

Towards an equal future: Reimagining girls' education through STEM



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Contents

Foreword	01
1. How is the learning crisis affecting girls?	03
2. Why is STEM learning so important for girls?	07
3. What are the gender disparities in STEM education?	13
4. Why are girls under-represented in STEM?	15
5. How can we transform opportunities for girls through gender-responsive STEM education?	19
Call to Action	21
Endnotes	25



Foreword

The year 2020 marks the 25th anniversary of the adoption of the Beijing Declaration and Platform for Action, the most comprehensive global agenda for girls and women to date. It expressed unwavering commitment to girls' and women's empowerment and their full participation in all spheres of society.

The world has changed rapidly since the Beijing Declaration was adopted, a change driven largely by science, technology and innovation. We see today technological advances that we could only dream about 25 years ago, accompanied by new jobs, new opportunities for economic empowerment and a demand for better educated individuals, especially in science, technology, engineering and mathematics (STEM) areas. Despite progress, gender equality continues to be elusive. Some areas essential for the achievement of women's empowerment, such as STEM, continue to be dramatically lacking in women's participation.

Climate change and the COVID-19 pandemic are exacerbating gender and other inequalities – and disproportionately affecting women and girls in all countries. As the world responds to these crises, there is a need for STEM knowledge and skills. There is also a steep price of excluding girls and women from participating in scientific and technological solutions that could save lives. These crises could also be opportunities for innovation and education, which we need to explore for the sake of girls.

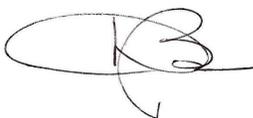
The document shows that the world still faces a learning crisis and a skills crisis that is leaving girls ill-prepared to develop critical knowledge to participate in the Fourth Industrial Revolution. This risks reversing gains in women's participation in the workforce. It is not intended to be an exhaustive assessment of girls' education or a comprehensive gender analysis of the STEM field. Rather, this document seeks to call attention to the potential of STEM education to transform gender norms in the education system, to improve quality learning opportunities for girls, and to highlight key actions that can accelerate girls' transition between education and technical expert jobs in STEM industries. Critically, STEM education also has the potential to contribute to personal empowerment, transformation of communities and nations, and building economies for the future.

The evidence presented here provides a foundation for a call to action for global, national and regional actors. All stakeholders are called to work together to dismantle the barriers that girls face to develop the skills they need to become users, shapers and creators of scientific knowledge and new technologies. Once this ball is rolling, girls will gain greater ability to choose the skills they want to learn and how to apply them, empowering them to contribute to a gender-equal world.

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1. How is the learning crisis affecting girls?

The last 25 years has seen a steady rise in girls' access to education around the world. In 1998, there were 143 million girls of secondary school age out of school compared to 127 million boys¹. Today, 97 million girls and 102 million boys of secondary school age are out of school. Yet for many children, just being at school does not mean they are learning. By 2030, some 880 million children will not be on track to develop the skills they need to succeed in the workforce.² This means that millions of children and young people are not developing the skills they need to successfully transition to adulthood. **We are facing a learning crisis, which is leading to a skills crisis.**

For girls and women, this crisis includes difficulty accessing quality learning opportunities in Science, Technology, Engineering and Mathematics (STEM) – subjects traditionally ascribed to and dominated by boys and men – and lower levels of achievement in digital skills³. **Education systems have allowed gender divides to be perpetuated and to disproportionately affect the most marginalized girls.** While girls tend to outperform boys in reading skills in most regions, they continue to be under-represented amongst top-performers in STEM subjects, and women continue to be under-represented in the STEM workforce. This is a tremendous waste of talent and human potential.

The under-representation of girls and women in STEM is deeply rooted in unequal gender norms that tell us that girls are not cut out for subjects that require problem solving and an inquisitive mind. Girls deserve to access an education that prepares them for the jobs of the future and to be ready and equipped to participate in the Fourth Industrial Revolution. To give all girls opportunities to learn, achieve and excel in science, technology, and in engineering solutions, we need to reimagine education systems where gender-responsive STEM learning happens in every classroom (Figure 1).

In addition to the STEM gender divide, there is a digital divide in the largest youth generation the world has

ever seen⁴. In developed countries, 94 per cent of young people aged 15-24 use the internet compared with 67 per cent in developing countries and only 30 per cent in Least Developed Countries⁵. As COVID-19-induced school closures and lockdowns have shown us, this divide limits most children from accessing the same learning opportunities and quality STEM education as their better-connected peers, leaving girls further behind. However, **achieving in STEM subjects goes beyond digital access, it is about the skills that STEM learning cultivates** that are applicable throughout life; thinking laterally, problem solving and innovating. In an age that is shaped by technological advances, having the know-how to operate, use and create technology and science-based solutions will be critical to the advancement of young people and crucial for girls' and women's health, education, voice and empowerment.

The intensive use of digital resources during the pandemic have many students, governments and service providers considering the future of education. **This is a moment of change;** a moment to advocate for gender equality in educational opportunities and to identify key areas of acceleration that could lead to gender equality in education and in the workforce.

Education interventions by governments, UN agencies, private sector, NGOs and civil society have clearly worked in improving girls' access to education. However, consistent quality education in safe, gender-responsive environments across the board remains limited, affecting girls' opportunities to learn to their fullest potential and transition to workplace opportunities. The lack of this type of learning wastes the potential of education to transform unequal gender expectations and harmful gender norms. If the purpose of primary, secondary schooling and vocational training is to provide equitable opportunities for children and young people, irrespective of their background, gender and ethnicity, it has failed. Business as usual is not leading to equal opportunities and empowerment for every girl.

Figure 1

Gender-responsive STEM education

is an approach to teaching and learning with the transformative potential to deliver on the promise of the girls' education and empowerment agenda in the 21st century.

This approach to learning has enormous potential to transform gender stereotypes in the classroom and in the workplace.

STEM educated girls and women gain the confidence, agency, and tools to question key issues in the world around them and propose solutions to solve such problems.

This in turn challenges traditional views of men and women about what girls are able to do and what they can aspire to and prepares girls for future jobs that have not even been invented yet.

By learning science, mathematics, technology and engineering solutions in an integrated manner to solve real-world problems and to challenge gender inequality, children and young people improve their understanding of how things work and improve gender-equitable use of digital technologies – and girls become equipped with scientific and technical knowledge and skills that they can apply to real-life contexts in ways that:



AGENCY
& VOICE



CRITICAL
UNDERSTANDING

Strengthen their agency – in terms of voice, participation and decision-making – over their own health, future financial and career choices, and social interactions

Enable them to critically understand social and environmental issues in the world around them, actively participate in debates to solve such problems, and propose relevant solutions



LEARNING
OUTCOMES



TRANSITION TO
EMPLOYMENT

Motivate them to learn and achieve at the highest levels, helping to close gender gaps in learning outcomes for STEM subjects and digital literacy

Facilitate their transitions to employment and livelihoods in the context of the Fourth Industrial Revolution – in traditional STEM careers and jobs requiring STEM knowledge and skills developed in secondary education and technical training⁷



EMPOWERMENT

Empower them to be innovators, entrepreneurs, and changemakers

Girls need an education that goes beyond literacy and numeracy, that equips them with the tools to equally and actively participate in solving the complex challenges our world faces. With

technological change accelerating and economies rapidly changing to face the effects of the recent COVID-19 global pandemic, failure to invest in girls' STEM education – and empower girls and women to participate in the digital revolution – will not only forfeit the economic potential of half the population, but exclude girls and women from world-class digital learning solutions and a whole range of new

occupations that require STEM-related skills. The greatest challenge for closing the economic gender gap is women's under-representation in emerging roles, especially those in STEM fields.⁶

Eliminating these persistent gender disparities requires a concerted effort between governments, private sector, researchers, communities – and girls and young women themselves. **Efforts to prepare girls and young women to equally participate in the workforce, including in STEM fields, need to be accelerated.**



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2. Why is STEM learning so important for girls?

We cannot afford to live in a world where scientific and technological solutions are desperately needed – and exclude half of the world's talent. We need girls and women.

Between 40 million and 160 million women will need to transition between occupations by 2030, often into more skilled roles requiring more complex digital, cognitive, social, and emotional skills. If girls and women are not ready and able to navigate these transitions successfully, they will lose more productive and better-paid work opportunities. Even worse, it may reverse progress in female labour market participation.⁸ Solutions are primarily designed by and for men, resulting in many products and technologies not meeting the needs of women and girls. Alienating women and girls from using and designing technological applications means missing out on their perspectives and ingenuity in meeting challenges.⁹

STEM learning is about encouraging girls to think as innovators

Learning to think and solve problems like scientists and engineers can equip girls with the knowledge, confidence and creativity to address major challenges in their communities, such as generating sufficient energy, preventing and treating diseases, maintaining supplies of clean water and food, and solving the problems of environmental change.¹⁰

STEM education allows learners to understand how the world works, driving exploration and discovery.¹¹ STEM teaching and learning builds on a desire to solve complex, persistent and extended real-world problems using practices unique to science, technology, engineering and mathematics, while drawing on the connections within and between these disciplines.¹² The goal of learning STEM skills and knowledge is for children and young people to be able to understand, participate and shape a world in which health,

education, and inequality challenges require innovation and science-based solutions. Now more than ever before, STEM education is relevant for every child, not only for those with aspirations to pursue STEM careers. For girls in particular, STEM education provides rich opportunities for forming a self-image of being capable, resourceful, and able to contribute to solve important problems, which is critical for girls given their limited opportunities to act and be seen as thinkers and innovators in their daily lives.

STEM learning can contribute to develop girls' literacy and numeracy

Literacy should not just be about learning to read. STEM education engages girls and boys by applying their literacy – children read to learn – in critical use of complex information, assessing evidence and writing arguments and explanatory narratives.¹³ Similarly, STEM education supports the development of numeracy skills by engaging students in identifying trends, patterns, measuring, comparing, and creating models to solve real world problems.¹⁴ These skills are critical for girls to engage in coding and robotics, to understand the patterns in their own menstrual cycles, and to monitor their own health. STEM is a catalyst to improve the quality and gender-responsiveness of education.

STEM and transferrable skills

STEM opens opportunities for girls to develop transferrable skills to navigate and meet the evolving demands of the labour market and entrepreneurship.¹⁵ If using the relevant pedagogy, STEM education can promote active learning, helping students to develop their inventiveness, creativity, and critical thinking.¹⁶ It also helps to develop skills in collaboration, self-management and self-development, and systems thinking¹⁷ – giving them tools with which to become informed citizens and effective leaders.



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The innovators: Afghan Girls design COVID-19 ventilators

Engaging girls in STEM learning can lead to saving lives. The Afghan Girls Robotic Team – a team of five students age 14 to 17 years – are part of the Afghan Dreamers two-year programme for high-achieving girls. In response to the Herat Governor's public call for ventilators to help treat COVID-19 patients, the Afghan Girls Robotics Team presented a proposal for the design of an innovative and cost-effective ventilator. With limited resources, the team used locally-sourced materials to build two ventilator prototypes. One uses the engine and battery parts of a Toyota Corolla, a common car in Herat. The ventilator automatically operates an Ambu, a self-inflating plastic sac used by medical professionals to help patients breathe. The team is developing the other model based on a design by the Massachusetts Institute of Technology, with input from Harvard University experts. If the World Health Organization and the Afghan Health Ministry approves one of the team's prototypes, they will be able to mass produce it for US\$ 300, compared to the usual average cost of US\$ 30,000.



Strengthening education system using STEM in low-income countries

UNESCO's CapED Programme¹⁸ supports fragile and low-income countries design and implement education reforms to achieve national development priorities and SDG4 Sustainable Development Goal 4 (ensure inclusive and equitable quality education).

In Niger, where girls have lower enrolment rates, and do not perform and progress as well as boys, a UNESCO study found that teachers' pedagogical practices and attitudes in STEM subjects are partly responsible. Thus, focusing on teachers could reduce the gender gap and improve girls' performance, retention and learning outcomes. In 2016, the CapED Programme launched a pilot in 15 secondary schools in Niger, training teachers and principals in gender responsive pedagogy in STEM subjects. In the classrooms of the participants, girls and boys started sitting together in class and teachers encouraged girls to participate. Teachers have reported being more aware of the harm caused by gender bias. As a result, the initiative was expanded to primary schools and new regions, involving some 9,500 teachers and education staff. The approach evolved with the integration of training modules in all teacher training institutions for primary level teachers, with secondary to follow. Since then, 5,000 gender-responsive teachers have graduated and entered the education system per year. An estimated half a million students (40 per cent girls) now have access to gender responsive pedagogy.

The CapED programme supported Uganda to develop national guidelines for the implementation of gender responsive pedagogy, in line with the 2019 National Teacher Policy,¹⁹ which includes strategies that enable girls and boys to fully participate and perform in STEM related subjects. The guidelines were piloted by training 465 primary and secondary school science teachers on how to explore gender issues in school and classroom settings. In the next phase, UNESCO and the Government aim to set up support structures in teacher training institutions and schools to roll out the guidelines.

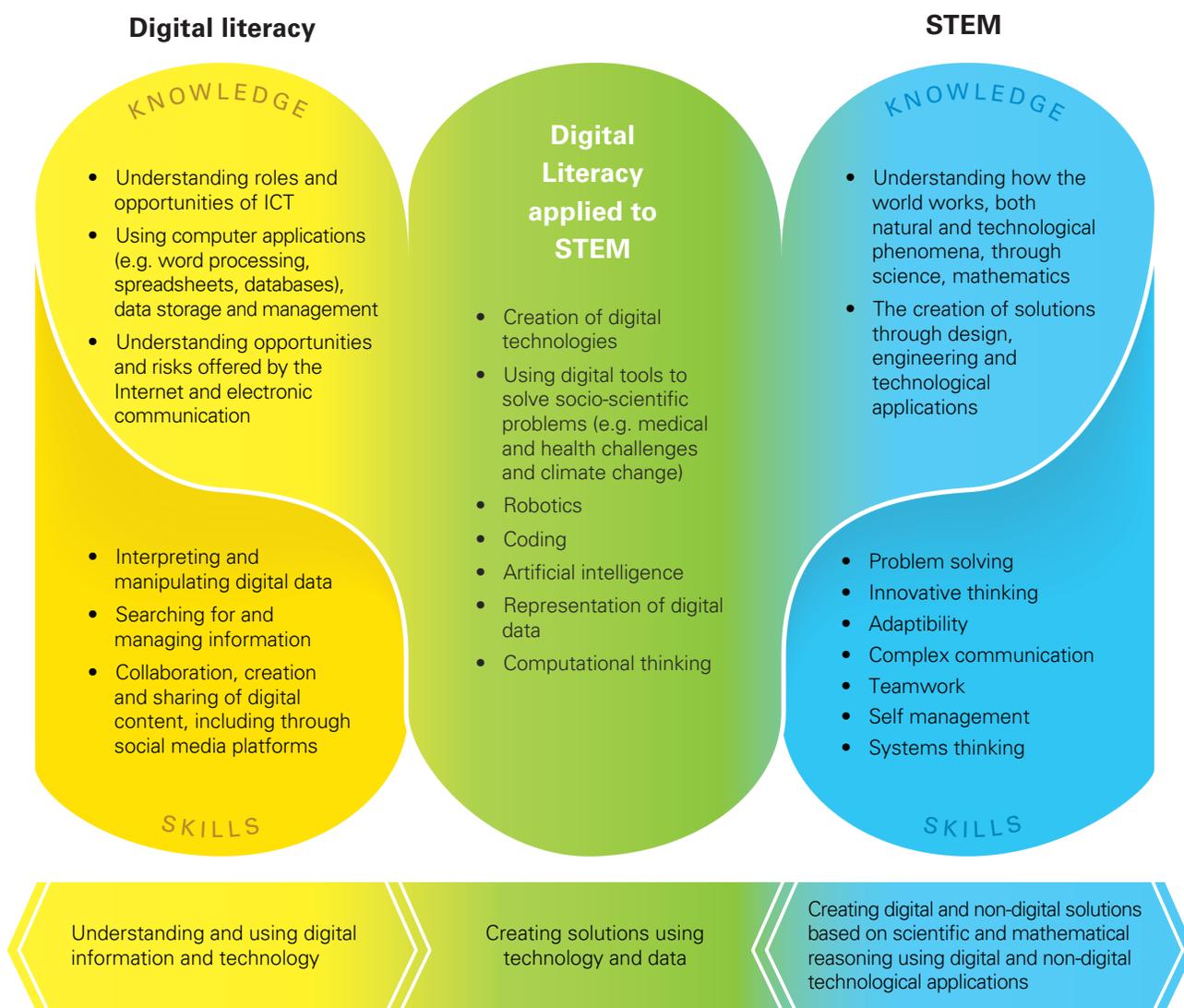
This programme is helping thousands of girls to participate more actively in the classroom, leading to better learning outcomes and a brighter future for them. Even in low income countries with limited resources in the education system, a transformation in teaching practices – using STEM – has the potential to transform gender relations, what children learn, and how girls access STEM.

STEM and digital literacy

Digital literacy for children is the set of knowledge, skills, attitudes and values that enable children to confidently and autonomously play, learn, socialize, prepare for work and participate in civic action in digital environments. It includes the ability to use and understand technology, to search for and manage information, communicate, collaborate, create and share content, build knowledge and solve problems.²⁰ Crucially, digital literacy enables girls to take advantage of connectivity and the internet to surf the web, access new information and interact

with others while remaining safe and healthy.²¹ STEM education and digital literacy overlap and reinforce each other (Figure 2). Taking this further, STEM education provides a foundation for children to apply digital literacy in designing technological devices and solutions – such as robotics and app design – and solving complex problems. A gender-responsive approach to STEM education ensures that girls have opportunities to think through technology as a vehicle for change, with multiple impacts on culture, society, politics, economy, the environment²² and gender equality.

Figure 2



Safety Online

One in three children (0 to 18-year-olds) use the Internet. In developing countries, children and young people are leading internet usage. Online technologies present many possibilities for children and young people to communicate, learn new skills, express creativity, and contribute to a better society. But they can also bring new risks, such as exposing them to issues of privacy, illegal content, harassment, cyberbullying, misuse of personal data or grooming for sexual purposes and even child sexual abuse.

Any education programme designed to enhance children's access to digital technology must include foundational cyber security skills. Combining online safety online with STEM can help to reinforce computational thinking and programming skills. It will also help give girls and young women confidence to learn and work online without fear.

The International Telecommunication Union (ITU) Guidelines on Child Online Protection 2020 provide a roadmap to create a safe and empowering online experience for children around the world.

STEM and job-specific skills

Adolescent girls with job-specific skills related to STEM – such as engineering, computer programming, cloud technology, robotics, health sciences and technologies – are better equipped to equally and actively participate in changing economies and evolving labour markets.

Currently, traditional employment sectors are declining in response to automation, while innovation opens up new ones demanding different skills. Without STEM skills – critical thinking, problem-solving and digital skills – girls and women will be further left behind from equal economic and social participation.

Preparing women for the STEM workforce

The ILO's Women in STEM Workforce readiness programme, funded by JPMorgan Chase Foundation, provides women with critical STEM related skills to increase their employability, career advancement and improve workplace productivity in the Philippines, Indonesia and Thailand. The programme promotes public-private collaboration to design and jointly deliver trainings to address the skills needs within industry and to build the capacity of Technical and Vocational Education and Training (TVET) systems to deliver STEM related trainings.

The programme has developed and implemented industry specific training tools, including a unique set of soft skills training modules for enterprises to improve transferable skills such as creativity, critical thinking, teamwork and problem solving reaching more than 12,000 women workers across Indonesia, Philippines and Thailand. Over 500 women have completed this training in the Philippines and an additional 1,000 low skilled women workers in Thailand have been reskilled through industry-specific technical trainings programmes.

To complement this, the ILO launched the #WOMENCANDOIT Scholarship for women in TVET, studying web development, game development and animation. Designed to increase interest and enrolment in technology programmes among women high school graduates, the scholarship programme has attracted thousands on social media. More than 200 women have graduated from the programme with 30 per cent taking jobs in the Information Technology and Business Process Management sector. In response to the pandemic, a further 200 women will receive scholarships for online training on web development, game development and animation, paired with modules on job readiness to further equip them for the labour market.

STEM education as a disruptor of unequal gender norms

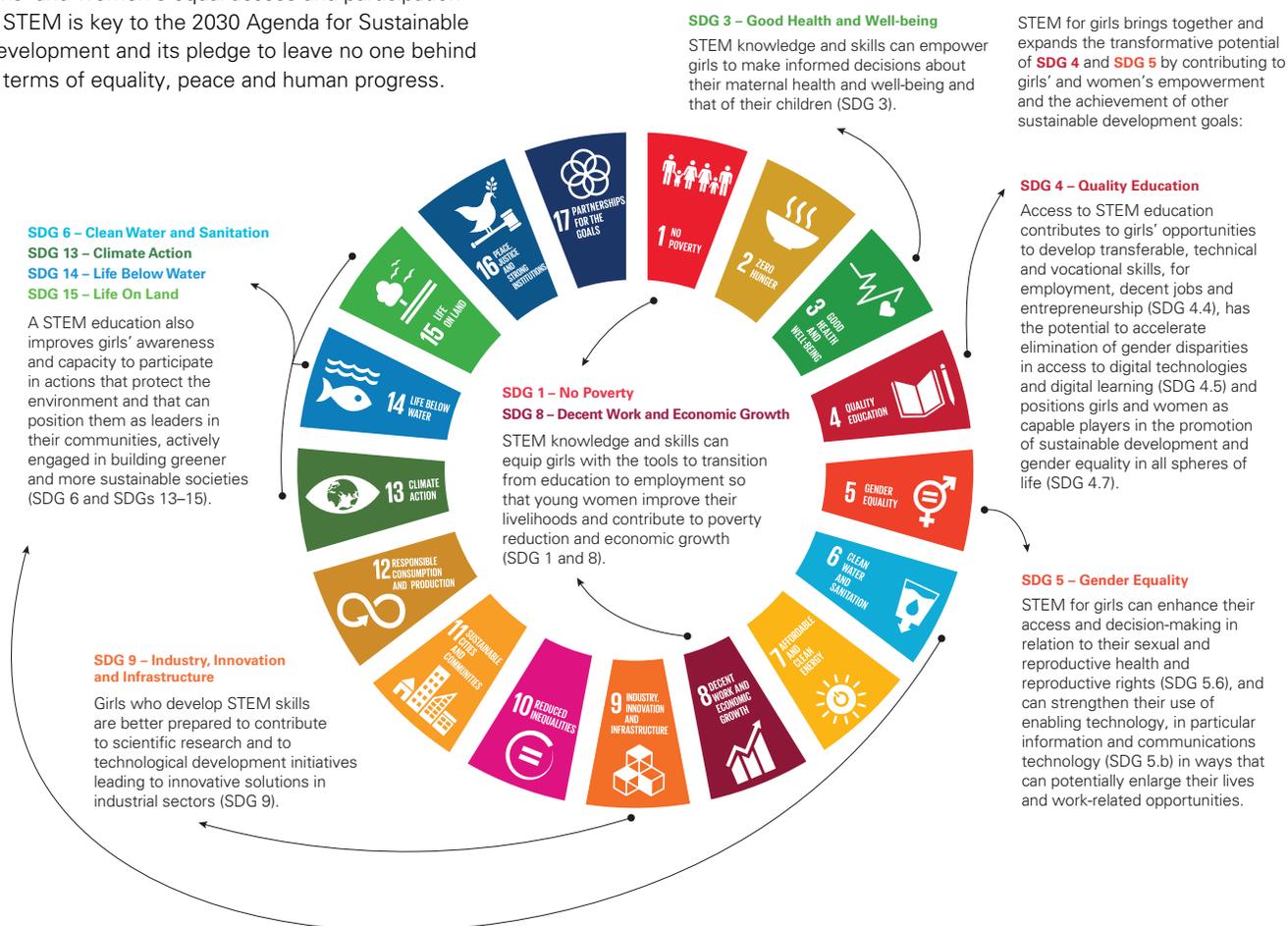
Sharing positive messages with girls about their STEM abilities is critical from early childhood through to adolescence – by parents and teachers, especially. Exposing them to female role models and providing them with

equal opportunities as boys to engage with STEM toys and activities has the potential to influence gender socialization. This in turn disrupts harmful gender norms that lead girls to doubt their competence in STEM and have low self-esteem.²³ Furthermore, if secondary schools and colleges can actively promote girls' access to STEM studies, these norms could start to disappear.

Figure 3

STEM education as an accelerator of the 2030 Agenda for Sustainable Development

Girls' and women's equal access and participation in STEM is key to the 2030 Agenda for Sustainable Development and its pledge to leave no one behind in terms of equality, peace and human progress.



The cost of Inaction

Inaction will exact a toll. Without STEM for girls:

- Inequality will be perpetuated. At the current pace, it will take 99.5 years to achieve gender parity world-wide.²⁴
- The gender digital divide will increase.
- The world will continue to be designed by and for men.
- Young women's potential will remain untapped: they risk continuing to be unemployed or in low paying jobs that run the risk of automation; they will continue to be underrepresented in STEM occupations²⁵ and better paid jobs; and they may

continue to miss on future jobs as economies shift, demanding diversified skills.

- Girls and women will be ill-prepared to respond to climate change challenges and propose effective solutions for their local communities.
- Women may be less equipped to make decisions about their health care and that of their infants.

Increasing women's participation in STEM careers also has the power to close the gender pay gap and boost women's cumulative earnings by \$299 billion over the next ten years, expediting global economic development²⁶



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3. What are the gender disparities in STEM education?

Girls are consistently underrepresented among top performers in STEM subjects. In mathematics, girls tend to perform as well as boys. In Sub-Saharan Africa girls of primary education age continue to significantly lag behind boys in mathematics achievement, and this is also the case for adolescent girls in South-eastern Asia.²⁷ In Sub-Saharan Africa and Latin America and the Caribbean regions, grade 6 girls had similar (or higher) representation than boys amongst top math performers in only 12 out of 42 countries.²⁸ This gap continues to persist in secondary. In science girls tend to perform, on average, as well as boys. However, adolescent girls had the same or better representation as adolescent boys in the top math and science performers in only three and 13 countries (out of 78), respectively.²⁹

Girls in low and middle-income economies are particularly disadvantaged in developing digital skills. In high-income countries, there is very little difference between the share of adolescent girls and boys with basic digital skills. This is not the case in many low and middle income countries. For example, in Ghana, 16 per cent of adolescent boys possess digital skills compared to only 7 per cent of adolescent girls. Gender gaps increase as ICT tasks become more sophisticated in low, middle and high-income economies – in 31 out of 70 countries, at least 10 per cent of male youth and adults have programming and coding skills but this is true for female youth and adults in only eight countries.³⁰

Women are underrepresented in STEM labour market transitions. Female workers make up an estimated 26 per cent of workers in Data and Artificial Intelligence roles, 15 per cent of workers in Engineering roles and 12 per cent of workers in Cloud Computing roles.³¹ Limited participation of women in the workforce is especially acute in the industries that offer better paid

jobs and lifelong learning opportunities. For example, only 30 per cent of tech industry professionals are women.³² The explanation for this under-representation is not lack of ability, but lack of opportunity.

While more female STEM entrepreneurs – or “STEMpreneurs” – are making their mark, they face challenges to growing their business. **Female mentorship is low** in STEM fields (14 per cent for women STEMpreneurs as opposed to 38 per cent for non-STEM women entrepreneurs in Latin America),³³ as is peer-to-peer learning and exchange of good practices. Lack of networks to access markets, key investors and investment opportunities is also a barrier for these women.

Women with STEM degrees may not pursue STEM careers, due to lack of mentoring and career coaching. In addition they may choose to avoid the challenges that women in STEM occupations face in the workplace. Issues such as **discrimination in hiring and promotion, harassment, pay gaps, treatment by co-workers, balancing work and life,**³⁴ and **lack of corporate policies supporting career development** could discourage new entrants from pursuing STEM careers or spur current ones to exit.

Girls are constrained from performing at the highest level. Biased gender norms can cement stereotypes of girls and women as lacking abilities to engage in STEM subjects. These gender norms and expectations are in the way of developing and refining skills such as being inquisitive or feeling confident being an outspoken proponent of potential solutions to problems. Facing low expectations of their STEM abilities, and limited opportunities to excel, take a toll on girls' **self-confidence, beliefs and attitudes towards STEM, and aspirations to pursue STEM careers.**³⁵

In science and mathematics, **girls usually have a lower belief in their abilities than boys.** In the majority of countries, where girls had significantly lower achievement than boys in math and science, girls also had a significantly lower sense of self-confidence related to the STEM subjects.³⁶ Stereotypes about STEM as masculine subjects and social norms about what girls can and should do are reproduced in teacher and parental expectations and interactions, and shape girls' beliefs and attitudes towards STEM.

Girls' career expectations reflect gender stereotyping. More boys than girls aspire to a career as a scientist and engineer (in 72 out of 78 countries)³⁷ or an ICT professional (in all countries). Meanwhile, more girls than boys were interested in a career in the health field (in all countries). The gap in aspirations is not exclusively driven by achievement. In general, even when boys and girls had similar performance, a smaller

proportion of girls than boys reported that they want to pursue a STEM career. Gender gaps in aspirations and attitudes towards science and mathematics at secondary level carries over to girls' post-secondary life. There is declining STEM engagement by girls at higher education levels and lower entry into STEM careers.³⁸

Globally, girls and young women age 15 to 29 years are twice as likely as young men to neither be employed nor engaged in education or training programmes. Only 18 per cent of girls in tertiary institutions globally pursue STEM fields compared to 35 per cent of boys. Within STEM fields, gender differences are most visible in engineering, manufacturing and construction (7 per cent of girls compared to 21 per cent of boys) and ICT (3 per cent of girls, 6 per cent of boys).³⁹ This is consistent with career aspirations amongst secondary-age girls – girls' preference towards health occupations drive gender parity in natural sciences in tertiary education.



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What are the gender disparities in STEM education?



4. Why are girls under-represented in STEM?

Gender norms and gender stereotypes limit girls' motivation and engagement with STEM. A girl is traditionally taught that femininity means she should not be disruptive or get her hands dirty. Early on, girls are given dolls and static objects to play with as opposed to mobile objects that are more complex and may have multiple parts, such as trucks and constructions sets. And as girls grow up, their mobility is often restricted, limiting their opportunities to explore their curiosity. Gender stereotypes that STEM studies and careers are for boys negatively affect girls' interest, aspirations,

engagement and achievement in STEM.⁴⁰ Caregivers and teachers often reinforce the notion that boys are better in science and mathematics than girls. Moreover, the curriculum and learning materials can reinforce gender stereotypes and unequal gender norms in STEM. Interviews with girls in Sudan said that they were not doing well in mathematics "because we are girls."⁴¹ This barrier becomes circular, with images of boys and men dominating STEM-related play, study and work in order to appeal to boys, thereby discouraging girls from aspiring to it.

The Little Adventurers: taking STEM to young girls

In Colombia, a baseline study for a STEM intervention showed that white caregivers of boys had a strong preference for STEM toys for boys, while black caregivers of girls strongly preferred non-STEM toys. These parental stereotypes are quickly learned by young children, encouraging boys and disadvantaging girls early on, especially girls from racial and ethnic minority groups. Preschool girls outperformed boys in math skills by 0.17 standard deviations, yet both boys and girls associate STEM with boys. Based on this data, a coalition of stakeholders* developed a programme, *Pequeñas Aventureras* (Little Adventurers), which focused on the development of STEM and foundational skills (literacy and numeracy), and work with teachers and caregivers to examine and eliminate gender stereotypes. The coalition developed a toolkit comprised of teaching guides, tutorials, a structured plan for each session or activity, a web series, computer games and interactive posters that teach children STEM-related concepts. In addition, the Government texted households three times per week promoting gender equality and concepts related to futures in STEM career and STEM learning. The programme covered 661 community-based pre-school programmes for low-income children, 5,629 children, 845 educators and 3,784 caregivers.

Researchers then measured the math skills of the children participating in the study and the gender aspirations and stereotypes of children, mothers, community and parents. Preliminary results show a decrease in gender stereotypes held by the educators was even larger (0.26 standard deviations). These initial findings from *Pequeñas Aventureras* indicate that the approach decreases gender and racial STEM-stereotypes of educators as well as pre-schoolers.

*The programme is the result of the collaboration between the Colombian Institute for Family Wellness (a government agency), Sesame Workshop, the Interamerican Development Bank (IDB), and Carvajal Foundation (a private sector partner), and Innovations for Poverty Action (IPA).

Similarly, girls have **limited exposure to female role models in STEM**. Girls' interest and confidence in their abilities increase when they are exposed to positive STEM role models.⁴² Observing and interacting with women who are experts in STEM fields improves girls' attitudes towards STEM.⁴³ Hearing the stories of women – particularly women who look and sound like them – can help to debunk gender stereotypes and learn what it means to persevere.

Girls' **socio-economic background** plays a role in their STEM participation and learning achievement.⁴⁴ Amongst top performers in mathematics, girls of higher socio-economic status are over-represented (19 per cent) relative to girls with lower socio-economic status (3 per cent). Boys with a higher socio-economic status are over-represented amongst top performers in both math and science.⁴⁵

Women and girls who face **ethnic, racial and linguistic discrimination** are not excluded from STEM learning only because of their gender. They also have no role models that look like them, talk like them and share their lived experiences. In some indigenous communities, traditional knowledge and technologies have been developed and perfected by women over millennia, yet those knowledge systems are often belittled and invalidated in schools,⁴⁶ decreasing girls' motivation to engage in STEM education.

Girls and women with disabilities face unique barriers to their education and career development in STEM,⁴⁷ including stigma, underestimation of their skills, and education and labour market systems that are not inclusive.⁴⁸ Traditional education in STEM disciplines – often using laboratory work and fieldwork – is frequently unaccommodating to the needs of children with disabilities.

Women with immigration or refugee status, despite having STEM skills, may not have the permission to work in STEM-related fields in host countries. Validating women's prior learning is key to enabling women's work in STEM fields. In addition, STEM education in alternative education modalities and accelerated programmes needs to be available to refugees and migrant girls, so that they develop the knowledge and skills to pursue further education in STEM and transition to work.

Marginalized girls are **less likely to have female teachers** for STEM subjects. Gender inequalities in the teaching workforce are deep-rooted and systemic. Female teachers in rural areas are scarce. Having a female teacher helps girls to more effectively challenge stereotypes than if they have a male teacher, even when using the same learning materials.⁴⁹ In Swaziland, most women who pursued careers in science and technology made the decision to do so in or before their teens and were motivated by secondary school teachers.⁵⁰

Advancing indigenous women in STEM: playing the long game

Australia is making noteworthy steps in advancing girls' access to STEM education and careers. among them is the Government's ten-year AU\$25 million investment **to increase the participation of indigenous girls in STEM**. This includes AU\$20 million for the Indigenous Girls STEM Academy, which will support up to 100 Indigenous girls each year to explore the possibilities of a STEM career through school and tertiary education – and help transition into the workforce. The Academy operates nationally, with locations chosen strategically according to populations, language groups and increasing access for high-achieving, Aboriginal and/or Torres Strait Islander women and girls. An additional AU\$5 million will support the Stronger Smarter Institute, engaging Aboriginal and Torres Strait Islander women who are teachers of STEM subjects. This initiative will support the training of up to 100 new STEM specialized, female, Aboriginal and/or Torres Strait Islander teachers. Attention will be given to supporting their attainment of teaching qualifications, networking and professional practice development, and improving all teacher's knowledge and understanding of STEM.

Marginalized girls face significant barriers in their transition to the STEM workforce.^{51,52} Caregiving responsibilities and domestic chores added to inequality in access to labour markets opportunities, unequal pay, and unstable working conditions limit marginalized young women's application of STEM skills their transition to the workforce. Misalignment between secondary and post-secondary education programmes and labour market demand, lack of career guidance, and often unwelcoming male dominated STEM workplaces constrain girls' transition to STEM careers.⁵³

Gender-responsive pedagogies have not made their way into STEM education yet. Girls are more

interested in mathematics when it is taught from an applied, hands-on perspective than boys.⁵⁴ Engaging girls in dynamic interactions and problem solving in STEM classes has shown to engage girls at a higher level.⁵⁵ Outdated and rigid education in STEM subjects often focuses on prescribed procedures that limit exploration and creativity.⁵⁶ Encouraging girls' curiosity through creative thinking and problem solving are key to STEM learning.⁵⁷ Some countries have education systems in which STEM teaching and learning overall is underdeveloped, let alone gender-responsive. Countries are all at different starting points. Educators and decision-makers in countries where STEM needs to be strengthened may have a difficult time understanding

Tackling gender equality in STEM field with a multipronged approach

UNICEF Bolivia is carrying out multi-level interventions to reduce the gender gap in STEM areas, ensuring that children and adolescents can build the skills they need for the world of tomorrow. This work has included supporting:

- A communications campaign with illustrated success stories of remarkable girls in STEM and motivational webinars featuring outstanding girls and women in scientific and technological areas, which is helping to strengthen the Student Network of Women in Science and Technology.
- The 'Youth Space' of the Municipal Government of El Alto, which provides opportunities to low-income adolescents and youth, with a focus on STEM and digital skills development programmes for girls that explores coding and social innovation.
- Advocating for local actors to invest in evidence-based studies that inform public policy and programme design. UNICEF has kicked this off by launching an analysis of the ecosystem of girls and STEM in Bolivia, which will identify the barriers and opportunities for girls in STEM.
- Promoting events to put STEM for girls on the public agenda. For example, the Symposium #niñez360°, 'Designing the future, the science and technology in the hands of girls', in June 2019, focused national attention on STEM for girls and was attended by the vice-president of Bolivia.
- Celebrating campaigns to recognize women's work in STEM fields during the International Day of Girls in Technology Information and Communication (ICT), in partnership with the Presidency of the Senate, which recognizes women and girls who are achieving in STEM, arts and sports fields. This campaign also debuted a direct communication channel so that girls interested in these areas can speak to women working and studying in these fields.

This multipronged strategy had led to commitment from the Ministry of Education and Government Agency for Information and Communication Technologies to include the building of STEM skills in the formal education system, thus creating sustainability at scale, and paving the way for accelerating progress in girls' education.

the need to focus on girls specifically. Work needs to be done to show that the gender-responsive STEM education seeks to transform teaching and learning so that boys and girls experience quality education while dismantling stereotypes and gender norms that hold girls back.

Existing **STEM initiatives have limited reach and sustainability**, mostly benefitting girls who are in well-resourced urban schools. The rural/urban divide is impacting exposure to STEM learning. STEM education may be more available in cities because of better

schooling infrastructure or more readily available private sector supported initiatives. Innovative STEM education approaches linked to real world situations – and particularly focused on girls – are more commonly found in extra-curricular activities implemented by non-governmental organizations or the private sector than in formal primary and secondary education. Activities such as school clubs, coding camps and robotics clubs, typically providing more freedom for girls to explore STEM without fear of grades and tests.⁵⁸ However, these programmes are limited as to how much they can demonstrate improvement in learning outcomes.⁵⁹

Designed by girls, for girls: the story of a period tracker app

Girls from low and middle-income countries across the world have been collaborating through UNICEF's GirlTech initiative with one aim: to bring girl-friendly menstruation education and individual cycle tracking to as many girls as have access to mobile phones. In Human-Centred Design workshops girls crafted app models that would meet their needs and wants, and digital realities – and sought solutions about phone sharing and connectivity limitations.

The result is beyond expectations: the 'Okky' app is uniquely designed to empower girls with menstruation education in fun, creative and positive ways, functioning online and offline. Girls informed everything from Okky's technical specifications, gamified features and content to its look and feel. Girls ensured the app was easy to navigate by design, ensuring that all users – regardless of their digital literacy – are comfortable using the app, and can navigate it easily through visuals, simple user journeys, text-to-speech option, avatar support and tutorials, content in local languages, and relevant and engaging girl-friendly content. An app like this starts to solve a number of issues for girls: users are able to increase their digital literacy while learning about their body, puberty and menstrual health.

5. How can we transform opportunities for girls through gender-responsive STEM education?

Most education systems today include science, mathematics and technology – addressed as stand-alone subjects – in their national curriculum. While some curricula may need to be updated to reflect scientific and technological advances, the solutions to the issues raised must be bigger. To adequately respond to the gender divide and meet the needs of girls, **we need realize the transformative potential of STEM education.**

Key to this will be the promotion of a **gender-responsive and integrative approach** to teaching the skills and knowledge that girls need to interact with the world and effectively participate in the workforce of the future. This entails breaking disciplinary silos, integrating science, technology, engineering and mathematics into a cohesive learning approach aimed at developing skills and knowledge via real-world applications. It also entails actively and persistently challenging gender stereotypes.

Gender-responsive STEM education includes transformation in teaching practices that are grounded in real life problems and lived experiences, while giving girls every opportunity to achieve at the highest level. This in turn will prepare girls and boys to increase their understanding of how things work, will enable them to design solutions for climate change impacts, health and using technology for innovative and effective civic participation and access to services that further girls' empowerment. It is critical for education systems to build bridges with the private sector to ensure that after

completing the STEM education path, private sector is actively promoting opportunities for young women.

Our approach to STEM education emphasizes gender equality and girls' empowerment, with especial attention to marginalized girls, including in humanitarian contexts. We urge governments, schools, parents and private sector partners to see STEM as a promising educational approach core to quality learning and girls' empowerment.^{62,63} Using a girl-centred approach, STEM skills can be developed by girls and applied to real life contexts in ways that empower them to have critical awareness of their human rights; strengthen their agency in terms of voice, participation and decision-making; enhance their equal opportunity to access/build material, human and social resources with improvements in their well-being and life outcomes, and become innovators, entrepreneurs, and a force that drives change.⁶⁴

Education systems cannot drive such transformative change alone. The vision for stakeholders must be to inspire policy makers and practitioners – public and private – to accelerate change for girls' education and empowerment; to inspire girls to stand up, inspire each other and grow a network of thinkers; to inspire young women transitioning into the workplace of today and tomorrow; and inspire communities to transform unequal gender norms that limit opportunities for all.⁶⁵ STEM Education for all girls, has the potential to accelerate this change.



Taking gender-responsive STEM education to scale

Only 10 per cent of girls in some regions in Viet Nam sit the exam to gain access to upper secondary school.⁶⁰ Teachers have limited opportunities to access a STEM education and learn about innovative and gender-responsive approaches to teaching. Students in remote areas especially are usually not exposed to teachers qualified in STEM subjects. Although Viet Nam has one of the fastest growing internet penetrations in the region, the COVID-19 pandemic and the efforts to use online education have revealed the digital divide in the country, especially in remote areas. Many families cannot afford internet at home or have access to digital devices, leading parents frequently to favour boys' learning over girls'.⁶¹

The Viet Nam Ministry of Education and Training, with the assistance of UNICEF, the Global Partnership for Education and other education stakeholders, is putting in place a raft of measures to make the education system address inequalities and champion gender inclusion. These reforms include:

- Integrating comprehensive sexuality education into STEM, starting from pre-school to secondary, and including substantial content on gender, power dynamics and human rights in teacher guidelines.
- Developing gender-responsive career counselling to encourage girls to become interested in STEM jobs and providing ethnic minority girls with STEM mentors.
- Focusing teaching and learning materials for 3-6 year olds on “unstereotyping” so that teachers promote progressive and positive portrayals of girls, women, boys and men in the learning environment.
- Building gender-sensitive budgeting and a Digital Literacy Framework into the new Education Sector Plan, to close gaps in STEM learning outcomes for girls and address the digital divide.
- Introducing Augmented and Virtual Reality (AVR) education solutions in Viet Nam's remote mountainous provinces where teachers have difficult access to STEM training. AVR will empower marginalized girls to learn-by-doing by directly engaging with their STEM subject matter through gamification and immersive interactive experiences.

Call to Action

The learning crisis needs urgent action. We urge governments, schools, parents and private sector partners to see gender-responsive STEM as a promising educational approach core to quality learning and girls' empowerment. This is not about raising the profile of STEM industries but highlighting that STEM skills are pervasive in everyday life and contribute to the development of children, families, communities and countries. This shift needs actions that can create long-lasting change.

We want to **foster a global coalition** that nurtures girls to move from foundational skills and being passive users of digital technologies, to developing STEM skills

and knowledge necessary to become problem-solvers, shapers and creators – paving the way for every girl to participate in the fourth industrial revolution. All actors must coordinate their work to create an ecosystem in which girls can thrive in the short, medium and long-term – as users of new technologies and members of the workforce of the future.

It is an ecosystem in which workplaces do not merely inherit a workforce developed from community and government investment in education but are active partners in its formation.

This ecosystem needs investment from all stakeholders.

Who is in the STEM learning ecosystem?

Any organization, business, institution or individual with a stake in social and economic development. These include:

- **Governments** and their ministries in education, vocational training, finance, women, youth, labour, community development, trade and industry, social protection – or their equivalents in any given national context.
- **Private sector:** local and multinational businesses – in digital technology, information technology, artificial intelligence, STEM-related industries, corporates requiring STEM skills, charitable foundations, education specialists, sector councils, industry associations, employer associations, chambers of commerce.
- **Civil society:** local and international NGOs, charitable foundations, and local civil society organizations.
- **Bilateral and multilateral partners:** the UN and its agencies, the World Bank, the International Development Bank, regional development banks, DFID, USAID, DFAT, SIDA and other donor countries, and ministries of trade and business from around the world.
- **Academia:** schools, universities, research and development institutions, individual experts, vocational training centres, non-formal education and training providers.
- **Families and communities:** community leaders, schools, religious leaders, school teachers and tutors, parents, siblings, caregivers, peers, mentors, social media influencers.
- **Girls:** Girls will not be the passive recipients of an enhanced education and workplace system. They will be active participants in its formation and sustainability. They just need strong support to do it.

Joint initiatives, collaboration between ministries of education and science, technology companies, and community engagement will drive the change girls and young women need to help them access and achieve using STEM skills. We are calling for all stakeholders to act in four main areas: education, employment, community, and information and data.

Reimagine girls' education and empowerment through STEM education

We call on governments and their partners to transform and modernize education systems so that even the poorest girls have access to quality STEM Education. Beyond that we need to strengthen partnerships for girls' transition from school to STEM jobs by link education institutions to workplaces. The following actions will be critical:

- **Include gender-responsive STEM learning and career opportunities** in national development plans, education sector policies, ICT and science policies.
- **Invest in innovative gender-responsive STEM pedagogies** in early childhood education, primary, secondary and TVET education, boosting girls' learning and confidence to solve real world problems using technology and **building skills among primary teachers and secondary STEM teachers** helping them to understand and address unconscious bias in the teaching practice and assessments – and to engage all learners equally.
- **Invest in women teachers** and women teacher educators, so that they develop STEM knowledge and skills that enable them to inspire girls and facilitate their learning, thereby developing a female teacher pipeline for STEM subjects.
- **Revise** learning materials, removing gender bias and stereotypes, and ensuring that women and girls are depicted as valuable contributors to and leaders in science and technology.

- **Increase access to STEM education through increased digital connectivity for all children**, especially for girls in hard-to-reach areas with limited capacity. Every girl should be able take advantage of the increased access to world-class digital learning solutions and have the tools and motivations to engage with digital technologies, as users and creators.
- **Provide community-based digital skills training** for out-of-school girls – using existing community groups or forming new STEM clubs for girls – leveraging devices they already have access to and use regularly. This training can help with engagement in distance education and digital entrepreneurship.
- **Introduce innovative, digital education solutions** – such as Augmented and Virtual Reality (AVR) and virtual science labs – that reimagine classrooms, particularly in marginalized and remote areas, with limited teaching capacity for STEM; as well as technologies that support girls with disabilities to develop STEM skills that improve their learning outcomes
- **Create initiatives to support girls' school-to-work transition**, such as career guidance at school, apprenticeships, mentorships and work experience programmes – supporting girls' future aspirations and creating pathways for them to transition into the STEM workforce.
- **Work with industry networks and enterprise-based STEM career programmes** connecting STEM professionals with girls in schools for role modelling and mentoring – and foster a cadre of girls to lead the way for the next generation.
- **Instigate financial incentive schemes** – such as **scholarship programmes** and science and technology **competitions and prizes** – to draw young women into STEM post-secondary education.
- **Make clear budget commitments and allocations** for gender responsive STEM education at national and provincial/regional levels.

Reimagine future jobs for girls

Employers play a key role in this school-to-work transition not only because they know which qualifications and competencies young women need to be attractive to employers, but they also have the power to make the workplace safe for women and nurturing for their continuous growth in STEM careers.

We call on stakeholders to collaborate with workplaces to create supportive and safe environments where girls and women can apply and continue to develop their STEM knowledge and skills. The following actions will be critical:

- **Sponsor incentivized apprenticeship schemes** and **offer stipendiary internships** to girls and young women to enhance their transition into labour market, focusing on mentorship of disadvantaged girls, in workplaces that are free from sexual abuse, harassment and gender-based violence.
- **Forge public-private partnerships** between education systems, governments and companies working in emerging technologies. For example, 3D technologies, artificial intelligence, nanotechnology, robotics and gene therapy. We need marginalized girls to have opportunities for job-shadowing, mentorship, scholarships and developing aspirations to work in emerging industries with well-paid jobs.
- **Create networks for women STEM professionals** for large scale communication campaigns that help transform perceptions of women in STEM, and for women in STEM to connect with girls through mentoring, career support, skills training and networking.
- **Develop and enforce anti-harassment policies** to eradicate gender-based violence in the workplace and instigate **family-friendly policies** to make workplaces more attractive to women.
- **Invest in girl-centred solutions and innovations.** This could be linked to incubation support for these young female innovators to refine their solutions, form marketable ventures and take them to scale.

Reimagine a world where communities support girls to engage, achieve, and excel in STEM

We call on stakeholders to work closely with the community in advancing the STEM agenda, as some of the barriers that girls face are community-enforced gender norms.

- **Engaging men and boys** in valuing the capacity, abilities and contributions of women, and making male dominated spaces welcoming and safe for girls and women.
- **Monitor gender-gaps in participation and achievement** in STEM subjects and STEM apprenticeship opportunities, **with community oversight**, so that immediate action is taken by government to identify the causes of inequalities and effectively address them.
- **Initiate communication and advocacy opportunities** to change parental and community perceptions about girls' in STEM education and employment, including celebrating the success of girls in STEM and linking communities with employers to share experiences of women in STEM industries.

Backing girls and young women with evidence...

We call on stakeholders to work together to track and evaluate girls' participation in STEM-based learning and their entry into further study and the workforce. It is only through evidence that we can establish the efficacy of this approach and chart future pathways to help girls access STEM education equitably. The following actions will be critical:

- **Develop collection and reporting mechanisms** for STEM-based data, disaggregated by gender and age:
 - » Uptake and retention of girls and boys in STEM education programmes;
 - » Achievement in STEM learning assessments;
 - » STEM equity index for regular reporting of girls' and women's participation in STEM;
 - » Needs of the market for positions related to STEM.

- **Sponsor academic research** for an evidence-based understanding of barriers to girls participation and achievement in STEM for advocacy, what works in STEM programmes and to map future opportunities.
- **Build a global framework for information-sharing** on national solutions for digital literacy and STEM skills, with a particular focus on South-South lessons.
- **Document best practices** of girls' STEM education and workforce engagement – to be shared with a global knowledge community.

Take action to accelerate gender equality in Technology and Innovation

Generation Equality is a campaign, a movement and a multi-partner platform that takes action to accelerate gender equality. It is committed to a better understanding and intentional actions to bridge the gender digital

divide among young people. ITU and UNICEF will be co-leading the action coalition as representatives of the United Nations. Both organizations will leverage some established initiatives such as EQUALS,⁶⁶ the Global Partnership for Gender Equality in the Digital Age and GIGA.⁶⁷ We call on stakeholders to join Generation Equality and engage in shared actions, including:

- joint efforts for closing tech infrastructure gender and geography gaps in access to internet connectivity;
- enhance skills' development platforms for delivering STEM and digital skills to all adolescent girls;
- new insights and piloting solutions to address the safety risks girls are increasingly exposed to on digital platforms; and
- mobilizing an expanded ecosystem of partners to leverage and collectively build the bridge across the digital divide for girls of today's youth generation.



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