalence credits
- Facilitating knowledge and skills acquisition in such areas as the use of drones to assess environmental damage—which requires collaborating on the use of airspace in the South Asia region—and developing the new STEM skills needed for the responsible deployment of the drones, their programming, the analysis of data gathered, the geomapping of hotspots, and solutions to address the reduction, recycling, and reuse of the materials to turn waste to wealth
- Tackling air pollution through renewable energy generation, transmission, distribution, and utilization
- Moving faster to address transboundary weather events and protect people by sharing resources, data, and expertise
- Building resilience in food systems by harnessing renewable energy and adopting climate-smart strategies for green buildings and transport in cities

- Exploring digital opportunities that encourage intraregional investment in STEM education, expanding access to services and markets, creating jobs, fostering innovation, lowering transaction costs, and improving people's lives, including through the pursuit of game-changing solutions to the challenges to digitalization, cybersecurity, and broadband internet and smartphone access
- Drawing on ongoing collaborations, for instance, harnessing the significant untapped hydropower resources in the Himalayan region to help Bangladesh, Bhutan, India, and Nepal trade in electricity, buying and selling surplus power, to meet their power needs with fewer carbon emissions
- Replicating the ongoing collaboration between India and Sri Lanka to boost scientific knowledge, extend cooperation on science and technology, and explore new areas for collaboration on wastewater technology, biotechnology, sustainable agriculture, aerospace engineering, robotics, big data analytics, and artificial intelligence

To advance these goals, South Asian countries could host workshops with scientists and innovators to lead discussions and inspire collective action on green jobs and development; strengthen national research and education networks, finance STEM research, and foster the exchange of expertise across education institutions; target scholarships to help and encourage girls and women to remain focused on STEM education in secondary education and beyond; strengthen outreach by the WePOWER initiative to harness the benefits of collective action and consider similar initiatives in areas such as technology; and invest in cross-border trade.

STEM skills and experiences, coupled with a diversity of perspectives, are integral to building South Asia's STEM workforce in research and in developing new products and ideas. Thus, inclusion and diversity must be championed by governments and by STEM stakeholders that stand to benefit from more diverse workforces. Though women themselves would likely be credible champions, in South Asia they are often constrained by a range of factors. This report addresses some of those factors.

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APPENDIX

Country Profiles

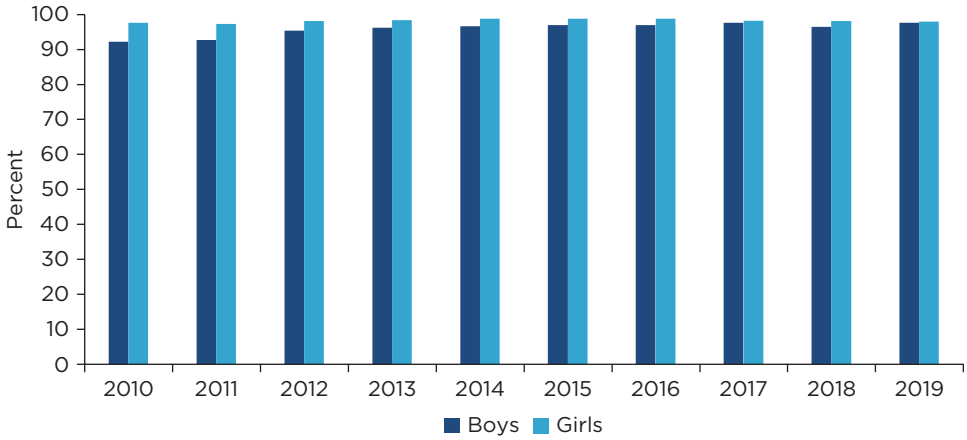
Bangladesh

Although Bangladesh has made enormous strides in girls' education since 2000, rural girls often have fewer opportunities than boys from rural areas, and do not receive a quality education. To address this concern, governments, international development entities, and civil society organizations have supported interventions with impacts large and small, but Bangladesh's education system concentrates on rote memorization—a leading cause of poor achievement and low retention.

PRIMARY AND SECONDARY EDUCATION (GRADES 1–10)

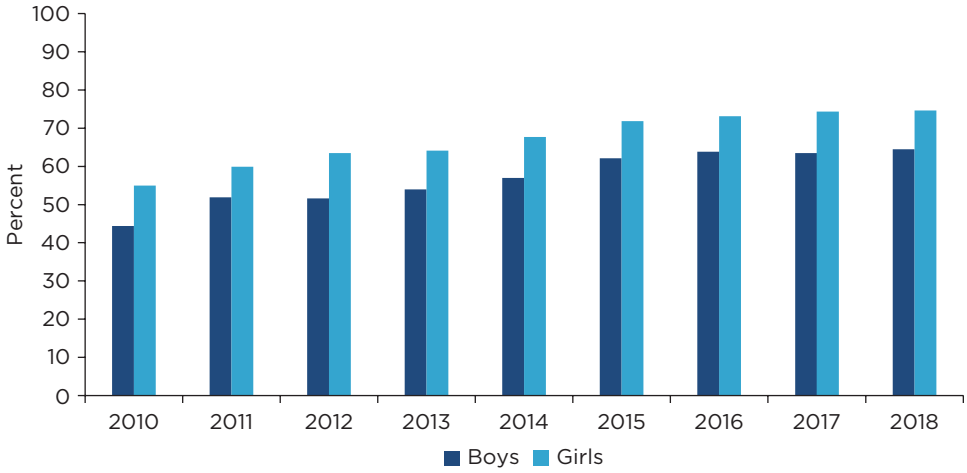
Bangladesh has achieved gender parity in primary and secondary education. Indeed, girls have higher enrollment rates than boys (figures A.1 and A.2). Gender parity is not, however, sustained in higher education, where 46 percent of female students drop out before completion (compared with 34 percent of males). In addition, grade 10 results for 2018–20 show that the share of females studying science was lower than that of males. Female students at that level were more likely to study humanities.

FIGURE A.1 Net Enrollment in Primary School in Bangladesh, 2010–19



Source: Bangladesh Ministry of Primary and Mass Education 2010–19.

FIGURE A.2 Net Enrollment in Secondary School in Bangladesh, 2010–18



Source: BANBEIS 2018.

TERTIARY EDUCATION

In tertiary education, female students in science, technology, engineering, and mathematics (STEM) institutions are limited to medical, dental, and nursing colleges. Enrollment in engineering, textile, and tech institutions remains low. Just 9 percent of female college students take STEM courses. Moreover, female tertiary graduates struggle to find jobs. Unemployment among female tertiary graduates is 21 percent, nearly three times that of males.

TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

Although more female students are enrolling in technical and vocational education and training (TVET) institutions, the percentage of female students remains far below that of boys. The case is similar for female teachers in these institutions, with four times as many male as female teachers.

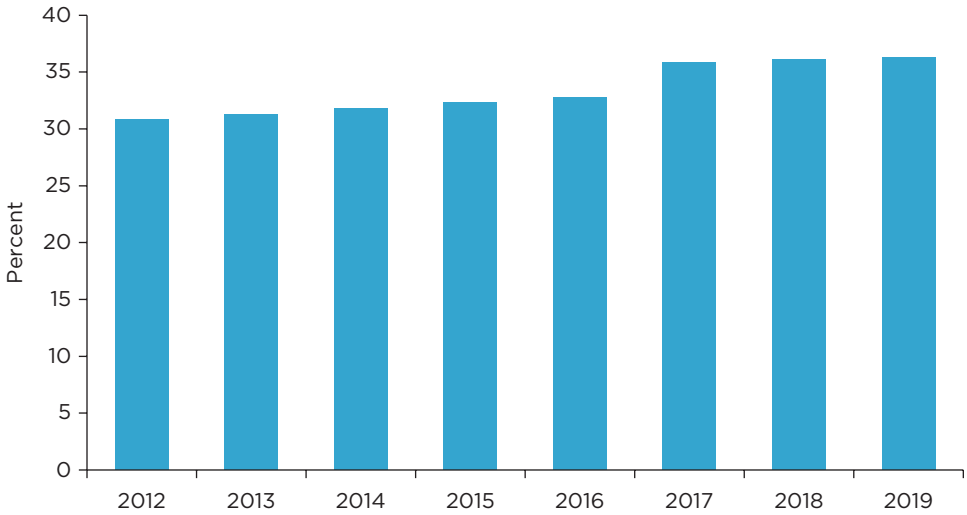
STEM WORKFORCE

Bangladesh has seen a consistent rise in overall female participation in the labor force (figure A.3), although female participation is still half that of males. In contrast, the number of men and women working is almost the same, though the quality of employment is lower for women. And even though included in the employed labor force numbers, women often do not get paid for their work—especially in agriculture—because they are family workers. When women do receive wages, they are far lower than those for men.

FACTORS IMPEDING WOMEN'S ACCESS TO STEM EDUCATION AND CAREERS

- A shortage of teachers in some schools for some subjects
- Weak school infrastructure for enhancing STEM learning
- Low digital literacy among university students
- Falling wage employment opportunities in farm and agroprocessing industries, leaving women at greater risk of income insecurity.

FIGURE A.3 Female Labor Force Participation Rate in Bangladesh, 2012–19



Source: International Labour Organization, ILOSTAT, https://ilostat.ilo.org/data/.

Bhutan

The constitution of the Kingdom of Bhutan guarantees all children free education through the completion of middle secondary school (grade 10). It also mandates that the state provide education to improve and increase the knowledge, values, and skills of the entire population, with education directed toward the full development of human potential. Thus, all Bhutanese students, no matter their ability and interest, study the same science and mathematics curriculum through grade 10.

PRIMARY AND SECONDARY EDUCATION (GRADES 1–10)

The government accords the highest priority to developing the competencies of students in STEM subjects. The Royal Education Council developed a new science and mathematics curriculum for implementation in grade 9 in 2021 and grade 10 in 2020 and will further expanded it to grade 7. The different curricula focus on supporting real-time experiential learning to stimulate the development of critical thinking, communication, creativity, and collaboration. Students in grade 6 are selected to study in a STEM school and to focus on a subject for in-depth study. Since 1978, completion rates for middle secondary education have increased considerably (table A.1).

TABLE A.1 Middle Secondary School Completion Rate in Bhutan

Year	Male (%)	Female (%)
1978	0.9	5.6
2018	90.6	74.6
2020	93.3	77.0
1978–2020	51.8	52.0

Source: Bhutan Ministry of Education 2019.

HIGHER SECONDARY EDUCATION

In 2018, 24,529 students were enrolled in higher secondary education—52 percent of them female. Students at this level choose from arts, commerce, or science streams. Science had the lowest enrollment for both females and males, and in recent years there was no significant increase in female enrollment, perhaps because of the fixed number of courses available at the higher secondary level.

TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

TVET has been introduced into the mainstream education system, with programs integrated at all levels of the school system beginning in 2016. Enrollment in TVET requires different qualifications depending on the course and availability.

Most TVET students enroll after failing to secure government-sponsored higher education scholarships. Among the total enrollment of 12,026 over the period 2008–19, 72 percent were males and 28 percent females.

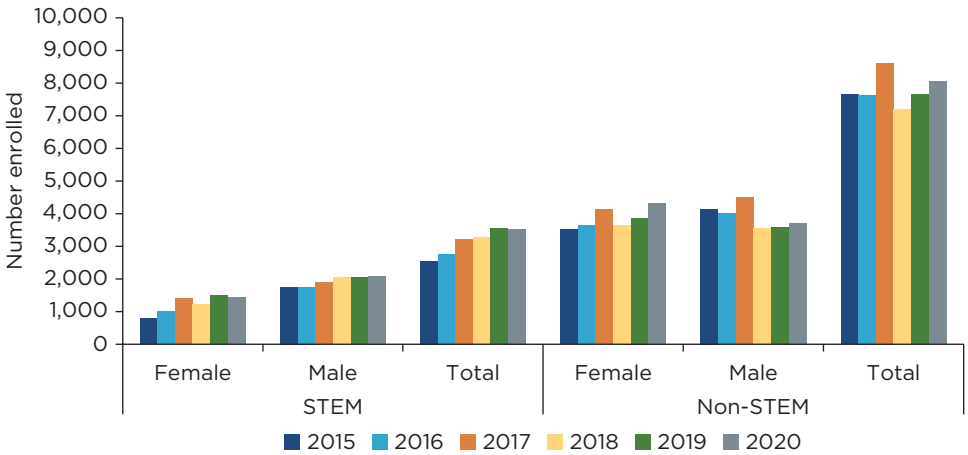
HIGHER EDUCATION

Female enrollment rates are lower in higher education than for males, and also in STEM fields. Male students greatly outnumber females in science and technology, business, engineering, and traditional medicine. In contrast, females outnumber males in nursing, general disciplines, management, language and cultural studies, information technology, and law. During 2015–20, females accounted for 43 percent of STEM students (figure A.4).

LABOR MARKET

The goal of every TVET trainee is to secure a meaningful job. But, among youths ages 15–24, unemployment in Bhutan is 12 percent: 10 percent for males and 14 percent for females. Unemployment is highest among those with a bachelor's degree (13 percent), followed by those with higher secondary (9 percent) and middle secondary (4 percent) educations. Females account for less than a third of employed TVET graduates, and only 61 percent of female TVET graduates were employed, compared with 80 percent of male TVET graduates.

FIGURE A.4 Gross Enrollment Trends in STEM and Non-STEM Streams in Bhutan, 2015–20



Source: Bhutan Council for School Examinations and Assessment 2021.
Note: STEM = science, technology, engineering, and mathematics.

FACTORS IMPEDING WOMEN'S ACCESS TO STEM EDUCATION AND CAREERS

- Parents' economic status is important for girls who do not receive state scholarships, and girls' household obligations may keep them from completing secondary, higher secondary, and more advanced education.
- TVET is considered college for poor people. Training and working conditions for TVET graduates, especially women, are not congenial.
- Women in Bhutan perform 71 percent of unpaid care work, which largely goes unrecognized.

India

India has a large pool of young people who complete graduate-level courses, yet many remain unemployed. As a result, Indian industry faces a shortage of trained workers. Moreover, schools and higher education institutes face challenges in producing graduates with adequate knowledge and skills.

PRIMARY AND SECONDARY EDUCATION (GRADES 1–10)

The primary and secondary levels determine whether students enter higher secondary school. Although India has made much progress on primary education since 2000, only 30.7 percent of students make it to higher secondary schools, with more girls than boys doing so, even across social (socioeconomic strata, across castes, and scheduled castes and scheduled tribes) groups. Table A.2 provides the net enrollment ratio in India for girls and boys by level of education.

TABLE A.2 Net Enrollment Ratio in Schools in India, by Level and Gender, 2014–19

Level	Gender	2014–15	2015–16	2016–17	2017–18	2018–19
Primary	Girls	98.9	99.3	96.4	94.8	94.3
	Boys	97.9	98.3	95.7	93.8	92.9
	Total	**88.4**	**98.7**	**96.0**	**94.3**	**93.6**
Upper primary	Girls	81.1	82.7	80.8	81.2	77.9
	Boys	78.4	79.9	78.6	79.4	76.0
	Total	**79.7**	**81.2**	**79.6**	**80.3**	**76.9**
Secondary	Girls	53.8	58.4	58.1	59.5	56.1
	Boys	54.1	58.2	57.9	59.2	55.2
	Total	**54.0**	**58.3**	**58.0**	**50.3**	**55.6**
Higher secondary	Girls	28.6	27.0	26.0	20.8	31.6
	Boys	28.8	27.6	26.4	29.2	29.9
	Total	**28.7**	**27.7**	**26.7**	**29.5**	**30.7**

Source: India Unified District Information System for Education dashboard, https://dashboard.udiseplus.gov.in/#/home.
Note: STEM = science, technology, engineering, and mathematics.

Moreover, there are no significant differences between the average performance of girls and boys in science and mathematics (table A.3). Thus, the main concern is why gender differences persist in postsecondary technical enrollment.

TABLE A.3 Average Score of Students on the National Achievement Survey in India, 2017 and 2018

		Gender			Social group			
Class	Subject	National average	Male	Female	Scheduled caste	Scheduled tribe	Other backward classes	General
VIII	Language	307	306	308	302	299	310	312
	Mathematics	269	269	269	264	265	272	267
	Science	274	275	274	270	273	277	273
	Social studies	278	278	279	273	278	281	277
X	English	253	251	255	246	245	252	264
	Mathematics	254	255	253	247	246	255	262
	Modern Indian language	254	253	255	252	244	253	261
	Science	253	252	253	249	248	253	257
	Social studies	254	254	254	251	248	255	258

Source: Government of India Ministry of Education 2020b, 2021.

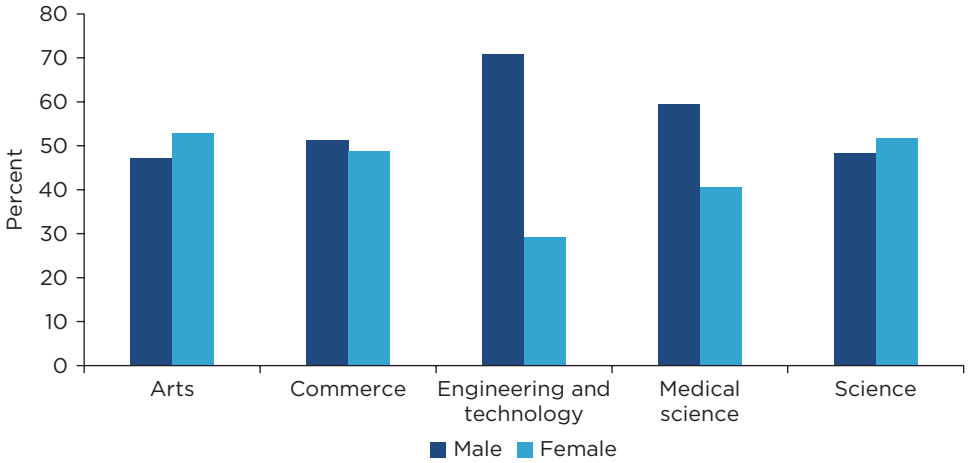
HIGHER SECONDARY EDUCATION

Subject teachers are lacking in higher secondary schools. Nearly 40 percent of secondary schools do not have mathematics teachers; a third do not have science teachers (Government of India Ministry of Education, 2015). These shortages might influence student choices and participation. Moreover, many schools in tribal areas do not offer science classes, leaving students with no choice but to enter the arts stream.

HIGHER EDUCATION

Participation differs by gender more in higher education. In streams like arts, general science, commerce, information technology, and some other nonscience disciplines, gender differences are insignificant (figure A.5). But many more women opt for medical sciences and education disciplines, and only 3.1 percent of women are enrolled in technical and professional courses. Traditional engineering disciplines—civil, electrical, mechanical—attract fewer women than men. Yet, women outnumber men in contemporary engineering disciplines such as computer science, electronics, and information technology. Moreover, women's participation in STEM has increased and is likely to further improve in new disciplines such as artificial intelligence and biotechnology.

FIGURE A.5 Undergraduate Enrollment in Major Subjects in India, 2019–20



Source: Government of India Ministry of Education 2020a.

TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

India has seen steady growth in the number of TVET institutions. Between 2000 and 2019, the number of industrial training institutes almost quadrupled to 16,000, of which 80 percent were private. Some 3.4 million students are enrolled in these institutes, although only 11 percent were female (Government of India Ministry of Skill Development and Entrepreneurship, 2016).

LABOR MARKET

Female labor force participation is low, indicating that many highly educated women—often with degrees in STEM fields—are not working. More men are employed in all sectors. Thus, women face disadvantages in the labor market. And women's participation in science education is skewed regionally. Most women scientists belong to forward castes, with negligible participation from other social groups (Kurup et al 2010).

FACTORS IMPEDING WOMEN'S ACCESS TO STEM EDUCATION

- Low learning outcomes, starting at the primary level, inhibit the transition of women to STEM in higher education. Moreover, high entry barriers prevent entry to science streams in higher secondary schools.
- Availability of local schools offering STEM subjects is low, and the distances that students need to travel in rural areas to attend higher secondary schools are problematic.

- At the postsecondary level, some professions have become feminized and others are dominated by men. These differences are seen across and within STEM disciplines and streams.

Maldives

According to the government of Maldives, STEM education raises two main issues. First, most students pursue business because the science stream is not available on their home islands. Accordingly, few students pursue STEM subjects in higher education. Second, demand is greater than the supply of STEM-educated graduates in local industries such as energy and climate resilience. The government's strategic action plan includes regulations to support women's participation in STEM and funding for STEM education.

GENERAL EDUCATION (GRADES 1–12)

Maldives imposes no barriers on either sex in attaining general education. A survey conducted for the Maldives STEM Education and Careers Country Report (2021) found, however, that more than half of students in general education were unaware of or did not have enough information about STEM. Of those, nearly three-quarters were girls. And though mathematics is compulsory in secondary education, only 45 percent of enrolled girls study science, compared with 51 percent of boys.

HIGHER EDUCATION

Of the 40 fields of study offered in higher education institutions, only 10 are related to STEM—and only at the bachelor's level (table A.4). The rest involve non-STEM fields, such as education, arts and humanities, business administration, journalism, health and welfare, law, and services. Moreover, students have limited opportunities for scholarships and loans for STEM fields.

LABOR MARKET

In 2014, the labor force participation rate was 79 percent for men and 47 percent for women. Between 2009 and 2014, the country's unemployment rate for men dropped from 7.9 percent to 4.8 percent, and for women from 23.7 percent to 5.9 percent.

TABLE A.4 Bachelor's Degrees in STEM Offered in Maldives

Main field	Field of study
Natural sciences, mathematics, and statistics	Biology
	Earth science
Information and communication technology	Database and network design and administration
	Software and application development and analysis
Engineering, manufacturing, and construction	Chemical engineering and processes
	Electricity and energy
	Mechanics and metal trades
	Motor vehicles, ships, and aircrafts
	Food processing
	Materials (glass, paper, plastic, and wood)

Source: Republic of Maldives Ministry of Higher Education 2020.
Note: STEM = science, technology, engineering, and mathematics.

FACTORS IMPEDING WOMEN'S ACCESS TO STEM EDUCATION AND CAREERS

- Lack of information, opportunities, and qualified teachers
- Sociocultural barriers, such as early marriage for both boys and girls
- Lack of mentorship in STEM fields for students and young people aspiring to STEM careers
- Lack of job opportunities and higher education opportunities in STEM fields, especially on the islands.

Nepal

In recent decades Nepal has reduced illiteracy and expanded access to pre-university education, significantly increasing the number of students enrolled at the basic and lower secondary levels. Still, gender disparities remain in education. For example, in 2019 compared with other island nations, Maldives had the lowest net enrollment rates in upper (higher) secondary education against gross national income per capita. Boys tend to drop out because of difficult and expensive sea travel from one island to another in nearly all atolls; children age 16 and older, especially boys, can engage in income-earning activities and may opt to leave school and join the labor market; some students at age 16 and older opt for TVET; and some families who can afford to do so send their children at age 16 to school overseas for STEM studies, medicine, and other fields.

PRIMARY AND SECONDARY EDUCATION (GRADES 1–10)

Girls and boys have similar promotion rates at the primary and secondary levels (figure A.6). Moreover, dropout rates have fallen for all students—but with lower dropout rates for girls across all grade clusters. In grade 3 there was no gender difference in the average score on mathematics, and in grade 5 girls scored slightly higher than boys. But by grade 8, boys outscored girls in mathematics and science. Thus, the gender divide in mathematics and science learning may start in grade 8, which is important because students must choose between STEM and non-STEM subjects in that grade.

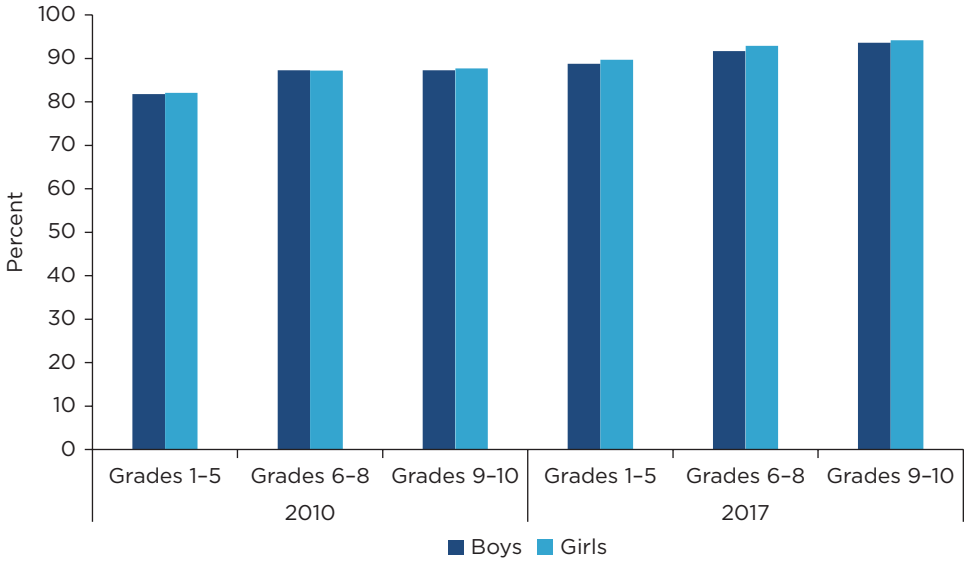
HIGHER SECONDARY EDUCATION (GRADES 11–12)

More girls than boys are enrolled in higher secondary education, which is a major social milestone, given that most girls in Nepal are married by the time they are age 17 or 18. Still, girls take science examinations at a much lower rate than boys (figure A.7).

HIGHER EDUCATION

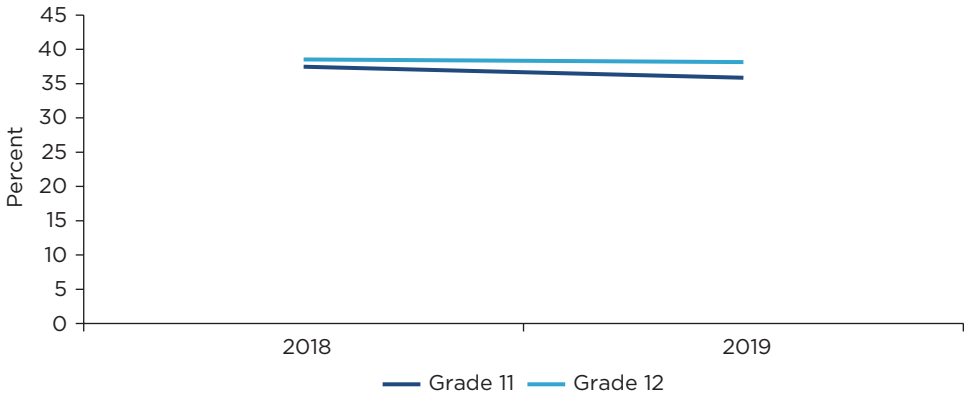
Gender differences in STEM become especially pronounced in higher education. The share of female graduates in some STEM subjects—engineering, science, and technology (table A.5)—is the lowest among South Asian countries. The female-to-male ratio is much higher in management, education, humanities, and social sciences.

FIGURE A.6 School Promotion Rate in Nepal, by Gender, 2010 and 2017



Source: Nepal Ministry of Education, Science and Technology 2010, 2017.

FIGURE A.7 Share of Females Appearing for Examinations in the Science Stream in Nepal, 2018–19



Source: Nepal Ministry of Education, Science and Technology 2020.

TABLE A.5 Enrollment in STEM-Related Subjects in Higher Education Institutions in Nepal, 2018–19

STEM-related subject	Male	Female	Share of females (%)
Agriculture	660	285	30.2
Animal science, veterinary science, and fishery	261	92	26.1
Engineering	24,127	4,891	16.9
Medical sciences	7,469	11,085	61.2
Science and technology	23,662	13,365	36.1

Source: University Grants Commission Nepal 2020.
Note: STEM = science, technology, engineering, and mathematics.

TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

Large shares of females are enrolled in health diploma programs, with a gender parity ratio of 2.36. But for engineering diplomas, gender parity is just 0.21, and for agriculture it is 0.84—reflecting traditional male preferences for those subjects. TVET is considered a second-best option in Nepal, often ignoring its academic and career potential.

LABOR MARKET

The labor force participation rate in Nepal is 39 percent, with 54 percent for men and 26 percent for women. In addition, the unemployment rate for women is

13.1 percent—compared with 10.3 percent for men. Thus, many women are not in the labor force, and those searching for jobs are not getting them.

FACTORS IMPEDING WOMEN'S ACCESS TO STEM EDUCATION AND CAREERS

- Female students tend to be less confident about their STEM abilities. Even though science and mathematics are compulsory school subjects, teaching and learning are of very low quality.
- There is a shortage of female STEM teachers.
- Colleges tend to have a male-oriented culture, which can make it hard for women to feel comfortable.
- Parental support for women's education falls after the bachelor's level.
- Women face social barriers and differential treatment in the labor market.

Pakistan

STEM education is a relatively new concept in Pakistan. Still, with the rapid global development of science and technology, it has become an important approach to enabling innovative learning. Some 60 percent of Pakistanis are younger than 30. So, investing in STEM education and careers is a practical, pressing need for economic growth. Although the government has introduced a few STEM policies, education does not receive the attention it deserves. Since 2018, budget allocations to education have averaged just 2.3 percent of GDP, which is well below the international benchmark of 4 percent to 6 percent of GDP.

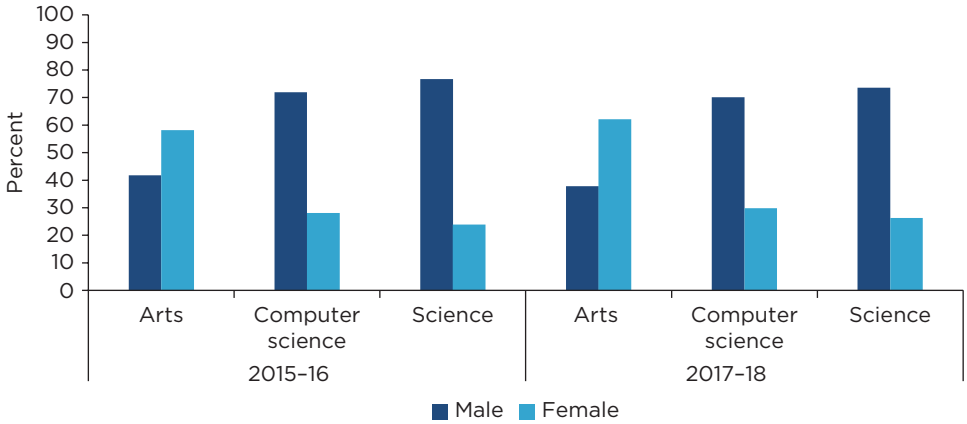
PRIMARY AND SECONDARY EDUCATION (GRADES 1–10)

Public schools teach 56 percent of students; the rest are enrolled in private institutions. About 56 percent of all students are male, and 44 percent are female.

HIGHER SECONDARY EDUCATION

Enrollment is falling for female students in higher secondary school in Khyber Pakhtunkhwa province, and there are considerable gaps relative to male students, reflecting the limited availability of female higher secondary institutions. More girls are enrolled in arts than in science and computer science (figure A.8). In Punjab, female enrollment has been rising as a result of better access to schools in the province, but the trend in girls' enrollment in arts relative to science is similar.

FIGURE A.8 Enrollment in High School in Khyber Pakhtunkhwa Province, Pakistan, by Subject, 2015–16 and 2017–18



Source: Pakistan Ministry of Federal Education and Professional Training NEMIS Database 2015–16, 2017–18.

TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

After completing midlevel education, students can opt for a technical or vocational stream for two years at the lower secondary level. Institutions throughout the country offer such courses. Students can continue to higher secondary levels while enrolled in technical and vocational institutes. In Khyber Pakhtunkhwa and Punjab, female enrollment is rising for vocational training but is quite low in technical education. One reason women's enrollment is lower than men's is the type of trades offered, which are of limited interest to women.

LABOR MARKET

Women account for fewer than 18 percent of Pakistan's engineers, scientists, mathematicians, technologists, and inventors. Leveling the playing field for women in STEM would create opportunities and unleash an untapped resource for the energy sector.

FACTORS IMPEDING WOMEN'S ACCESS TO STEM EDUCATION

- Negative gender stereotypes
- Lack of female role models and absence of guidance
- Lack of teachers for STEM subjects with the needed technical knowledge and problem-solving orientation
- Lack of higher education institutions and unaffordability of the ones there are
- Lack of mobility or transport facilities to educational institutions.

Sri Lanka

Sri Lanka aspires to become globally competitive by integrating technology into every sector of its economy, investing strategically in new technologies, and linking the education system to innovations. Thus, the country needs to develop a generation of students with the knowledge, skills, and attitudes required to achieve technological advancements and innovations that enhance productivity in a sustainable way. The government has introduced policies to encourage demand for education, including free schools, subsidized public transport, scholarships for grade 5, and a health insurance scheme. In addition, different types of schools provide opportunities for students to pursue different subject streams at the collegiate level.

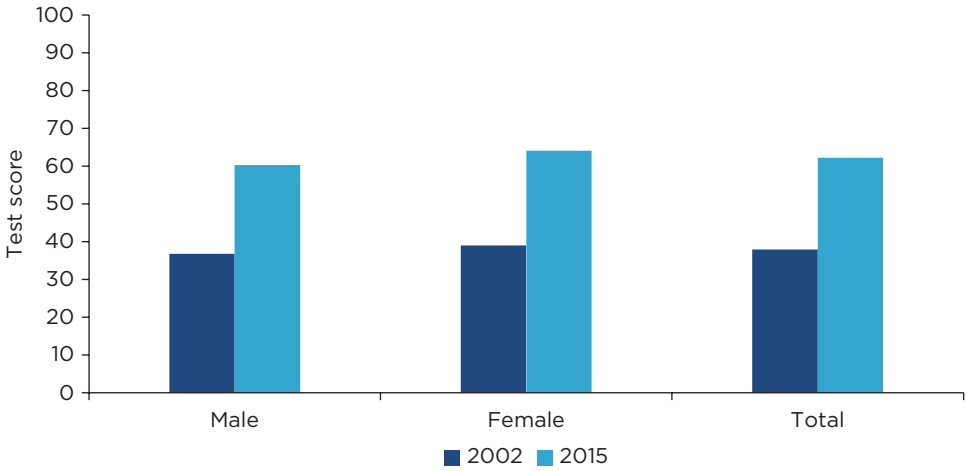
PRIMARY EDUCATION (GRADES 1–5)

At the primary level, STEM education is limited to mathematics and environmental studies. A national assessment of grade 4 students in mathematics found that girls scored higher than boys in both 2002 and 2015 (figure A.9). Moreover, an assessment of 2019 grade 5 examinations revealed gender differences, with 54 percent of girls and 46 percent of boys scoring above the cutoff marks.

SECONDARY EDUCATION (GRADES 6–11)

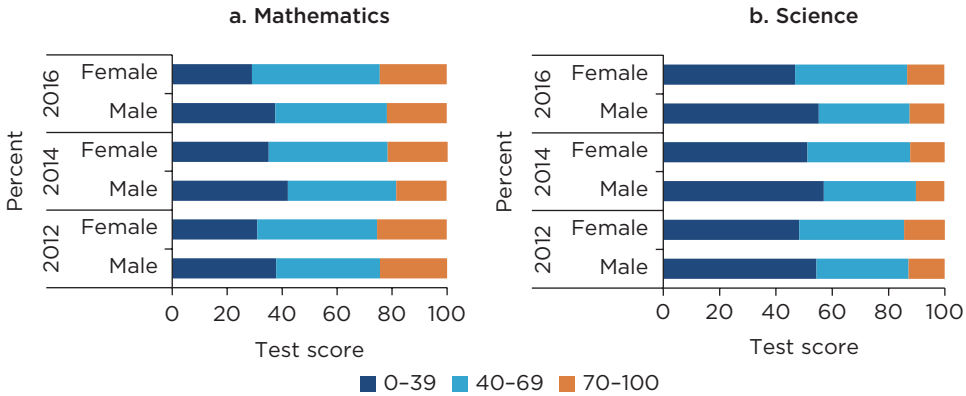
At the secondary level, in addition to mathematics, students are introduced to science, practical technical skills, and health science. Many schools with computer labs also offer classes in information and communications technology. National assessments of

FIGURE A.9 Mathematics Assessment in Grade 4 in Sri Lanka, by Gender, 2002 and 2015



Source: NEREC 2013, 2015, 2017.

FIGURE A.10 National Assessment of Grade 8 Learning Outcomes in Mathematics and Science in Sri Lanka, by Gender, 2012, 2014, and 2016



Source: NEREC 2013, 2015, 2017.

grade 8 students in mathematics and science in 2012, 2014, and 2016 indicated that girls outperformed boys in these subjects (figure A.10).

COLLEGIATE EDUCATION (GRADES 12–13)

At the collegiate level, students can select biological science, physical science, biotechnology, or engineering technology streams. They can also choose non-STEM subjects, such as commerce, arts, and vocational streams.

TECHNICAL VOCATIONAL EDUCATION AND TRAINING

Female access to STEM TVET is limited because TVET is considered the domain of males.

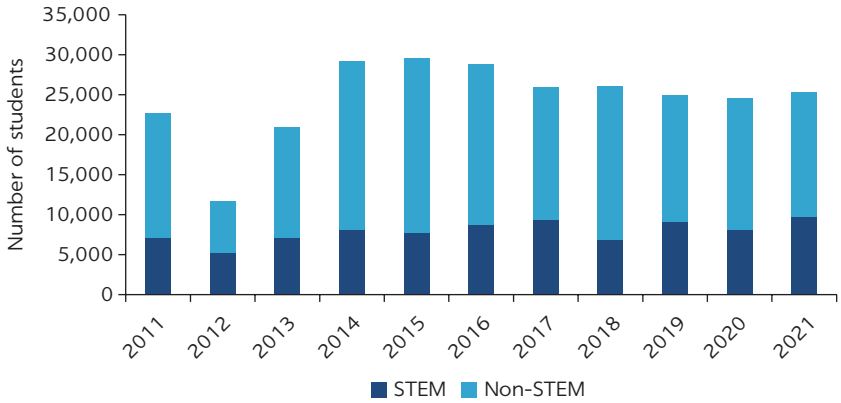
HIGHER EDUCATION

More females graduate from non-STEM streams, such as arts, education, management, commerce, and law, and more males graduate from STEM streams, such as engineering, architecture, and computer science. The number of STEM and non-STEM graduates of state universities is shown in figure A.11. More postgraduate female students graduate with non-STEM than STEM degrees, so enrollment among females in STEM postgraduate degrees should be encouraged.

LABOR MARKET

Sri Lanka's labor force consists of 8.1 million workers, but female participation is just 34 percent. In 2019, 45 percent of workers were engaged in STEM-related occupations.

FIGURE A.11 STEM and non-STEM Graduates of State Universities in Sri Lanka, 2011–21



Sources: University Grants Commission, 2011–21; World Bank calculations.
Note: STEM = science, technology, engineering, and mathematics.

FACTORS IMPEDING WOMEN'S ACCESS TO STEM EDUCATION AND CAREERS

- Shortages of teachers in some schools for some STEM streams
- Limited infrastructure facilities in some schools to enhance STEM learning
- Social perceptions that some occupations are better suited to males.

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green press INITIATIVE

Building a skilled and diverse science, technology, engineering, and mathematics (STEM) workforce is crucial for economic development, cross-border trade, and social inclusion in South Asia. However, underrepresentation of girls and women in STEM education and careers remains a persistent issue. What kinds of macro and micro socioeconomic interventions are needed to increase girls' and women's access to and participation in STEM education and careers in South Asia?

Engendering Access to STEM Education and Careers in South Asia compares trends in South Asia with global trends to examine how access to and choices of STEM fields affect girls' enrollment in upper secondary education, technical and vocational education and training, and higher education in the region as well as their selection of careers. Based on the analysis, it offers recommendations to policy makers and practitioners to improve inclusion. The following are among the findings:

- The five key opportunities to foster inclusion and enrollment in STEM education—and staunch the "leaky pipeline"—are at the upper primary, lower and upper secondary, and tertiary education levels, and during the early career years.
- A strong pathway from STEM education to career depends on an integrated, systematic approach that motivates students to pursue STEM fields, builds STEM skills, and removes barriers to diversity.
- With the increasing migration of workers between countries in South Asia, preparing a critical mass of semiskilled and skilled STEM migrant workers has cross-border value, especially for workers migrating from smaller to larger economies.

New ways of defining STEM occupations are required to help develop and sustain female interest in STEM education and careers. Potential strategies that governments can pursue include raising awareness and building knowledge and skills in STEM outside the formal academic environment—such as in after-school programs, science fairs and competitions, and summer camps—and developing and systematically disseminating standardized resources. Inclusion and diversity must be championed by governments, the private sector, and other stakeholders who stand to benefit from more diverse workforces. Though women themselves would likely be credible champions, in South Asia they are often constrained by a range of factors. This report addresses some of those obstacles.

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