Keeping Doors Open

Girls, STEM & Their Future Careers

2020

Girl Guides

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INTRODUCTION

When it comes to STEM, we have a long way to go to balance the equation for girls' and women's participation. Girls continue to receive messages that STEM isn't for them and may be closing the door on STEM careers as early as Grade 8. As a result, girls could be limiting their career potential and pathways, particularly as the economy and workplace evolves. And as a society, we could be missing out on generations of future innovators and problem-solvers.

Science, technology, engineering and math (STEM) are fields that open a world of possibility. Professionals in these fields are at the forefront of tackling many of the biggest challenges facing humanity: from disease, to climate change, to clean drinking water access and more. Many innovative, analytical, and creative people find meaningful work in these fields. Not only that, but we know that STEM skills and careers will be foundational in the future economy.

And yet it's not news that STEM is an area where girls and women are still sorely underrepresented.

This underrepresentation doesn't happen all at once – it happens as girls and women drop off at every step along the path toward STEM educational and careers fields, something often referred to as the "leaky pipeline."

As an organization focused on supporting girls to be everything they want to be, Girl Guides of Canada (GGC) decided to research girls and STEM. We wanted to understand what getting into the STEM pipeline looks like for girls under age 18 – well before they enter post-secondary studies – and why so many are not pursuing opportunities in these fields. We want to ensure that girls have equitable access to high-earning and high-skills jobs – both today and in the future – and that they have the knowledge and tools to make informed decisions about their education and future careers.

> *"At each step along the education stream, fewer and fewer young people choose to study science or engineering, and the drop-off for girls and women is considerably larger than that for boys and men." – Natural Sciences and Engineering Research Council of Canada*[1]

What did we learn?

Girls might be prematurely closing doors to STEM for three main reasons:

1. **Girls continue to receive messages that STEM isn't for them.** Influences from parents, peers, teachers, media, and society at large continue to subtly – and not so subtly – tell girls that they shouldn't (or can't) be interested or succeed in STEM subjects.

2. **Girls may not be aware of the steps they need to take to open certain doors.** In many cases, girls need to start making decisions as young as age 13 that can impact their ability to pursue STEM fields in the future. But they might not be equipped with enough information to make informed decisions at this early age.

3. **Girls may not realize many of the doors even exist.** There are a wide variety of STEM fields and entry points into those careers, many of which girls may not be aware of. We know that girls are often interested in careers that help people, make the world a better place, and that allow them to be creative, but often aren't aware this is possible through STEM.

Together, these three factors create an environment in which girls are making decisions at the same time that they're being unfavourably influenced by others in their lives in ways that are detrimental to their pursuit of a future in STEM. Empowering girls to navigate to the STEM pipeline is about supporting them to make informed decisions about education and careers so that they don't close doors prematurely. It's also about debunking harmful norms and stereotypes about what girls can do.

What we did

GGC set out to explore what the pathways to STEM careers and skills look like for girls under 18, and how this relates to girls' preparedness for the future of work.

This report draws on a variety of sources, including both primary and secondary research. First, acknowledging that much work has been done to date on girls and STEM, we conducted a desk review. This included a literature review and jurisdictional scan to gather a robust fact base on the current state of the leaky pipeline in Canada, with a focus on knowledge that has been generated on girls under age 18.

We also heard directly from girls. More than 5,000 girls ages 4-17 across Canada told us about their dreams for their future careers by submitting drawings, photos, and written responses to a GGC call-to-action, which provided a view into girls' future aspirations. This report draws on a qualitative analysis of a sample of the girls' submissions.[i] In addition, we conducted a survey with 1,000 girls in Canada age 10-18 to ask them about their career motivations[ii] and led focus groups with girls age 12-17, where we learned about their future educational and career aspirations.[iii]

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i   There were 5,467 submissions received in total. Due to time constraints, roughly 3,500 fully documented for analysis. Two separate analyses of the submissions were undertaken:

- First, for a content analysis of the text only, all entries that did not have an identifiable career or were over the age of 18 were removed, leaving 2,995 submissions to be analyzed. The table of 2,995 cases were imported into NVivo and each submission was made a distinct case with the attributes of age and province categorized. Each case was coded based on the Canadian National Occupations Classification (NOC) categories, and other notable statements.
- Second, for a qualitative analysis of the images, a sample of 500 entries were chosen by random selection using Excel's random number between a set range function. Out of the 500 entries the ones with an associated image were imported into NVivo, totaling 327 entries. Each image was examined and coded. Codes were based on a flexible coding structure that was created before analysis began and was added to throughout the coding process. In addition, each image was annotated based on careful examination and reflection of the images, symbols, and words girls used to describe their future aspirations.

ii   Working with Abacus Data, the survey was conducted with 1,000 girls in Canada age 10-18 from August 6-19, 2019. A random sample of panelists were invited to complete the survey from the Leger partner panel. Participants were recruited through their parents, who were asked to complete a short online survey before being asked to pass the device or invite their daughter/ward to complete the survey. Respondents then completed the survey alone, or with the assistance of their parent/guardian. The comparable margin of error for a probability-based sample of this size is ±3.1%, 19 times out of 20. The sample was statistically weighted to match Canada's population according to age, region, and socio-economic status.

iii   Working with Northstar Research Partners, two interactive, collaborative workshops were conducted with girls age 12-17 in August 2019, in Mississauga, ON and Calgary, AB. A total of 46 girls participated across the two sessions. Across both groups, there was a mix of ethnicity, household income, household composition, disability, and immigration/time in Canada. For those age 16-17, sexual orientation was also taken into consideration.

Lastly, we approached this problem with a human-centred design-thinking mindset. We consulted with external stakeholders who are experts in the field of gender equality in STEM and STEM education for youth, including corporations, associations, NGOs, and women STEM professionals, and internal stakeholders who are experts in non-formal education, youth engagement, and diversity and inclusion. This enabled us to co-create recommendations for action , using design-thinking methods and tools.

When we talk about STEM in this report, we're referring to what Statistics Canada calls "occupations in natural and applied sciences."

This includes a wide variety of careers: from chemist, to engineer, to computer programmer, to physicist, and beyond. Careers in healthcare – such as doctor, surgeon, nurse, and pharmacist – are science-based, but not considered part of the STEM umbrella in this case.

We've also decided to focus our attention on STEM fields where we know women are most under-represented, and which are also most likely to be elevated in the future economy – namely, engineering and computer science. We want to empower girls to thrive in the places they don't currently see themselves reflected, and to access the high-growth industries of tomorrow.

Our Goals

The goal of this report is to empower girls, parents, educators, employers and others to understand the current realities for girls in STEM and support girls to thrive in these areas. The recommendations for action (p. 23) are designed to be a useful tool for the trusted adults in girls' lives so they can help girls as they aspire, set goals, and work hard for the academic and career journeys of their choice.

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The goal is not for every girl to enter a STEM field. In fact, it's quite the contrary. At Girl Guides, we believe that every girl should be empowered to explore, discover, and choose everything she wants to be – and for many, this *isn't* STEM. But too many girls today are closing doors to STEM before they really have a chance to explore or know if this *is* the right choice for them.

Similarly, when we talk about career planning, the goal is to enable girls to keep their options wide open, so that they don't make decisions prematurely, before they've had a chance to look through every door and understand their own strengths and interests. This is not about rushing girls to have their life definitively mapped out; rather, it's to support girls to make the informed and empowered decisions that work for them.

GIRLS and STEM: WHAT'S THE PROBLEM?

The leaky STEM pipeline: we hear a lot about this when it comes to adult women in post-secondary education and the workforce. What exactly does it mean?

The leaky pipeline is a metaphor to describe the barriers that women face when entering, progressing, and staying in STEM fields.[2] For many reasons, women leave the pipeline at different points throughout the educational and career path – these are the "leaks." Some have also used the metaphor of the "glass obstacle course" – to reflect the inequitable, gendered experiences women face trying to progress in STEM careers.[3]

From the perspective of girls under 18, we're talking about the process of girls even *getting to* the STEM pipeline – how do they navigate to a post-secondary program where they then enter the pipeline? Based on our research and what girls told us, we saw doors opening and closing for girls along *every* step of the way.

Whichever metaphor you choose, the well-known reality is that women continue to be underrepresented in STEM fields – as students, as graduates, and as professionals.[4]

For racialized women, the leaks along the pipeline are even more pronounced. Racialized women are less likely to hold STEM degrees than white women[5] and those with STEM credentials are less likely than white women to find STEM employment and persist in STEM fields over time.[6]
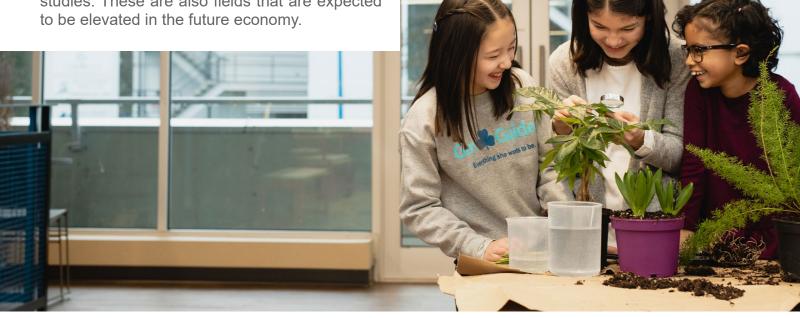
When looking within the different STEM fields, there are clear gender differences: women are mainly concentrated in the sciences, while men are concentrated in engineering, mathematics, and computer science.[7] This is important because engineering, mathematics and computer science have higher median wages than fields like life sciences, where women tend to be concentrated.[8] Engineering and computer science in particular are where the large majority of STEM jobs are concentrated,[9] where graduates tend to have a higher skills match to the job they find post-graduation,[10] and where more opportunities tend to be available without requiring graduate studies. These are also fields that are expected to be elevated in the future economy.

Through asking thousands of girls about their career dreams, we learned that only a small minority of girls are thinking about STEM as a future career goal. As a girl-driven organization, Girl Guides was interested in seeing what the path to STEM looks like for girls before they've even entered post-secondary education. We learned that doors can begin closing during adolescence, as early as age 13.

We believe that girls may be closing doors to STEM early, because they continue to get the message STEM isn't for them, because they aren't always aware of the options open to them, and because they're required to make decisions early that might not be fully informed.

By the numbers: women and girls in STEM

A round-up of the latest facts from Canadian research on women and girls in STEM:

Girls with higher mathematics marks in high school are less likely to opt for a STEM university program than boys with lower marks.[11]

As first-year undergraduate students, women make up:
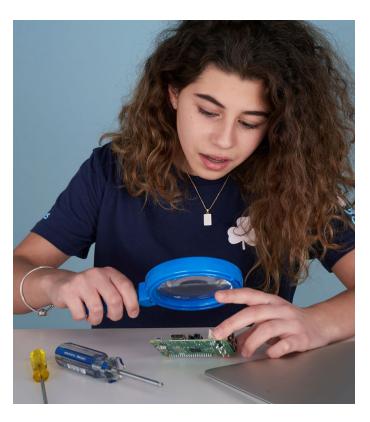
63.8% of non-STEM programs

56% of science and science technology programs

27.6% of mathematics and computer and information science programs

19% of engineering and engineering technology programs[12]

- Indigenous students account for only 1.2% of undergraduate enrolment in engineering programs,[13] and Indigenous men are twice as likely to graduate from a STEM program as Indigenous women.[14]

- Women represent 59% of all university graduates, but they only account for 39% of graduates from STEM programs.[15]

- 18% of women STEM graduates are in occupations requiring a high school diploma or less.[16]

- A longitudinal study found only 3 in 10 women STEM graduates were employed in a STEM field, versus 4 in 10 men graduates.[17]
  - Racialized women were even less likely to persist in STEM fields.

- Women made up only 18% of newly-licensed engineers in 2018.[18]

- Black, Filipina, and Indigenous women are much less likely than other groups to participate in the tech sector.[19]

Every girl should feel empowered to make whatever choice for her future that is best for her. Whether the best choice is STEM or another path, social pressures or a lack of career planning knowledge shouldn't be closing doors for girls while they're still in their early teens.

"I want to help solve climate change." – Future environmental scientist from Ontario, age 10

"I want to discover new stars and maybe planets." – Future astronomer from British Columbia, age 11

It's also crucial we address these barriers for girls because STEM will play an important role in the future of work. Not only will STEM career fields and industries be where many jobs of the future are concentrated, but technical STEM skills – in addition to soft, socio-emotional skills – will be needed across careers in all industries.[20] Without a strong foundation in STEM skills, girls are at risk of being left behind in the economy of tomorrow.

We also risk leaving their minds untapped in tackling the pressing challenges of the future – and we can't afford to leave 50% of the population out of this problem-solving. Research has shown that greater diversity strengthens innovation[21] and having more girls in STEM will increase that diversity. And without that diversity and stronger innovation, we all lose out.

Are girls interested in STEM careers?

When we asked girls across Canada to share their career dreams with us, we heard from hundreds of girls who were interested in STEM careers. But the proportion was quite small compared to the total number of girls who responded to our call-to-action.

We used the National Occupations Classification (NOC) system to categorize girls' dreams, which is the Government of Canada's standardized language used for describing the work performed by Canadians.[22] Using this system, careers in STEM are referred to as occupations in natural and applied science. Some health occupations (such as physicians) are related to STEM but aren't considered STEM jobs according to the NOC.

Top categories for girls' career dreams, in order of popularity:

1 Art, culture, recreation and sport

2 Education, law, and social, community and government services

3 Health

4 Sales and service

5 Natural and applied science

Girls' top career areas in natural and applied sciences, in order of popularity:

1 **Physical sciences** Mainly astronauts among younger girls, but also chemists, geologists, astronomers and paleontologists among older girls

2 **Life sciences** Most popular among older girls, and mainly biologists, zoologists, and forensic scientists

3 **Engineers**

4 **Architects, urban planners, and land surveyors**

5 **Computer and information systems professionals**

Girls' interest in STEM careers increases with age, as does the diversity of STEM careers mentioned. This makes sense, as older girls have a more concrete understanding of the specific careers available to them. In general, excluding the ambitious young aspiring astronauts, girls seem to express the most interest in STEM careers that have a direct human or animal connection (e.g. biologist or zoologist).
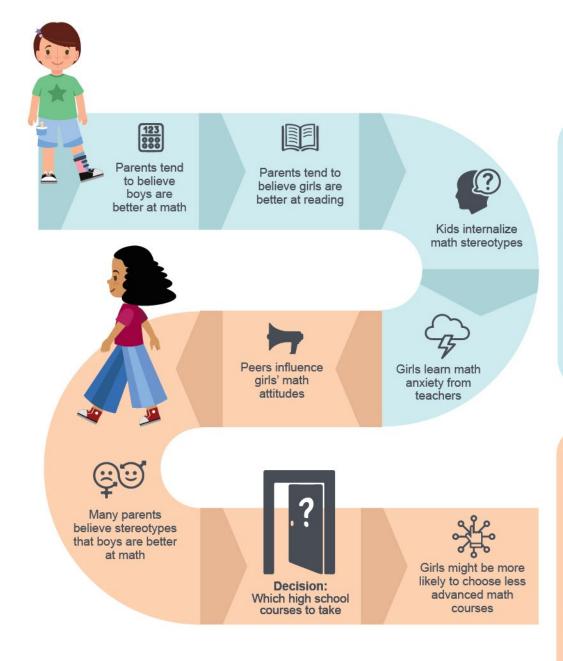
"Biology is what I consider to be the most interesting branch of science, since we get to learn about the creatures of the seas. Only 5% of the world's oceans have been explored, which means that 95% is still a mystery. I want to be a part of discovering new species and mapping out the ocean floor, as well as doing more research on already discovered marine life."
— Future biologist from Ontario, age 15

GETTING TO THE PIPELINE

What getting to the STEM pipeline looks like for girls

Parents tend to believe boys are better at math

Parents tend to believe girls are better at reading

Kids internalize math stereotypes

Peers influence girls' math attitudes

Girls learn math anxiety from teachers

Many parents believe stereotypes that boys are better at math

Decision: Which high school courses to take

Girls might be more likely to choose less advanced math courses

CHILDHOOD
Ages 5 - 12

In childhood, parents tend to believe that boys are better at math and girls are better at reading.[23] Kids begin to internalize gendered stereotypes about math.[24] In elementary school, teachers' math anxiety is imparted onto girls, but not boys, and impacts girls' math achievement.[25] At this point, parents believe that math is more difficult for girls than for boys.[26]
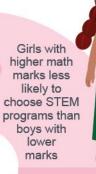
ADOLESCENCE
Ages 13 - 14

In adolescence, parents of girls hold stronger gender stereotypes favouring boys in math.[27] In grade 8 or 9, girls have to make critical decisions about high school courses. They're supported by parents, teachers, and guidance counsellors as they make these choices. Girls in Grade 9 might be more likely to take less advanced math rather than the advanced course despite otherwise being on the advanced academic track.[28]

Decision: Which math and science courses to take

Peers influence girls' post-secondary choices

Girls with higher math marks less likely to choose STEM programs than boys with lower marks

ADOLESCENCE
Ages 14 - 18

In high school, peers influence girls' math attitudes and choices for post-secondary programs.[29] Girls view themselves as hardworking rather than smart when it comes to STEM classes.[30] Girls in Grades 10 and 11 need to decide which math and science courses they take. In Grade 12, they need to make critical decisions about the post-secondary programs they apply to and enter. Girls with higher math marks are less likely to choose STEM university programs than boys with lower marks.[31]

Decision: Entering post-secondary programs

Decision: Post-secondary applications

Girls see themselves as hardworking – not smart – in STEM

Women twice as likely to switch from STEM to non-STEM
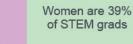
Sexism and gender-based harassment at school

Decision: Staying in program of study or switching

POST-SECONDARY
Age 18+

In post-secondary studies, women are twice as likely to switch from STEM to non-STEM programs in the first two years.[32] More than half of post-secondary graduates are women, but women are the minority of STEM graduates (39%). And they're more likely to be graduating from science and technology (59%) compared to engineering (23%), math (30%), and computer science (30%).[33]

Women with STEM degrees have higher unemployment rates

Women are 39% of STEM grads

Women less likely to graduate from engineering, math, and computer science

EARLY CAREER
Age 22+

Women with a STEM degree have a higher unemployment rate and are more likely to be in a job that doesn't match their skills, as compared to men. Women work in STEM fields with lower median wages.[34]

Sexism and gender-based harassment at work

Women with STEM degrees more likely to have skills mismatch at work

Decision: Career path

Keeping Doors Open: Girls, STEM & Their Future Careers

What influences girls?

It's been well-documented that there are deeply engrained social norms and stereotypes that tell girls that STEM isn't for them. Girls get these messages about STEM from many sources: parents, teachers, peers, and the media, to name a few.

Through GGC's past research with girls, we know that one quarter (24%) of young people age 12-18 agree that boys are more capable than girls of doing things in society such as learning math and science, playing sports, and taking on leadership roles.[35] We also heard that more than one in ten girls (14%) age 15-17 say they have faced expectations to follow a career path that is considered traditionally "female," such as nursing, teaching, or social work.[36]

But the stereotypes about girls having less aptitude for STEM subjects isn't based on fact: research has shown that gender is not a factor in math or science abilities, and that boys are not inherently better than girls at math.[37] And Canadian test results show that that girls' and boys' aptitudes in math and science are similar across grade levels.[38]

Trusted adults: parents and teachers

Research has shown that both parents and teachers tend to believe that boys have a natural ability in math, and that girls have to work harder to succeed at math. So, while boys and girls might have the same success in math, one is seen as a result of natural ability and the other a result of hard work.[39] This false assumption can have a real effect on girls: parents' beliefs about their child's math ability actually has a stronger impact on how good the child thinks they are at math than the child's past achievement in math.[40]

When parents and teachers hold gendered stereotypes that turn into expectations about a girl's ability to do math, girls are at risk of "stereotype threat" and developing math anxiety.[41] Stereotypes about girls' abilities in STEM fields can actually undermine girls' performance in these fields.[42]

Stereotype threat happens when girls believe in a stereotype about themselves – or even when they don't believe the stereotype but are worried about others believing it about them. When girls are worried about reinforcing the stereotype about them (e.g. "girls are bad at math"), it can actually impact their abilities, characteristics, or attitudes (e.g. they do worse on a math test).[43]

Math anxiety is an attitude toward math that girls can internalize, which makes them feel tense and anxious. It can interfere with a girl's ability to solve math problems and can mean she doesn't perform as well as she's able to.[44]

Both stereotype threat and math anxiety can contribute to girls performing poorly in STEM subjects and may even deter girls from continuing to explore STEM fields.

Girls can also learn math anxiety from both parents and teachers.[45] When girls see women teachers who are math anxious, they themselves begin to doubt women's abilities in math and their performance in math declines.[46]

Peers

Peers' attitudes can impact girls' willingness to pursue STEM. A study found that when friends uphold traditional gender norms, the likelihood of girls choosing STEM fields of study decreases by 31%.[47] Through our own research, GGC learned that nearly two in ten girls (16%) aged 15-17 hide the fact that they like STEM for fear of being rejected by their peers.

Media

Girls also get messages about who should pursue STEM from media. A study of more than 1,000 STEM professionals depicted in media and entertainment found that STEM characters are twice as likely to be portrayed as men. When women are portrayed as STEM characters, 60.4% are white women with a majority working in life sciences (65.8%), while men are more likely to be portrayed as engineers, scientists, and in computer science occupations.[48]

"I discovered coding last summer, and I loved it. One obstacle I might face is being a girl. The STEM fields are mostly dominated by men, so I might find it harder."

– Future computer scientist from Ontario, age 13

Combined, these influences can impact girls' likelihood to pursue STEM at every step along the way.

How girls are making decisions about education and career paths

Girls are making decisions about the courses they'll take, the post-secondary programs they'll apply to, and the careers they'll pursue.

This all happens within the context of the education system.

To understand the options open to young people today, we conducted a scan of 118 post-secondary programs in STEM fields at 38 post-secondary institutions (both universities and colleges) in three populous Canadian provinces: Alberta, British Columbia, and Ontario. This included 93 bachelor's degrees and 25 diplomas.

All of these programs are specifically designed to prepare students for professional and technical occupations in STEM. The programs we examined report that they prepare students for 31[iv] different STEM occupations, as defined by the NOC system – everything from industrial engineers to web developers to forestry technologists.

By looking at the application criteria for these programs, we were able to draw a line directly from the courses girls take at the high school level to the occupations open to them later in life.

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iv   NOC identifies 62 STEM occupations.

What we learned

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Most degrees or diplomas – **roughly three quarters** – require an advanced Grade 12 math course,[v] and nearly all require some Grade 11 or 12 math.

• While advanced Grade 12 math is more likely to be required for university degrees, more than a third of the college diplomas also required an advanced math course.

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While science courses weren't as widely required as math courses, **more than half** of the degrees and diplomas also require an advanced Grade 12 level science course, and roughly two-thirds require some Grade 11 or 12 science.

• Of those that require an advanced level science course, most require physics specifically.

Looking at the STEM occupations these programs prepare girls for, **more than three quarters** of the occupations require an advanced level Grade 12 math course, and **two thirds** require an advanced level Grade 12 science course. In other words, by taking an advanced level math or science, girls would be eligible to apply for programs that would prepare them for the majority of STEM occupations.

v   "Advanced level" refers to 30-1 sequence courses in AB, University (4U) stream courses in ON, and any Grade 12 math in BC, where there is no streaming.

What does this mean for girls?

Girls might not be aware of the steps they need to take to open certain doors.

Because prerequisites for Grade 11 and 12 courses start earlier in high school, the course selection decisions girls make starting in Grade 8 in BC and Ontario, and Grade 9 in Alberta, can already have impact on which doors remain open to them down the road.

In fact, as early as age 13, girls are making academic decisions that can impact their ability to pursue STEM fields of study and careers in the future. And in many cases, the decisions they're making can affect which doors open and close.

We have reason to believe this decision-making is a problem for girls specifically. A cohort analysis from the Toronto District School Board, the largest school board in Canada, found that a sizable number of Grade 9 girls were enrolled in the applied math course, despite all their other courses being in the academic stream. Girls were twice as likely to be in this scenario than boys in the cohort.[49] Applied courses are more practical and concrete and are prerequisites for the courses designed for college entry requirements or the workplace. Academic courses are where students explore abstract concepts and are prerequisites for the courses designed for university entry requirements.[50] Research has also found that low-income, Black, Indigenous, and other marginalized students are overrepresented in applied and lower-level courses.[51]

> *"I will have to study a lot of math and science, but it will be worth it… Who knows what's out there?"*
>
> *– Future astronaut from Saskatchewan, age 10*

Girls might not realize many of the doors even exist

Given how early these course selection decisions need to be made, it begs the question: are girls and their parents being properly equipped to make informed decisions about academic planning? Through talking to girls in focus groups, we learned that many of them have an idea of their future career, but few understand the process to get there. And for girls under 16, while many know they want to pursue post-secondary education, few know what they want to learn once they're there. Another study found that low-income and racialized students in particular may have less access to the information needed to make important course selection decisions.[52]

It's worth repeating that girls are also making these crucial decisions at the same time that they're getting messages – from peers, educators, trusted adults, the media, and elsewhere – that STEM subjects aren't really for girls. As a result, they can close doors prematurely.

Through hearing from thousands of girls about their career dreams, we know that while it's the minority, many girls *are* thinking of STEM careers. However, girls were more interested in health occupations (which are STEM-adjacent) or occupations in physical sciences or life sciences. Careers in the sciences are the STEM fields which have a greater representation of women, but they are also lower paying, and tend to have fewer career opportunities without a graduate degree. Far fewer girls expressed interest in careers in engineering or computer and information system technologies. But these are the areas where women are most underrepresented – and which pay more and have more jobs available.

The reality is that there is a huge variety of careers in STEM that most girls – and probably most adults – aren't aware of. Based on the career dreams girls shared with us, we saw that girls are primarily thinking of STEM jobs which they can see directly helping people or animals, or that are related to their current interests. For example, veterinarian (a health occupation) and marine biologist (a life science occupation) were very popular choices because girls like animals and want to help them. Astronaut, geologist, or paleontologist were also popular because space, gems, and dinosaurs hold a long-standing fascination with kids.
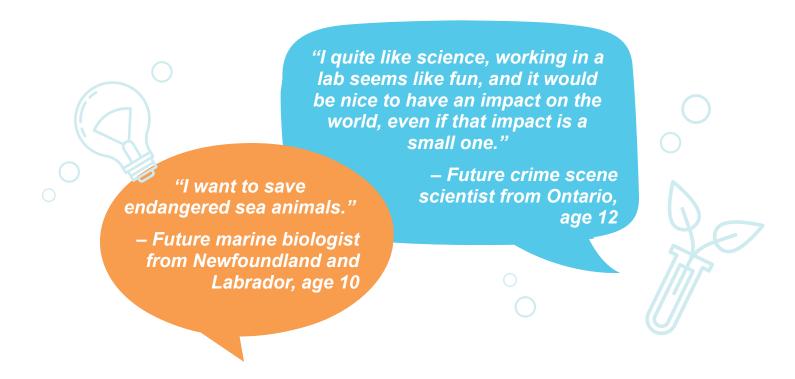
But the question is: how can we empower girls to connect their passions to a broader array of careers, and specifically to careers that align with the projected future of work in Canada? And how can we, as parents, educators, employers, and others work to address inequities for girls today and in the future?

In some cases, it might also be that the messaging around STEM isn't resonating with girls – and so they're passing doors by, not knowing what's on the other side.

For example, through talking to girls, we know that helping people, making the world a better place, and being creative are among the top motivations for girls in their future careers – this has been found in other research as well.[53] But when we asked girls about their career ambitions, most girls who were interested in occupations in natural and applied science didn't note that they "wanted to help", while those interested in health occupations were very likely to say they wanted to help either people or animals.

Girls aren't getting the message that careers in STEM can help people through solving the world's most pressing challenges – and this gap in knowledge might be doing them a disservice by dissuading them from considering these fields.

"I quite like science, working in a lab seems like fun, and it would be nice to have an impact on the world, even if that impact is a small one."

– Future crime scene scientist from Ontario, age 12

"I want to save endangered sea animals."

– Future marine biologist from Newfoundland and Labrador, age 10

Girls aren't getting the message that careers in STEM can help people through solving humanity's pressing challenges – and this gap in knowledge might be doing them a disservice by dissuading them from considering these fields.

Not only that, but we found that there are a sizable number of occupations in STEM fields that have clear pathways from college diploma programs. In fact, college programs were designed to prepare students for nearly half of the STEM occupations we examined. But in focus groups with a diverse range of girls, most of them told us that, while post-secondary education is a given for them, they aren't considering college as an option.

SO WHAT?

The decisions a girl makes as early as Grade 8 can impact which doors are open to her as a young adult. As she progresses along her education journey, she might not have the support and information needed when selecting courses. At the average age of 13, after exposure to gender-biased STEM messages during very foundational years in her life, a girl is choosing if she will have access to future fields of work – often without information on the scope of that decision.

It's crucial that girls and their parents are empowered with the resources and support to make informed decisions as they navigate academic and career planning, so that girls aren't unnecessarily pigeon-holed and pushed in a direction that isn't for them or that they aren't unknowingly closing the door on a world of opportunities.

To illustrate this point, let's look at a few scenarios:

Opting out for a higher average

In Grade 9, when picking courses for her first year of high school, Layla in Alberta chooses the "10-1" sequence math and science courses – these are the prerequisites for the more advanced Grade 11 and 12 math and science courses needed to apply for most STEM programs.
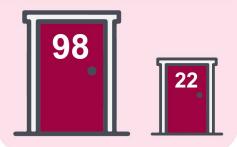
At this point, Layla is on track to be eligible to apply for virtually all post-secondary STEM programs.

But Layla doesn't do well in her math class. She's always had some anxiety about math, and with exams in high school, this becomes even worse. She doesn't want her average to slip by taking "harder" math courses.

So, she decides to take the "-2" sequence math (which is less advanced than the -1 sequence course) the following year to bring up her overall average.

This decision means that it will be difficult for Layla to get the prerequisite courses to take 30-1 Math or 31 Calculus in Grade 12 – the courses required for most post-secondary STEM programs.

While Layla now has an excellent grade in math and a higher overall average, only a handful of STEM programs are open to Layla.[vi]

Skipping physics

In Grade 10, when picking courses for the next year, Zoey in British Columbia decides to take Biology 11 and Physics 11 because she really likes science.

Combined with the math course she's taking, at this point, Zoey is on track to be eligible to apply for virtually all STEM programs.

When selecting Grade 12 courses, there's a lot of courses Zoey wants to take. Physics 12 conflicts with another course she's interested in, so she decides Biology 12 is the only science course she'll take this year. Besides, Zoey decides she's more interested in biology since she finds it relates more to helping people and the planet.

Because she also took a Grade 12 math course, Zoey is still eligible to apply for a lot of post-secondary STEM programs. But there are many programs she can't apply to because she didn't take Grade 12 physics – mainly those in engineering and applied sciences.
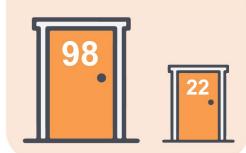
Streaming early

In Grade 8, when picking courses for her first year of high school, Romy in Ontario chooses all Academic stream courses. These are the prerequisites for university stream Grade 11 and 12 courses down the line.

But Romy has never gotten very high grades in math class. She assumes she's just bad at math. In fact, some people have told her it's not her strength. So she decides to take the Applied stream math course even though all her other courses are Academic.

This decision means that it will be difficult for Romy to get the prerequisites for Grade 12 "4U" math courses that are required for most STEM post-secondary programs. Only a handful of STEM programs are now open to Romy.

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vi   The number of "doors" is based on the proportion of STEM degrees and diplomas each girl is eligible to apply to in Alberta, British Columbia, and Ontario based on the courses she selected.

Empowering girls to choose, today

It's entirely possible that Layla, Zoey, Romy, and many other girls might not be interested in pursuing STEM.

But when they're making these decisions at the same time that they're getting the message that girls are bad at math, or that engineering isn't a career that helps people, then it's worth questioning whether these decisions are informed and empowered ones. Are girls actively choosing not to pursue STEM – or are they defaulting out of these fields because of stereotypes and social norms? And when they're making these decisions as early as Grade 8, it's also worth questioning whether they have all the information they need to understand the implications down the line.

To be clear – this isn't about pushing girls who genuinely don't enjoy STEM through a door. It's about ensuring girls have as many doors as possible open to them, so their options are open to pursue everything they want to be.

There are, of course, other routes toward STEM careers. If they're missing a credit, girls can take an extra course in summer or night school. If they change their mind after pursuing a non-STEM degree, they can go back to school. If they're midway through their career and want to change things up, they can retrain and pivot. But these re-routing options aren't always straightforward or efficient. Why not strive to remove the barriers so that STEM can be their first choice, or so that their journey to STEM is as smooth as possible, if it would be the right choice for them?

We'd be remiss not to acknowledge that when it comes to barriers, there are other factors at play as well. Given that the cost of post-secondary tuition has tripled over the past 15 years, post-secondary affordability can be a significant barrier.[54] For many girls who want to pursue STEM programs of study, and who make decisions along the way to keep these doors open, doors can still close if they or their families lack the financial resources or access to networks to make higher education a reality. To ensure all girls can choose STEM if they want to, all of these factors need to be addressed.

Empowering girls for the future

Overcoming these barriers for girls in STEM is about empowering them to make the right choices for themselves today and in the immediate future. But it's also about their ability to thrive in the future economy.

While we don't know exactly what the future economy will look like, we know that the economic landscape is rapidly changing, and is being shaped by emerging and disruptive technologies and increased automation. The Fourth Industrial Revolution is starting to create new high-growth industries, highly-valued jobs, and high-demand skill sets which will be critical to Canada's economic prosperity and achievement of a high quality of life. Jobs will continue to grow in high-skilled professional and technical fields like STEM and will demand a high level of digital literacy. According to the United Nations, "65% of children entering primary school today will have jobs that do not yet exist."[55]

Keeping doors open for girls in STEM is even more pressing when STEM fields are likely to see increased growth in the future economy, and particularly engineering and computer science.

As we learned, for the minority of girls who are interested in STEM, there's still a gap: they're most likely to be interested in fields where women have already made some strides, which are less financially-rewarding, and where there's less likely to be jobs now and in the future. Speaking with girls in focus groups, it was only when prompted that girls recognized that automation will replace many jobs – and even then, they were sure it wouldn't be their jobs. It's crucial that we find ways to translate girls' interests into more future-proofed fields, while maintaining what's at the core of their passions and motivations.

Even for girls for whom STEM fields truly aren't a fit, this is still a conversation worth having. The skills learned through STEM courses will be fundamental to the future of work, even in non-STEM occupations.[56] Technical skills like digital literacy, computer programming, and working with machines will become important for many types of jobs.[57] But girls and women continue to lag in digital literacy, likely due to the influences and barriers discussed here.[58] Not only that, but STEM subjects are an excellent space for girls to learn soft skills like resilience, a growth mindset, and coping with failure that will also be important for thriving in the future of work.[59]

If we don't address the doors that close for girls in STEM, then we risk girls being left behind in the economy of tomorrow.

WHAT CAN YOU DO?

How can we empower girls to keep their options open to even get into the STEM pipeline, and not prematurely close doors? There are steps we can all take to support girls to make informed and empowered choices for their futures.

> *"She designs*
> *She builds*
> *Won't resign*
> *She's filled*
> *With determination*
> *To be an engineer*
> *To help our nation*
> *Because she has no fear"*
>
> *– Future engineer from British Columbia, age 14*

Girls

Keep your options open

- **Take math and science:** During course selection, keep your options open by taking math and science courses – and especially the more advanced courses, if you're in a province that has course streams. This doesn't mean you have to go into STEM, but if you decide you want to down the line, the option will be there.

- **You don't need to have it all figured out:** It's okay if you don't know what programs you want to apply to, or what career path you want to pursue. If you keep your options open by taking a broad range of fundamental courses (including math and science), then lots of doors will be open to you when it's time to apply!

- **Think about skills:** Planning for the future doesn't have to mean focusing on a specific career or job. You can choose to focus on the types of skills you want to build and use.

- **Start at the end and plan back:** If you have an idea of the direction you want to head in, make sure your bases are covered by starting at the end and working backward. If you have an idea of the different post-secondary options you want open to you, look at the admission requirements and then work backward from there to figure out the courses you should take now.

Access resources and support

- **Ask for help:** There can be a lot to consider when you're making decisions about your future. Make an appointment with your guidance counsellor or ask a teacher or parent if they can help walk you through the course selection or post-secondary application process. If you're not sure about pre-requisites or admission criteria, see if they can help you navigate it.

- **Look for resources:** Look for informational websites and other resources to support your academic and career planning, so that you can make informed decisions. This could include college and university websites or your school board's website.

Get inspired by role models and mentors

- **See it, be it:** Put up posters and quotes from women who you look up to. Look for progressive media sources that showcase awesome women leaders. On social media, look for examples of girls and women you identify with and diverse role models who are excelling in their fields – and follow them for ongoing inspiration! Check out movies, books, and graphic novels about amazing women in STEM.
- **Career questions:** Talk to your parents and the other adults in your life about what they do at work or while volunteering. Ask them if they use any STEM skills in their jobs, how they help people, or the impact that their work has.

Be curious and open-minded

- **Ask "why" and "how":** When you see a local community problem or world issue, be inquisitive and creative to think about how you would solve it (even if it's just to daydream!). Try building things or taking things apart.
- **Look for STEM in everyday life:** STEM touches our lives in lots of different ways. Looking at tech specifically, it goes beyond video games and computers – it impacts healthcare, music, transportation, politics, and so much more. Consider the ways the things you're passionate about are touched by STEM and how you could pursue these passions.
- **Explore career options:** Browse a job posting website or career fair. What kind of jobs have you not heard of before? If they sound interesting, can you learn more about them? If your school offers co-op courses, this is a great place to start.
- **Join and explore:** Join clubs and extra-curricular activities that give you a chance to explore STEM-related activities and skills. Don't want to commit long-term?

Look for special events and competitions like hackathons.

Be aware

- **Keep stereotypes in check:** Be aware of how we all get messages about who's good at STEM. Is this affecting your own attitudes towards STEM subjects? Question your friends or peers if you hear them repeating harmful stereotypes about STEM.

Parents and other trusted adults

Encourage girls to keep their options open

- **Support course selection:** When selecting high school courses, encourage your daughter to keep her options open by taking math and science – and especially the more advanced courses, if you're in a province that has course streams. This will mean more doors will be open to her when it's time for post-secondary applications.
- **Think about skills:** Planning for the future doesn't have to mean focusing on a specific career or job. Girls can choose to focus on the types of skills they want to build and use.
- **Encourage multiple career options:** Many kids will be undecided about the direction they want to go in, especially when they're making course selection decisions so young. It's okay if your daughter isn't sure or has multiple ideas. Help her keep her options open so she's not stuck on a set course that's difficult to reverse. The reality is, most people today will have multiple careers over their lifetime.

Foster curiosity

- **Build things:** Buy toys that encourage girls to be creative builders. Take time to show girls how things are made and how they work. Have an old piece of tech or an old toy? Have her take it apart and try to put it back together. Try out a Girl Guides activity at home like **Take It Apart**, where girls can pick up tools to deconstruct some appliances to find out what's inside and how it works.
- **Integrate tech in an educational way:** Tech doesn't have to just be about social media or streaming content. Encourage girls to use tech and digital spaces purposefully in their many different

interests. For example, are you going for a hike? Look up online maps beforehand and talk about how satellites work.
- **Encourage experimentation:** Does your daughter ask a lot of questions? Encourage it! Get her to hypothesize an answer to her questions, then test that hypothesis to see if it holds true. She's learning how to experiment and test theories!

Be open to learning yourself

- **Explore today's educational and career paths:** We're all constantly learning. Be open to continue to learn about new and different educational and career pathways so you can support your daughter to make informed and empowered choices.
- **Educate yourself on the future of work:** The future economy will look different, so you might need to reframe how you think about career planning and job security for your daughter. Educate yourself on the skills and industries that are growing.

For example, explore how artificial intelligence and automation are changing the workforce and how this will impact the skills young people need to thrive in the future.

- **Learn about tech:** Build your own digital literacy and technical skills and invite your daughter to join you or teach you. Again, girls using tech isn't just about social media or streaming content – it can be about solving problems, from the everyday to the complex. Not sure where to start? Check out Girl Guide activities like **Binary Basics** to get crafty while learning about code, or **Bugbot Builder** to build a machine that moves.

Have conversations

- **Rethink how you talk about STEM:** If the topic comes up, be mindful of the vocabulary you use to talk about STEM. For example, sometimes words like "science," "technology," and "math" have negative or inaccurate associations for kids. Instead you can talk about STEM as subjects that are creative, help people, and make the world a better place – especially if you know these are motivators for your daughter.
- **Ask about school:** Have open conversations about school where you ask your daughter what she's learning and what she's interested in. Look for signs of the types of subjects and skills she gravitates towards.
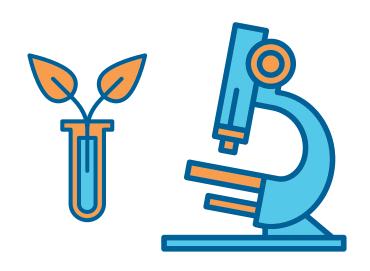
Look for opportunities for her to explore what's out there

- **Delve into different career ideas:** Find spaces for your daughter to explore different options for school and careers. For example, many colleges or universities hold STEM outreach events for kids on campus. Or how about taking a field trip to explore STEM somewhere you wouldn't normally visit – like the local

water treatment plant or the office of a tech company?

- **Seek out extracurriculars:** Look for extra-curricular activities that expose girls to STEM. For example, look into STEM clubs, coding camps, or special events or competitions. **Girl Guides can be a great space** for girls to explore STEM skills and activities through our girl-driven programming.

Find inspiring mentors and role models

- **Connecting mentors:** Find examples of successful women in STEM and other non-traditional roles, particularly if they come from your neighbourhood or cultural community. Could your daughter meet with them to have a conversation, or shadow them at work?
- **Role models online:** Be mindful of where girls aren't seeing themselves reflected and use social media as a tool to fill this gap. If you're looking for inspiration, check out GGC's **Spotlight on: Engineering video series**, featuring girls and women who are blazing new trails in engineering, plus activities you can follow along with.
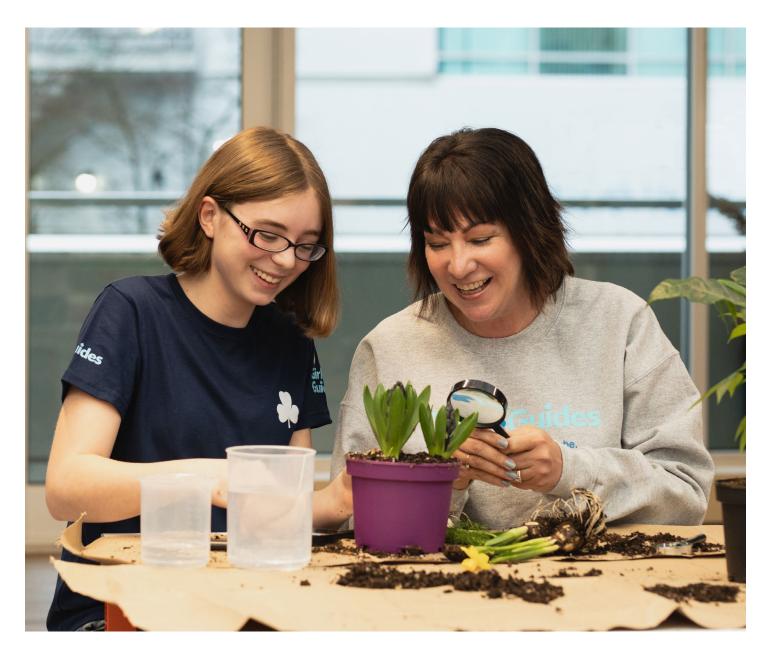
Cultivate a growth mindset

- **Model growth:** Push yourself and the girls in your life to pursue things outside your comfort zone. Encourage a spirit and joy of learning and exploration, not just top marks.
- **Use positive problem-solving language:** Instead of focusing on issues, barriers, or failures, approach challenges with problem-solving language. For example, start with "how might we" statements to get girls thinking.
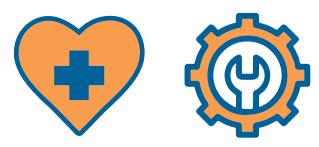
Be aware of stereotypes and biases

- **Get to the roots:** Be mindful of the stereotypes and biases about girls' aptitude and interest in STEM subjects. Remember that research shows that boys are not inherently better than girls at math.[60] Challenge girls when they say something isn't for them – ask, "Why do you think so?" Affirm girls' abilities in math and science.

K-12 Educators

Support informed academic and career planning

- **Encourage girls to keep their options open:** If students ask about courses, encourage them to take a broad range, including math and science, so that as many options as possible are open to them later down the line. Even in Grades 7 and 8, start planting the seed that taking math and science courses keeps doors open for the future.
- **Learn about current pathways to future careers:** Be open to continuing to learn about new and different educational and career pathways so you can support girls to make informed choices with up-to-date information.
- **Start young:** Include younger students in post-secondary outreach events, even though admissions might be a few years out for them. It can get them thinking about the options they want open to them in Grade 12.
- **Integrate career learning in the classroom:** Think about how to incorporate connections to careers and self-discovery in different classes. In addition to taking classes dedicated to careers, seeing how careers connect to different subjects will broaden their understanding of what's possible.

- **Connect with resources:** Connect girls, particularly those from lower-income families and other marginalized communities, with the guidance, resources, scholarships, or programs that can help make post-secondary education more of a reality. Research shows that encouragement and one-on-one support makes a real difference for marginalized students.[61]

Learn about the future of work

- **Educate yourself on the future economy:** We're all constantly learning. Even if you teach a seemingly unrelated subject, you can explore how technological advancement (like artificial intelligence or automation) may impact this field in the future – and bring these learnings into the classroom.
- **Bring tech to life:** Look for opportunities to integrate tech and digital literacy into other lessons and showcase how it's applicable to girls' lives. Want an idea? Check out our **Cyber-Escape** activity to create a cybersecurity-inspired escape room!

Challenge assumptions

- **Talk about college:** Girls might have assumptions about post-secondary admissions and educational pathways that are unfounded. For example, are they disqualifying college as an option without really considering it or without knowing what careers it could prepare them for? Ask questions about why girls want to pursue a certain path. And include college and technical programs in discussions of post-secondary education. Remember, many college STEM programs actually require advanced math and science.
- **Reframe "STEM":** Many girls might assume that STEM careers don't match

with their skills or motivations. Challenge these assumptions by relating STEM to everyday life, showcasing the broad array of careers, and talking about how these careers are creative, help people, and make the world a better place.

Seek out inspiring role models and mentors

- **Women role models:** Find ways to expose girls to women role models in STEM fields and other non-traditional roles. Can they join the class as a guest speaker, in-person or by video? Consider taking field trips to places where students can see STEM professionals in action or explore STEM skills and activities. When possible, think about having a regional emphasis, to show students what professionals in their immediate community are actually doing. Check out GGC's **Spotlight on: Engineering video series,** which features girls and women blazing trails in engineering, plus activities to follow along with.

Foster a growth mindset

- **Encourage risk-taking and experimentation:** Often students are primarily focused on grades and this might stifle creativity and experimentation. While academic achievement is important, provide opportunities and support for girls to take risks in STEM subjects and get out of their comfort zone without fear of negative consequences.
- **Use positive problem-solving language:** Instead of focusing on issues, barriers, or failures, approach challenges with problem-solving language. For example, start with "how might we" statements to get girls thinking.

Think about stereotypes and biases

- **Check biases:** Be mindful of the stereotypes and biases about girls' aptitude and interest in STEM subjects,

based on their gender, race, culture, ability, and more. Challenge harmful stereotypes if you hear students perpetuating them. Review class content for gendered language that might alienate girls. Affirm girls' abilities in STEM subjects.

K-12 Education System

We're encouraged by the work being done by education organizations, provincial ministries of education, and other stakeholders which has started to create a roadmap for education system change in the following areas:

Boosting STEM education

- **Making STEM skills foundational:** STEM skills are important for all Canadians. Regardless of whether students are concentrating in STEM subjects, they should receive an appropriate amount of STEM education.[62]
- **Leveraging tech in the curriculum:** School curricula should continue to increasingly include new technologies so that students can build their tech and digital literacy from an early age – as well as opportunities for teachers to build their capacity to lead tech education.[63]

Connecting school subjects and career pathways

- **Making pathways empowering:** Education pathways should be transparent and flexible. Students should be adequately supported to navigate and make informed choices with a view to the future options available from each pathway.[64]
- **Integrating career learning:** Information about higher education and future careers should be integrated throughout the regular school curriculum in a more holistic way across the continuum of students' K-12 education and into adulthood.[65]

Competency-based, experiential, and interdisciplinary learning

- **Focusing on competencies:** To support all students to thrive in the future, school curricula should continue to increasingly include competency-based approaches to learning, focused on students learning foundational skills like communication, critical thinking, and a sense of self and community.[66] We're encouraged by changes in Alberta, British Columbia, and Quebec, where provinces have embedded core competencies like these into their curricula in recent years.[67]
- **Promoting hands-on learning:** STEM education should continue to become more experiential to allow students to see the real-world applications of their learning.[68] For example, BC's new curriculum has a focus on learning through doing, engaging students in authentic tasks to connect what they're learning to real life.[69]
- **Weaving STEM across the disciplines:** Interdisciplinary and co-operative approaches should be increasingly embedded into STEM education, so that STEM learning can be woven into other disciplines.[70]

Post-Secondary Institutions

Connect with K-12 schools

- **Offer outreach events:** Engage with K-12 schools in your region to offer STEM-specific outreach events.
- **Accessible outreach:** Ensure outreach efforts are broadly accessible to girls from many different communities. For example, consider offering online events or subsidizing travel costs for outreach events.

Tap into girls' motivations

- **Messaging:** Girls are interested in careers that are creative, that help people, and that make a difference in the world. Ensure these types of messages are incorporated into your recruitment materials and outreach strategy when promoting STEM programs of study.

Foster an inclusive and safe culture

- **Keep campus safe:** Commit to creating an inclusive and safe culture for students of all genders, identities, and communities in STEM programs at your school. This includes having clear harassment policies and regularly monitoring for toxic behaviour.

Corporations and Employers

Be a role model and mentor

- **Tap into your talent pool:** Enable women STEM employees to be role models for the next generation by supporting their volunteering and mentorship. Feature a diversity of women in advertisements and recruitment materials.
- **Mentor and sponsor:** Through programs, internships, or summer jobs, start to introduce and integrate girls into the social, technical, and professional networks that they will need to succeed. Commit to mentoring and sponsoring girls so they can access opportunities for growth.
- **Connect with K-12 schools:** If you're an employer within a local community, consider doing outreach to local K-12 schools to present students with real-life role models in STEM careers.

Support programs for girls in STEM

- **Make the investment:** Invest in programs for girls in STEM, especially hands-on programming that is inclusive, accessible, and gives girls specific tools and skills. Celebrate and award girls studying STEM through awards and scholarships, and consider offering scholarships for innovation, not just academic excellence.

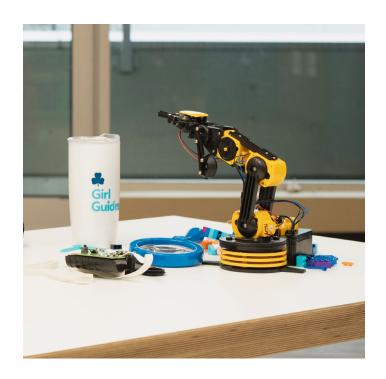## Foster an inclusive and safe culture

- **Make work safe:** Foster an inclusive and safe culture for girls and young women who work for you. For example, ensure you have policies in place so that your workplace is free from harassing behaviours for all employees, including the most vulnerable. Monitor the environment regularly for toxic behaviour.[71]

Use your power and influence

- **Shift the conversation:** Use your power and influence to shift the public conversation, working in partnership with organizations who are leading the charge.
- **Contribute to policy change:** Be at the table talking about education and career pathways to drive change at the policy level.

Tap into girls' motivations

- **Messaging:** In your outreach materials and programs, connect STEM to important causes that girls can connect to, and demonstrate how STEM careers are creative and respond to real-world challenges.
- **Create new role models:** If you're in the industry, develop video games and toys that have female protagonists and appeal to girls.

GIRL GUIDES OF CANADA

Girl Guides of Canada–Guides du Canada (GGC) empowers every girl in Guiding to discover herself and be everything she wants to be. In Guiding, girls from 5-17 meet with girls their own age in a safe, supportive and inclusive space to explore what matters to them. Guiding is where girls take the lead, put their ideas into action and jump into a range of empowering activities – all with the support of women mentors committed to positively impacting girls' lives.

Girl Guides offers programming options ranging from cybersecurity activities and science experiments to exploring career options and discussions on feminism and gender inequality. We focus on equipping girls with twenty-first century skills that are transferrable to other areas of their life, such as building problem-solving skills through the engineering process, or hypothesizing through forensic-science inspired investigations. This programming is delivered in a safe, all-girl space that is designed to address the roadblocks and stigmas girls might encounter elsewhere in their lives. Girls in Guiding develop the skills to confidently navigate the world and grab hold of every opportunity that comes their way – now and in the future.

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Available online at girlguides.ca/girlsinSTEM

For inquiries, contact advocacy@girlguides.ca

Acknowledgments

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