

THIS IS WHAT **STEM** **LOOKS LIKE!**



HOW TO GET AND KEEP GIRLS ENGAGED IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH

**THE WOMEN'S
FOUNDATION
OF COLORADO**

This guide was made possible by generous contributions from **Xcel Energy**, **XTO Energy**, **an ExxonMobil subsidiary**, and members of The Women's Foundation of Colorado STEM Coalition:

- **Arrow Electronics**, co-chair
- **CH2M**
- **Goodbee & Associates**
- **Lockheed Martin**
- **MWH, now part of Stantec**, founding co-chair
- **QEP Resources**
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- **Stephanie Copeland**
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OUR MISSION

Building resources and leading change so that every woman and girl in Colorado achieves her full potential.

LETTER FROM THE PRESIDENT AND CEO

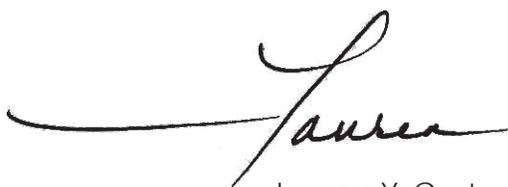
In the 1960s and 1970s, when almost 5,000 children across three countries were asked to draw a picture of a scientist, only 28 girls and no boys drew a female scientist, indicating that children don't think scientists look like girls or women. Children still don't see women and men equally in STEM. When the study was repeated in the U.S. in 2009, 35 percent of children depicted a woman scientist. While this progress is encouraging, biases that diminish girls' opportunities to explore STEM begin early and are deeply rooted. This is why The Women's Foundation of Colorado aptly named this guide, *"This Is What STEM Looks Like!"*

As the only community foundation in Colorado focused on improving economic outcomes for women and girls, we work in many ways to help girls and women advance their earning potential through learning. Careers in science, technology, engineering, and mathematics (STEM) offer high wages and are multiplying here in Colorado, but women and girls are under-represented in STEM education and careers. Although women comprise nearly half of Colorado's workforce, they make up less than a third of the STEM workforce in our state. Girls' and young women's interests in these fields must be nurtured from a young age and they must have access to engaging learning experiences to develop the skills necessary for success.

We developed *"This Is What STEM Looks Like!"* to help parents and families, formal and informal educators, and community role models for girls and young women learn how to encourage and inspire girls from birth to adulthood to explore the world around them. This guide will also give you tools to motivate and expose girls to experiences to develop STEM skills and build confidence in their abilities so they will be prepared to pursue STEM careers.

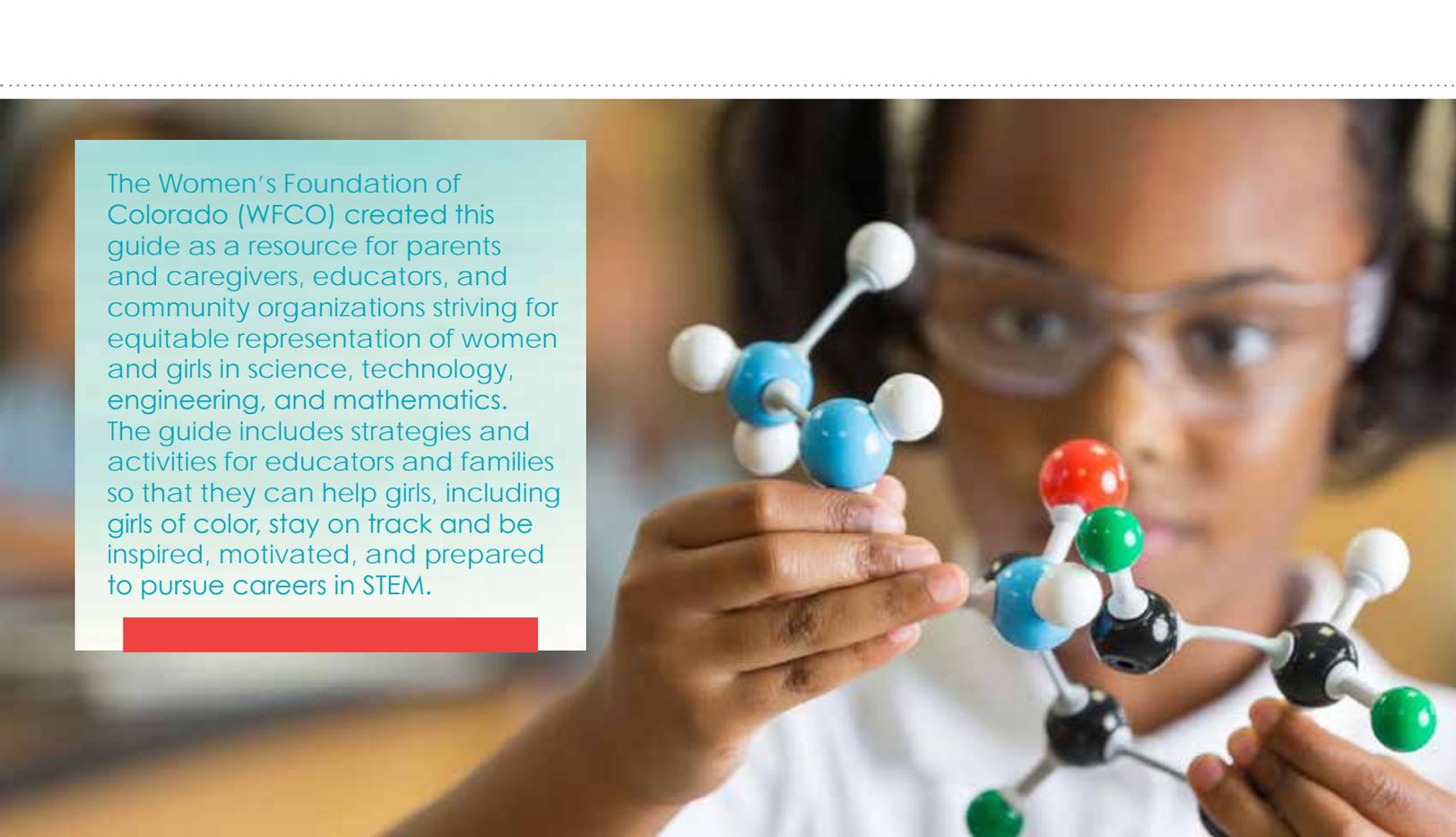
The Women's Foundation of Colorado is also working with leading STEM employers in our state to cultivate more inclusive workplaces where women are welcomed, valued, and supported in their success. Together, we can build on girls' natural curiosity, connect them to diverse role models, and prepare them to lead Colorado's innovation industries in the future.

We hope this guide sparks and cultivates passion for STEM exploration with the girls and young women in your life so they may achieve a lifetime of economic security through exciting careers in STEM!



Lauren Y. Casteel
President & CEO
The Women's Foundation of Colorado

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The Women's Foundation of Colorado (WFCO) created this guide as a resource for parents and caregivers, educators, and community organizations striving for equitable representation of women and girls in science, technology, engineering, and mathematics. The guide includes strategies and activities for educators and families so that they can help girls, including girls of color, stay on track and be inspired, motivated, and prepared to pursue careers in STEM.

Executive Summary

Why STEM?

Nationally, and in Colorado, the demand for a skilled STEM workforce is growing and STEM jobs offer higher salaries than non-STEM jobs.¹ Women working in STEM jobs earn, on average, 33 percent more than those in other fields,² yet women account for only 29 percent of the STEM workforce.³ In Colorado, women earn more than 50 percent of two-year and four-year degrees,⁴ but less than a third of Colorado graduates in STEM are women.⁵ Women's under-representation in STEM fields starts early, with gender gaps in STEM interests beginning in middle school and growing throughout high school, college, and career. Far too many girls and women are discouraged from pursuing success in STEM fields. Now is the time for change.

Resource Guide

We've created this guide to introduce parents, caregivers, and educators to the many opportunities that STEM can provide for girls and women. You'll find resources to help girls explore and prepare for those opportunities and tools to inspire, motivate, and prepare young women to thrive in STEM careers. In addition to tools for creating exciting, hands-on learning experiences, the guide includes: an overview of the status of girls and women in STEM in Colorado, definitions of STEM-related terms, and a call to action. Each chapter includes strategies that are specific to a certain age group, as well as benchmarks to strive for in each stage of girls' lives to prepare them for future STEM opportunities. You might also see some repetition in concepts as they are relevant for girls of many ages. We've included a sampling of the many STEM resources available locally, statewide, and from across the nation.



12 STRATEGIES

for Engaging Girls and Young Women in STEM

By going deeper into this guide, you can learn how to put 12 strategies into practice:

STRATEGY 1:

Provide opportunities for mastery experiences.

- Girls underestimate their abilities, especially as they get older. Help them recognize what they can do and recognize their work.
- Have girls take ownership of their decisions and help them with language so that they can advocate for themselves.

STRATEGY 2:

Provide opportunities for girls to learn by observing others.

- Female role models and mentors can help girls see themselves as future STEM professionals.
- Seeing female role models and mentors in action inspires girls.

STRATEGY 3:

Provide opportunities for girls to be recognized as innovators by their peers and their community.

- Empower girls to lead teams so boys and girls alike recognize them as creators.

STRATEGY 4:

Take a holistic approach. Help girls cope with the misconceptions and biases that stand in the way of STEM engagement.

- Teach girls about growth mindset and how it impacts their sense of self.
- Educators and caregivers can be mindful of their own behavior and challenge biases that can stand in the way of STEM experiences and engagement for girls.



STRATEGY 5:

Educators and community organizations can provide opportunities for parents/caregivers to see their daughters practicing science, technology, and engineering skills and solving problems using math.

- Design events, such as family STEM nights, and put girls in charge. Parents will feel proud of their girls and expand their understanding of what their daughters are capable of doing.
- Put girls in the spotlight whenever parents come to school. This can be through community nights, in design or science labs, in school gardens, or by integrating STEM into other parent-related activities in which girls take the lead.

STRATEGY 6:

Give parents/caregivers ideas about how they can continue STEM learning at home with their children.

- Parents/caregivers can influence a girl's career trajectory and expose their daughters to a variety of STEM learning opportunities.
- Teachers can provide tools for parents to continue working on STEM learning at home. Develop age-appropriate STEM learning idea sheets to get them started.
- Community organizations should make a commitment to reach out to parents to continue STEM learning at home. Extracurricular opportunities can set the foundation for girls to explore STEM opportunities.

STRATEGY 7:

Educate parents/caregivers on how best to advocate for advanced STEM opportunities for their daughters.

- Parents need tools to understand different types of STEM opportunities that may be available so that they can advocate for schools and community organizations to bring those opportunities to their community, if they are not yet offered.
- Invite parents to connect with teachers and school leaders about implementation of the latest educational policies as they pertain to women and girls.
- Parents can also build relationships with elected officials to share their thoughts about STEM education and career opportunities for women and girls in their communities.
- Parents and community members can advocate for internships and apprenticeships with STEM employers.

STRATEGY 8:

Show parents/caregivers where they can find STEM opportunities for their girls.

- Community organizations can work together to have one database to list all programs by location and type of opportunity, such as [The Connector](#), and keep information current.

STRATEGY 9:

Educators and community organizations can provide multi-faceted communications about how STEM relates to students' daily lives and everyday experiences.

- Offer opportunities for families to engage in citizen scientist programs and develop programs for families with multiple touch points. These can include field studies, family STEM nights, and community share-out days.

STRATEGY 10:

Help educators access and share STEM resources.

- Educators need resources that build their understanding of integrated STEM education, such as the chance to see what a great STEM classroom looks like and how great STEM teaching can tap into their students' potential.
- Teachers can find funding opportunities for professional development through resources like the National Science Teachers Association.

STRATEGY 11:

Provide training and resources for educators to develop curriculum that is inclusive of girls, including girls of color.

- We all have hidden biases. Uncovering our hidden biases can help us discover steps to take so that we do not unintentionally exclude certain students from STEM experiences.
- Parents can examine how they treat girls and boys and thoughtfully consider if they offer different types of toys or experiences to girls that do not foster STEM skills.



STRATEGY 12:

Link educators with industry partners so they can see and experience the work of STEM professionals.

- Educators can use STEM professionals and their experiences to create meaningful, engaging units of studies for students.
- Girls then benefit from hands-on learning and educators can help their students explore authentic problems in STEM.



WOMEN WORKING IN STEM
JOBS EARN, ON AVERAGE,

33%

MORE THAN THOSE IN OTHER
FIELDS,² YET WOMEN ACCOUNT
FOR ONLY 29 PERCENT OF THE
STEM WORKFORCE.³

Chapter Summaries

INTRODUCTION

The introduction sets the stage for the issues that pertain to girls and women in science, technology, engineering, and math careers. We present data about why STEM careers matter and how severely under-represented women, especially Latinas, African American women, and Native American women, are in these fields.

CHAPTER 1

By age 5, keep me curious! This chapter focuses on the innate curiosity of girls in early childhood. Their drive to ask questions and explore their natural world is something to cultivate and develop. Caretakers, whether parents, grandparents, teachers, or community members, can foster that sense of curiosity, expose girls to opportunities for exploration, and teach them how to utilize tools to solve everyday problems. By age five, girls should begin to understand the role of STEM professionals in the community, see STEM professionals as problem solvers, and begin to see themselves in that role as well. This chapter presents strategies and activities for caregivers and educators to expose toddlers and preschoolers to STEM experiences.

CHAPTER 2

By age 10, I can ask! This chapter focuses on further developing girls' abilities to ask questions of relevance to their lives. Strategies and activities include ways to foster the natural inquirer within young girls. We explore common challenges for girls in this age span that could keep them from pursuing STEM careers in the future, such as negative perception of abilities and lack of awareness of opportunities. Parents, caregivers, and formal and informal educators will learn strategies to build girls' STEM skills and confidence and discover how to counter messages that tell girls they do not belong in STEM.

CHAPTER 3

By age 13, I am shaping my future. In this chapter, we explore issues that are relevant to this age group such as girls' perception of STEM abilities, societal pressure, and teacher biases that may hinder girls from pursuing STEM pathways. We explore strategies such as building self-efficacy both for teachers and for girls and exposure to real-life, hands-on opportunities in STEM that continue to prepare girls for STEM pathways. Activities include girls learning about and meeting STEM professionals like themselves, understanding issues regarding representation in these fields, and exploring the contributions they can make to these fields. With these strategies, girls move from being consumers of information to creators and contributors who make a difference.

Chapter Summaries

CHAPTER 4

By age 18, I am preparing to solve 21st-century challenges. This chapter focuses on opportunities that help girls see themselves as STEM professionals in the near future. We present research-based strategies to provide greater access to opportunities that prepare, inspire, and motivate young women to become problem solvers and pursue careers in STEM. We also describe the potential that STEM careers provide for girls to earn family-sustaining wages, as well as the economic benefits to their communities.

CHAPTER 5

Beyond age 19, I am thriving; I am changing the world. This chapter presents issues that young women face when entering the workforce or pursuing post-secondary education and strategies for overcoming those challenges. We present research on current trends for this age group. We also explore strategies to mitigate the micromessages that women encounter, including educator bias, and workplace climates that may not be inclusive of women. We provide tools that young women can use to persist in STEM fields and lead change.

CONCLUSION

The Concluding Recommendations for Action summarize the need for equitable representation of women, including women of color, in STEM careers. We present a vision of what it will be like as girls become equally represented in STEM careers and provide a summary of actions everyone can take to support systems-level change for women and girls in Colorado.



“Women’s under-representation in STEM fields starts early, with gender gaps in STEM interests beginning in middle school and growing throughout high school, college, and career. Far too many girls and women are discouraged from pursuing success in STEM fields. NOW IS THE TIME FOR CHANGE.”

Contributors

WFCO developed this guide through the collaboration of more than 30 partners. We are grateful to these partners and to the lead author and co-authors, all of whom you can read about in the Contributors section.

This guide was made possible by generous contributions from **Xcel Energy**, **XTO Energy**, **an ExxonMobil subsidiary**, and members of the WFCO STEM Coalition:

- **Arrow Electronics, co-chair**
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- **MWH, now part of Stantec, founding co-chair**
- **QEP Resources**
- **SSG MEP**
- **Stephanie Copeland**
- **Suncor**
- **Zayo Group**

The need for equitable representation of women, including women of color, in STEM careers is an economic imperative, an innovation catalyst, and an issue of equity and inclusion. Gender parity in STEM will give us access to much-needed STEM employees to help businesses grow. In addition, bringing in the perspective of women and communities of color boosts creativity and innovation. Equity, access, and inclusion of women, including women of color, are simply the right thing to do. Jobs in STEM fields provide an opportunity for women to earn family-sustaining wages and to bring their unique ideas and perspectives to STEM solutions that can address the complex challenges facing us in the 21st century. By implementing the ideas and strategies in this resource guide, we can ensure women and girls of Colorado have the chance to build STEM skills and pursue STEM careers.

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How To Use This Guide

This guide can be read from cover to cover, and chapters can also be utilized independently. Suggestions and resources to help girls explore are included throughout the guide. Ideas are sometimes introduced in one chapter, and then explored in more depth in another chapter.

The ideas presented are organized into “Try This,” “Start Here,” and “Spotlight” boxes, and “Read All About It,” “Activity,” and “Toolbox” sections. “Read All About It” sections are ideas for books to explore different STEM topics. “Start Here” sections provide professional development information or resources for formal and informal educational settings. Parents and caregivers can also benefit from these resources. “In The Spotlight” segments feature organizations that are helping girls advance through STEM opportunities. These groups, from Colorado and across the nation, are using best practices in STEM. “Try This” sections are meant to get your ideas flowing. The ideas in this guide are meant to be a starting point. We encourage you to try your own ideas, too.



TRY THIS!

- Count your little one's body parts, such as fingers and toes, to start associating numbers that represent objects in her environment.
- Describe the colors in her world.
- Think out loud. Ask questions that you are wondering about and describe your everyday actions to your child.
- Have conversation with your newborn and respond by mimicking her sounds and facial expression. Describe her actions.
- Add your own ideas!



TOOLBOX

Basic Science Process Skills

Observing - using the senses to gather information about an object or event. Example: Describing a pencil as yellow.

Infering - making an “educated guess” about an object or event based on previously gathered data or information. Example: Saying that the person who used a pencil made a lot of mistakes because the eraser was well-worn.

Measuring - using both standard and non-standard measures or estimates to describe the



READ ALL ABOUT IT!

There are many STEM books for early childhood that support conceptual understanding such as books about color, numbers, and relationships. Here are a few of our favorites:

- Two Little Fingers and Two Little Toes by Mem Fox
- My Colors, My World/ Mis Colores, Mi Mundo by Maya Christina Gonzalez
- The Very Hungry Caterpillar by Eric Carle
- My Granny Went to Market by Stella Blackstone
- Colors by Julia Fyfe/Les Levine (English/Spanish/French)

Continue the conversation. Add books that triple learning concepts such as numbers, colors, and sequencing.

START HERE!

For ideas on different types of questions see Detailed Results – Open-ended Questions in English and Spanish as well as other helpful resources.

Open-ended questions are questions that have multiple answers and can be answered in multiple ways. This type of question stimulates children to use more language, see multiple ways of solving problems, and encourages creative thinking. This resource suggests educators and caregivers ask questions such as “What does this remind you of?” and “What would happen if...”

The Saxon Children's Museum (www.saxonchildrensmuseum.com) has great examples of “what” questions that can help children deepen their thinking. Question examples include “What do you notice about how it's moving?” “What else have you seen other kids try?”

BOX 1.1. IN THE SPOTLIGHT:

St. Vrain Spark! Discovery Preschool

Since August 2012, Spark! Discovery Preschool has been serving preschoolers in St. Vrain Valley Schools. Spark! Discovery Preschool is a Science, Technology, Engineering, and Mathematics focused preschool. Their STEM mission was inspired by a program called Innovation Academy for a Smarter Planet, a unique, multi-year partnership between IBM, CU Teach, Skyline High School, STEM, and St. Vrain Valley Schools, which Paige Gordon, Spark! Discovery's Administrative director and developed in its first four years of existence.

Spark! Discovery Preschool's mission is to ignite creative thinking, innovation, problem solving, and discovery to encourage every young learner's curiosity and joy of lifelong learning in order to influence an ever-changing world. Preschoolers experience six collaboratively developed units of STEM throughout the two-year preschool experience. These highly engaging units focus on solving relevant problems, integration and connections of concepts, the development of STEM-based dispositions (such as risk-taking, empathy, creativity, etc.), 21st-century skills, and inquiry-based learning strategies.



Learn more at <http://www.sparklady.com>

ACTIVITY 2.2:

Examine Your Language

Parents and teachers can use this activity for their own benefit as well as to coach girls to reflect on their use of language.

Notes: How often do you find yourself using fixed mindset language, either in talking to yourself or in talking to others? (Note: Though the language below uses math as an example, this concept applies to any subject or skill.)

Advice: How might you change fixed mindset language that you currently use to be more growth-mindset focused? As is parent/educator, how might you help girls modify their language?



Fixed Mindset	Growth Mindset
"You're really smart at math." (Read mindset praises ability)	"You worked really hard on those math problems!" (growth mindset praises effort)
"Math is just really hard for some people."	"Everyone learns in different ways. Let's keep trying to find the way that works for you."
"Why can't you get better scores on your math tests?"	"What mistake did you make on math tests that taught you something?"
"I had to try really hard to understand that problem. I had not too good of math!" (Read mindset looks down on effort)	"I had to try really hard to understand that problem, and I got better at math because of that!" (growth mindset sees effort as a good thing)



DEFINITIONS OF KEY TERMS USED THROUGHOUT THE GUIDE

STEM: The acronym stands for science, technology, engineering, and mathematics. STEM learning experiences embed 21st-century skills and engage a girl in real-world, relevant experiences that are problem-based in which she can solve problems that matter to her, to her community, and to her world.

Under-Represented Groups: Groups whose membership in the STEM workforce is less than their total representation in the U.S. workforce as a whole. This includes women in many fields, such as engineering and information technology, and people of color (see definition below). Under-represented groups also include groups historically marginalized, such as the Lesbian, Gay, Bisexual, Transgender, Queer, Intersex, and Asexual (LGBTQIA) community; women veterans; women with disabilities; and women from rural areas who may not have access to the same opportunities as those who live closer to major metropolitan areas.

People of Color (POC): “Refer[s] collectively to African Americans, American Indians and Alaska Natives, Asian Americans and Pacific Islanders, Hispanic/Latino Americans, multiracial individuals, and all other persons who are not categorized as white by the U.S. Census.”¹¹

Design Thinking Process: A systematic approach to problem solving that is similar to the Engineering Design Cycle but is focused on what the learner experiences as she identifies and thinks through problems. Stanford’s [d.school](#) describes design thinking² with the user first defining the problem and then implementing solutions. The user’s needs are at the core of concept development. The five steps, which can be sequential, but can also be revisited and cyclical, are as follows:

- **EMPATHIZE:** Work to fully understand the experience of the user for whom you are designing. The designer does this through observation, interaction, and immersing herself in the client’s experiences.

- **DEFINE:** Process and synthesize the findings from your empathy work in order to form a user point of view that you will address with your design.
- **IDEATE:** Explore a wide variety of possible solutions through generating a large quantity of diverse possible solutions, allowing you to step beyond the obvious and explore a range of ideas.
- **PROTOTYPE:** Transform your ideas into a physical form so that you can experience and interact with them and, in the process, learn and develop more empathy.
- **TEST:** Try out high-resolution products and use observations and feedback to refine prototypes, learn more about the user, and refine your original point of view.³

Engineering Design Process: A series of steps that engineers use to solve problems. This process is cyclical. On many instances, it must also be repeated and engineers make improvements and test possible solutions along the way. There are many versions of the engineering design process, but most include identifying the need or problem and the constraints, researching the problem, imagining possible solutions, selecting a promising solution, building a prototype, trying or testing it out, and improving design based on results from testing a prototype.⁴

21st-Century Skills: “A broad set of knowledge, skills, work habits, and character traits that are believed—by educators, school reformers, college professors, employers, and others—to be critically important to success in today’s world, particularly in collegiate programs and contemporary careers and workplaces. Generally speaking, 21st-century skills can be applied in all academic subject areas, and in all educational, career, and civic settings throughout a student’s life.”¹⁵ These skills and behaviors include critical thinking and reasoning, information literacy, collaboration, self-direction, and invention.⁶

ADDITIONAL COMMENTARY

Throughout the guide, you will notice that some of the chapters have co-authors. These contributors were willing and able to dedicate their own time and resources to write specific sections of that given chapter. We appreciate their commitment to advancing girls in STEM.

The guide contains stories to help the reader ground examples in practice. Any similarities to actual persons, living or dead, are purely coincidental. At times, the authors may have used examples inspired by a real occurrence; however, pseudonyms were used to protect peoples' identities.

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INTRODUCTION

THIS IS WHAT **STEM** LOOKS LIKE!

HOW TO GET AND KEEP GIRLS ENGAGED IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH



Violeta García, PhD

The future of the women and girls of Colorado lies in access to opportunities through which they can reach economic security. Occupations related to science, technology, engineering, and mathematics (STEM) offer higher wages and are projected to grow at faster rates than other occupations over the next decade. With nine million jobs expected by 2022,¹ this growth presents an opportunity for the women and girls of Colorado. To take full advantage of these prospects, girls must be aware of, interested in, and prepared to pursue careers in STEM.

Parents and caregivers, educators, and community organizations play a critical role in helping girls access and benefit from STEM education and career opportunities. Moreover, STEM workers create solutions to tough, complex challenges in areas like medicine, agriculture, and the environment. The issues of our time require diverse perspectives, innovative solutions, and engaged citizens who care about making a difference in the world. Girls and women in STEM fields can thrive and contribute to their communities.



9M WITH **9M** JOBS EXPECTED BY 2022,¹ THIS GROWTH PRESENTS AN OPPORTUNITY FOR THE WOMEN AND GIRLS OF COLORADO.

GOALS FOR THIS IS WHAT STEM LOOKS LIKE!

This Is What STEM Looks Like! provides resources and information for parents and caregivers, educators, and community organizations striving for equitable representation of women, including women of color, in STEM occupations. This guide is intended to create awareness of the current status of girls in STEM in Colorado and highlight opportunities for change. We present intended outcomes for girls by ages 5, 10, 13, 18, and beyond 19 years of age – benchmarks in the development of STEM skills and on the path to success in STEM careers. You'll also find research-based strategies to help girls achieve these outcomes.

Throughout each chapter, you will learn about issues facing girls and you will be introduced to strategies to help counter those challenges. We have included activities to inspire, motivate, and prepare girls to pursue a career in STEM.

By implementing the strategies and suggested activities in the guide, you will raise girls' awareness of and motivation to pursue STEM education and career opportunities and help them develop the necessary skills. Resources also suggest ways to design culturally responsive learning opportunities for girls from diverse backgrounds across Colorado. Together, we can engage and inspire girls in STEM.

WHAT IS STEM?

The acronym STEM was first used to describe careers in science, technology, engineering, and mathematics at the National Science Foundation in the early 1990s.² Since then, the acronym has taken on multiple meanings. For the purposes of this guide, we will refer to STEM as the occupations in those fields that are driving the highest growth in our current and future workforce, which include occupations in healthcare and finance, as well as engineering and computing. You can browse a sample list of STEM occupations at [O*NET](#).³

In addition to STEM occupations, in this guide we use the phrase STEM learning to encompass the conceptual understandings in science, technology, engineering, math, and computer sciences, as well as the development of 21st-century skills in girls through hands-on, problem-based learning that is relevant to girls and grounded in everyday experiences.

*“inspire, motivate,
and prepare girls
to pursue a career
in STEM”*

WHY STEM?

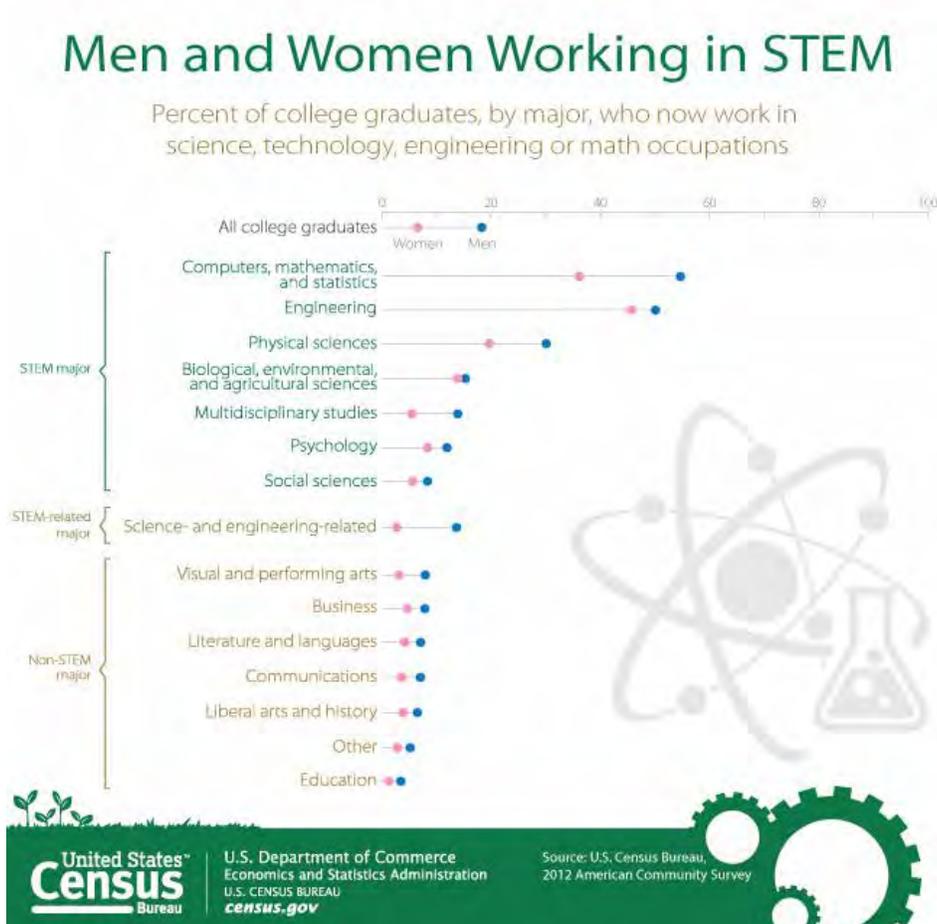
Nationally, and in Colorado, the demand for a skilled STEM workforce is growing and STEM jobs offer higher salaries than non-STEM jobs.⁴ Women working in STEM jobs earn, on average, 33 percent more than those in other fields,⁵ yet women account for only 29 percent of the STEM workforce.⁶ In Colorado, women earn more than 50 percent of two-year and four-year degrees,⁷ but less than a third of Colorado graduates in STEM are women.⁸

Women's under-representation in STEM fields begins early as a result of different social expectations for boys and girls. Teachers and other adults often have unconscious biases that prevent them from encouraging girls' performance in math and science. Gender gaps in STEM interests begin in middle school and grow throughout high school, college, and into careers. Far too many girls and women are discouraged from pursuing success in STEM fields.

We are ready for change. This guide provides parents and caregivers, educators, and community organizations with research-based strategies and resources to help advance girls in STEM at all levels of the educational continuum so that young women can reach their full potential.

We recognize not all girls will pursue STEM careers; however, the value of STEM skills extends beyond STEM careers. Therefore, the strategies and activities presented in this guide provide an opportunity for girls to develop habits of mind, skills, and awareness of the many opportunities they could pursue (Figure 1).⁹

FIGURE 1. MOST STEM GRADUATES WITH A BACHELOR'S DEGREE DO NOT WORK IN STEM FIELDS.



WOMEN IN STEM OCCUPATIONS

Women make up 48 percent of the total U.S. workforce but only 28 percent of those working in science and engineering fields.¹⁰ Increasing retention of women pursuing STEM fields is of the essence because these jobs pay 33 percent more on average than non-STEM jobs and they tend to have a lower gender wage gap as well.¹¹ A number of groups throughout the nation are actively working to increase girls' and women's participation in STEM studies and careers. This guide offers connections to many resources for improving gender equity in STEM, beginning with our youngest girls and through their preparation to enter the workforce.

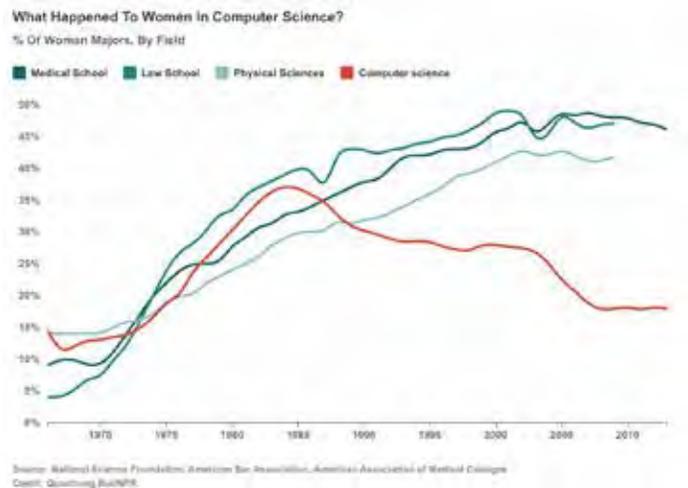
While women have made great strides advancing in certain STEM occupations, especially in pharmacy and biology, women in engineering and computer science have faced greater struggles. In 1960, women represented one percent of those in engineering professions. According to the American Association of University Women (AAUW), overall representation of women had increased to only 12 percent by 2013 (see Table 1). For an in-depth analysis of the history of women in engineering, read *Girls Coming to Tech*, which describes the journey women have faced in a field considered "masculine territory," where women were considered invaders and had to fight to create their place against all odds. We have made great progress, and the pursuit for equality continues.

TABLE 1. WOMEN IN SELECTED OCCUPATIONS AS SUMMARIZED IN AAUW'S SOLVING THE EQUATION¹⁴

STEM OCCUPATIONS	PERCENTAGE IN 1960	PERCENTAGE IN 2013
Engineering	1%	12% ↑
Chemists & Materials Scientists	8%	39% ↑
Computer & Mathematical Occupations	27%	26% ↓
Biological Scientists	28%	53% ↑

Since the early 1980s, when the personal computer was commercialized and initially marketed as a boys' toy, there has been a decrease in the percentage of women in the computer science field. Today, women work in computer science at the same rate as they did in 1976 (Figure 2).

FIGURE 2. WHAT HAPPENED TO WOMEN IN COMPUTER SCIENCE?





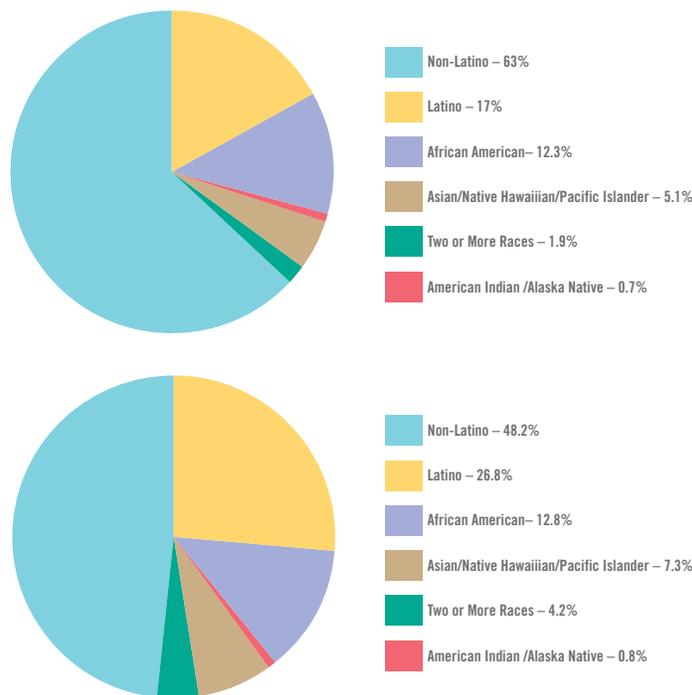
OPPORTUNITIES FOR STEM ENGAGEMENT AND STEM CAREERS FOR WOMEN

Experts including those who contributed to this guide and organizations such as the U.S. Department of Education have noted a lack of awareness by the general public of the benefits of STEM occupations.¹⁶ Making explicit connections to the societal impacts and communal goals¹⁷ that STEM professionals achieve gets girls and women interested in STEM occupations, develops resiliency so women can thrive in the STEM workplace, and carves new paths for future female STEM professionals. It is also important that young women of different races, ethnicities, and socioeconomic backgrounds see themselves as capable of achieving success in STEM careers. This guide shows how to make explicit connections to the everyday work of STEM professionals, including professionals from diverse backgrounds, so girls and young women can see their future selves accessing and thriving in STEM careers.

CHANGING DEMOGRAPHICS

The mismatch between the growing diversity of the population and the employees entering STEM fields (especially in engineering and computer science) highlights one of the largest disparities in economic opportunity. Figure 3 indicates that over 50 percent of all people in the U.S. will be from non-white backgrounds in 2050, yet the diversity (or lack of diversity) of STEM professionals is not changing to reflect this shift.

FIGURE 3.
BY 2050, THE PERCENTAGE OF LATINOS IN THE U.S. WILL GROW SUBSTANTIALLY.



Source: NACME analysis of National Population Projections from U.S. Bureau of the Census, 2013.

In addition, the Latino population is relatively young and growing at a rapid rate; therefore, preparing young Latinas in STEM is critical to meeting the projected workforce needs.¹⁸ We have an opportunity to train the girls and young women who make up our future workforce for jobs that lead to economic security.

WOMEN IN THE STEM WORKFORCE MATTER TO COLORADO

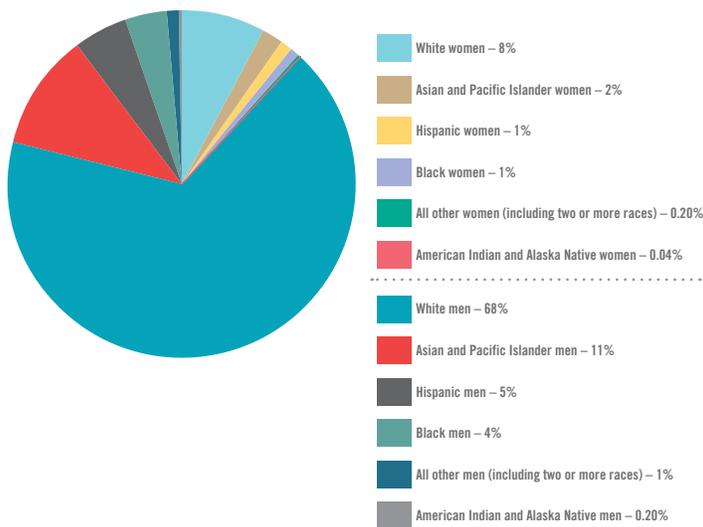
Women from diverse racial and ethnic groups comprise a small percentage of STEM professionals and the nation needs more workers with middle- and high-level skills. For example, Asian and Pacific Islander women made up two percent and black and Latina women each made up one percent of the U.S. engineering workforce between 2006-2010 (Figure 4). Women in computer science do not fare much better. From 2006 to 2010, Asian and Pacific Islander women made up four percent, black women three percent, and Latinas just one percent of the computing workforce.¹⁹ In comparison, white men and Asian men held 79 percent of all engineering jobs, while men historically under-represented in STEM fields, which includes African Americans, Hispanics/Latinos, American Indians and Alaska Natives, held 21 percent of all engineering jobs.²⁰ Trends in computer science are similar with Asian and white men making up 64 percent of the computing workforce while women make up 25.5 percent of the total workforce.²¹

The engineering and the computing workforces stand out as having especially poor representation of women as compared to other STEM industries. This is particularly troubling given that engineering and computer jobs account for more than 80 percent of the STEM workforce, and offer a better return on the educational investment and more job prospects than other STEM fields.²²

FIGURE 4.

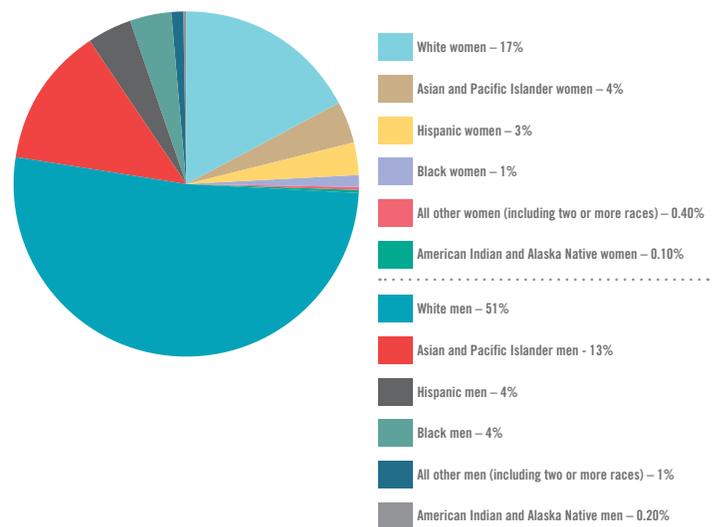
ANALYSIS OF ENGINEERING AND COMPUTING WORKFORCE BY GENDER AND RACE/ETHNICITY FROM 2006-2010²³

ENGINEERING WORKFORCE, BY GENDER AND RACE/ETHNICITY, 2006-2010



Source: AAUW analysis of U.S. Census Bureau (2011a).

COMPUTING WORKFORCE, BY GENDER AND RACE/ETHNICITY, 2006-2010



Source: AAUW analysis of U.S. Census Bureau (2011a).

There has never been a better time to work together to advance gender equity and inclusion in Colorado's STEM workforce. Our economy is strong and STEM industries are growing, but not everyone in Colorado can take advantage of these opportunities. Failing to tap into the skills and talents of women, including women of color, will negatively affect our economic well-being as well as the health and vitality of our families and communities. The Women's Foundation of Colorado (WFCO) is excited to work with companies and industries throughout the state to ensure we get on – and stay on – the path to ensuring that everyone in Colorado has the opportunity to be an active part of Colorado's future growth.



How To Read This Guide

The guide was written for many audiences—for parents, educators, and caregivers of girls to provide tools of empowerment to inspire, motivate, and prepare girls and young women to thrive in STEM opportunities and careers. Each chapter has strategies that are specific for the age group as well as strategies that may overlap across multiple age bands. This guide can be read from cover to cover, and chapters can also be used independently. You may see some repetition in concepts or ideas that are relevant for girls of many ages and you may see more detail in some chapters than in others.

What About Boys?

This guide focuses on providing strategies for people who interact with girls. Many of the strategies, which are imperative for girls, will also be useful for boys. As boys, too, must recognize girls as capable and competent in STEM, adults can help them learn about issues that impact girls from birth all the way into the workforce.

Partners For The Development Of This Guide

WFCO developed this guide through the collaboration of more than 30 partners. A full list of the authors, co-authors, and collaborators who made this guide possible is included in the Contributors section.

Chapter Summaries

CHAPTER 1

By age 5, keep me curious! This chapter focuses on the innate curiosity of girls in early childhood. Their drive to ask questions and explore their natural world is something to cultivate and develop. Caretakers, whether parents, grandparents, teachers, or community members, can foster that sense of curiosity, expose girls to opportunities for exploration, and teach them how to utilize tools to solve everyday problems. By age five, girls should begin to understand the role of STEM professionals in the community, see STEM professionals as problem solvers, and begin to see themselves in that role as well. This chapter presents strategies and activities for caregivers and educators to expose toddlers and preschoolers to STEM experiences.

CHAPTER 2

By age 10, I can ask! This chapter focuses on further developing girls' abilities to ask questions of relevance to their lives. Strategies and activities include ways to foster the natural inquirer within young girls. We explore common challenges for girls in this age span that could keep them from pursuing STEM careers in the future, such as negative perception of abilities and lack of awareness of opportunities. Parents, caregivers, and formal and informal educators will learn strategies to build girls' STEM skills and confidence and discover how to counter messages that tell girls they do not belong in STEM.

CHAPTER 3

By age 13, I am shaping my future. In this chapter, we explore issues that are relevant to this age group such as girls' perception of STEM abilities, societal pressure, and teacher biases that may hinder girls from pursuing STEM pathways. We explore strategies such as building self-efficacy both for teachers and for girls and exposure to real-life, hands-on opportunities in STEM that continue to prepare girls for STEM pathways. Activities include girls learning about and meeting STEM professionals like themselves, understanding issues regarding representation in these fields, and exploring the contributions they can make to these fields. With these strategies, girls move from being consumers of information to creators and contributors who make a difference.

CHAPTER 4

By age 18, I am preparing to solve 21st-century challenges. This chapter focuses on opportunities that help girls see themselves as STEM professionals in the near future. We present research-based strategies to provide greater access to opportunities that prepare, inspire, and motivate young women to become problem solvers and pursue careers in STEM. We also describe the potential that STEM careers provide for girls to earn family-sustaining wages, as well as the economic benefits to their communities.

CHAPTER 5

Beyond age 19, I am thriving; I am changing the world. This chapter presents issues that young women face when entering the workforce or pursuing post-secondary education and strategies for overcoming those challenges. We present research on current trends for this age group. We also explore strategies to mitigate the micromessages that women encounter, including educator bias and workplace climates that may not be inclusive of women. We provide tools that young women can use to persist in STEM fields and lead change.

CONCLUSION

The Concluding Recommendations for Action summarizes the need for equitable representation of women, including women of color, in STEM careers. We present a vision of what it will be like as girls become equally represented in STEM careers and provide a summary of actions everyone can take to support systems-level change for women and girls in Colorado.

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CHAPTER 1

KEEP ME CURIOUS!



**“And though she be but little,
she is fierce.”**
William Shakespeare,
A Midsummer Night's Dream

Violeta García, PhD

Children are born with an innate curiosity to explore their surroundings. The very first stage in girls' lives is loaded with opportunities to discover, to focus, to engage, to explore, and to eventually make problem-solving a core skill even before they can crawl.

You've probably noticed that when babies interact with their parents, they stare. This powerful stare indicates that girls are seeking new information. As they continue to grow, babies start to mirror behavior. By participating in “serve and return,” a concept that describes how a child interacts with her caretaker and the caretaker responds, babies gain new skills.

Shonkoff and Bales conducted a study with caregivers focusing on infant interactions with their mothers and they found that when the mother did not respond to their infant, the baby displayed signs of stress.¹

Every interaction during this early learning stage builds a foundation to create the neural connections that help children develop self-awareness, interest in the natural and physical world, numeracy skills, age-appropriate spatial reasoning skills, and experience science, technology, engineering, and math learning and skill development.²

By age five, girls' experiences with their parents/ caregivers and community can foster opportunities that will help them enter pathways to future STEM opportunities. Keep in mind that at the most basic level, a child's environment has to support health, optimal well-being, and development. The National Association for the Education of Young Children has established developmentally appropriate practices for infants, toddlers,³ and preschoolers,⁴ which parents and caregivers can apply in a variety of settings to engage girls in STEM. Most of these activities or tips in this guide are intended to be flexible, so please make accommodations and scaffold as necessary.

OUTCOMES BY AGE 5

As girls, including girls from diverse backgrounds who have been historically under-represented in STEM, reach age 5, they:

- Retain interest in the natural world
- Know how to ask open-ended questions
- Remain curious about STEM concepts and topics
- Actively participate in STEM learning opportunities
- Experience the practices of STEM
- Develop numeracy skills
- Develop age-appropriate spatial reasoning skills
- Are exposed to early STEM opportunities
- Are exposed to female STEM professionals and entrepreneurs
- Are exposed to STEM professionals from diverse groups who have historically been under-represented in STEM careers

This chapter begins with a brief introduction to the world of newborns and how STEM learning takes place during this formative stage. We proceed with the changes happening as girls become mobile and move into toddlerhood. We explore activities that foster STEM learning, including concepts that girls can experience at this stage and skills that they can practice early in their lives, such as questioning, observing, and testing predictions. We also provide a brief explanation of the importance of each outcome and include suggestions and activities for ways parents, educators, and community-based organizations can build a strong STEM ecosystem of experiences. We hope that this will help inspire, prepare, and motivate girls to enter and stay in STEM pathways as they begin in their educational journey.

STEM learning naturally occurs in early childhood. By being more intentional, we can more readily recognize and boost learning for girls from birth to age 5.

NEWBORNS AND STEM

Exposing newborns to the awe and beauty of the world is an essential foundation for their development. They learn from those in their immediate environment: they learn how best to ask for milk, to be changed, and to play. Eventually, they begin to mimic behavior that elicits certain responses, such as giggling to make a parent smile. They respond to funny faces and cuddles from parents and caregivers.

Early exposure to books, stories, and language helps baby girls thrive. By the time a child learns to verbalize her needs and wants, she amazes her caregivers with the number of words that she knows. Every interaction helps her develop skills that will serve her as she pursues more formal exploration of the natural and physical world. Consider this baby girl as an emerging young scientist!



TRY THIS!

- ❑ Count your little one's body parts, such as fingers and toes, to start associating numbers that represent objects in her environment.
- ❑ Describe the colors in her world.
- ❑ Think out loud. Ask questions that you are wondering about and describe your everyday actions to your child.
- ❑ Have conversation with your newborn and respond by mimicking her sounds and facial expression. Describe her actions.
- ❑ Add your own ideas!



READ ALL ABOUT IT!

There are many STEM books for early childhood that support conceptual understanding such as books about color, numbers, and relationships. Here are a few of our favorites.

Ten Little Fingers and Ten Little Toes by Mem Fox

My Colors, My World/Mis Colores, Mi Mundo by Maya Christina Gonzalez

The Very Hungry Caterpillar by Eric Carle

My Granny Went to Market by Stella Blackstone

Colors by Julia Pimsleur Levine (English/Spanish/French)

Continue the conversation. Add books that inspire learning concepts such as numbers, colors, and sequencing.



SHE'S ON THE MOVE! ENTERING TODDLERHOOD

Between six and nine months, girls begin to move. This is an exercise in trial and error. She rolls and realizes that movement occurred. She is now in a new location. She tips over and gets back up. This constant trial and error sets the foundation for further exploration. She begins to question, to add new variables that she can test. Will this object keep me from falling? What is the best way to go down those steps? While she may not verbalize these types of question at this stage, one can see that young children are indeed testing and trying in every interaction they have with their environment.

Her observation skills and inquiry abilities develop through sensory experiences: looking, listening, touching, feeling, and tasting. She has to touch things and put them in her mouth. She might hit and throw an object to learn about its behavior. Does it make a sound? Does it break? She also begins to sort information in her environment, which includes exploring attributes such as size, shapes, numbers, and colors. All of these discoveries are foundational to future STEM learning.

At this stage, math examples have to be concrete. For example, she can relate to having one ball, or one cupcake. By the time she reaches toddlerhood, around two years, she begins to understand that two cupcakes are more than one. She also begins to develop spatial reasoning abilities. This may happen when she falls down a step and she learns to sit and scoot down instead, or when she tries to pick up a block that is at the bottom of a pile.



TRY THIS!

- ❑ Help her use her whole body to learn. Count her nose, her eyes, her fingers, her legs, and her arms.
 - ❑ Engage her senses. Have her explore colors by mixing them and making new colors. Try different materials with different textures and describe the similarities and differences.
 - ❑ Offer three-dimensional shapes for her to explore and sort.
 - ❑ Interact with her by playing with blocks to develop spatial reasoning skills.
 - ❑ Go out in nature and find shapes and textures in her environment.
- ❑ Tell stories. You don't always have to have books to tell stories. Tell her stories about what you loved to do as a child. Use sequence words (first, then, last) to tell your story. You can also tell stories about your day.
 - * **For example**, you can tell a story as it's happening by tracking a sequence of events. "First, we're going to eat breakfast, then we will take the garbage outside, then we will go to the zoo." Later in the day you may say, "We're having so much fun at the zoo now. After the zoo, we'll go to the grocery store." By continually tracking events throughout the day, children can learn the experience of time and before/after.

HOW CAN WE HELP YOUNG GIRLS RETAIN INTEREST IN THE NATURAL WORLD?

Adults can cultivate the natural curiosity in young girls. This curiosity can be fostered indoors, but can also be fostered outdoors. At home, we can provide young girls with materials found around the house that they can touch, feel, and even chew on. Outdoors, we can do the same. Children are curious. They want to use all their senses to explore the environment. Sometimes, adults' desire to keep kids clean and tidy may limit their children's ability to explore.

Parents and caregivers might tell their children not to get dirty or remind them that if they climb a tree they might get hurt. While this is possible, children stand to gain skills and confidence through risk-taking. When young children succeed at what may appear to be a very challenging task for their age and ability, they learn that they are capable human beings. Give kids opportunities to explore. When you explore with your child, you can help her develop the ability to ask good questions.



START HERE!

Connections to Environmental Education

Get the Materials: Educators can receive the complete *Environmental Experiences for Early Childhood* materials by attending a Project Learning Tree training, [in person](#) or [online](#). Resources available are great for parents and anyone who works with young children. The activities are fun and easy-to-do. They encourage families to take children outdoors in ways that are exciting, safe, and full of learning.

Build a Garden: Have your child design a small garden and plan where they want to plant. Have them care for the plants and document change over time. Then use the fruits and veggies grown to make a meal or two.

Read: *Ten Seeds* by Ruth Brown.



WHAT ARE EFFECTIVE WAYS TO HELP YOUNG GIRLS ASK OPEN-ENDED QUESTIONS?

Before children can verbalize their wants and needs, they cry to express a need; later, they may point to communicate. This is a great time to start to model different types of questions. When children start speaking, they want to know what things are called and start asking convergent questions, or those that have a clear answer. For example, a girl may ask what day of the week today is, or if it's sunny outside. These types of questions, while essential, are called closed-ended questions and they do not provide opportunities for deeper thinking. To develop the deeper thinking skills of a future scientist, adults can also introduce girls to questions that do not have a right or wrong answer. These are called divergent questions, or open-ended questions. Children at this stage love “why” questions and “What’s this” questions. Take the opportunity to explore together to find answers.



START HERE!

For ideas on different types of questions visit [Desired Results – Open-ended Questions in English and Spanish](#) as well as other helpful [resources](#).

Open-ended questions are questions that have multiple answers and can be answered in multiple ways. This type of question stimulates children to use more language, see multiple ways of solving problems, and encourages creative thinking. This resource suggests educators and caregivers ask questions such as “What does this remind you of?” and “What would happen if...”

The Boston Children’s Museum [STEM Sprouts Teaching Resource Guide](#) also has good examples of “what” questions that can help children deepen their thinking. Question examples include “What do you notice about how it’s moving?” “What else have you seen other kids try?”

Children ask many different types of questions. Adults can also help children ask different types of questions to deepen their thinking and curiosity about the natural world. There are questions with exact answers and questions that require complex answers. There are also questions that do not yet have answers. Parents, caregivers, and educators can foster question development along a continuum of questions that have answers, to questions that children can build on and explore throughout their lifetime. After all, these are the children who we hope will have the drive, the curiosity, and the opportunity to push their thinking to new limits. It is during these children's lifetime that we anticipate and hope to find the cure to global problems such as cancer, global climate change, and tackling the dramatic reduction of global biodiversity. Read the following Try This! section for question ideas.



Children explore what things do, how they move, and what happens when they push, pull, tug, or throw those things. As they enter toddlerhood, children begin to ask lots and lots of questions. Caregivers have the opportunity to stimulate children's minds and encourage them to continue to ask questions.



TRY THIS!

Start with "What" questions.

What do you see?

Younger children benefit from questions that they can answer from direct observation.

You can build on the type of question by asking *What would happen if we....?*

This presents an opportunity to experiment with new tools, materials, or things.

Closed-ended questions

- What day is it today?
- What color is your shirt?
- What would happen if we added sugar to the water?
- What would happen if we mixed the yellow paint with the blue paint?

Open-ended questions/statements

- Tell me about...
- What do you feel, see, hear, taste, and smell?
- What does this remind you of?
- How can keeping our environment clean help us?



READ ALL ABOUT IT!

[*Improve Your Verbal Questioning*](#) by Kenneth E. Vogler⁵

[*The use of productive questions in the early childhood classroom*](#) by Rachel Alice Dengler.⁶

Lift the Flap Questions & Answers by Katie Daynes

The resources listed above focus on questioning strategies that can be helpful for parents and for caregivers working with young children.

WHAT STEM CONCEPTS AND TOPICS ARE RELEVANT FOR GIRLS FROM BIRTH TO AGE 5?

STEM learning happens when children are exposed to key ideas, or concepts, in science, technology, engineering, and math, and as educators help children understand the connections of these ideas to their daily lives. It continues when children build foundational 21st-century skills⁷, such as communication, collaboration, critical thinking, and creativity.⁸ You can find specific STEM standards adopted by the Colorado State Legislature per grade level, starting in [preschool](#).⁹ You can also find examples of developmentally appropriate learning targets through the [National Association for the Education of Young Children](#).¹⁰



READ ALL ABOUT IT!

This is a list of organizations and governing bodies that set recommendations or have a large influence for setting early childhood developmental benchmarks.

- Colorado Early Learning and Development Guidelines <https://www.cde.state.co.us/early/eldgs>
- Developmentally Appropriate Practice: Focus on Preschool published by the National Association for the Education of Young Children. <https://store.naeyc.org/store/developmentally-appropriate-practice-focus-preschoolers>
- *Teaching STEM in the Early Years: Activities for Integrating Science, Technology, Engineering, and Mathematics* by Sally Moomaw. <https://www.amazon.com/Teaching-STEM-Early-Years-Integrating/dp/1605541214>
- Zero to Three <http://www.zerotothree.org/>
- Too Small to Fail <http://toosmall.org/>
- National Association for the Education of Young Children, For Families <http://families.naeyc.org/>
- Colorado Office of Early Childhood. Early Learning and Development Guidelines <http://earlylearningco.org/>



STEM Concepts By Age 5

Concepts are key ideas that children can explore and understand in science, technology, engineering, and mathematics. These big ideas include quantities, numbers, classification, order, shapes, colors, attributes of objects, cause and effect, living things, environment, life cycles, change over time, earth materials, and daily and seasonal changes. Young children can learn about topics like plants, butterflies, simple machines, and weather.

STEM Skills By Age 5

STEM skills are things that children should be able to do. For example, by age five, girls should be able to build structures with blocks; say and follow directions; gather, collect, and describe materials; record information; use tools such as magnifying glasses, scales, and rulers in investigation and play; make and record by drawing, acting out, or describing observations; count and represent objects; match a quantity with a numeral; sort, match, and group shapes; and use words to describe attributes of objects.

STEM PRACTICES

[STEM practices](#)¹¹ are habits of mind that scientists, engineers, people who work in information technology, and mathematicians exhibit. These are special skills that are extremely important to STEM and are also beneficial for other areas of life.

In addition to the skills listed above, STEM professionals:

1. Ask questions and define problems
2. Develop and use models
3. Plan and conduct investigations
4. Analyze and interpret data
5. Use mathematics and computational thinking
6. Construct explanations and design solutions
7. Engage in argument from evidence
8. Obtain, evaluate, and communicate information



While a preschooler may not yet exhibit all the practices above in a formal way, learning to think like a scientist or an engineer starts during these formative years. We can build a solid foundation for young girls to be able to immerse themselves in these practices.

By age five, children can be curious about new tasks and challenges; able to explore and experiment; able to show capacity for invention and imagination; able to ask questions based on discoveries made while playing; able to organize objects in different ways to learn about the objects and group of objects; able to use appropriate mathematics tools strategically; and able to use numbers to count and order objects.



TOOLBOX

Basic Science Process Skills

Observing - using the senses to gather information about an object or event. Example: Describing a pencil as yellow.

Inferring - making an "educated guess" about an object or event based on previously gathered data or information. Example: Saying that the person who used a pencil made a lot of mistakes because the eraser was well-worn.

Measuring - using both standard and non-standard measures or estimates to describe the dimensions of an object or event. Example: Using a meter stick to measure the length of a table in centimeters.

Communicating - using words or graphic symbols to describe an action, object, or event. Example: Describing the change in height of a plant over time in writing or through a graph.

Classifying - grouping or ordering objects or events into categories based on properties or criteria. Example: Placing all rocks having certain grain size or hardness into one group.

Predicting - stating the outcome of a future event based on a pattern of evidence. Example: Predicting the height of a plant in two weeks' time based on a graph of its growth during the previous four weeks.

Excerpted from [Research Matters to the Science Teacher by Dr. Michael Padilla](https://www.narst.org/publications/research/skill.cfm)
<https://www.narst.org/publications/research/skill.cfm>.

Caregivers can encourage these habits of mind by asking questions, fostering curiosity, providing opportunities for exploration, and providing opportunities for children to share what they are learning about the natural world. As girls continue to experience STEM practices, they will see themselves as people who can solve problems, search for information, think analytically, and defend their arguments with reasoning. All this prepares them to solve 21st-century challenges.¹² St. Vrain Spark! Discovery Preschool is one example of a school that helps learners develop STEM skills, learn STEM concepts, and apply design thinking to solve real problems (see Box 1.1).

BOX 1.1. IN THE SPOTLIGHT:

St. Vrain Spark! Discovery Preschool

Since August 2013, Spark! Discovery Preschool has been serving preschoolers in St. Vrain Valley Schools. Spark! Discovery Preschool is a Science, Technology, Engineering, and Mathematics focused preschool. Their STEM model was inspired by a program called Innovation Academy for a Smarter Planet, a unique, multi-year partnership between IBM, CU Teach, Skyline High School STEM, and St. Vrain Valley Schools, which Paige Gordon, Spark! Discovery's Administrator, directed and developed in its first four years of existence.

Spark! Discovery Preschool's mission is to ignite creative thinking, innovation, problem solving, and discovery to encourage every young learner's curiosity and joy of lifelong learning in order to influence an ever-changing world. Preschoolers experience six collaboratively developed units of STEM throughout the two-year preschool experience. These highly engaging units focus on solving relevant problems, integration and connectedness of concepts, the development of STEM-based dispositions (such as risk-taking, empathy, creativity, etc.), 21st-century skills, and inquiry-based learning strategies.



Learn more at <http://sdpk.svvsd.org/>



HOW CAN WE ENGAGE GIRLS IN STEM LEARNING OPPORTUNITIES?

Caregivers play a critical role in exposing girls to STEM learning opportunities and, with knowledge of the opportunities available, can incorporate STEM into everyday activities. Let's look at Maya's interaction with her dad.

Maya, age 5, woke up one Sunday morning and asked her dad to take her to the zoo. Maya wanted to visit the new rhino to see if it was different than the last rhino that was there. Her dad found a list of free days at local museums and zoos that Maya's preschool had provided, and they made a plan to visit the zoo together in a few weeks. In the meantime, they went for a walk in their neighborhood and talked about what the squirrels in the park eat.

Requests like Maya's give parents and caregivers the chance to let their daughters be scientists. At the zoo, Maya will have the opportunity to make new connections to her prior knowledge from previous visits. She is also building a mental log of the animals that come and go and creating

connections between the zoo and other animals that live in the wild around her home. Her animal picture log includes bunnies, squirrels, and a snake (that she's never seen but has collected evidence [i.e. dry snake skin] to support her claim that one exists).

Parents or caregivers can take advantage of the many free days available at local cultural institutions. Mark your calendar and countdown to the date. In Denver, the [Scientific and Cultural Facilities District](#) offers a calendar that lists free days at the Denver Zoo, the Children's Museum, and other places.



TRY THIS!

- Study a snake skin if you come across one. Then, observe, discuss, and record other animal signs such as scat, chewed bark, and tracks.
- Observe and document a plant's life cycle.
- Take a hike and find one plant that you want to observe four times in one year (ideally as the seasons change).
- Visit Project Budburst Buddies at <http://budburst-buddies.org/journal-pages>. You will find games and activities that you can do with your little one. Or, you can fulfill the citizen science component by contributing your data under "report what you saw" at Project Budburst's website. You can also use this plant log with a bulb (paperwhites, tulip) to track the life cycle of a plant, although you might not be able to contribute that data to the site.
- Ask your daughter to draw her observation and you help her label the parts that she sees and any other observation she wishes to document. As she develops fine motor skills and learns to write, she will be able to label the diagram on her own.

Prompt:

.....
Draw what you see.



Prompt:

.....
Observe carefully.



Add:

.....
Scientific language
to create a diagram.



WHAT ARE NUMERACY SKILLS AND HOW CAN WE HELP YOUNG GIRLS DEVELOP THEM?

In preschool, mathematics is best learned as an applied science. Children can experience mathematics throughout the day in many ways. Math lessons that integrate language and vocabulary development can help children recognize and make connections to describe their environment. Mathematical thinking occurs whenever we compare, sort, work with patterns, and identify shapes.¹³

[Numeracy](#)¹⁴ refers to basic concepts and skills that relate to quantities. Children have many opportunities to use numbers to represent quantities and to count. These quantities can be represented with a numeral.¹⁵ Girls can use counting to describe the size of our families, how many pets we have, how many books we own, or how many objects are in a bin.

Girls can develop numeracy skills by having fun with numbers. Children as young as two can repeat numbers and their understanding of the relationship to quantity develops soon after. Once children discover numbers, they begin to count everything around them. As they learn to compose numbers, they will make the connection that quantities can be combined to make greater quantities and that's how we add. When we take away a certain quantity, we subtract. Understanding quantities like more or less and heavier or lighter also helps children understand numbers.



Work On Math Skills Together

Help children recognize that math is all around them. For more math ideas, you can visit



(Wikimedia Commons, 2015)

[Developing Early Math Skills](#)

<https://www.zerotothree.org/resources/299-help-your-child-develop-early-math-skills>

Peel a clementine and separate all the slices. Count them with your child before she starts to eat them. Count the slices each time she eats one.

You can do this activity with any fruit or vegetable that has slices or that can be sliced into multiple pieces.

Introduce the concept of zero. Zero is when we do not have any quantity present.

Recognizing that numbers are all around us and that quantities help us understand our world are critical foundational skills in STEM. In addition, children need to have opportunities to measure objects, and to observe shapes in our world and describe them in relation to one another. Having a good grasp of numbers can help children count sides of shapes and classify them based on attributes. Classification also plays an important part in pattern recognition. Young children can follow patterns, such as $\triangle\triangle\blacklozenge\triangle\triangle_ _ _$, and predict the sequence of shapes. You can also make connections to pattern recognition in music.

Caregivers may not always feel comfortable with the idea of teaching mathematical skills and concepts, however, many parents and caregivers already do! Parents, caregivers, or educators with less confidence in their abilities or less information about teaching mathematics may benefit from additional training. Community organizations that work with caregivers/parents or educators have the opportunity to provide ideas and examples of how to foster mathematical thinking and scientific literacy in the early years. Examples of organizations providing STEM professional learning include Denver's Early Childhood Council [workshops](#) and Zero to Three's [math and science resources](#).



TRY THIS!

Create a pattern. Use blocks or beads to create a pattern and have your child finish the pattern and explain it to you.

Go for a walk. Find a pattern in nature.

Cook a meal together to enhance STEM skills and interest. You can practice measurement, estimation, planning, collaboration, and learn about concepts such as changes in matter, heat, mixtures, and solutions. <http://kidshealth.org/en/parents/cooking-preschool.html?WT.ac=p-ra>

Read. *The Cooking Book: Fostering Young Children's Learning and Delight* by Laura J. Colker.



Natural connections between STEM disciplines and art and creative expression have created an opportunity for STEAM education. The addition of the “A” to the STEM acronym acknowledges that there is a special place to provide opportunities that foster out-of-the-box thinking and expression. An example of an organization that has embraced the STEAM approach is PBS (Public Broadcasting Service) through their early childhood programming (See Box 1.2)

BOX 1.2. IN THE SPOTLIGHT:

Fred Roger's Approach: From STEM To STEAM

Fred Rogers naturally integrated STEM concepts in his PBS program *Mister Rogers' Neighborhood*. His goal was to help children understand more about themselves and the world around them. His legacy lives on with new programs: *Daniel Tiger's Neighborhood*, *Peg+Cat*, and *Odd Squad*. Sesame Street is also embracing the STEAM approach.

<http://www.fredrogers.org/professional/video/steam/>

These programs focus on developing 21st-century skills using everyday moments such as singing in the rain and starting with the ordinary.



TRY THIS!
STEM Learning All Around

Make your own “Ways to play” list. For help getting started, check out <http://www.bostonchildrensmuseum.org/learning-resources/100-ways-play>.

Whole body movement. Show your child how to move her body to mimic the movement of leaves, machines, or other objects. Whole body movement, including yoga, is also a great way to learn math concepts and skills. There are free activities to get started. Read more at <http://www.mathandmovement.com/whatis.html>.

Create a makerspace. Set aside an area in your home with materials that can be used to design and create. Have basic tools such as scissors, tape, glue, and plenty of materials such as toilet paper tubes, cardboard/cereal boxes, egg cartons, and other common household items and let girls tinker with them. For ideas on how to start visit <http://www.naeyc.org/tyc/making-young-learners-intro>.

Read. *Rosie Revere, Engineer* by Andrea Beaty. <https://www.amazon.com/Rosie-Revere-Engineer-Andrea-Beaty/dp/1419708457>.

WHAT ARE SPATIAL REASONING SKILLS AND HOW CAN WE HELP GIRLS ACQUIRE AND PRACTICE THESE SKILLS?

Researchers have identified spatial ability as an area in which girls oftentimes lack confidence and ability. Spatial ability or spatial reasoning is the ability to manipulate objects in our heads. By five, girls should have many experiences and opportunities to describe shapes and space. Spatial awareness is one component of spatial reasoning that may facilitate future learning of STEM concepts.¹⁶ Girls and other students from groups historically under-represented in STEM fields may show a disadvantage in spatial reasoning abilities when they enter STEM fields. However, these are skills that can be taught starting at a very early age. When building with blocks, a young child develops the ability to see an object through multiple perspectives – from the top or bird’s eye view, from the left side, from the right side. Later in life, this young girl will have the ability to “turn” the object in her mind—a skill that is essential in the physical sciences and engineering.

For an in-depth exploration of spatial intelligence or spatial reasoning, visit [Parenting Science](#).¹⁷ The authors note that improving spatial reasoning abilities is correlated with the ability to develop strong arithmetic skills in primary school.¹⁸



TRY THIS!

Use positional words to describe place or location of objects. For example, instead of saying "I need a cup," be more specific by describing location and say, "I need the cup that's on the table."

Positional words include the following: up/down, slow/fast, here/there, over/under, right/left, back/forth, first/last, in/out, and below/above.

Play With H₂O

Playing with water provides great sensory experiences and opportunities to practice positional words. If playing in the tub, use a toy to practice positional words such as under/over, on/in, inside/outside.



TRY THIS!

Give verbal directions to your child (4-5 years) to follow.

1. Have her go get an item from a location in the house.
2. Have her go outside and get an item for you. Keep an eye out if you are concerned for safety reasons.
3. Gradually increase the complexity of the directions to help her develop the ability to follow them. (Put the object in the bag, on top of the bag, under the bag, etc.)

Take turns. Have her give you directions to find an object.

Co-pilot: Ask her to give you directions on your way to and from school.

Teach her your home address and have her draw a map.

Note: younger children can follow one- or two-step directions, while older children will be able to follow multi-step directions.

EXPOSURE TO STEM PROFESSIONALS

Preparing young girls to experience concepts and skills in STEM is one component of quality STEM learning experiences. Girls also need to have opportunities to see STEM professionals as part of their communities and their lives. Schools often give girls the chance to meet professionals and learn about their communities. They may learn that firefighters help keep our cities safe, doctors and nurses help keep us healthy, mail carriers help move communication and packages, and teachers help educate our children. However, girls less often have the opportunity to meet STEM professionals outside the healthcare field, such as engineers who design roads and bridges, engineers and architects who designed their schools, and software developers who create the apps they love to use on smart devices.

WHY DO GIRLS NEED TO BE EXPOSED TO WOMEN STEM PROFESSIONALS AT THIS EARLY AGE?

Exposing children to STEM professionals who are women can help kids see established versions of who a STEM professional can be. By starting at a very early age, children grow up with a more inclusive mindset about access to STEM careers. Women in STEM will be common for young girls to see instead of outlier examples.



TRY THIS!

Invite researchers, engineers, and computer scientists, in addition to police officers, firefighters, and nurses to come talk to students during community-themed units. This is a great way to expose girls to a variety of STEM professionals. If you have the opportunity to take young kids to community sites, visit places where you typically find STEM professionals. Visit a lab, an engineering firm, or a research university.

Parents play an important role in recognizing their daughters' abilities to succeed in STEM. Mothers can be very effective STEM influencers for their daughters and help their daughters develop a science persona. When a girl sees her mother interested in STEM experiences herself, the daughter will see herself as a STEM learner, too.

WHY DOES IT MATTER IF YOUNG GIRLS ARE EXPOSED TO STEM PROFESSIONALS FROM DIVERSE GROUPS WHO HAVE HISTORICALLY BEEN UNDER-REPRESENTED IN STEM CAREERS?

Encouraging Play Across Genders And Across Cultures

Girls need to see a wide variety of STEM professionals from all walks of life. Their own identity as a future STEM professional may be influenced by seeing people who look like them, in gender, ability, and in ethnic or cultural diversity. The famous draw-a-scientist test, in which children are asked to draw a scientist, shows the persistent stereotype of a scientist as a white man with crazy hair and a lab coat.¹⁹ By exposing students to scientists of different backgrounds, we can help expand the definition and image of scientists to be more inclusive of women and people of color.

Recognition by peers that girls, including girls of color, are capable of succeeding in STEM professions is a critical component of identity development. At an early age, children need to see diverse people as creators and doers and learn how their work as STEM professionals makes our communities better. When girls see and interact with professionals from a variety of backgrounds they can broaden their understanding of STEM professionals and this helps to reinforce their own STEM identity.

Chapters 3, 4, and 5 have additional resources on connecting girls to STEM professionals from diverse backgrounds. Try starting with your local community and then reach out beyond your community to create special events to promote girls in STEM.



The Gendering Of Toys

Over the past forty years, toys have become more segregated into “boy toys” or “girl toys.” When [selecting](#)²⁰ toys for your early learner, make sure you select based on the opportunity for learning rather than based on gender labels. Question the intent of the toy. Be selective. Purchase toys that help develop spatial reasoning skills and let children create patterns, build, count, and sort. Select puzzles with pictures that probe deeper thinking and question development. Focus on toys that develop children's physical, cognitive, academic, musical, and artistic skills.²¹ These types of toys tend to be gender neutral, or not gender-typed.

Young children's innate curiosity, originality, and creativity can be developed through play using toys and further enhanced using technology. [LEGO](#)²² provides tools that can be used in the preschool learning space to get girls thinking creatively and to promote math and science skills.

My Toddler Can Use A Smartphone!

Young children are part of a technological world. Children as young as 1 or 2 have learned to swipe across smartphone screens or digital pads. Technology expands the range of tools available for children to seek information, to solve problems, to perform transformations, and to learn at their own pace.²³ Technology is here to stay. There are ways we can use these resources to develop STEM skills in young children.



“Young children are part of a technological world.”



TOOLBOX

Tips On Using Technology

- **Be intentional.** Choose apps carefully before downloading them. Set time limits, too. Apps that inspire learning include apps that teach children how to count, sort, and classify. There are apps that develop problem solving abilities where children have to come up with a plan to make something happen, for example, to get through to an object by cutting or manipulating objects. Technology games can also be used to arrange and position objects to develop spatial awareness.²⁴
- **Make it a quality time experience.** Interactions between child and parent are better than children's independent use of technology.
 - Lydia Plowman and her research team have studied the use and impact of technology for 3- and 4-year-olds at home.²⁵ The authors present a framework of four areas of learning that could be supported by technology: acquiring operational skills, extending knowledge, and understanding of the world, developing dispositions to learn, and understanding the role of technology in everyday life.²⁶
- **Be equitable.** Caregivers and educators making technology available in learning spaces should make sure that both boys and girls have equal opportunities to interact with the devices.²⁷
- Don't just consume. **Create.** Read the following section for more details.

Moving From Consumers Of Technology To Creators

To move from consuming technology to creating it, children as young as four or five can begin to understand coding skills and create programs. [Technology in Early Childhood](#)²⁸ is a site that has a wealth of information to help children develop skills and abilities so that they can write their own programs. Immersing children in technology does not have to mean negating play or outdoor experiences; it can be an additional way to help children develop thinking skills.



Community Organizations

Colorado is home to many community organizations that serve as partners in STEM learning, such as the Denver Zoo, the Children's Museum of Denver, the Denver Museum of Nature and Science, and the Fort Collins Museum of Discovery. There are also smaller organizations across Colorado such as Walking Mountains Science Center in Avon or the Poudre Learning Center in Greeley. To learn more about community organizations and programs in our state, visit the [Colorado Collaborative for Girls in STEM](#) (CoCoSTEM). This site will link you to

[The Connector](#), which is a comprehensive list of STEM opportunities for all ages. If you work with an organization that serves girls in STEM that is not yet listed, please register so our community members can know about the opportunities offered.

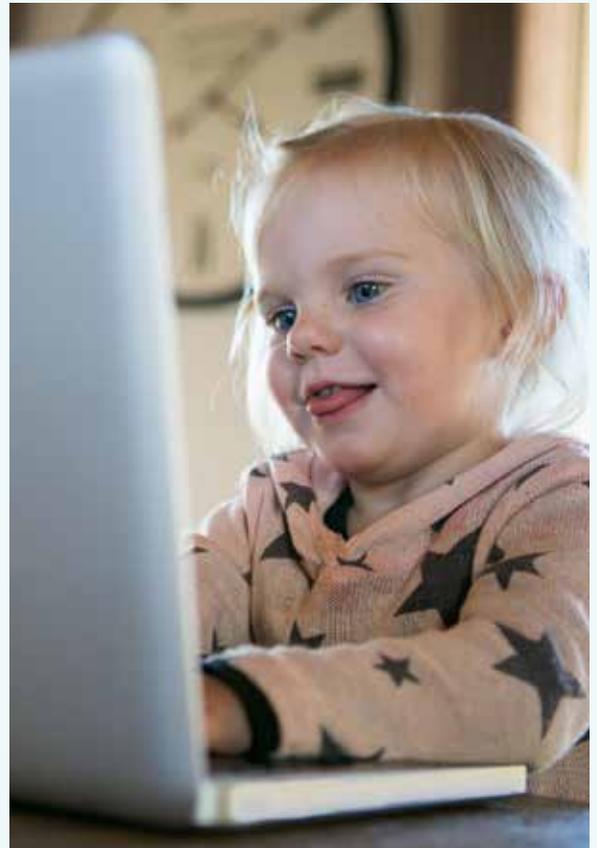
Often, STEM opportunities can be found at local libraries, colleges and universities, and right in your own backyard through organizations such as the [Girl Scouts](#), or the [Boys and Girls Clubs of America](#). Other organizations offer camps during school breaks or over the summer.



TRY THIS!

Computer Science Related Resources

- Check out PBS KIDS Super Vision. This is PBS KIDS' second app designed specifically for parents. PBS Parents Play & Learn, also available for free, offers parents simple activities that they can do with their kids to support math and literacy around specific locations such as the grocery store or the park. PBS KIDS also offers more than 30 apps for kids, designed to help build literacy, math, science, and school readiness skills and more. More information about PBS KIDS' apps is available on pbskids.org/apps.
- Expose children to coding at an early age. Check out the Code-a-Pillar <http://www.theverge.com/2016/1/5/10716994/fisher-price-thing-and-learn-code-a-pillar-toys-2016>.
- There are also other apps that teach logic to early learners such as Lightbot <https://lightbot.com/> and Kodable <https://www.kodable.com/>.



BOX 1.3. IN THE SPOTLIGHT:

Children's Museum of Denver

The museum creates extraordinary experiences that champion the wonder and joy of childhood. The [exhibits](#) are organized around major concepts that are essential to child development – explore, imagine, investigate, and create.²⁹ Visitors will find dozens of ways to build STEM practices and abilities through play.

Check the Children's Museum's website for a current schedule of free days.

Learn more at <https://www.mychildsmuseum.org/>



TRY THIS!

A Day At The Children's Museum

You made it to the museum and you're not quite sure what to do. Now what?

Try a little acting: Dramatic play at the museum – take on roles as scientists, astronauts, and engineers.

Try using your body: Have your child use whole body movement to practice positional words or by using other objects in the museum.

Try exploring science concepts: You can learn about balance, gravity, and force all in one place.

Try developing questions: Use these sentence starters: I wonder how... What do you think... What does __ do? What would happen if we__?

Most importantly, have fun while learning together!

Learning in early childhood happens constantly, through exploration, play, and daily activities. Caregivers, educators, and community organizations all have the opportunity to help girls build STEM skills and see themselves as creators, designers, and thinkers. By building a solid foundation, we hope that girls will be ready for the next stage in their STEM development trajectory.

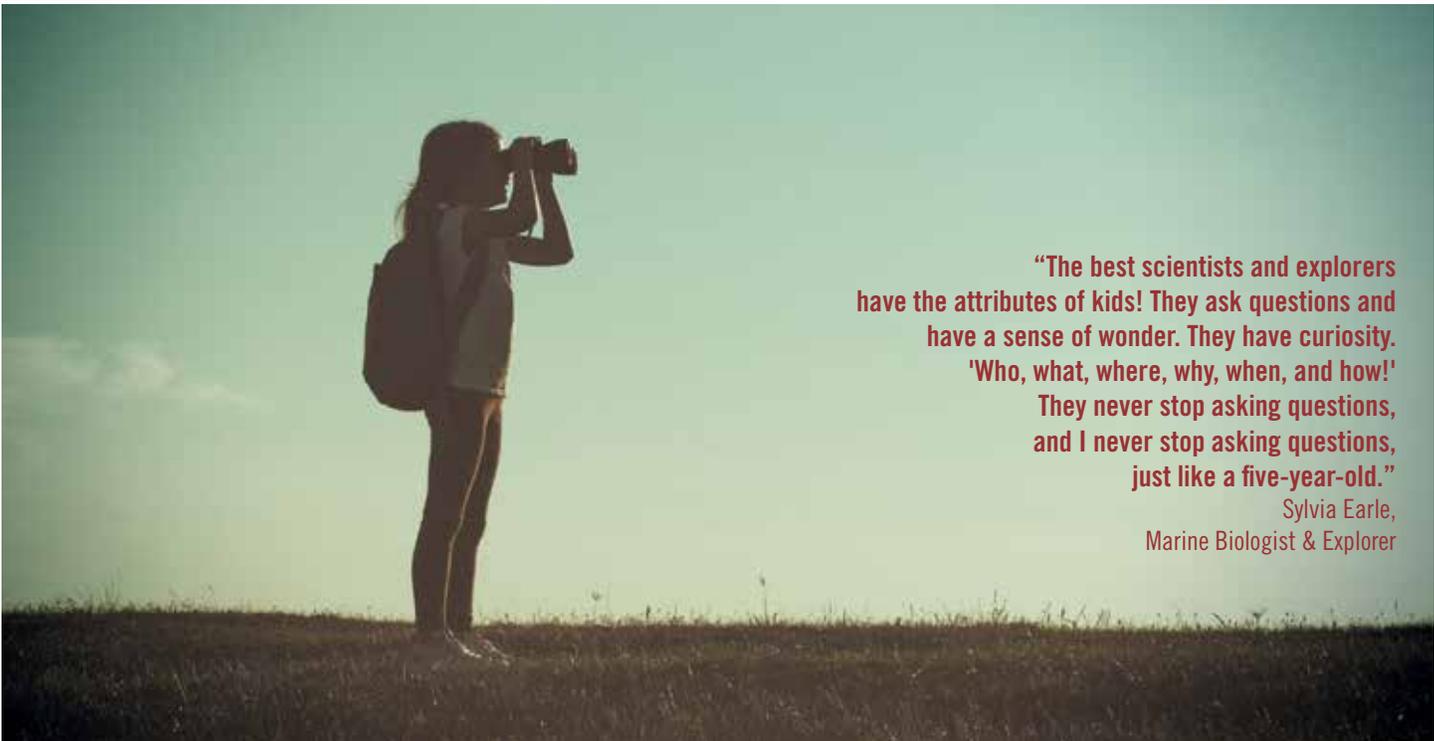
“Learning in early childhood happens constantly, through exploration, play, and daily activities. Have fun while learning together!”

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CHAPTER 2

I CAN ASK!



“The best scientists and explorers have the attributes of kids! They ask questions and have a sense of wonder. They have curiosity. 'Who, what, where, why, when, and how!' They never stop asking questions, and I never stop asking questions, just like a five-year-old.”

Sylvia Earle,
Marine Biologist & Explorer

**Violeta García, PhD
Becky Peters**

Between 6 and 10 years of age, girls begin to develop a greater awareness of their roles in society. The messages girls receive during this formative period will either perpetuate negative stereotypes about women in STEM or help them carve a new path where they feel welcome and embrace STEM learning opportunities.

Four key issues impact girls' perceptions about STEM careers and girls' preparation to pursue STEM pathways:

1. Girls, including girls of color and those from low socioeconomic backgrounds, often have limited exposure to STEM opportunities.

2. Implicit biases can prevent girls from accessing STEM opportunities.

3. Teachers' own confidence in their ability to teach math and science, as well as their own beliefs about girls' abilities to excel in these areas, impacts girls' confidence in math and science.

4. Schools seldom teach engineering, computer science, and design thinking in early grades.

In this chapter, you will find ways to help girls develop the ability to inquire and solve problems, critical skills as young women move into middle school and high school. While we explore the four identified issues listed above, we propose ways for parents, caregivers, and formal and informal educators to help girls persevere in STEM learning opportunities. We present strategies to counter the messages girls receive that tell them they do not belong in STEM.



OUTCOMES BY AGE 10

As girls, including those from diverse backgrounds who have been historically under-represented in STEM, reach 10 years of age, they:

- Continue to be inspired in STEM
- Continue to appreciate STEM concepts and topics
- Develop 21st-century skills
- Experience the design thinking process
- Develop awareness of STEM opportunities at home and in their local community
- Participate in age-appropriate STEM opportunities
- Meet female STEM professionals and entrepreneurs
- Meet STEM professionals from diverse groups who have historically been under-represented in STEM careers

HOW CAN I HELP GIRLS CONTINUE TO BE INSPIRED IN STEM?

In Colorado, students in early grades have experienced a decrease in time spent doing science from 2.9 hours per week to 1.6 in less than a 10-year period.¹ Exposure to engineering and computer science is also very limited.² Sometimes, STEM learning experiences are not offered because parents, caregivers, and educators may not be aware of the benefits of such opportunities. Alternately, they may not have had formal training and may lack exposure to STEM themselves, so they may fear failing or not doing things right. Parents and teachers may not know where to start.

Exposing girls to computer science, maker spaces, and other STEM opportunities can begin to inspire them to develop an interest in STEM. STEM opportunities come in many forms and can be offered in a variety of learning spaces. STEM learning can occur inside a classroom, in an outdoor classroom space, or in an everyday moment. Frequently, disciplines are instructed in silos, separated from other subjects, and these silos need to be broken. In the classroom, the most engaging STEM learning occurs when math and science concepts are embedded in problem- or project-based learning through integrated experiences. Engineering and technology are core components of the “making” aspect of STEM. Through this approach, STEM becomes pedagogy rather than stand-alone subjects. Educators have the chance to make connections to real-life experiences and everyday student experiences. They can invite STEM professionals to show students how they use STEM skills and knowledge in their work and to improve their communities. Girls learn how they can make a difference in their communities through STEM. Caregivers and community organizations that serve girls can build STEM experiences

around everyday moments where students can see STEM and make connections that reinforce the important skills and concepts girls learn.

Unfortunately, not all kids in Colorado have access to STEM learning opportunities. STEM programs are limited in rural Colorado and are mostly found along the Front Range.³ However, the opportunity to create STEM learning spaces in local libraries, in schools, and at home, exists. The easiest way to start is to step outside and explore nature.

ACTIVITY 2.1:

Step Outside

Parents and caregivers can expose girls to outdoor experiences where they can develop inquiry skills by developing awareness of the natural world and the human-created world. Try this activity with your child.

Tools: A magnifying lens and/or binoculars if available, but not necessary.

Goal: To take time to start listening and observing nature without disruption.

STEP 1. OBSERVE

- Find a comfortable spot to sit and take a couple of minutes to look around in silence.

Ask yourself:

- What do I see?
- What if I look closer? Is there something new that I did not see before? Are things moving? Do I know what all of these things are around me? Why are they here?

STEP 2: LISTEN.

Ask yourself:

- What sounds do I hear?
- What do these sounds tell me about my community? What animals do I hear? What sounds come from things that humans made? What sounds come from nature?
- Just sit there and enjoy.



Getting kids outside is one of the best ways to help them develop and improve questioning skills. What do they wonder about? What problems do they see in their community? Could they develop a solution to solve such problems? Students can also begin to contribute to scientific understanding as they find answers to their questions. Citizen scientist opportunities, such as [Project BudBurst](#) or [The Great Bird Count](#), allow girls and their families to contribute data to answer big questions in science, such as, “Are flowers blooming earlier than prior years?” Girls can keep their own video logs to document changes over time and they can also add the data to larger databases across the nation.

Kids can also access the outdoors through the Every Kid in a Park initiative. Every 4th grader in the United States (and their family) is eligible for a National Park pass “to experience the places that are home to our country’s natural treasures, rich history, and vibrant culture FREE OF CHARGE!”⁴ Educators can apply for transportation grants from Every Kid in a Park, too.

Exploration helps girls become better problem solvers, more curious learners, and self-directed thinkers who can come up with innovative ideas. Adults have an active role to play to make sure that girls develop an appreciation for nature and the environment.



READ ALL ABOUT IT!

Last Child in the Woods by [Richard Louv](#). This book discusses the importance of nature in the lives of all children and provides suggestions to overcome what Louv has named Nature-Deficit Disorder.

How to Raise a Wild Child: The Art and Science of Falling in Love with Nature by [Scott D. Sampson](#). This book offers strategies for adults to help kids fall in love with nature and to foster a sense of place.



The Sensory Garden: Your Guide to Exploring the Gardens at the Poudre Learning Center. [El Jardín Sensorial \(bilingual edition\)](#): Su guía de exploración de los jardines en el Centro de Aprendizaje Poudre by Peggy Hoerner. Peggy dedicated her life to creating opportunities for students to explore, experiment, and experience their local environment.

In addition to exploring the outdoors, girls need to know what STEM professions entail to understand why it's so important that they learn to ask good questions and to identify problems they can solve.

Girls may not be familiar with what STEM professionals do. Explore opportunities for them to learn about different professionals and the types of problems they like to solve. Let's look at Fatima's story, which shows us that sometimes girls have to see what engineering is all about before they choose to engage.

Fatima⁵ heard that there's an engineering club starting up at her school. Her parents asked her if she was interested in joining, but she explained that she really doesn't like working with computers or building bridges. Satisfied with this response, her parents didn't ask about it again. A few weeks after the program began, Fatima's friend Amy explained excitedly how she got to design air filters to help solve the city's pollution problem, and next week they would get to study how animals stay warm so they can try to develop warmer clothing for people living in cold climates. Amy was proud of the fact that the idea to develop warmer clothing was her idea - it came from a question that occurred to her as she walked to school. Fatima wondered what other cool projects she'd miss out on this year.

Providing girls opportunities to step out of their comfort zone is essential to stimulate new experiences. A girl's hesitation may come from a lack of prior experiences. Therefore, presenting opportunities multiple times can be helpful to pique their interest. Sharing testimonials from girls who have "been there, done that" also provides a unique experience. Parents and educators can invite girls through various approaches rather than accepting "no" as a final response.

These types of experiences may change how they perceive people who do science and engineering.



The first images that come to mind when people consider these professions can tell us a lot about what a person knows, or thinks they know, about STEM careers. STEM professionals work on a variety of projects, many of which are grounded in the advancement of society and the development of community. Regrettably, there are a lot of misconceptions about these fields among adults, teachers, and students.⁶

For example, the "Draw a Scientist" test asks children to draw a picture of a scientist. Sketches are scored based on certain attributes, such as gender and apparel. In the original test, which was administered to almost 5,000 children across three countries, only 28 girls and no boys drew a female scientist.⁷ The results indicate the general view that society has that scientists are men.



The results of this test have not changed dramatically over many years, demonstrating the persistence of stereotypes about STEM professionals. A recent study by Wellesley College, available at [this link](#), shows that the traits men and women often perceive to be important in a scientist, such as competitiveness and courageousness, and common perceptions about women, such as being caring and unselfish, are incompatible.⁸ In addition to misconceptions about science and gender, many people have the mistaken belief that science is done in a lab, in isolation, without direct consequence on people's lives.

WHAT CAN I DO TO HELP GIRLS CONTINUE TO APPRECIATE STEM CONCEPTS AND TOPICS?

Caregivers and educators can benefit from understanding the core components of STEM learning to help girls see how relevant STEM is to their everyday lives. Parents and educators can also benefit from knowing more about STEM as a pedagogy, or as a way of teaching and learning.

Core Components Of STEM Learning

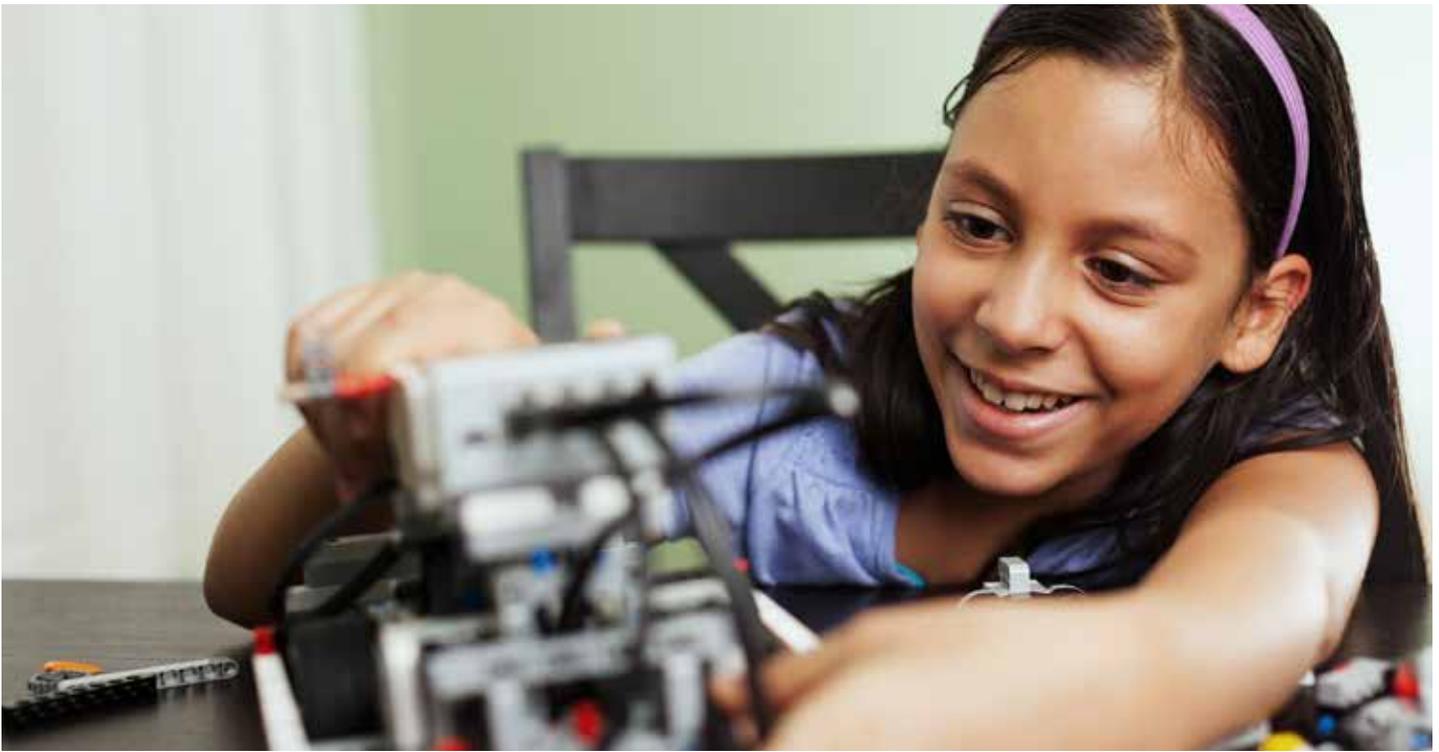
At the most foundational level, STEM is about questioning the processes and limitations of the world around us to seek deeper understanding of how the world works and how we might improve that world. STEM is much more than the sum of its four parts; it is a pedagogy, and is most effectively taught or practiced when it is integrated.⁹ For a more detailed definition of STEM, please refer to the Introduction.

The more educators learn about STEM, the more confident they will feel supporting STEM learning for their students. Studies show that teachers who demonstrate science or math anxiety pass on negative perceptions and feelings to their students.¹⁰ Positive teacher support engages students in math and science learning.¹¹ Researchers found that this particular role for teachers is even more important as students enter higher grades.¹²



READ ALL ABOUT IT!

- If you would like more information about specific STEM concepts and skills that are developmentally appropriate for children ages 6-10, check out the [Colorado Academic Standards](#) and the [Next Generation Science Standards](#).
- For curriculum samples, you may want to refer to *Chapter 3 The STEM Road Map for grades K-2*¹³ and *Chapter 4 The STEM Road Map for grades 3-5*¹⁴ in *The STEM Road Map: A Framework for Integrated STEM Education*.
- For resources that link engineering to the classroom, see Box 2.1 and [Engineering is Elementary](#), a curriculum designed for elementary-age students to explore science and engineering concepts through hands-on experiences and investigations using the engineering design cycle.



BOX 2.1. IN THE SPOTLIGHT:

eGFI

The American Society for Engineering Education (ASEE) developed [Engineering: Go For It](#) to promote best practices in K-12 STEM and engineering education. Their site has resources for students, teachers, administrators, parents, community members, industry partners, mentors—basically, everyone! Sign up for their e-newsletter, browse lesson plans by grade level or content area, read about engineering professions, and much more.



Find eGFI at <http://www.egfi-k12.org/>



When we talk about STEM fields we are not only referring to science, math, engineering, or technology in isolation, but rather the intersection of these fields and the exploration of how they work together to address real problems that impact the human condition. We can frame problems or issues through a humanitarian approach to better engage girls, since girls who are attracted to STEM are also interested in many subjects and career opportunities, not only those confined to these four areas.¹⁵ In fact, many organizations advancing STEM initiatives are moving towards STEAM – science, technology, engineering, art, and mathematics. Integrating the arts incorporates an additional dimension and makes explicit connections between creativity and innovation and problem solving (see Box 2.2).

BOX 2.2. IN THE SPOTLIGHT:

Integrate the Arts into STEM?

By Ruth Catchen

The acronym STEAM inherently ties itself to STEM, and it is my belief that there is no STEAM without STEM. STEM is rooted in practicality: problem solving, critical thinking, and workforce readiness. As an integrated pedagogy, it seems only natural that it overlaps with other content. The content many call for is the arts. So, what does “the arts” include and how does including them benefit STEM education?

Adding the arts to STEM should not be confused with arts classes and it is not a call to replace them. A teacher may use physical experience, such as dance, to give students an opportunity to understand how molecules move and change. Music can be used to replicate patterns and so their importance to math and science is seen and experienced in less abstract ways. Listening to music, students can hear the patterns, both melodic and rhythmic. The visual arts offer opportunities to understand and develop aesthetic skills while students work through a design challenge using the engineering design process: the use of light and color, shapes, and perspective.

Benefits Of Adding The Arts To STEM:

- Support STEM learning from varying perspectives.
- Enrich and enhance student experience giving self-efficacy so students can better engage in rigorous STEM lessons.
- Using the arts to take risks and embrace unconventional ideas or experiences.
- Use the arts as a ‘hook’ to attract a more diverse student base to study STEM subjects.
- This includes learning how to discern beauty (yes, evaluate ‘things’ and works of art from an aesthetic perspective).
- Use emotion for positive impact in solving problems.
- Add the arts to help students connect STEM skills to a larger variety of STEM subjects and STEM jobs such as fashion design, culinary arts, architecture, and structural design.
- Use the arts as a communication tool and demonstration of knowledge (i.e. a video, mosaic, newsletter, etc.).

Arts opportunities reach more students who may not engage immediately in STEM subjects benefiting overall engagement and participation in STEM subjects. The arts enhance these STEM attributes:

- Understand how to take risks and accept failure as a process
- Tenacity and persistence
- Creativity
- Exploration of innovative ideas
- Ability to evaluate and understand aesthetic value
- Collaboration and teamwork

For a how-to guide about integrating the arts into STEM, visit <http://www.stemartseffect.com/>.



Integration of the arts into STEM fields is common in computer science. As more careers and fields of study become increasingly entangled with technology, certain levels of creativity and design will require knowledge of computer systems. Adults can teach children to identify, evaluate, and create the processes we rely on our computers to carry out. To open our children to the widest possible view of their own futures, we have to allow them to explore not only concepts like body systems and civil infrastructures, but also computer processes and the inner workings of their favorite app. After all, the reason for education is to discover the world around us, and the world around us is full of technology.

Educators and computer scientists across the nation are excited about the opportunity to teach coding and computer science to children. Leaders in the field have built free online resources for learning how to code (e.g. code.org and codecademy.com) to meet the demand for exposure to computer science principles.

In Colorado, statewide and local initiatives support the push for computer science education for students of all ages (see Box 2.3 for a local example). Talk to your legislators about how local policy can advance computer science opportunities for girls in your school or community.

BOX 2.3. IN THE SPOTLIGHT:

Bitsbox

Bitsbox teaches kids app development, computer programming, coding language, and even typing skills. Bitsbox is unique in that it teaches younger children to code through typed, written-out commands. Their simplified JavaScript syntax lets children employ simple commands to create unique and modifiable apps.

Over 500,000 kids in 50 countries have created apps on Bitsbox's website, which has a number of free activities and apps you can create and explore. Locally, Bitsbox has partnered with a number of elementary schools in St. Vrain Valley School District in Longmont, where students as young as age 6 are typing and modifying lines upon lines of real code as demonstrated in the picture.

Computer science literacy is quickly gaining recognition in education for younger generations, and learning how to code can quickly advance a girl's STEM interest and levels of self-efficacy. As with any other language, starting early improves ability and proficiency for a lifetime.

For a unique coding experience, open a free account at [Bitsbox's website](https://bitsbox.com). You can use your web browser to access Bitsbox, or you can receive a monthly subscription box sent directly to your house with fun coding challenges and new apps to build.



Check out <https://bitsbox.com>

There are many schools and other organizations in and around Denver providing computer science opportunities such as [CompuGirls](#), [BlackGirlsCode](#), and [OpenWorld Learning](#) (see Box 2.4).

BOX 2.4. IN THE SPOTLIGHT:

OpenWorld Learning... Creating Possibilities Through Technology

OpenWorld Learning (OWL) bridges the digital divide through supporting low-income students' school success by tapping the power of digital technology and peer teaching to develop leadership and ignite a love of learning. OWL encourages girls to assist fellow students in finding answers to their questions, to give class presentations about their work, and to share their successes. Because of this, OWL students demonstrate improved test scores in math, reading, writing, and science, as well as improved attendance, behavior, and school attitudes. Girls in OWL programs learn approximately 30 percent more essential technology skills by the end of the school year. They also consistently demonstrate stronger learning characteristics, such as responsibility and participation in the classroom, which increases the level of student learning and engagement, thereby promoting future college and career success.

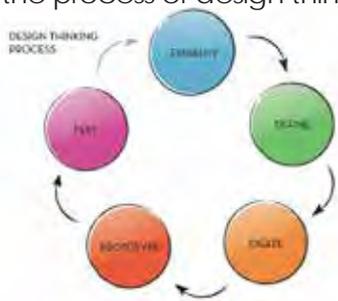


OWL motivates 3rd to 6th grade girls to pursue STEM education by instilling a passion for STEM through educational programs in Denver-area schools during after-school hours. OWL transforms school computer labs into powerful learning communities where students are encouraged to develop increasingly sophisticated projects using web-based tools. OWL enables girls to develop digital literacy skills as they explore exciting new technologies, including computer programming, graphic design, stop-motion animation, and robotics.

OWL provides a 12-to-one teacher-to-student ratio, to motivate, hold their attention, and sustain individually paced and customized instruction. For example, girls get to see the beginning of [CodeGirl](#), the YouTube documentary about a girls-only coding competition, and this inspires them to learn more and create. Girls are also introduced to different programs, such as [Scratch](#) and [MicroWorlds](#), and encouraged to select the format of their choice for the rest of the quarter. They are able to pursue individual outside interests through the world of code.

WHAT ARE 21ST-CENTURY SKILLS AND HOW CAN I HELP GIRLS DEVELOP THESE SKILLS?

One of the current buzzwords in education is 21st-century skills. While there are varied definitions of 21st-century skills, the simplest list is the [four C's](#): communication, collaboration, critical thinking, and creativity. The Colorado Department of Education includes some of the aforementioned skills in their definition of 21st-century skills in addition to information literacy, invention, and self-direction. Read the Colorado Department of Education's [Transformative Teaching](#) brochure for ideas on how to create deeper learning experiences for students by integrating 21st-century skills into lesson design. These skills can be integrated authentically through the process of design thinking.



Design Thinking

Design-based learning grounded in inquiry is an effective way to introduce girls to STEM careers and habits of mind.¹⁶ The engineering design

cycle (EDC) provides a tangible, adaptable process for approaching problems and can create truly powerful learning experiences. The modification of the EDC that is becoming more widely used in many industries is called design thinking. The design thinking process is simple enough to be applied in many contexts but also deep enough to accommodate multiple levels of complexity and inquiry. Because engineering is inherently interdisciplinary, the design thinking process helps people make connections that bring about innovative solutions.¹⁷

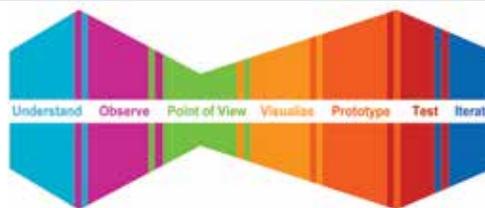
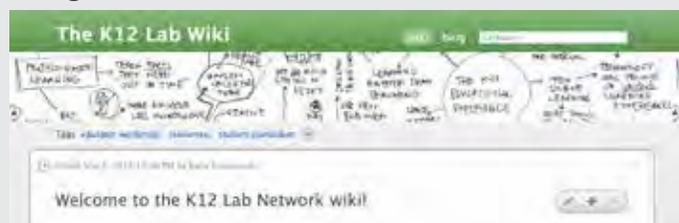
When a young girl uses the design thinking process, she focuses on failing fast and failing often. She does this in order to learn from her mistakes so that she can develop the best idea possible. Design thinking encourages action, growth, empathy, and problem solving. Learn more about design thinking at dschool.stanford.edu.

**“Fail fast. Fail often. Learn from mistakes.
Develop the best idea possible.”**

BOX 2.5. IN THE SPOTLIGHT:

Design Thinking Crash Course From Stanford's d.school

The Design Thinking Crash Course provides a 90-minute, virtual introduction to using design thinking. Learn their process for design, see their methods for sharing ideas, and try out some design projects. For more ideas on lesson-based integration of design thinking in your classroom, visit the [d.schools' K-12 wiki site](#), full of lesson ideas, visual resources, and curriculum around design for K-12 education.





TRY THIS!

- **Don't reinvent the wheel.** Use online databases of design challenges to try out a few design thinking cycles with your girls. For example, teachengineering.org is a collaborative, free, searchable digital library of engineering design challenges for all ages. Another place to visit is engineeringchallenges.org. The site hosts a list of grand engineering challenges facing future generations from the National Academy of Engineers and the National Science Foundation.
- **Design learning spaces.** Use design thinking to come up with new solutions for issues that may be impacting your house, classroom, or community. Create inclusive spaces with a variety of uses and flexibility. Check out blogs and other maker movement [resources](#) to create your own makerspace.



Design thinking begins with empathy and moves through a problem-solving cycle that encourages action, productive failure, and iteration based on feedback (See Box 2.5 and Box 2.6). When we provide specific, positive feedback to girls on their process and effort, we help to improve their persistence, confidence, and performance in math and science.¹⁸ Design thinking provides girls with opportunities to explore questions that address issues in their community. They can go through the entire process and design solutions to real problems that are relevant to their daily lives.

As girls experience the design thinking process, they master key skills that are widely used by STEM professionals. Table 2.1 lists some of these skills.



READ ALL ABOUT IT!

- *Dream, Invent, Create* published by Start Engineering provides ways to introduce engineering to kids in elementary school and early middle school through children's everyday world experiences.
- *Design, Make, Play* by Margaret Honey and David E. Kanter is a resource for practitioners, policymakers, researchers and program developers that illuminates creative, cutting-edge ways to inspire and motivate young people about science and technology learning.
- *Inquiry & Innovation in the Classroom* by A.J. Juliani provides insights as to how we might help students be more inquisitive, creative, engaged, and self-motivated.

TABLE 2.1
WHAT SKILLS, COMPETENCIES, AND ATTRIBUTES DO GIRLS DEVELOP
WHILE PRACTICING THE DESIGN THINKING PROCESS?

Critical thinking	Creativity	Empathy	Synthesis
Analysis	Giving, receiving, and incorporating feedback	Collaboration	Project management
Planning	Optimization	Learning from failure	Working with constraints
Civic engagement	Entrepreneurial competencies	Scientific thinking	Identifying problems
Testing solutions	Interviewing	Communication	Objectivity
Identifying important information	Academic language development	<i>and more...</i>	

BOX 2.6. IN THE SPOTLIGHT:

IBM Innovation Academy (IA)

Since 2010, St. Vrain Valley School District in Longmont has been partnering with IBM to provide a two-week, immersive program in STEM and design thinking aligned to IBM’s Smarter Planet Initiative themes. Students in grades K-5 work alongside IBM engineers to learn about topics such as smarter water, food, or transportation, solve design challenges pertaining to those fields, and develop a solution of their own creation based on their learning and using the design process. The academy culminates in an exhibition of learning where students put their prototypes and thinking on display for IBM partners and community members. Read more and see student videos at blogs.svvsd.org/innovationacademy.



From a parent of an Innovation Academy student:

“Spending time at IBM gave our daughter a picture of what it’s like to work in a technical environment. Sometimes kids think that working in a tech company is like being in math class all the time, and IA showed her that real life is much better. She loved her time on their campus, and it helped show her that she’d enjoy working in a STEM field.”

There are a number of established educational approaches that are rooted in inquiry. Whether the girls in your life learn in a problem-based, project-based, inquiry-based, design-based, or other environment, combining authentic questions with the application of skills can be a powerful instructional tool.¹⁹ There are established strategies and programs such as BSCS’ [5E Instructional Model](#).²⁰ For an

example and an easy to understand explanation of the instructional model, visit NASA's website [5E model](#).²¹ The Public Education and Business Coalition ([PEBC](#))²² seeks to empower teachers to be confident in implementing inquiry in their classrooms and offers resources to support teachers in this work. No matter the method, the following tips in the Try This! box can help make student-centered learning more effective in your classroom, household, or community.

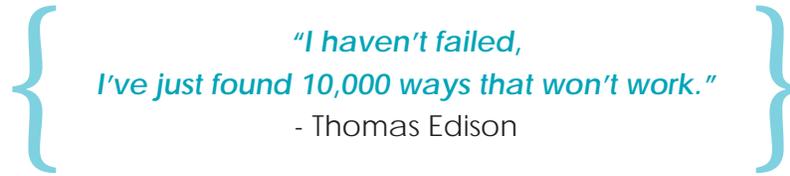


TRY THIS!

- **Teach through inquiry.** If you think about it, asking good questions and continuing down the path of inquiry is the heart and soul of scientific thinking. Albert Einstein and Stephen Hawking must be among the most talented minds in history, and their ability to create theory and access knowledge was and is rooted in inquiry. Teach your students or daughters about women scientists and point out how in the past, women's work had to be legitimized by men to be taken seriously. Madam Curie, for example had to conduct research under her husband for her work to be legitimized. Innovation, theory, progress, and the evolution of ideas - all of these things start with good questions that can be asked by women and men alike.
- **Move away from step-by-step directions.** Allow for open-ended questioning and multiple pathways to meaningful learning. Give your child a goal and see how she approaches the task.
- **Be a facilitator of learning.** Think of yourself as an academic coach instead of a distributor of knowledge. Let girls find out answers on their own instead of providing information for them. Also, don't rush to tell them if they're right or wrong; rather, help girls explore how they might prove their answer or test their solution.
- **Ask more questions.** Research indicates that the volume of questions we ask in our lives peaks at about age 4.²³ Around that time, we start to scale back on our inquiry for fear of not knowing, of asking "dumb" questions, or of appearing unintelligent. Further, adults may "shush" girls for asking too many questions. If you want girls to be curious about the world, modeling curiosity is the most powerful tool at your disposal. Ask people about their professions. Oftentimes, people will jump at the opportunity to explain their work and their passion projects. Ask other adults meaningful questions during conversations. Ask your girls about how the world works - they may surprise you with how much they know, and they will be more open to asking questions if they see you making the leap as well.
- **Participate in community events** where girls are provided with opportunities to create things from scratch. The [Maker Movement](#) has inspired many events in which girls get to build, create, and tinker. Other opportunities might be called hackathons, which are events that can last one to several days where many people collaborate through computer programming. Events have been held by schools and through city governments to seek solutions to local problems. Keep in mind that not all girls thrive in a very competitive environment. Sometimes, there might be maker opportunities that are longer-term commitments rather than intense 12- to 48-hour events. Get to know what your daughter prefers and encourage her to pursue new opportunities.

GROWTH MINDSET

By intentionally using growth mindset language, we develop an approach to learning that will supersede self-doubt when it comes to achievement in STEM fields. Failing forward and learning from mistakes is a skill that everyone can use; it is an essential way of thinking for girls, for their caregivers, and for the educators who work with them.



*“I haven’t failed,
I’ve just found 10,000 ways that won’t work.”*
 - Thomas Edison

Serena is a good student, and is used to getting straight A’s. She knows how to follow directions and performs well in class and on tests. When she gets a B on a math test in 2nd grade, she comes home crying, upset because she thought she was good at math, and afraid that she has disappointed her parents and her teacher. After a few more months, math continues to get more difficult and she realizes it doesn’t come as easily to her as it did before. Meanwhile, she often overhears her aunt confess that she’s “Just not a math person.” She’s heard adults and friends use this phrase before, and she reasons that it must apply to her, too, since she has to work so hard at math these days. She wonders what other subjects she might not be well-suited to study...

Serena's story demonstrates what Carol Dweck terms a fixed mindset. Dr. Dweck of Stanford University conducted vast research into the idea of a fixed vs. a growth mindset as people approach life’s challenges.²⁴ As a young student who wants very deeply to please her teacher and her parents, Serena believes her struggles in math indicate an inability to learn math or to ever be good at math. People with fixed mindsets tend to focus on the ability they believe that people were born with rather than on people’s capacity for growth and development. On the other hand, people who’ve embraced a growth mindset understand that they can improve with effort.

Had Serena heard other adults in her life using language such as, “I’m working on learning more math” (or Spanish, or cooking, or statistics, or any subject) without fear of judgment from other people, she may begin to exhibit a growth mindset about her math performance. Due to the rigorous nature of STEM fields, it is quite common for young girls to adopt a fixed mindset about their abilities in science, technology, engineering, or math.²⁵

What message do we want to send to girls while they’re developing their self-concept and becoming more conscious of their own abilities and opportunities? Parents, caregivers, and educators can examine their own language and make changes to promote a growth mindset in girls like Serena.

ACTIVITY 2.2:

Examine Your Language

Parents and teachers can use this activity for their own benefit as well as to coach girls to reflect on their use of language.

Reflect: How often do you find yourself using fixed mindset language, either in talking to yourself or in talking to others? (Note: Though the language below uses math as an example, this concept applies to any subject or skill.)

Adapt: How might you change fixed mindset language that you currently use to be more growth-mindset inspired? As a parent/educator, how might you help girls modify their language?



Fixed Mindset	Growth Mindset
"You're really smart at math." (fixed mindset praises ability)	"You worked really hard at those math problems!" (growth mindset praises effort)
"Math is just really hard for some people."	"Everyone learns in different ways. Let's keep trying to find the way that works for you."
"Why can't you get better scores on your math tests?"	"What mistake did you make in math today that taught you something?"
"I had to try really hard to understand that problem. I must not be good at math." (fixed mindset looks down on effort)	"I had to try really hard to understand that problem, and I got better at math because of that." (growth mindset sees effort as a good thing)



TRY THIS!

- **Help to educate on growth mindset.** Make it a point to understand what having a growth mindset can do for your own self-efficacy. Teach girls what neuroscience research says about plasticity and learning throughout our lives. The more girls get this message, the better they will become at using growth language around STEM learning.
- **Test yourself.** Not sure if you have a growth or fixed mindset? Test yourself at www.mindsetonline.com.

Experiences in design thinking connect directly to a growth mindset. The idea of design thinking has captured the attention of professionals and students in all sorts of fields, from education²⁶ to engineering, to business and marketing, to healthcare and politics. Because design thinking highlights the necessity of failure in order to grow, it has much in common with Dweck's research on mindset.

Learning environment plays another important role in the sphere of growth mindset and design thinking. Consider a girl who has an amazing growth mindset, utilizes design thinking, and learns from failure at every turn. If she is educated mostly through lecture-style instruction and hours of note-taking, will that foster or hinder her perception of how she learns best? The environment surrounding a girl can foster STEM engagement and growth through more student-led learning experiences.



START HERE!

Mindsetkit.org is a comprehensive website that provides resources for parents, educators, and community mentors on developing a growth mindset and teaching with growth in mind. Visit this site for free lesson plans, activities, research articles, and self-assessments.

Youcubed.org is another resource that provides tutorials and advice around developing a growth mindset specifically with respect to math. The site offers How to Learn Math, a free massive online open course (MOOC) developed for parents, students, educators, and mentors to help them develop the right attitude towards learning math. Jo Boaler of Stanford University, whose mission is to inspire all math learners, created both sites.

With Math I Can asks site visitors to take a pledge to stop saying, "I'm not good at math." This collaboration between Amazon Education and a number of other organizations provides lessons and ideas for every classroom.

HOW CAN I HELP GIRLS DEVELOP AWARENESS OF STEM OPPORTUNITIES IN THEIR COMMUNITY OR ELSEWHERE?

Often, girls may not be aware of STEM opportunities in their communities. Their parents may also not be aware of what's out there, or they may lack the resources necessary to take advantage of certain opportunities. For a list of STEM opportunities for girls, visit the Colorado Collaborative for Girls in STEM [website](#), which will link you to [The Connector](#), a database that has a comprehensive list of STEM offerings across the nation. If you know of a STEM opportunity that is not yet listed, please contact the organizers and add it to the repository.



Educators and community organizations can help promote opportunities by making sure families understand how exciting and rewarding STEM learning can be. Creating personal, authentic relationships with families creates a sense of trust,²⁷ especially among families whose children have historically been under-represented in STEM careers. Parents and caregivers have to know that their children will be in good hands; this is especially important for girls. Creating trust is essential to serving girls whose caregivers may not be used to letting them go really far away from home alone without a family member, such as on field studies. Sometimes, educators or community organizations may have to invite two girls from the same community to partake in an experience.

Monica, a 5th grade girl, was selected to attend Space Camp and her parents would not let her go. Upon closer examination, Monica's teacher learned that her family simply did not want her to go alone. The community raised funds to send an additional girl, Marie, to camp with her.



WHAT CAN I DO TO HELP GIRLS PARTICIPATE IN STEM OPPORTUNITIES?

Sometimes, STEM opportunities appear when you least expect them, and girls, their caregivers, and educators have to be prepared to identify such opportunities and to take advantage of them.

Marisol was sitting at the dining room table with her brother. Her mom came into the room and announced that the radio no longer worked. She handed it to Marisol's brother, Javier, and asked if he'd like to take it apart to see if he could fix it. Marisol sat and watched her brother take apart the radio.

Parents and educators make daily decisions that positively or negatively affect young girls' self-belief about what they are capable of doing. Societal messages may tell a girl that certain activities, like taking things apart, are not meant for her. In turn, she might internalize these subtle social cues and start believing that some things are for boys and other activities are for girls. By taking a close look at your play area, at home or in school settings, and questioning the purpose of the toys and materials found in that area, you can begin to see if you are unconsciously perpetuating inequities.

Hidden biases keep girls from participating in STEM learning opportunities. Marisol's story above highlights her mom's unconscious bias regarding girls when she selects her son as the maker, the doer, and the one who can take things apart and explore. Marisol's mom may not be aware that she is exhibiting this behavior. Though it may be socially acceptable, it impedes girls from participating in STEM learning. In the classroom and outdoors, girls should be

encouraged to be as active in their learning as the boys. Educators can be more intentional about encouraging and validating girls' participation in STEM. Typically, society tells girls to show good behavior in school and to follow instructions. In general, girls are socialized not to take risks. Boys at this age may have not yet learned to moderate behavior and impulses, and studies show teachers dedicate more attention to boys and unconsciously give them more opportunities to talk.²⁸

ACTIVITY 2.3:

Toy Check

What **empowering** messages do the toys you have convey regarding the potential role or capabilities of girls?

- There are toys to build with.
- Toys promote investigation.
- There are materials to draw, paint, and create new products.
- There are materials that can be taken apart.
- Toys promote spatial abilities.*
- There are materials that promote scientific inquiry and engineering design.
- Make-believe toys or dress up outfits reflect a wide variety professions in the community and inspire creativity and a sense of wonder.

What **disempowering** messages do the toys you have convey regarding the potential role or capabilities of girls?

- Toys reflect gender bias--girls have only dolls, cooking sets, and babies.
- Toys come with step-by-step instruction and do not promote imagination.
- You have building toys, but urge your girl to create things like the pictures in the instruction manual.
- Make-believe toys that reinforce stereotypical gendered roles, such as play makeup and beauty items, are plentiful.
- Dress up clothing is limited to princess dresses and other fictional characters.

* *Spatial abilities refers to the ability to rotate objects in your mind (mental rotation), the ability to perceive objects in comparison to one's own body (spatial perception), and the ability to use multiple-step strategies to analyze objects in one's mind (spatial visualization).*

Girls need opportunities to learn to experiment, to tinker, and to be self-directed learners. Often, parents, caregivers, and educators might unconsciously offer opportunities to boys without considering that girls also might enjoy taking things apart and learning about how they work. This is especially critical for the development of spatial visualization skills. Girls need opportunities to investigate how objects come together so they can see them in their heads and then be able to manipulate objects easily. These skills are essential in future advanced courses such as chemistry and organic chemistry, physics, and engineering.³⁰ Girls can improve spatial abilities through tinkering, building, playing with 3-dimensional objects, and even through [video games](#).



TRY THIS!

Old equipment dissection. Find an old piece of equipment (VHS, CD player, hard drive, etc.) and teach girls how to use a screwdriver, a hammer, and other tools to take it apart. If you cannot find a piece of equipment readily, visit your local thrift shop or low-cost home improvement stores. Allow the child to explore and ask questions such as, “What types of materials did you find?” or “What do you think that part is for?” This technique, known as reverse engineering, is used by professionals, too!

Makerspace. Set aside a space for creation. This space can be as simple as a table with a storage bin. Find materials such as scissors, screwdrivers, glue gun, nails, hammer, and other basic tools to put things together and to take them apart. Let your girl tinker, build, design, and showcase her work. Be aware that it takes time to develop self-regulation, but know that these spaces foster creativity like no other. You will experience a lot of uncertainty. This is where innovation happens. Learn about what Preston Middle School in Fort Collins has done to build a makerspace in Chapter 3, Box 3.1. For more resources, check out [The Maker Issue](#).³¹

Make the world a better place. Invite your girls to work on projects that are intriguing to them. Are they passionate about saving endangered species, learning about computer science, or helping younger siblings to get down the stairs safely? Helping girls see the humanitarianism and connections in engineering and STEM fields will boost their desire to learn more.



STEM opportunities can be created at home, at school, or during out-of-school hours. They can happen spontaneously or be carefully designed to meet the needs of learners. STEM learning can take place anywhere, anytime (see Box 2.7). Parents, caregivers, and teachers need to adjust their mindset and create space to make learning opportunities happen. Children are always listening, observing, and absorbing.

BOX 2.7. IN THE SPOTLIGHT:

Girls in Science

Fostering Confidence in the Sciences Through Extracurricular, Educational Programming

Girls in Science is an after-school program that nurtures and inspires an interest in science for girls in the 3rd through 5th grade. The program was developed to address a national trend of girls falling academically behind in science by their middle and high school years.

The Girls in Science program curriculum is designed to connect the study of science to real-life situations. Activities are hands-on, inquiry-driven, and fun. It is a program of [Walking Mountains](#) and it expands beyond the natural sciences to cover all science disciplines. Students work in cooperative learning groups during activities and then share their observations and new knowledge with all program participants.

The program also offers an opportunity to high school students to serve as role models and mentors by volunteering their time to teach and assist. High school volunteers are students who excel in science in their own academic studies and intend on pursuing collegiate studies and careers in the sciences.

Get to know some of the Girls in Science by [reading this blog post!](#)

For more information about Girls in Science visit <http://www.walkingmountains.org/project/girls-science/>



HOW CAN I CONNECT GIRLS TO FEMALE STEM PROFESSIONALS AND ENTREPRENEURS?

Girls can develop their STEM identity by meeting and interacting with peer mentors and by meeting and learning about STEM professionals and entrepreneurs who are women. There are efforts such as [Million Women Mentors](#) that seek to connect mentors to organizations, and organizations that build bridges to industry leaders, such as [Nepris](#) or [MySTEMLink](#). Parents, caregivers, and educators can also connect with your local chamber of commerce to learn about key industries in your region, and to businesses that have STEM professionals who may be interested in sharing their story with young girls. Teachers can invite STEM professionals to their classrooms. Before doing so, take some time to think about the outcomes you hope to achieve and to help visitors prepare to share their story with your

particular age group. Encourage them to do a hands-on activity with the girls so your students walk away with an exciting and memorable impression. Check out TechBridge's Role Models Matter [toolkit](#).

When role models or mentors are not available locally, students can meet role models through virtual spaces or learn about them through vicarious experiences such as through SciGirls (see Box 2.9). The Denver Museum of Nature and Science (DMNS) also offers [Scientists in Action](#), through which girls can see STEM professionals working on-site either at the museum or at field study sites. If one of these opportunities doesn't work, you can use videos available at [Career Girls](#) and NASA's [Exploring Careers](#) site. There is also a special site for careers connected to math (see Box 2.8). You can follow the journey of STEM professionals as they explore questions of interest to them. Then, you can take the same idea and help girls discover and solve individual problems that are of interest to them.

BOX 2.8. IN THE SPOTLIGHT:

weusemath.org



"When am I ever going to use this?"

This is one of the most common questions asked in math classes today. Fortunately, weusemath.org has taken the time to ask STEM professionals for examples of how they utilize math in their work each day. You can learn more about these professions and how they use math at this site. You can also access many resources to learn more about how engaging math can be.

BOX 2.9. IN THE SPOTLIGHT:

SciGirls

SciGirls is a show for kids that features girls ages 8-12 asking questions and putting science and engineering to work. The girls work alongside a scientist mentor to design their own inquiry-based investigations. They think of ways to solve problems and design studies to test predictions, collect data, and draw conclusions based on their findings. The shows also feature a character named Izzie who poses a challenge to viewers at the beginning of the episodes and shows the process she goes through to resolve that problem.

Topics range from the environment to technology and include using robots to help people, studying animals and plants, and using the engineering design process to create solutions to everyday problems. All of the investigations are archived online and you can find supporting materials on the website, too.

SciGirls helps viewers see the variety of opportunities in science, technology, engineering, and math. Learn more at <http://pbskids.org/scigirls/home>.

SciGirls Latina, a Spanish language version, will soon be launched. In the meantime, you can access many of the existing, entertaining STEM videos in Spanish through YouTube, such as [Aquabots](#).³²



WHAT DO GIRLS GAIN FROM MEETING PROFESSIONALS FROM DIVERSE GROUPS WHO HAVE HISTORICALLY BEEN UNDER-REPRESENTED IN STEM CAREERS?

It is difficult to imagine a girl like Fatima, whose story was highlighted earlier in this chapter, sustaining any kind of interest in engineering or math when she does not learn and understand what people in those professions do every day, or that the people in those professions can look like she does. When asked, “What do you want to be when you grow up?” children default to what they know and who they see represented in their lives. Soccer player, doctor, teacher, and singer are all common answers at this age because children are surrounded with examples of these professions. By expanding their understanding of STEM careers and increasing their exposure to female STEM professionals, parents, caregivers, and educators can encourage more girls to follow their interests and passions around STEM. The Toolbox section on this page lists engineering careers and examples of the work these professionals do. For a more extensive list of STEM careers, visit [Career Kids](#).



TOOLBOX

So...What do Engineers do?

They use creative thinking and design to create new processes and products, or to improve existing ones. Here are a few examples from www.engineergirl.org. Read more in their “Try on a Career” section.

TYPE OF ENGINEER	POSSIBLE EXAMPLE OF THEIR WORK
Aerospace Engineer	Create satellites that detect drought around the world
Biomedical Engineer	Create a prosthetic leg designed especially for children
Chemical Engineer	Develop chemotherapy that has fewer side effects
Environmental Engineer	Assess a project’s potential effect on an endangered species
Electrical Engineer	Design cell phones that have more features
Mechanical Engineer	Design “smart” toys for kids
Materials Engineer	Invent clothing that repels mosquitoes
Software Engineer	Build apps, develop Web apps, and create games
Network and Computer Systems Engineer	Develop systems for computers to talk to one another and for the people who use them to talk to one another
Information Systems Security Engineer	Test and develop ways to make sure systems are safe from malicious activities



TRY THIS!

- ❑ **Explore careers together.** Many adults don't have a working knowledge of what engineers or other scientists do for a living. Learn alongside your girls and read about different career opportunities. Job titles may surprise you these days: Do you know what Machine Learning Engineers, Information Security Analysts, or Computer Network Architects do for a living?
- ❑ **Play Engineering I-Spy.** When you hear of an interesting technology, breakthrough, design, product, or process, dig into it a little and figure out how it was developed. Who developed the grip on your pen? Who tested the material for that waterproof rain jacket in your closet? Who made your favorite app? Were STEM professionals involved?
- ❑ **Make connections.** When girls learn about the rock cycle in school, take some time to explore what earth resource engineers do all day. Or if she's learning about motion, challenge her to design an assistive device for a person living with a physical disability.



READ ALL ABOUT IT!

- **Cool Careers:** From SallyRideScience.com comes this informative book series geared toward upper elementary and middle school readers. Each book introduces the reader to 12 scientists or engineers in fields such as biotechnology, earth science, and engineering.
- **Start-Engineering.com:** StartEngineering seeks to engage and inspire elementary through high school students in STEM fields and concepts. They have a number of publications (including coloring and activity books) that highlight futures in STEM careers.



WATCH THIS!

At Engineering is Elementary/Engineering is Everywhere, watch [Derby's story](#). Learn how biomechanical engineering helped a dog play for the first time. <http://www.eie.org/engineering-everywhere/curriculum-units/prosthetics>



By educating ourselves and helping girls understand the impact they can have on their community through an engineering career, we'll open their world to a future they might never have dreamed for themselves. And they, in turn, will create a future none of us could have imagined and be prepared to succeed in jobs that do not yet exist.

HOW CAN EDUCATORS CREATE STEM LEARNING EXPERIENCES?



TRY THIS!

For Educators: Where do I start?

1. Immerse yourself in what STEM professionals do. Shadow an engineer, a scientist, and an information technology professional. What skills does she utilize? What materials are important in her line of work? How does she utilize the design process? What are some of the concepts she is applying?
2. If you do not know an answer, help students learn the thinking process necessary to find the solution. Do a think-out-loud as you search together. Eventually, students will learn how to search and they may even teach you different ways to find information. You are a learner, too. Embrace that role.
3. Connect industry professionals to your classroom. If students are interested in meeting professionals who can provide insight to their projects, invite them. You can learn together.
4. Be open-minded. If you help kids develop research skills, observation skills, inquiry skills, and problem-solving skills, you will help them learn for a lifetime.
5. If you have anxiety about math or science and teaching those subjects, work to reduce your anxiety and embrace a growth mindset instead. Students, especially female students with female teachers, may subconsciously internalize this anxiety and messages that say that they should not be good at math or science because they are girls.

SciGirls Seven is a great way to start to change your learning environment to promote STEM. You can do a classroom makeover and start fresh, or you can implement one strategy at a time. You are the artist. Paint your STEM canvas at your own pace.



TOOLBOX

SciGirls Seven – How to Engage Girls in STEM

Check out the resources that SciGirls Seven has put together to give educators ideas about how to engage girls in STEM. On this website, you will find a book that outlines their educational approach, rooted in what research has revealed engages girls in STEM. These strategies are effective for all learners, including girls of color:

1. Girls benefit from collaboration, especially when they can participate and communicate fairly.
2. Girls are motivated by projects they find personally relevant and meaningful.
3. Girls enjoy hands-on, open-ended projects and investigations.
4. Girls are motivated when they can approach projects in their own way, applying their creativity, unique talents, and preferred learning styles.
5. Girls' confidence and performance improves in response to specific, positive feedback on things they can control—such as effort, strategies, and behaviors.
6. Girls gain confidence and trust in their own reasoning when encouraged to think critically.
7. Girls benefit from relationships with role models and mentors.



You can read all about each strategy and get ideas about what you can do to get started at <http://www.scigirlsconnect.org/scigirls/>.

Create a community of practice. Participation in a supportive community of peers exploring new methodologies together helps educators transform their classrooms. Bring other teachers on board and help each other re-design learning spaces, lessons, or curriculum and ultimately transform the culture in your school. If you do not find a community within your school, consider ways to find your support elsewhere. You can meet people at conferences or visit other sites and see what STEM learning looks like there. STEM integration occurs along a continuum, and so it may look a bit different at your site.

Ultimately, having someone who cares about you and what happens in your classroom can be a real boost to getting your initiative started. You can check out an example of STEM educators creating their own professional development group in Box 2.10.

BOX 2.10. IN THE SPOTLIGHT:

EleSTEMary

The Pikes Peak Coalition For Elementary STEM Education

In 2012, a small group of elementary teachers created a professional development organization to share their love of STEM education with their colleagues in the Pikes Peak region. Their goal is to put more STEM into the elementary schools, so the name eleSTEMary is fitting. These leaders each have unique experiences with STEM trainings that inspire them to not only bring STEM into their own classrooms, but share ideas and success with area teachers. EleSTEMary lead teachers donate their time to create and instruct monthly workshops that are free of charge to participants. The workshop topics always connect STEM with Colorado Academic Standards. Funded by a National Defense Education Program Grant, eleSTEMary has impacted over 1,100 students from eight districts throughout the Pikes Peak Region. For more information on attending a workshop or bringing eleSTEMary into your school, visit <http://www.elestemary.org>.



The mission of eleSTEMary is to promote greater STEM education awareness among elementary educators as they work to incorporate 21st-century skills, contributing to the preparation of scientifically and technologically literate citizens and future workforce.

Join or Create a PLC. A Professional Learning Community (PLC) can potentially increase educators' self-efficacy in science teaching. Activities that you can incorporate into your PLC include demonstrations of labs or design thinking. You can also conduct a lesson study, a method in which teachers design a common lesson and take turns teaching while the rest of the team observes. Teachers reflect on best practices and share ways to improve after each iteration, and can build confidence by teaching others what they are doing in their classrooms. These mastery experiences are essential to identifying as an educator who fosters STEM learning.

Some organizations focus specifically on providing resources and professional development for educators and community organizations, such as Girls Scouts. Resource Area For Teaching (RAFT) in Denver is one organization doing this work. In 2016, RAFT launched a new program called RAFT on Wheels, through which the organization partners with local libraries to reach eight rural communities. You can learn more about RAFT in Box 2.11.

BOX 2.11. IN THE SPOTLIGHT:

Resource Area For Teaching - RAFT

RAFT provides hands-on experiences that help students learn best, especially when it comes to STEM and 21st-century skills of critical thinking, creative problem solving, and collaboration. Hands-on, experiential, and inquiry-based learning environments enable students to become active participants in their learning. These inclusive, learner-focused environments promote critical thinking and problem solving, and create opportunities for real world context and understanding.

Creating a place where children are encouraged to explore and discover together without fear of failure gives students the chance to find strengths and interests in themselves, and their classmates, that they may never have imagined.

RAFT's model supports all learners and focuses on girls in STEM by serving as a capacity builder for a number of girl- and STEM-focused organizations. RAFT provides low-cost resources to large groups like Girl Scouts and to small groups like Cool Girls Science and Art Club. Teachers and community organizations can learn more about RAFT on their [website](#).



Collaborate on curriculum design.³³ Curriculum often has to be re-defined to better integrate STEM and having a team to do it makes it more fun than doing it alone. If you are an educator who follows a pacing guide or curriculum materials that are predetermined by your district, you can STEMify them. STEMify refers to creating units that are integrated by themes or by core concepts. This process embeds 21st-century skills and STEM competencies and abilities that students can master. Incorporating STEM concepts works best when educators have a clear understanding of why this work matters to your students, and how to ensure that materials and experiences are culturally responsive and relevant to your student population.



TRY THIS!

- ❑ Take an existing lesson and STEMify it. Be sure to embed inquiry and design thinking in your development.
- ❑ Create a concept map for your entire year/course. This will help relieve some stress about coverage. The focus will be on exploring concepts in depth through a certain lens but will not be limited to only learning basic facts that students can simply Google anyway.
- ❑ Take a look at the STEM Road Map in the Read All About It! section in the next column for sample integrated STEM units and lessons.
- ❑ Whenever possible, guide students through questioning.
- ❑ Try creating hands-on experiences so students can discover concepts rather than telling students about them or having them read about them in a book.



READ ALL ABOUT IT!

- [STEM Road Map: A framework for Integrated STEM Education](#) edited by C.C. Johnson, E.E. Peters-Burton, and T.J. Moore offers integrated STEM curricula encompassing the entire K-12 spectrum, with complete grade-level learning based on a spiraled approach to building conceptual understanding.
- [Monitoring Progress Toward Successful K-12 STEM Education: A Nation Advancing?](#) by The National Academies Press summarizes 14 indicators related to students' access to quality learning, educators' capacity, and policy and funding initiatives in STEM.
- [STEM Learning Is Everywhere: Summary of a Convocation on Building Learning Systems](#) by National Research Council
- [STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research](#) by National Research Council
- [Exploring Opportunities for STEM Teacher Leadership: Summary of a Convocation](#) by National Research Council
- [Science and Children magazine](#) by The National Science Teachers Association

Note: Items from the National Research Council are free to download.

"If you help kids develop research skills, observation skills, inquiry skills, and problem-solving skills, you will help them learn for a lifetime."



READ ALL ABOUT IT!

Resources to help parents/caregivers and teachers understand the role of math in everyday learning.

- [*What's Math Got to Do with It? How Teachers and Parents Can Transform Mathematics Learning and Inspire Success*](#) by Jo Boaler
- [*Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages, and Innovative Teaching*](#) by Jo Boaler

The last page of this chapter contains a self-advocacy tool for girls. This tool is designed to give girls ideas about how to seek opportunities, to foster a growth mindset, and to help girls be immersed in STEM learning so they can develop a positive perception of themselves as future STEM professionals. Please share this resource with girls in your life who are 6-10 years of age.

In this chapter, we've provided a sampling of the tools and resources available in Colorado to empower girls between 6 and 10 to advocate for STEM opportunities. The resources can also assist anyone who works with girls--parents/caregivers, educators, and community organizations—to ensure that girls have the tools, preparation, inspiration, and motivation to continue on their STEM journey. Girls will benefit greatly from a solid foundation filled with opportunities to ask questions and explore their interests.



TOOLBOX

Self-Advocacy For Girls

Ask around. Stay open-minded and find out about as many careers as you can. Ask people in your community what they do for a living - if it sounds interesting, see if they can help you learn more about it. Ask an adult to help you make connections and to make a list of questions that you can ask STEM professionals when you meet them.

Try it out. Have you ever tried a new food and discovered that it's your new favorite thing to eat? It might be the same with engineering, or science, or math! Be open to trying new things and having new experiences - you never know what your new favorite subject might be.

Be your own advocate. If you notice that there are opportunities that are offered to certain kids and not to you, ask if you can be part of those experiences, too. When you see cool STEM opportunities happening in other places, ask yourself what you can do to bring that opportunity to your space. For example, if you learn of a neat summer camp happening in another city, ask your parents and teachers if there is anything like that in your city. If not, can they help bring those types of activities to you?

Enter a STEM competition or design challenge. You might even get a special invitation to the White House! Watch a video of the Super Girl Scouts [here](#).

Be a leader in starting a movement. You can start with something as small as a makerspace at home with basic tools for you to create and innovate. A makerspace is a space that has materials that are low cost such as cardboard, tape, glue, and scissors and might have other tools such as soldering irons and 3D printers and computers. You do not need to have fancy items to call your space a makerspace. Just include things that you can use to build and create. Check if your community library,

recreation center, or Boys and Girls Club has a makerspace that you can use. You can reach out to your community to make sure that other kids have those opportunities at school or at local community learning spaces, such as the library. Be your best advocate.

Make mistakes and learn from them. If you work hard at understanding something, you will get better at it. It's that simple. Everyone in this world makes mistakes - what will help you become the person you want to be is how much you learn from the mistakes you make.

Be mindful of your thoughts. Listen to the voices in your head. What are they saying? Are the voices promoting messages that inspire learning and creativity or are you constantly being hard on yourself? Positive self-talk can have great effect on your attitude and approach to life.³⁴

Get outdoors. Spend time outdoors and investigate. Bring your family along!

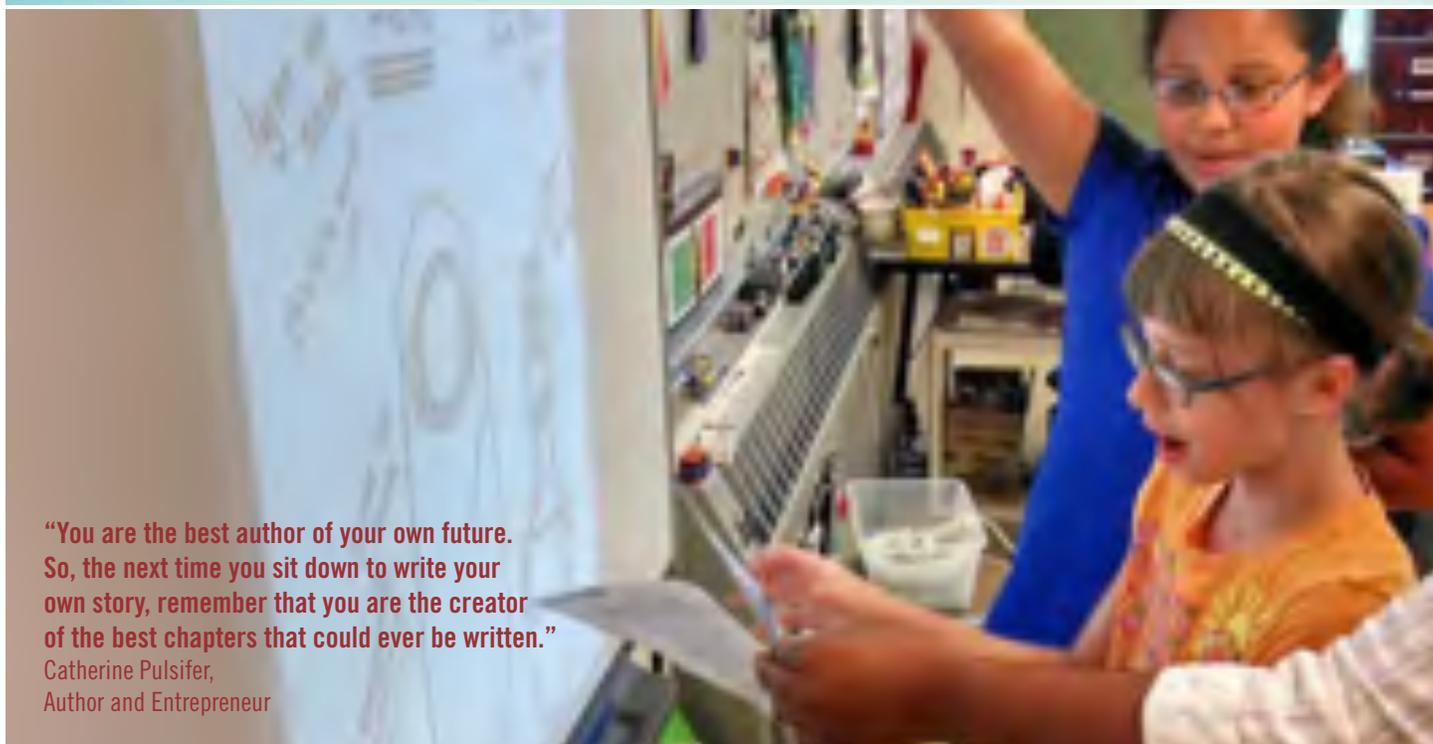
- Read a great book about getting outside like *Maisy's Nature Walk* by Lucy Cousins
- Learn how to use outdoor tools such as a compass, GPS, and other equipment. Ask adults for help and, if they don't know how to use a tool, find someone who can teach all of you together.
- Join a program to spend your summer break outdoors. There are programs all over Colorado like Girls in Science (see Box 2.7).
- Join a citizen science program such as [Project BudBurst](#) that gives you the chance to make observations in your community and contribute your data to help scientists learn more about our environment.
- Participate in [The Great Bird Count](#) and help scientists who study birds keep track of where they are.
- Visit [The Connectory](#) to find more opportunities.

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CHAPTER 3

I AM SHAPING MY FUTURE



“You are the best author of your own future. So, the next time you sit down to write your own story, remember that you are the creator of the best chapters that could ever be written.”

Catherine Pulsifer,
Author and Entrepreneur

**Violeta García, PhD
Patty Kincaid**

As girls move from being children to becoming teenagers, a space commonly referred to as the tween years, they face challenges that may not have been evident in earlier years. The transitions

during these years can cause girls to feel a sense of isolation. Tweens seek autonomy, yet they have a need to belong, to be part of something greater than themselves. Having a sense of belonging can instill confidence, motivation, and lead to current and future success. The critical tween years are the time for girls to begin to shape their future. Caregivers and educators can build ecosystems that foster opportunities to expose girls to STEM experiences where they can

learn skills that will help them solve problems and plant the seed for them to start thinking about the contributions they can make in the world. This can set the foundation for the mark they would like to leave behind.

In U.S. mainstream culture, it has been said that, “We raise girls to be perfect, and raise boys to be brave.”¹ What if we—parents and caregivers, educators, and community organizations—change this quest for perfection and instead build a solid foundation for girls to be able to take risks, to fail, to get back up again, and to take pride in the work they do?



By 13 years of age, many girls decide whether or not to pursue STEM career pathways. This is a critical age at which girls' self-confidence in STEM concepts and skills may waver, leading girls to self-select out of these areas because of a perceived inability to succeed.² Therefore, helping girls foster an identity focusing on strategies where they get to see themselves as scientists³ or as engineers, and as people who are capable of creating technology⁴ is essential to improve women's representation in STEM.

Though many of the resources cited in prior chapters are applicable to female students ages 11-13, many of the possible issues they and others perceive, as well as the realities in pursuing and succeeding in STEM-related learning, take on new importance. In 2007, the National Science Foundation Press released a piece titled "[Back to School: Five Myths about Girls and Science](#)."⁵ Many of the myths, like girls being less interested in science than boys when they start school (when the reality is that in elementary school about as many girls as boys have positive attitudes toward science), still resonate today for educators, parents, caregivers, communities, industry, and the public in general. Such misconceptions can block girls from becoming more deeply engaged in STEM.

OUTCOMES BY AGE 13

As girls, including girls from diverse backgrounds who have been historically under-represented in STEM, reach 13 years of age they are prepared in STEM. They:

- Continue to experience design thinking and come up with their own applications
- Design their own investigations focused on questions they care about
- Explore careers in STEM
- Continue to be inspired by STEM
- Understand connections between STEM concepts and other disciplines
- Develop proficiency in foundational STEM skills

WHAT DO STEM OPPORTUNITIES LOOK LIKE FOR GIRLS AGES 11-13?

STEM opportunities can vary widely. Some schools may offer STEM programs and distinguish themselves as problem-based learning (PBL) schools or innovation schools that focus on sustainability, while others may embrace experiential learning or Outward Bound-type principles as the means to integrate STEM learning. STEM opportunities may not always be labeled with the STEM acronym. For example, if a library has a makerspace, this can be considered a STEM space, too. You can read about the Preston Middle School Media Center Makerspace in Box 3.1.

BOX 3.1. IN THE SPOTLIGHT:

PRESTON MS MEDIA CENTER MakerSpace

The Preston Media Center MakerSpace, located in Fort Collins, invites students and staff to tinker, create, prototype, explore, build, and have fun. The MakerSpace offers a variety of activities: 3D printing, soldering, using the Oculus Rift, coding with Arduinos, creating vinyl art with a Cricut, creating digital painting, and designing and creating origami. In addition, there are many literary sources (magazines, books, blogs, printed articles) provided to increase STEM literacy, entrepreneurial thinking, and the love of reading. The MakerSpace offers a friendly environment before, during, and after school explicitly designed to welcome girls and under-represented populations in STEM. It is a safe place for all to learn, collaborate, and make new things, including friends.

To learn more about Preston Middle School and their STEM efforts visit:

<https://pre.pedschools.org/>

To learn more about their signature summer STEM Institutes program visit:

<http://www.steminstitutes.org/>

To learn more about their annual educator symposium visit:

<http://www.stemsymposium.org/>



If you and the girls in your life do not have access to opportunities to learn how to become a scientist, engineer, tech professional, or how to apply math in these contexts, we encourage you to create your own STEM spaces. STEM can be found in everyday moments. You can help girls design their own opportunities. Girls and their families can start at home, using the ideas in the following Try This! box, and then create community spaces so other girls can benefit from these experiences. STEM opportunities can also be offered through [afterschool](#)⁶ or summer programming. In any case, if students have the opportunity to design, make, create, experiment, and they are learning about and applying STEM concepts, they are experiencing STEM learning. Maker experiences that connect to solving problems at school or in their communities are even more engaging for girls. The work needs to be engaging at different levels, from basic curiosity to solving a problem or dealing with an issue that makes their community better. This approach gets girls interested in STEM and keeps them engaged.

Educators looking to explore more ways to keep girls curious can visit [Practice Brief 35: How can I foster curiosity and learning in my classroom? Through talk!](#) The [STEM Teaching Tools](#)⁷ website provides many great briefs on different aspects of STEM teaching and learning.



TRY THIS!

- ❑ Design a makerspace at home, in your classroom, in your community, or in all three! A makerspace can be as simple as a table with a storage bin. Find materials such as scissors, screwdrivers, glue gun, nails, hammer, and other basic tools to put things together and to take them apart. You can also include tools such as soldering irons and 3D printers. They can be helpful, but are not necessarily essential. Let your girl tinker, build, design, and showcase her work.
- ❑ Invite a STEM speaker to your school or library. You can contact STEM employers in your community to request a speaker or you can tap into our nation's resources. For example, your organization can request speakers from [Jet Propulsion Laboratory NASA](#). There are travel costs associated if you want to invite one of the STEM professionals or astronauts to your local site. There are also local professional societies such as the [Society of Women Engineers](#) and the [Society of Hispanic Professional Engineers](#) or the [Colorado Association of Black Professional Engineers and Scientists](#) that can help your organization identify a speaker near you.
- ❑ Meet a scientist virtually. The Denver Museum of Nature and Science (DMNS) also has a [Scientists in Action](#) program that gives students the chance to meet scientists and ask them questions.
- ❑ Take girls on a field study. You can take them to a local cultural organization such as [DMNS](#), [Denver Zoo](#), [Denver Botanic Gardens](#), or [Wings Over the Rockies Air and Space Museum](#). Many organizations have funds available for schools with high populations of students on free or reduced lunch. If you are limited by transportation, several organizations may have the resources to bring programming to your school. Use the school grounds, local parks, natural areas, and community spaces as sites for field studies.
- ❑ Create a space to post STEM programs available in afterschool settings or during the summer. Reach out to students who may need more information or support to access these opportunities.
- ❑ Connect with organizations such as [AAUW](#) Girls in STEM or [Pretty Brainy](#) (see Box 3.2) to explore mentoring opportunities.



Not all STEM experiences are created equal. Programs that place students at the center of the experience, where girls can do hands-on activities and investigate issues that inspire them, where educators are passionate about the work they do and link classroom experiences to learning beyond the classroom walls into the community, tend to be very successful at engaging, motivating, and preparing girls to continue their interest in STEM. Take a closer look at Pretty Brainy in Fort Collins, Colorado and how their program integrates art into the STEM experience to foster curiosity and creativity for innovation (Box 3.2).

BOX 3.2. IN THE SPOTLIGHT:

PRETTY BRAINY: EMPOWERING GIRLS TO GAIN STEAM

The science of electricity. Soldering. Helping her community. This is what Madeleine loved about spending Fridays with Pretty Brainy. Pretty Brainy empowers girls like Madeleine to gain STEAM — science, tech, engineering, art, and math — so they are equipped to pursue their highest ambitions and richly contribute to their communities and world.

Pretty Brainy designs innovative learning in which girls gain the experience and confidence to continue to study science and math and make informed decisions about the broadest of career options. The organization works with schools and nonprofits to provide STEAM enrichment, as well as to reinforce common core standards in the classroom.

Pretty Brainy respects girls as the problem solvers, thinkers, and decision makers that they are and we value their interests in philanthropy, making, and design. Through Pretty Brainy, girls have learned, for example, engineering design thinking to stop adolescent self-harm, increase runner safety on the roads, and find their authentic voice.

“I hope other girls my age get this amazing opportunity to participate in this awesome program. I have learned so much and helped my community while doing it. I want to thank everyone who is helping me want to become an engineer.”

See <http://prettybrainy.com> for information on how the organization supports educators, as well as girls.

Pretty Brainy
Empowering Girls to Gain STEAM™



“Pretty Brainy has been amazing. I could not think of a better way to spend my Friday nights.”

— Madeleine, age 13

Design thinking, a concept introduced in Chapter 2, is an approach mentioned by Pretty Brainy to solve real-world problems relevant to girls' communities. This methodology is a good way to capture students' attention and helps them develop authentic solutions to improve their communities.



IN WHAT WAYS CAN GIRLS 11-13 YEARS USE DESIGN THINKING? HOW CAN THEY COME UP WITH THEIR OWN APPLICATIONS?

Design thinking is an approach that helps students explore problems by putting the user at the center of the problem and at the core of the solution design. Inspiration comes from the desire to solve the problem posed by the user by carrying out a systematic, but not necessarily linear, process that includes the following stages: empathize, define, ideate, prototype, and test. This differs slightly from the science process where question development is inspired from observation, curiosity, or personal motivation, which may or may not include the end user as a core entity. Science is not meant to be learned through cookbook recipes and students benefit from learning science as a process with constant iterations, re-dos, and changes in design. Learn more at [How Science Works](#).⁸

In design thinking, the facilitator may initially pose problems or challenges to help the team understand the design process. Once learners are familiar with design thinking, they can find problems that they are interested in solving and that are relevant to their lives. Problems can range in scope and complexity. Sometimes, the facilitator may limit the range or problems that

students can pursue to make sure they focus on the concepts and skills applicable to their grade level. Other times, students may be free to explore more open-ended interests. Read more about an educator's personal journey using design thinking in the classroom in this Edutopia post on [Empowering Students with Design Thinking](#).⁹ It is important to note that pursuing inquiry in the classroom or in any learning space does not mean "without guidance."¹⁰ If students do not know where to find information, saying, "Don't ask me, figure it out," might be a source of frustration for students and they may or may not figure it out in the end. Facilitators of learning probe with questions and try to get at where the student is and where they need to go next in their exploration or design.

One way to apply design thinking is through problem-based learning (PBL) opportunities at school or in their local communities. When girls see themselves as problem solvers, their identities as creators and critical thinkers are reinforced. These are essential skills that will serve them well as they enter and persist in STEM pathways. Girls can be a vital part of defining problems of relevance to their communities and be recognized as problem solvers. You can read more about schools promoting design thinking and problem-based learning as part of the

BOX 3.3. IN THE SPOTLIGHT:

STEMinspired

STEMinspired (www.steminspired.org) is a nationwide network of K-12 schools, universities, and industry partners. The network originated in 2010 in Adams 12 Five Star Schools in Thornton, CO with the opening of STEM Magnet Lab K-8, and grew as a K-12 continuum with STEM pathways at Northglenn High School STEM and the addition of STEM Launch K-8 in 2012. Working in partnership with the community, STEMinspired fosters risk-taking, resilience, entrepreneurial identities, and growth mindsets through collaboration and stewardship.



As designers, entrepreneurs, and inventors who also happen to be educators, the network approaches its work as a start-up enterprise. STEMinspired's mission is to build bridges between K-12 education, higher education, and industry to change the STEM landscape.

STEMinspired works to create shifts in thinking - so that students become job creators, not just the workforce. Eighth grade students complete ten-hour internships through EPIC (Exploring Possibilities through Internship and Choice). After completing career surveys, planning with counselors, and exploring STEM careers using Couragion (<http://www.couragion.com/>), students experience work in STEM fields that will change the course of both their economic and academic trajectories. These valuable experiences enable girls to create opportunities for themselves as they explore career pathways and build relationships with mentors.

Several of STEMinspired's female science and engineering teachers left industry careers to inspire young women to enter STEM pathways, serving as mentors to many of the female students in the classroom and in afterschool enrichment programming. In partnership with the Colorado BioScience Institute, teachers further their training and expertise in STEM fields as participants in the Research Experience for Teachers (RET) Program. Immersing themselves in STEM-based, industry-relevant projects for several weeks anchors teachers in the professional work of STEMinspired's partners, and helps them bring current knowledge and research to students in the classroom.

Besides recognizing girls as makers and problem solvers, educators can also provide opportunities for girls to be recognized by their peers and their parents/caregivers as people who solve problems, who do science, and who can communicate effectively with various constituencies. Events such as [Girls in Science](#) at the Denver Museum of Nature and Science help caregivers see the potential in their girls as future STEM professionals. At this event, girls visit various clubhouses hosted by STEM professionals. Another event that focuses on 6th and 7th grade girls is GESTEM (Girls Exploring Science, Technology, Engineering, Math) hosted by the Society of Women Engineers (SWE). This event attracts

more than 1,200 girls; read more about it at this [link](#).¹¹

When their peers and the community recognize girls as creators and innovators, girls see themselves as experts and embrace their own ability to do science, to solve engineering or tech challenges, and to apply mathematics to solve problems (see Box 3.4). Educators can increase the

visibility of the work happening in their classes by inviting girls to enter local, [regional](#),¹² or [state science fairs](#),¹³ or through national competitions such as the [Google Science Fair](#).¹⁴ Some schools celebrate successes, such as a Science Bowl Championship, with a public event like a Parade of Champions to recognize participants' accomplishments.

BOX 3.4. IN THE SPOTLIGHT:

STEM Leadership Academy, Walking Mountains

STEM Leadership Academy (SLA) is Walking Mountain Science Center's (WMSC) after-school program that provides integrated STEM lessons. Utilizing an inquiry approach, students explore through innovative lessons inspired by student interest, Next Generation Science Standards, and Colorado Mathematics Standards. The SLA seeks to inspire the future of STEM innovators by providing youth access to and confidence in STEM topics. The program is offered to 6th, 7th, and 8th grade students and utilizes the following to prepare girls to pursue STEM careers:

Meaningful Objectives: Some girls hold a mistaken belief that STEM work is not tied to everyday life. In Girls in STEM, which nurtures 3rd, 4th, and 5th grade girls' interests in STEM, and SLA, Walking Mountains chooses topics that are meaningful to girls and that the lessons accomplish a purpose that girls recognize as worthy of their time and efforts. Girls want to see that their efforts are helping others, too.

Collaboration: Research shows that girls prefer STEM work when they are able to work in collaboration with each other. WMSC prioritizes group work. It builds confidence and creates a positive work environment associated with STEM disciplines.

Role Models: Research from several disciplines suggests that the presence of female peers, teachers, etc. increases female retention in STEM fields. WMSC has created an after-school program that provides female youth opportunities to interact not only with female teachers as role models in STEM education, but also guest presenters and video clips of women in STEM professions. This is as an extremely important aspect in inspiring young girls to be motivated in STEM.

Breaking Down Stereotypes: Research shows that the mere existence of negative stereotypes can hinder the academic performance of an individual. WMSC works to break down these stereotypes by creating opportunities for girls to find success in STEM subjects.

Curriculum units focus on topics that are STEM-related and engage students in relevant content. WMSC uses the 5-E model in lesson design, which is a constructivist approach. In and of itself, this approach to lesson design allows for the students to "construct" their own knowledge. They engage in making their own observations, asking questions, and coming to their own conclusions. This ensures that the topics remain interesting and relevant to students.

Learn more at <http://www.walkingmountains.org/programs>.



BOX 3.5. IN THE SPOTLIGHT:

Work Gone WILD (8th Grade - High School)

Work Gone WILD is a new model to introduce youth to careers that support environmental stewardship in partnership with the Colorado Alliance for Environmental Education, the Colorado Youth Corps Association, and Goodwill Industries of Denver. The program takes participants on a series of field trips to visit different natural resource agencies, organizations, and higher education institutions to learn about career paths and engage in hands-on activities that build relevant job skills. Throughout the experience, participants interact with 50 professionals in natural resources from 25 different organizations and agencies. Each day includes skill-building activities to "try on" jobs, activities to build job-related skills, and awareness building activities.



Learn more at

<https://www.caeer.org/workgonewild>.

HOW CAN GIRLS DESIGN THEIR OWN INVESTIGATIONS AND PURSUE QUESTIONS THAT THEY CARE ABOUT?

Educators and community organizations can hook girls into STEM learning by giving girls the chance to work on projects of interest to them. Have girls look at the world around them. What problems do they see? What problems would they want to solve? What questions do they want to answer? What do they want to learn more about? How can they improve something in their environment to make it better?

You can use Activity 3.1 to get girls thinking about their world, the questions that spark their interest, and the problems they would like to solve. Help them develop an action plan to get started. Remind them that it is okay to start even

if they don't have all the answers or the details; after all, investigating is exactly that—searching for information.



ACTIVITY 3.1:

Problems, Passions, Or Something You Are Curious About

1. What are you passionate about? What do you love to do?

.....
.....

2. What is one problem that you see in the world?

.....
.....

3. If you could improve something about what you listed above, what would it be?

.....
.....

4. What do you wonder about?

.....
.....

5. How do you plan to investigate or solve this question or problem? (Briefly outline your action plan.)

.....
.....

Once girls identify a question or an area of interest, they can conduct research to find out how others have studied the question or topic. Engineers define problems and design solutions; scientists develop questions with variables that can be tested.¹⁵ They also formulate hypotheses that are based on prior research. These types of questions have components called dependent and independent variables. There are also questions that focus on simple observation or comparison. These are also important to science because they set a foundation to ask deeper questions about the natural world. Many programs in Colorado provide opportunities for middle school girls to conduct research investigations. One example is El Espejo Girls Outdoor Adventure Camp, featured in Box 3.6.

BOX 3.6. IN THE SPOTLIGHT:

Middle School Girls As Researchers

El Espejo Girls Outdoor Adventure Camp in Greeley, CO

El Espejo, which takes its name from the Spanish word for mirror, is a summer science research program for girls in which girls get to see themselves as scientists. During the program, girls experience what it is like to be a scientist through different activities and projects at the [Poudre Learning Center](#) (PLC). During the weeklong program, they also have the opportunity to do their own research investigation in small teams. The PLC provides transportation from any of the middle schools in Greeley to the program. There is a fee to participate, and scholarships are provided for students who seek financial assistance.



Opportunities that inspire girls to ask their own questions help to develop a sense of confidence that is oftentimes lacking in a tween's experience. When girls are able to see themselves as researchers, their STEM persona or STEM identity further develops.¹⁶ The more opportunities that girls have to experience this sense of self-worth, the more resilient they will become, making them less vulnerable to future setbacks in their path towards pursuing STEM careers.

WHAT STRATEGIES CAN BE USED TO CONTINUE TO INSPIRE GIRLS IN STEM?

Organizations such as Walking Mountains Science Center (Box 3.4) and Girls Inc. of Metro Denver (Box 3.7) work hard to design inclusive spaces for girls. Their strategies include offering opportunities to see the value of STEM disciplines, emphasizing the importance of working together, connecting girls with role models, defying stereotypes, developing relevant content, and providing specialized training for staff who will be working with girls. It is very important to train staff who will be working with girls and girls of color to create awareness of biases and to tackle stereotypes associated with STEM professionals, so that they can help girls see themselves in those roles. Additionally, we need to recognize that we cannot make girls fit into STEM, but rather, we need to create inclusive spaces where STEM fits the girl.

BOX 3.7. IN THE SPOTLIGHT:

Girls Inc. Of Metro Denver (GIMD)

GIMD's Staff and Volunteer Training

Girls Inc. of Metro Denver creates trusting mentoring relationships with adult staff and volunteers who are trained in an approach that is grounded in a belief in girls' rights and abilities. Each new program instructor participates in at least 40 hours of training on best practice approaches in youth development.



Training Objectives:

- Bolster understanding of the Girls Inc. mission
- Build knowledge and skills around interactive lesson planning, engaging facilitation, and effective evaluation
- Increase the expertise of staff in youth development
- Increase the knowledge and expertise of participants in developing a Girls Inc. experience with impact
- Provide experiences, tools, and resources to build engaging and interactive programming

Each year, returning staff continue their professional development in training workshops that enhance their knowledge of youth development. In addition to staff, volunteers who regularly work with girls receive eight hours of training in developmental stages of girls, discipline methods based in positive reinforcement, anti-oppression and inclusiveness, and how to inspire and empower girls. The [Girls Inc. National Research Resource Center](#) provides a broader accessibility to training opportunities and resources via face-to-face and multimedia-based distributed learning to enhance the quality of programming, support programming outcomes for girls, and build organizational capacity.

About Girls Inc. of Metro Denver

Girls Inc. of Metro Denver's mission is to inspire all girls to be strong, smart, and bold. In 32 years, the organization has served over 35,000 girls with comprehensive programs and life-changing experiences that address the unique issues girls face. At Girls Inc., girls have access to the tools and support to succeed, including trained professionals who mentor and guide them in a safe, girls-only environment, peers who share their drive and aspirations, and research-based programming. Girls learn to set and achieve goals, boldly confront challenges, resist peer pressure, see college as attainable, and explore nontraditional fields such as Science, Technology, Engineering, and Math. Girls Inc. of Metro Denver is an affiliate of the national Girls Incorporated organization.

To learn more about Girls Inc. of Metro Denver's program, visit www.girlsincdenver.org.



Girls need to meet women who work as STEM professionals to defy the stereotypes or misconceptions they may have about STEM professionals. STEM professionals also need to tell girls about their interesting jobs, and connect with girls at a personal level to inspire them to continue their journey in STEM. SciGirls has put together a great [resource](#)¹⁷ to help role models connect with girls in this age group.



WHAT CAREER EXPLORATION TOOLS ARE AVAILABLE FOR GIRLS AGES 11-13?

Girls can begin to learn about STEM careers by meeting professionals in these fields and asking them about their personal and professional journey. These stories can help them determine what careers they want to learn more about. Keep in mind that technology is changing so quickly that the careers that girls in this age band will pursue may not yet exist. Entrepreneurial skills and 21st-century skills will be essential in the pathways they choose to follow.

In Colorado, all students must develop an Individual Career and Academic Plan ([ICAP](#)) starting as early as 6th grade. Parents/caregivers should become familiar with what the process entails. Even if ICAP is not offered in early grades (6th – 8th) at your school, caregivers and parents can help their girls learn about career options so they are better informed once the time comes to explore different pathways. There are several strategies that educators or community organizations can use to help parents/caregivers learn more about STEM careers and how exciting they can be.

TRY THIS!

- ❑ Invite girls and their parents to STEM events. Even though girls may think it is totally uncool to have their parents at these types of events, it is critical that adults see their girls as people who immerse themselves in science, and as people who develop solutions as future STEM professionals.
- ❑ Check out community STEM opportunities. The Denver Museum of Nature and Science offers a Girls in Science Day and Boulder and Fort Collins residents can visit Expanding your Horizons (see Box 3.9). You can also find other local STEM events at [The Connector](#).

EXPOSE GIRLS TO STEM PROFESSIONALS

When girls are exposed to women STEM professionals, they may learn that STEM professionals love to solve problems. They may also learn that many STEM professionals work in teams. Oftentimes, people working in STEM careers have a big project to tackle, and everyone takes a piece of the project, or multiple people collaborate on one aspect of the project. Girls will see that the problems they solve make a difference in our daily lives, covering everything from transportation, to clean water, to creating apps, or studying ecosystems. Sometimes, STEM professionals work alone and contribute their work to a larger problem. STEM professionals may also work in places such as banks or other finance companies and apply their skills to solve big problems using a lot of math and asking good questions.

Girls can meet STEM professionals in the community or they can visit companies that might give tours to show the work that happens

there. In these tours, they may see STEM professionals designing new products, working to improve the human condition, or helping other species on our planet. To learn more about STEM careers, visit [ScienceBuddies](#) or [WeUseMath.org](#). You can also view episodes of [SciGirls](#) (see Box 2.9 in Chapter 2) and pay attention to the mentors who help the girls figure out their projects. SciGirls has also developed role model [profiles](#) that you can view. If you have STEM professionals planning to visit your classroom or organization, share this best practice [resource](#) to get them started. Couragion (see Box 3.8) has also developed tools to help students explore STEM careers.

BOX 3.8. IN THE SPOTLIGHT:

Couragion Case Study

STEM Intention in Girls Increases Once Exposed to Couragion Role Models

At Couragion, we believe in measuring what matters. And when it comes to inspiring girls to pursue skills, competencies, and careers in science, technology, engineering, and math, we believe that measuring interests, intentions, and best-fit careers are what matters. Couragion gives students a firsthand look at careers via role model videos, games, and quizzes. In a 9th grade class recently exposed to just three Couragion role models, STEM intent increased by 4.6 points in all girls and by 16.3 points in Latina girls.

Why Couragion's career exploration & readiness works:

- 84 percent of the company's role models are under-represented in STEM and 81 percent are women. And many are "near peers" – all making it easier for students to relate to the role models and envision themselves pursuing those paths.
- Students see firsthand what a career is like and rate characteristics of each career to determine if it is a fit for their values, interests, and desired work characteristics. Couragion shows students the applicability of their current coursework while inspiring them to take and succeed in challenging STEM courses and educational pathways.
- For best-fit careers, students receive ongoing programming that enables them to continue to explore whether the career is truly a good match. For example, a girl with a high fit for a game development career would be presented with recommended coursework, relevant extracurricular activities, and tips about free tools such as the Unity game development platform. Such programming not only helps her to further explore whether the career is a good fit, but also enables her to hone 21st-century skills and make immediate progress toward such a career – thereby improving her career and workforce readiness and employability.

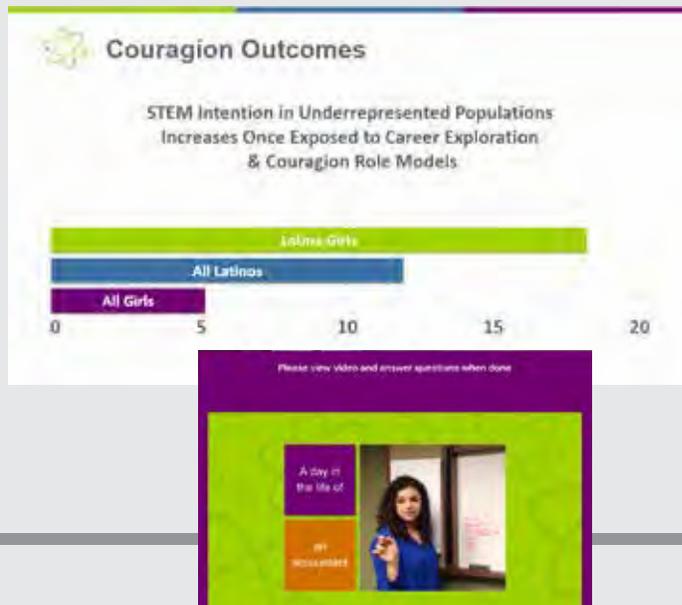
Who's a good fit for Couragion?

Students in 5th grade through career – in the classroom, after the bell, and at home.

Continued on page 93

About Couragion

Couragion is a women-owned education technology company. Our mission is to inspire under-represented youth to pursue skills, competencies, and careers in STEM. We recently celebrated our one-year anniversary and have just been awarded an innovation research grant from the National Science Foundation! The funded project mission is to improve the awareness and perception of careers that require STEM competencies. [To learn more, visit: www.couragion.com/.](http://www.couragion.com/)



You can use Activity 3.2 with your girls to determine what STEM professionals they may be interested in meeting.

ACTIVITY 3.2:

Tweens Meet STEM Professionals

I want to meet someone who _____

[fill in what problems/issues this person likes to solve.]

- Example 1: I want to meet someone who makes sure our water is clean.
- Example 2: I want to meet someone who works with robots in search and rescue.
- Example 3: I want to meet someone who builds apps.

To make this happen, I need to:

1. _____
2. _____
3. _____

Girls in rural Colorado may benefit from online interactions with STEM professionals. [Nepris](#) is one organization that connects industry leaders to Colorado classrooms. Some cultural organizations, such as the [Denver Museum of Nature and Science](#), showcase scientists in action through virtual fieldtrips as well.

BOX 3.9. IN THE SPOTLIGHT:

Expanding Your Horizons (EYH)

EYH is a national network that hosts one-day conferences to encourage young women to pursue science, technology, engineering, and mathematics careers. Locally organized EYH Network programs provide STEM role models and hands-on activities for middle and high school girls. The ultimate goal is to motivate girls to become innovative and creative thinkers ready to meet 21st-century challenges.

At the conference, girls pick from a series of workshops on topics such as food science, biomedical engineering, and particle physics. The students have a great time learning about new careers and participating in hands-on activities led by female professionals from a wide variety of STEM fields. The workshop leaders aim to give the students a positive experience and answer any questions about what they do and how they prepared for their careers. This is a wonderful opportunity for students to gain hands-on exposure to a variety of STEM careers and meet great role models.

Examples of EYH workshops:

Exploring the Micro World: Learn about the bugs that live everywhere around you, even on your body.

Build an Electric Butterfly: Using circuits and engineering, design a take-home electric butterfly.

Brain Power: See how your brain works and use the power of your brain to influence your environment.

Operation Build: Learn the basics of architecture through designing your own one-bedroom apartment.

“Making” with Minions: A Maker is an inventor, creator, builder, designer, or producer. Design your own minion with software and circuits.

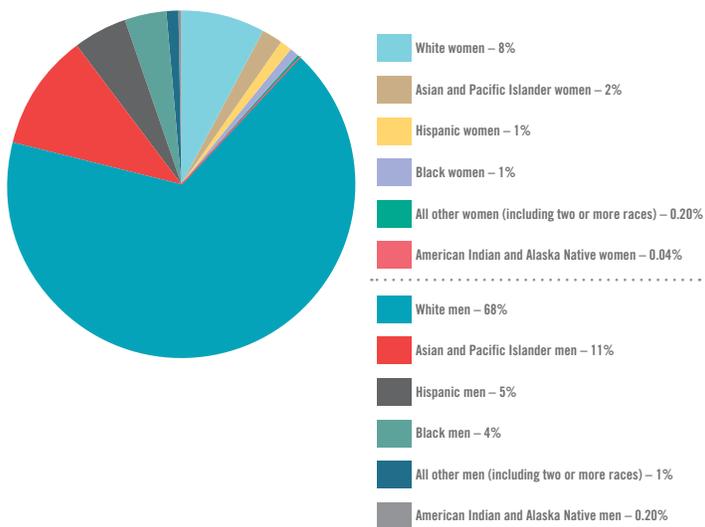
As girls learn more about STEM professionals, they may start to notice that women of different racial and ethnic backgrounds are not equally represented. They may even notice that relatively few STEM professionals are women. This might be evident if they go on a site visit to a tech company or an engineering company, where the average female representation is 17 percent and 8 percent respectively.¹⁸

When girls understand the issue of under-representation, they can take action. This can range from finding opportunities to creating their own programs. For example, they can mentor younger girls and teach them strategies that have helped them get where they are now. As they enter the workforce, their level of awareness of issues that typically push women out of these fields will help them search for workspaces that are inclusive of women and families. They may value companies that are willing to create those spaces over companies that perpetuate the status quo. Ultimately, girls can lead in being the change that is so needed in these spaces and the earlier they start learning about the issues, the more time they will have to develop solutions that work for them to make sure they do not enter and get pushed out by a system that was not designed for them. Such systems have to adapt as well to be inclusive of the needs of this changing workforce.

FIGURE 1.

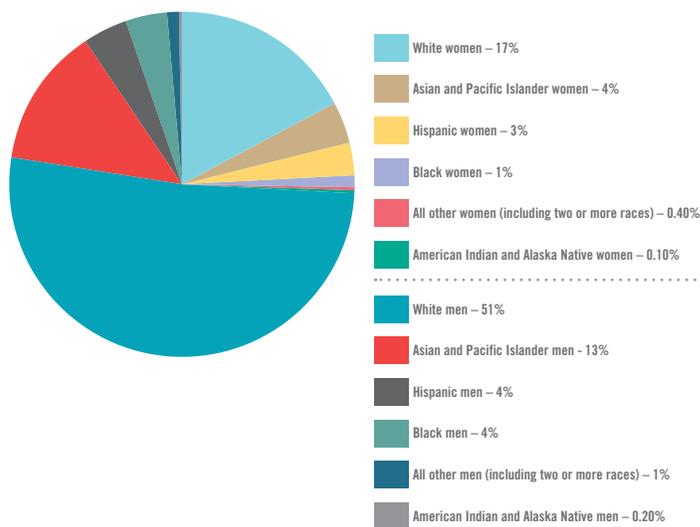
ANALYSIS OF ENGINEERING AND COMPUTING WORKFORCE BY GENDER AND RACE/ETHNICITY FROM 2006-2010¹⁹

ENGINEERING WORKFORCE, BY GENDER AND RACE/ETHNICITY, 2006-2010



Source: AAUW analysis of U.S. Census Bureau (2011a).

COMPUTING WORKFORCE, BY GENDER AND RACE/ETHNICITY, 2006-2010



Source: AAUW analysis of U.S. Census Bureau (2011a).

PROFESSIONALS FROM GROUPS HISTORICALLY UNDER-REPRESENTED IN STEM

Amazing women throughout history have made scientific discoveries and created tools and products that we use today; however, formal curriculum rarely covers this history in depth. Parents, caregivers, and educators can seek out and share information about women and women of color who have done amazing things. You will find many stories waiting to be told and waiting to be written. We have the ability to use these stories to inspire and prepare the next generation of girls, including girls of color, to pursue STEM careers.



TOOLBOX

Untold Or Seldom Told Stories Of STEM Professionals

Dr. Justina Ford: Dr. Ford was the first African American woman to practice medicine in Denver. At first, she was denied a medical license because she was a woman and African American. Once she was granted a license to practice medicine, area hospitals denied her and her patients access, so she forged her own path. Dr. Ford went on to have a 50-year career in medicine, serving diverse community members and learning many languages to provide them the care they needed.

Pearl Young: "The first woman to break the gender barrier at NASA Langley... was Pearl Young. She became an engineer at Langley in 1922 and eventually became the chief technical editor for the National Advisory Committee for Aeronautics."²⁰

Katherine G. Johnson: Johnson is a retired African-American NASA mathematician. She was awarded the Presidential Medal of Freedom in 2014 "for her contributions to the space program, starting with the Mercury missions in the '50s and early '60s, through the Apollo moon missions in the late '60s and early '70s, and ending with the space shuttle missions in the mid '80s. Among other things, she calculated the trajectories of America's first manned mission into orbit and the first Moon landing."²¹

Mary Sherman Morgan: Morgan is called America's first female rocket scientist. Read about her in the book *Rocket Girl: The Story of Mary Sherman Morgan, America's First Female Rocket Scientist* by George Morgan.

Dr. Grace Hopper and Forgotten Female Programmers. There is a group of women who were referred to as "computers" since their job was to compute things. Their stories are seldom told. You can read more about them at this [National Public Radio link](#).

Dr. Rosalind Franklin: Dr. Franklin was a British chemist and is "best known for her role in the discovery of the structure of DNA, and for her pioneering use of X-ray diffraction. She also laid foundations for structural virology."²²

Dr. Ellen Ochoa: Dr. Ochoa is a Mexican-American woman and the first Latina astronaut to go into space. In 1993, she went on her first flight on space shuttle Discovery. She solved problems using her robotics knowledge and skills.

Dr. Mae Jemison: In 1992, Dr. Jemison became the first African-American woman in space.

Encourage girls to learn about the STEM professionals currently working in research labs at universities in our state. There are professionals such as Dr. Prieto at Colorado State University, Fort Collins, developing game-changing technologies like more efficient batteries, and other scientists and engineers working on renewable fuels. Or find examples of girls who are close in age to the girls you serve so they can see the potential for their contributions at whatever stage in life they are in. Girls might be inspired to follow in the steps of [Sara Volz](#), who dedicated her high school years to growing algae to create biofuel. Use Activity 3.3 to get girls thinking about the untold stories of amazing STEM women all around them.

ACTIVITY 3.3:

Get To Know Her-story

1. **Research:** Find the name of a woman in STEM whose accomplishments are not widely known. Start [here](#) if you need a little help.
2. **Learn whatever you can about her.** What was her life like? What problems did she like to solve? What was life like during her era? What was she doing when she was your age?
3. **How does her story inspire you?**
4. **Share her story** with your parents/caregivers, teachers, and anyone willing to listen!
5. **Participate in The UN International Day for Women and Girls in Science** on February 11th each year. You can post pictures of your favorite scientists on social media.

IN WHAT WAYS CAN WE HELP GIRLS UNDERSTAND CONNECTIONS BETWEEN STEM LEARNING AND EVERYDAY LIFE?

STEM professionals may work in specific areas, but something they all share is their ability to solve problems and to ask really good questions. The more girls practice asking good questions and developing project plans to test solutions, the better prepared they will be to pursue pathways in STEM.

An engineer may ask questions that can improve the human condition. For example, engineers may work on ways to divert water from towns to prevent flooding and damage to homes. They may also design systems to make homes energy efficient. Scientists and engineers can develop

new materials or technologies to make our lives easier or more efficient. Check out [Engineer Girl](#) for more information.

Professionals in information technology (IT) may create systems that make communicating with people all over the world easier. For example, they create social media platforms such as Snapchat, Facebook, Instagram, and other apps. They have to figure out the problem and create a solution, or a product, to solve that problem. Parents and educators can send girls to the [TECHNOchicas](#) website housed under the National Center for Women & Information Technology ([NCWIT](#)) to learn more about careers in IT.

Math professionals work in all STEM fields because mathematics is the language of science. It helps us understand the world and it requires numerical and logical thinking, a skill that all STEM professionals need. Logical thinking refers to the ability to clearly express what the problem is, the approach or multiple approaches that can be used to solve the problem, and the assumptions that come with each problem-solving method. Numeracy refers to an understanding of numbers and the ability to work with them. Math is all about looking for patterns and connecting ideas.²³

Educators can better understand the connections between the different STEM disciplines by taking advantage of the many opportunities offered at higher education institutions and through industry partners who provide educators with externships, research opportunities, and coursework to extend STEM pedagogy and content knowledge. One example of a teacher externship is the Colorado BioScience Institute's Research Experience for Teachers (see Box 3.10).

BOX 3.10. IN THE SPOTLIGHT:

Colorado BioScience Institute

The Colorado BioScience Institute (The Institute) Research Experience for Teachers (RET) program, provides middle and high school teachers real-world STEM work experiences and helps them translate those experiences and new knowledge into the classroom. RET is an intensive four-week summer program in which teachers spend about 130 hours with an innovative STEM company working on real-world projects and 30 plus hours in professional development. The goal is to build long-term, collaborative partnerships between 6th-12th grade teachers, industry leaders, and the local university research community by involving the teachers in STEM-based, industry-relevant projects and helping them increase student engagement and interest in STEM topics/careers through increased teacher enthusiasm and knowledge about STEM industries. Data collected on the program to date indicate that teachers who participate have a 22 percent increase in self-confidence in teaching scientific research on average and a nearly 30 percent increase in their understanding of the business of science. Also, their students report a 33 percent increase on average of interest in pursuing a career in a STEM field. Participating companies conveyed that the presence of the teacher helped them better communicate their processes and findings to members of a non-scientific community and allowed them to gain a different perspective on their work. The Institute's RET program has led to increased company engagement with students as well, with host companies providing student tours, content expert presentations, and, in one case, an engineering challenge for students. By providing teachers experiential opportunities along with professional development, classroom implementation planning time, and authentic materials, the Colorado BioScience Institute's RET program is making a tremendous impact in Colorado's 6th-12th grade STEM classes.



Nicole McWright, 8th grade teacher from Adams 12, STEM Launch School, working in an Immunology & Beryllium Lab at National Jewish Health in the summer of 2015.

Learn more at [RET](#). 



HOW CAN GIRLS DEVELOP PROFICIENCY IN FOUNDATIONAL STEM SKILLS?

For girls to develop proficiency in foundational STEM skills, they need a supportive learning ecosystem composed of caregivers, educators, and community resources that can advocate on their behalf and provide authentic learning experiences grounded in the girl's reality. Educators must realize that foundational STEM skills are grounded in experiences that are meaningful and relevant to young girls. To see the connections, it is imperative that educators see what STEM professionals do and that they experience the practices of STEM professionals so they can create opportunities for STEM learning for their students.

Educators do not have to start from a blank page to design STEM learning experiences. If educators have existing curriculum, they can begin by adapting existing resources and using the Arizona STEM Network's STEM Immersion Guide. This guide outlines different levels of STEM integration: exploratory, introductory,

partial immersion, and full immersion. It also provides information to guide teachers, schools, administrators, and districts in program design. To read the guide, visit the [Arizona Framework for STEM](#).

With conversations, proposals, research, and policies flourishing around STEM education through Next Generation Science Standards, resources abound to support those involved in the redesign and implementation of curriculum. See [Curriculum Adaptation to NGSS](#) for more details.

Additional Colorado-based sample STEM units can be found in eNet Colorado. There are a significant number of resources organized by grade band, as well as math and data sets here: [eNet CO STEM Resources Database](#)²⁴ and sample science instructional units here: [eNet CO Middle School Sample Units and Resources](#).²⁵

In addition, [STEM Road Map: A Framework for Integrated STEM Education](#) provides an integrated approach for each grade from K-12. Educators will even find a complete sample middle school

unit on Transportation—Motorsports, focused on the crosscutting science concept of cause and effect, and a blank template to use for planning purposes.

Girls need teachers who are well-versed in designing STEM learning experiences. In designing STEM curriculum, consideration should be given to the “five core characteristics that distinguish *integrated* STEM learning experiences” as outlined in the *STEM Road Map*:

- “The content and practices of one or more anchor science and mathematics disciplines define some of the primary learning goals
- The integrator is the engineering practices and engineering design of technologies as the context and/or an intentional component of the content to be learned
- The engineering design or engineering practices related to relevant technologies requires the use of scientific and mathematical concepts through design justifications
- The development of 21st-century skills/competencies is emphasized
- The context of instruction requires solving a real-world problem or task through teamwork”²⁶



Well-crafted STEM learning experiences help build girls’ identities in science and mathematics. A person’s perception of what she is capable of doing can impact her ability to do well in math and science. Take a look at María’s self-efficacy in mathematics.

María’s grandfather, Papa, was born and raised in Central America. He was a business owner and drove buses for a living. During his breaks from driving, Papa would pull out a notepad and a pencil and play math games with the other drivers. He knew all sorts of tricks. He would ask his audience to start with a certain number and then he would insert additional numbers. The sum was always a row of nines. That was his favorite number. María internalized that if grandpa was that good at math, she could be good, too. When María moved to the U.S. her math performance was very strong. She loved playing with numbers and she practiced a lot.

Some people think that people are born with an aptitude for math. María thought that because her grandpa was good, she had a chance at being good, too. María’s performance was not necessarily a result of her family genes, rather it was constant practice. Every time she interacted with her grandpa, he would help her understand concepts such as numbers, patterns, and place value. She learned skills such as counting, subtracting, adding, composing, and decomposing numbers.

The opposite can be true when talking about belief in your ability to be good at something. For example, parents’ and caregivers’ perceptions of their ability (or inability) to do math and science as children may influence how their children feel about these subjects and how they perform in school. If parents/caregivers say they were bad

at math or science, their child might start believing that they will have the same fate. This is not the case. Girls must learn that, if they practice skills they are not yet good at, they will get better. Girls can even teach their parents/caregivers as they learn so they can recognize their daughters' abilities as STEM learners.

There is another phenomenon at play that impacts girls' perception of their abilities. It's called [stereotype threat](#).²⁷ This is when a person is afraid that the action or behavior they exhibit

will reinforce ideas that are stereotypical of their cultural group or gender. For example, if someone says, "Boys do really well on this task," and the person performing the task is a girl, she will not perform well on that task. She will perform better if she is told that the test is about problem solving abilities, or told nothing at all.

The following toolbox has been designed to help girls develop awareness of their thoughts and to move them towards a growth mindset. You can give it directly to the girls in your life.



TOOLBOX

Growth Mindset

<i>When you hear this in your head...</i>	<i>Change your thoughts to this...</i>
I can't do this.	What do I need to do first to tackle this problem?
My mom told me she hated math. Maybe I'm the same. This stuff is hard.	Just because my mom did not do well in math doesn't mean that the same applies to me. I can learn. I might not be good yet, but I will continue trying.
I failed. This is horrible!	Well, that didn't work. I'll see why it didn't work and try again. It's okay to fail and try again.
Only boys are good at this STEM stuff.	I can be good at this, too. Everything takes practice. Keep going.
I'm going to do horribly on this test. (Even though you studied and practiced a lot.)	I worked very hard to perform well. I am confident that my hard work will pay off.
Add your own:	Add your own:
Add your own:	Add your own:

The tips in the Toolbox are meant to be a starting point. Girls will experience many situations that will prompt negative thoughts about their abilities. The more they practice having a growth mindset, the more they will see that even if they do not know something now, it does not mean they will never know it.

The following questions are also helpful for educators to make sure their own thinking is not limiting their girls' abilities. If educators have the inclination to change the learning environment for students, they can start by asking themselves the following "how might we" questions:

- ❑ How might we create opportunities for students to ask questions?
- ❑ How might we get more opportunities for students to design their own investigations and ask questions they are interested in exploring?
- ❑ How might we take issues that are relevant to our communities and come up with solutions?

WHAT DOES A GREAT STEM CLASSROOM LOOK LIKE?

In a great STEM classroom, students have the opportunity to ask their own questions and develop solutions to problems that interest them. They learn about STEM ideas in depth. These ideas may include

our role as a human in the environment and improving the human condition. This classroom may not be a traditional classroom at all. Students may be learning in their community, outdoors, or at home. Learning takes place anywhere, anytime.

Learning should be linked to students' everyday lived experience. Students excel when they have opportunities to collaborate and find viable solutions to problems by asking authentic, relevant questions about their environment. Teachers facilitate deep and meaningful learning by helping students to ask good questions and at the same time, rarely give answers, but stimulating thought about solutions and developing students' ability to make connections that link ideas.

As students develop the ability to connect ideas, they will start seeing many opportunities to solve problems in their communities or at home. They may even start to expand their reach globally and work with organizations on the other side of the world. For example, middle school kids at Preston Middle School are working on a lights project for Uganda (see Box 3.11.).



BOX 3.11. IN THE SPOTLIGHT:

Engineering Brightness

[Engineering Brightness](#), formerly One Million Lights, is a group of students and teachers committed to making the world brighter. Through global collaboration with New Brunswick, the Dominican Republic, Uganda, Honduras, and Nicaragua, Engineering Brightness participants are engineering 3D printed, sustainable lanterns and distributing them to people without reliable electricity worldwide. Learn more about how Preston Middle School in Fort Collins, CO is helping to make the world a better place.

<http://linkis.com/nstacommunities.org/iWn1M>

HOW CAN COMMUNITIES HELP GIRLS PREPARE FOR STEM CAREERS?

Community organizations are a great asset to connect girls and educators to STEM professionals. In some Colorado communities, careers in natural resources may be more common, and in others, careers in technology may be more represented. For example, Boulder has many STEM professionals because of the presence of government labs and they have the highest high-tech start-up density in the region.²⁸ In rural Colorado, educators and community organizations can connect with the Bureau of Land Management, U.S. Forest Service, or the National Park Service. Learning about STEM careers and the many places where STEM professionals work gives girls the chance to see themselves in those careers. Where a girl lives in Colorado should not be a barrier to connecting her to STEM professionals.

Please share the following toolbox with girls you work with. Help them break the tasks into smaller components to accomplish them if necessary.



TOOLBOX

Tool For Tweens. Shaping Your Future In STEM

- Be aware of the skills you should be learning to be successful in STEM:
 - ◆ STEM Practices: Learn the skills scientists and engineers use to investigate questions and to solve problems. You will see that these practices are easy to incorporate in everyday thinking and tasks as a way of life.
 1. Asking questions and defining problems
 2. Developing and using models
 3. Planning and carrying out investigations
 4. Analyzing and interpreting data
 5. Using mathematics and computational thinking
 6. Constructing explanations and designing solutions
 7. Engaging in argument from evidence
 8. Obtaining, evaluating, and communicating information
 - ◆ Improving your spatial reasoning skills:
 - Play 3-D video games to improve spatial reasoning.
 - Solve puzzles that require three dimensional abilities.
 - ◆ Understand what 21st-century skills are and improve them:
 - Communication, collaboration, creativity and innovation, critical thinking, and problem-solving skills.

- Explore careers in STEM:
 - ◆ Use career exploration apps and watch role model [videos](#) on SciGirls.
 - ◆ [Nepris](#) - Use this site to connect industry leaders to the classroom. Ask your teacher for help.
- Participate in citizen science projects or community service:
 - ◆ [Project BudBurst](#) - <http://budburst.org/> Collect data about plants in your own backyard and submit your data for scientists to use.
 - ◆ [Celebrate Urban Birds](#) - <http://celebrateurbanbirds.org/> Add data about migratory birds and experience other activities to study birds.
 - ◆ [Nest Watch](#) - <http://nestwatch.org/> An opportunity to help scientists collect data about nesting birds.
 - ◆ Check out [SciStarters](#) for many more ideas!
- Enter a science fair:
 - ◆ [Denver Metro Science Fair](#) (6th Grade - high school)
 - ◆ [Colorado State Science and Engineering Fair](#) (6th grade - high school)
 - ◆ [Google Science Fair](#)
- Participate in a Design Challenge.
- Learn how to [code](#). Coding is a great way to utilize the design process. If you are not successful the first time, you can try again, and again.
- Shadow a STEM professional. The best way to start learning about what people do for a living is to see them in action. Ask STEM professionals if you can shadow them for a day to learn about what they do and the skills they use. You may discover that some careers require skills that employees do over and over again; others require people to be creative and to come up with new ideas. There are a wide range of STEM careers out there to discover. You can also begin to volunteer over the summer to learn more about what certain professionals do.



WHY DOES IT MATTER IF GIRLS PURSUE OR CHOOSE NOT TO PURSUE STEM CAREERS?

Women and girls make up half the population of the world, and we need women and girls to name the problems and issues that impact them and contribute to their solutions. STEM careers offer girls an opportunity to help and to contribute their perspectives, skills, and talents to make the world a better place. What girls bring to STEM no one else can bring. The current under-representation of women, including women of color, means that problems relevant to those communities may be going unsolved. STEM careers also offer good salaries. Early career women can earn enough to sustain themselves and their families if they enter an in-demand STEM career. A wider talent pool also brings new ideas and perspectives to solve problems. When we do not include girls in solving problems, we let potential remain undiscovered.

HOW CAN COMMUNITY ORGANIZATIONS ADVANCE GIRLS IN STEM?

Community organizations can play a vital role in changing the STEM learning trajectories of girls by working with multiple partners to improve STEM opportunities and the conditions in which these opportunities take place. Community organizations are part of the ecosystem that touches multiple aspects of girls' development. They can forge partnerships between industry leaders, other organizations, and schools.

Girls ages 11-13 need engaging experiences that give them the chance to continue learning about STEM pathways. They need to be surrounded by a community that helps them see their own potential, in which people are equipped with tools to help them acknowledge and recognize their abilities.

To advance girls in STEM, community organizations can:

- Help spread the message of the importance of having gender parity in STEM career pathways and into the workforce
- Help build capacity for educators and community organizations by providing tools, resources, and training on topics such as bias, micromessaging, teasing, putdowns, stereotypes, competition, marginalization, opportunities in STEM, and encouragement to enter and stay in STEM fields²⁹
- Provide tools for girls to recognize their voice, abilities, and potential
- Create awareness so that girls and their families understand that learning is a continuous process that can occur anytime, anywhere.
- Connect girls to mentors, expose them to career exploration, create awareness of opportunities in STEM, and help girls start to think about STEM pathways and multiple access points to enter those pathways

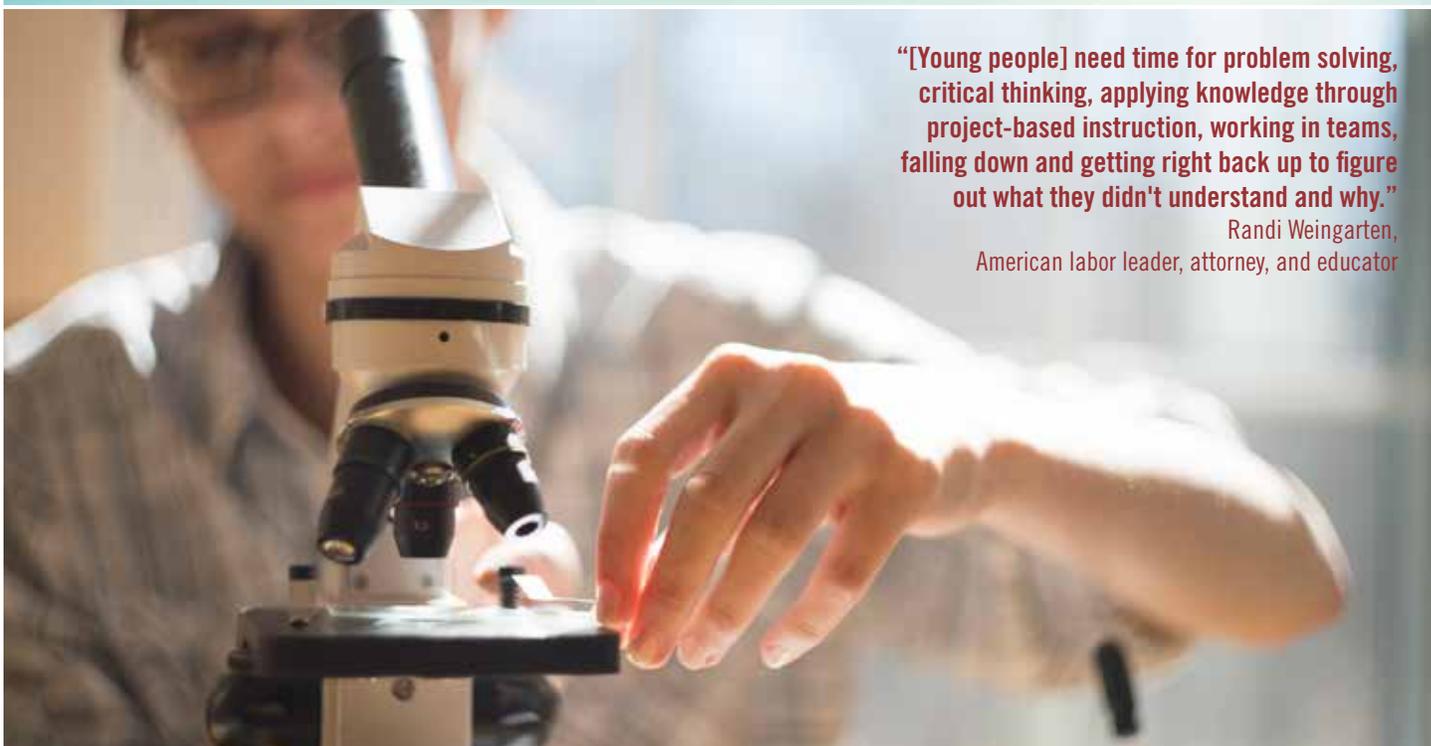
By the time girls reach 13 years of age, they should have options to explore different STEM career pathways. The activities in this chapter are a starting point for caregivers, educators, and community organizations to help girls advance in their STEM trajectory. To fully take advantage of these opportunities, they need to know about and practice design thinking and its applications, they need to design their own investigations, and they need to learn foundational ideas in STEM. These big ideas include cause and effect, innovation, and sustainable systems. Girls also need to develop skills to be able to solve problems, collaborate, utilize technology, work with people from other cultures, and distribute their time to manage projects and finish them on time.³⁰ The community must recognize and celebrate girls' contributions so girls see themselves as capable and feel confident in their ability to solve problems.

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CHAPTER 4

I AM PREPARING TO SOLVE 21st-CENTURY CHALLENGES



“[Young people] need time for problem solving, critical thinking, applying knowledge through project-based instruction, working in teams, falling down and getting right back up to figure out what they didn't understand and why.”

Randi Weingarten,
American labor leader, attorney, and educator

Violeta García, PhD

In adolescence, girls can continue to learn about and prepare for STEM opportunities, connect STEM with their interests and daily lives, and understand the value of STEM careers. Girls between 14 and 18 years of age also engage in self-exploration and may, at some points, experience uncertainty about the path they want to pursue in the future. These young women are starting to give serious thought to what path they want to take in life. We know there are few career paths that are directly linked to the individual courses they take, so they need to draw the connections across different fields of study and practical applications and as members of

interconnected communities. Unfortunately, STEM subjects are often taught in silos, which may decrease girls' motivation to pursue STEM pathways and their preparation for STEM success.^{1,2} To get young women STEM-ready, educators must break the silos surrounding STEM subjects, and girls must have opportunities to learn by tackling engaging, real-world problems that keep them inspired to persist in STEM courses.

Our culture sends girls micromessages, which perpetuate micro-inequities that tell them they do not belong in STEM or make them feel out of place. These messages become a self-fulfilling



prophecy and stifle girls' interest in STEM subjects. They hear that girls are not supposed to be good at math, so they perform poorly and accept that fate because they've heard this message so often. However, parents and educators can turn these micro-inequalities into microaffirmations,³ which are messages that tells girls that they do belong in STEM and they have what it takes to succeed. Together, we can boldly disrupt systems to create more inclusive spaces for girls and young women of all backgrounds.

By the time a girl reaches age 18, she has the chance to make many choices that can either open up STEM opportunities or that can make it harder for her to take advantage of them. Parents and caregivers, educators, and the community can offer support and resources so that girls can explore interesting STEM careers, prepare themselves to pursue STEM opportunities, and develop the skills they will need to solve 21st-century challenges.

OUTCOMES BY AGE 18

As young women, including young women from diverse backgrounds who have historically been under-represented in STEM, reach 18 years of age, they can enter STEM preparation programs and:

- Participate in one or more internships or apprenticeships
- Meet diverse professionals in STEM fields
- Understand various pathways to access STEM careers
- Develop deeper understanding of cross-disciplinary connections
- Complete high school ready to begin a career in STEM or post-secondary education in STEM

When girls are in lower grade levels, they display about the same level of performance in STEM subjects as boys.⁴ As they get older, their interest and participation in STEM starts to wane. By high school, girls are less likely to be interested in STEM pathways than boys. This attrition trend continues into college and as young adults enter the workforce.⁵ Latinas, African American girls, and girls from low socioeconomic backgrounds have even lower participation rates in STEM classes.⁶ Understanding how various activities can help girls access STEM careers can expand opportunities for them to experience what it is like to be a STEM professional. Internships or apprenticeships are a great way to for girls to get hands-on, relevant experience.

HOW CAN I HELP YOUNG WOMEN FIND INTERNSHIPS OR APPRENTICESHIPS?

Teen girls can find many ways to explore careers in their communities and across the nation. Firsthand experiences can help them learn what it is like to work as a professional in STEM fields.

Internships

Internships allow girls to participate in meaningful, productive work in a STEM company. They also allow girls to explore the day-to-day operations in a specific field. The best, most meaningful internships also provide girls with work experience through at least one project with clear deliverables. Many school districts have ways to connect employers and students, such as Denver Public Schools' [CareerLaunch Internship Program](#). If your area does not yet have such opportunities, consider ways you can help get a local internship program started. There are also opportunities for summer internships beyond Colorado through government organizations, including [NASA](#), and private companies. [Pathways to Science](#) offers a searchable database of programs and [STEMnet](#) contains a list of opportunities across

the nation. [The Connectory](#) has nationwide opportunities as well.

Encourage the young women in your life to use the resources in this toolbox to find and assess internships, meet potential STEM role models, and select a meaningful opportunity.

Apprenticeships

Certain fields require in-depth and long-term training. Historically, apprenticeships lent themselves to this type of training. While apprenticeships are not as common today, students can benefit from what they offered – careful observation, practice, and long-term skill development in fields that require precision and deep attention. Some leaders in Colorado are considering the Swiss Apprenticeship Model, which may increase students' participation in STEM. This model offers young people the opportunity to start as an apprentice to enter a trade, providing flexibility for learners to move between vocational and academic pathways. You can learn more about the Swiss Apprenticeship Model from [Colorado Succeeds](#).



TOOLBOX

Meaningful Internships

- I will seek an internship that offers an opportunity to work on a meaningful project.
- I will have the opportunity to be included in the day-to-day job activities, such as meetings, events, etc.
- I will have a point person or supervisor who cares about the deliverables on which I will be working.
- I will be doing work that is interesting to me.



BOX 4.1. IN THE SPOTLIGHT:

Project DIY

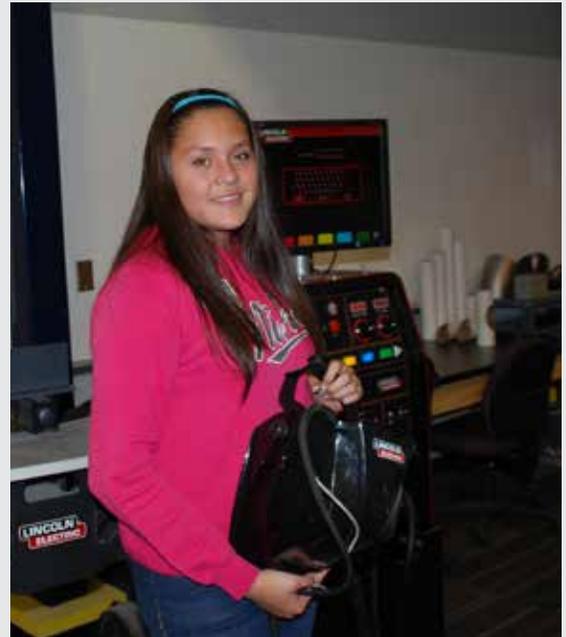
In summer 2016, 18 girls from [Denver Public Schools](#) got their hands dirty at Community College of Denver's (CCD) [Project Do It Yourself](#) (DIY) summer camp. The camp gave students from grades 9 through 11 hands-on experience in manufacturing programs and exposed them to women leaders in STEM careers.

The idea behind Project DIY is to engage young women in non-traditional careers such as welding, machining and engineering graphics, and mechanical design. CCD held two, weeklong camps with the help of financial support from [The Women's Foundation of Colorado](#).



Learn more about the program at

<https://www.ccd.edu/blog/press-room/denver-high-school-girls-get-their-hands-dirty-summer-manufacturing-camp>.



HOW CAN EDUCATORS, PARENTS AND CAREGIVERS, AND COMMUNITY ORGANIZATIONS LEARN MORE ABOUT STEM PROGRAMS?

Parents and caregivers have an important role to play in helping their girls develop a sense of identity, a STEM persona, that includes seeing themselves as scientists, mathematicians, or engineers. We can work together to support girls' interest in STEM; acknowledge girls' abilities; and let them know that even if they do not have all the tools today, they can learn by utilizing growth mindset tools (see Chapter 2 for more information). Together, we can inspire, prepare, and motivate girls to pursue and be successful in any STEM pathway they choose.

One of the biggest barriers to expanding opportunities for girls is lack of awareness of opportunities that exist. The New York Urban League⁷ has put together a [guide](#) that dispels myths about STEM and provides resources for parents and community members. These myths include: (1) STEM fields are not welcoming of girls and that (2) girls are not interested in math and science, among others.

Sometimes, parents, caregivers, and community organizations may not be aware of or may not know where to find opportunities for girls, including girls from diverse backgrounds traditionally under-represented in STEM and girls from rural Colorado, to participate in STEM.⁸ The National Center for Women & Information Technology (NCWIT) has developed resources for families and educators to help, particularly with the information technology field (see Box 4.2).

Additionally, adults may have hidden biases and may unconsciously not offer STEM opportunities to girls because they assume that girls might not be interested. Therefore, it is important to share opportunities with all students and to have universal goals and targeted strategies and objectives to personally invite girls to participate in these opportunities. For example, a universal goal is to expose every girl to a certain STEM experience or program, while a targeted objective includes creating programs that serve girls belonging to certain demographic groups that are extremely under-represented in STEM, such as Latinas, African American and Native American girls, and girls from low socioeconomic backgrounds.

Recognizing STEM opportunities when they are not labeled as such takes time and practice. A quality STEM program exhibits characteristics of personalized learning through projects and exposes girls to careers that they may not otherwise know exist. As a starting point for your search, check out the STEMworks [database](#), where you'll find programs that have gone through an intensive vetting process. This resource was originally created to help funders identify high-quality programs. Then, visit [The Connector](#) to check if any of the programs listed are offered in your community.

BOX 4.2. IN THE SPOTLIGHT:

National Center For Women & Information Technology (NCWIT)

NCWIT, based in Boulder, CO, is an organization that works to correct the imbalance of gender diversity in technology and computing. They understand that gender diversity positively correlates with a larger workforce, better innovation, and increased business performance. Therefore, they develop tools and resources to increase the number of women in technology and computing. Women have the potential to improve the design of products and services to better serve a more diverse population and increase their economic and social well-being by providing more women with stable and lucrative careers.

In addition to great [resources](#) for educators and families, you can also find information about [TECHNOLOchicas](#) and about the [Aspirations in Computing](#) program for girls interested in pursuing computer science. Be sure to also check out the [Top 10 Ways to Engage Underrepresented Students in STEM](#).



Learn more at <https://www.ncwit.org/>.





TOOLBOX

STEM Program Check

High-quality STEM programs for girls and young women have the following attributes:

- Hands-on learning
- Opportunities for girls to ask and investigate their own questions and design solutions
- Based on real-world experiences or solving actual problems in communities
- Promote the development of STEM habits of mind: asking questions, defining problems, finding solutions, constructing explanations, communicating information, etc.
- Focus on developing 21st-century skills: collaboration, communication, critical thinking, and creativity
- Make connections to professionals in STEM who can relate to girls, including girls of color
- Train staff on inclusive practices
- Focus on youth development and ways to work with girls, including girls of color
- Utilize strategies to attract and retain girls

For more detail, refer to page three in the [Design Principles 3.0 of effective STEM philanthropy](#).⁹

The [National Science Teachers Association](#) (NSTA) offers a comprehensive list of opportunities that give educators the chance to learn more about STEM careers by immersing themselves in research experiences. Educators can do a Semester at Sea or participate in summer research experiences or educational tours.

There are also opportunities for educators to learn more about the work of STEM professionals through externships with industry employers. The BioScience Institute, featured in Chapter 3, provides teachers with opportunities to get into companies, learn about STEM professions, take what they learn, and connect it to classroom experiences (see Box 3.10 in the previous chapter).

Educators can use online resources to find discipline-specific content. For example, the National Science Digital Library has a wealth of educational resources about STEM, including those that can help teachers make meaningful connections across STEM disciplines (see Box 4.3).



BOX 4.3. IN THE SPOTLIGHT:

The National Science Digital Library

Educators benefit from having a one-stop site for resources in the sciences. The National Science Digital Library provides high-quality online educational resources for teaching and learning, with current emphasis on the STEM disciplines—both formal and informal; institutional and individual; and in local, state, national, and international educational settings. The NSDL collection contains structured descriptive information (metadata) about web-based educational resources held on other sites by their providers. These providers contribute this metadata to NSDL for organized search and open access to educational resources.¹⁰

To view the thousands of resources, many adhering to Open Educational Resource access, visit <https://nsdl.oercommons.org/>. You can filter by grade level, type of resource, and by standard type.

Other hubs also share resources and some list professional development opportunities. For example, the Colorado Consortium for Earth and Space Science Education lists discipline-specific resources and offers opportunities for educators to develop integrated STEM learning experiences for their students (see Box 4.4).

BOX 4.4. IN THE SPOTLIGHT:

Colorado Consortium For Earth And Space Science Education (CCESSE)

CCESSE is a compilation of opportunities for educators, nonprofits, and corporations to work together to provide STEM programming; it currently highlights opportunities in the Pikes Peak region and beyond. For example, you will find information on the STEM BootCamp for K-12 Teachers and Peak Area Leadership in Science (PALS).

STEM BootCamp is a focused, three-day professional development program hosted by the Air Force Academy to enhance STEM teaching skills for Southern Colorado K-12 educators. Held annually each summer since 2010, the [Challenger Learning Center of Colorado](#) organizes and delivers the program and the National Defense Education Program (now known as DoD STEM) provides funding. This program is open to any educator nationwide. In 2015, 105 educators participated.

[PALS](#) provides science teachers in the Pikes Peak region with the opportunity to participate in a professional learning community in which they share educational ideas, lesson plans, methods, and materials related to science education. Teachers participating in PALS' monthly meetings have the chance to network with colleagues and increase their content knowledge and enjoyment of science related topics.

You can also find more programs for educators at <http://ccesse.org/Educators.aspx>. For a list of nonprofit STEM programs, mostly in the Pikes Peak region, visit <http://ccesse.org/NonProfits.aspx>.



WHERE CAN I FIND DIVERSE PROFESSIONALS WORKING IN STEM FIELDS AND HOW CAN I CONNECT THEM TO MY STUDENTS?

Role models and mentors matter in the quest to increase the participation of females in STEM. There are several directories, such as FabFems and Million Women Mentors, aimed at matching girls to organizations that recruit and train role models and mentors (see Box 4.5). In addition, NCWIT's AspireIT program uses a near-peer model to connect high school and college women with K-12 girls interested in computing.

BOX 4.5. IN THE SPOTLIGHT:



FabFems

FabFems is a database of women who come from diverse backgrounds and career paths who work in STEM disciplines. Girls and family members who support them can search for and contact role models listed in the FabFems national directory.

The FabFems directory is accessible to young women, girl-serving STEM programs, and other organizations that are working to increase career awareness and interest in STEM for girls.

Search for mentors and role models at <http://www.fabfems.org/>.



Young women and their mentors can also try directly contacting companies interested in doing outreach with girls and under-represented populations and invite them to act as mentors for your school or community organization. Girls can also participate in formal mentoring programs offered by community organizations to expose them to female role models in their communities. Read more about mentoring in Box 4.6.

BOX 4.6. IN THE SPOTLIGHT:



Girls in STEM

The mission of Girls in STEM is to empower high school girls to seek out a STEM career by connecting them with a network of professional women in STEM industries. These women serve as role models and/or mentors to empower girls so that they can identify with, and ultimately visualize themselves in, a similar career. Throughout the program, girls have the opportunity to visit work sites and interact with professionals in STEM fields. Girls in STEM serves approximately 50 girls in the Denver metro area.



Learn more at

<http://www.gstemdenver.org>.

Before working with girls in schools or enrichment programs, mentors and role models benefit from formal training. Techbridge developed the Role Models Matter Toolkit to help professional women connect with young girls in ways that are beneficial for both mentees and mentors. This resource is great for anyone who works with girls, including those in community organizations. When mentors are not properly trained, unintentional messages may portray STEM careers as something unattainable.¹¹ Therefore, preparing women who will serve as mentors and role models is a critical step so that girls can see their future selves as STEM professionals.

Many community organizations practice inclusivity as part of their core mission. For example, Girls Inc. of Metro Denver builds in youth training programs as part of all professional development for their staff (see Box 3.7 in the previous chapter). The staff who work with girls in the Eureka! program (see Box 4.7) also benefit from youth development training.

BOX 4.7. IN THE SPOTLIGHT:

Eureka! Program At Girls Inc. Of Metro Denver

Girls Inc. of Metro Denver aims to develop girls' enthusiasm for and skills in science, technology, engineering, and mathematics. Through hands-on activities, girls explore, ask questions, and solve problems. They also consider careers in these fields by interacting with women and men pursuing such careers.



The Girls Inc. Eureka! program is an intensive, five-year, STEM-based program that builds girls' confidence and skills through hands-on opportunities. Utilizing a "whole girl" approach, the program also incorporates sports and physical fitness, personal development, and college and career readiness. Serving middle and high school girls from across the Denver metro area, Eureka! broadens girls' future academic and career interests, encourages enrollment in advanced math and science courses, promotes positive risk taking, and assists girls in developing networks of peers and mentors to support their future endeavors.

Girls in elementary school participate in a Eureka! pipeline program called *Creating the Future* that connects Lockheed Martin volunteers with girls ages 9-12 to strengthen their interest and confidence in pursuing STEM education and careers.

To learn more about Girls Inc. of Metro Denver's program, visit www.girlsincdenver.org.





WHAT ARE THE VARIOUS PATHWAYS TO ACCESS STEM CAREERS?

The preparation necessary to enter STEM careers is somewhat of a mismatch with our current educational system. The traditional high school science sequence— biology, chemistry, and physics, coupled with math levels— does not engage students in STEM learning experiences directly connected to the most in-demand, high-growth careers in engineering and computer science. As a matter of fact, most high schools do not offer engineering or computer science courses to the majority of their students. While some programs are being designed to integrate engineering principles, these specialized courses are often not widely available and tend to exist in the career and technical education space.

In addition, even though the majority of engineering majors at the college level require a foundation in physics, many students do not have the opportunity to study physics until the 11th or 12th grade if they go through a traditional biology-chemistry-physics sequence. However, if students start in lower-level science courses, they may never reach physics since they will fulfill their required three years of science before they

get a chance. Some schools have switched their course offerings to algebra-based physics¹² so that students can take a wider variety of courses that will open rather than close future choices. Other schools have redefined the high school experience by creating exploration courses for the first two years of high school and offering advanced courses relevant to a particular pathway the final two years.

Looking at the educational continuum as having multiple on-ramps and off-ramps can open and broaden choices for students who may not have considered a STEM pathway early in their education. Career exploration may also open up possibilities that may interest students as early as 9th grade or as late as 12th grade or into post-secondary experiences.

Exposure to multiple STEM learning experiences in and beyond the classroom can help engage students who may not have considered STEM careers at all. Denver Public Schools (see Box 4.8) and [St. Vrain Valley Schools](#)¹³ have created programs to expose students to a variety of STEM learning opportunities. These pathways intentionally embed out-of-school experiences through internships and community-based learning.

BOX 4.8. IN THE SPOTLIGHT:

Denver Public Schools (DPS) CareerConnect

DPS CareerConnect brings together over 100 local businesses and more than 15 colleges to help 6,000 students envision and pursue a personalized path to their professional aspirations.



DENVER PUBLIC SCHOOLS
CAREERCONNECT

CareerConnect pathways are designed to strengthen college and career readiness and deliver greater impact. The curriculum pathways include sequenced courses beginning in 9th grade and culminating in a diploma, as well as industry-recognized credentials/certificates and earned college credit. Students experience personalized learning and college exploration, Advanced Placement courses, and concurrent enrollment at either community colleges or higher educational institutions.

At the same time, DPS CareerConnect provides a valuable link between students and industries. Students participate in hands-on workplace experiences and mentoring. DPS CareerConnect equips graduates with high-demand skills and leads them to opportunities for continued education and careers in Colorado's fastest-growing and highest-opportunity industries.

More information is available at www.dpscareerconnect.org.



WHAT IS INTEGRATED STEM LEARNING?

STEM integration refers to providing students with opportunities to learn in settings that require the cross-pollination of disciplines. Often, integration occurs around a big idea, such as energy. For example, students can explore energy issues through both a science lens and a social studies lens while using math to solve real-world issues.

STEM integration gives students opportunities to experience engineering design, explore technologies, and develop the habits of mind of STEM professionals so that students prepare to solve 21st-century challenges.¹⁴ Integration in formal educational spaces for girls 14-18 is more complex than in earlier stages of girls' education. High schools are typically organized in silos, where the math department may be at the opposite end of the building as the science wing and where English and social studies teachers

may or may not see connections between their subjects and STEM learning. Students may also be tracked into certain courses by math ability, which means that some students may never have the opportunity to take advanced courses in certain disciplines, such as physics. All of this makes integrated STEM learning a challenge during this stage; however, with collaboration and an intentional plan, STEM integration is doable.

Although integrated STEM learning may appear more feasible in informal educational spaces, such as during after-school or summer programs, incorporating integrated STEM in school settings can help bridge disciplinary boundaries and provide students with opportunities to collaborate on meaningful projects that pertain to issues in their local communities. Bryan et al. (2016) propose three different types of integration: content integration, supporting content integration, or context integration.¹⁵ Content integration refers

to the integration of learning objectives from various STEM disciplines to create lessons or units of instruction. Supporting content integration refers to the prioritization of one of the disciplines to focus the lesson and using other disciplines to support the learning of the primary discipline. For example, using math skills to understand science concepts. Context integration refers to the utilization of a story to ground the experience for learning specific content for a specific discipline, for example, using a story of migration and settlement to understand natural resource availability. Each of these types of integration can create bridges among the disciplines, and with careful design, they can be powerful in students' STEM learning.

In addition, educators have the opportunity to access resources such as the *STEM Road Map: A Framework for Integrated STEM Education*¹⁶ and the [Arizona STEM Immersion Guide](#), which can help them assess what they are already doing and to better understand opportunities for

integration. The STEM Road Map suggests thematic units where each content area contributes content to create an experience in which students make connections between disciplines throughout the day. This resource also outlines ideas for problems or challenges students can explore in 9th, 10th, 11th, and 12th grades. The challenge with this approach is that in many districts, students do not take the same courses in the same sequence and so the proposed standards may have to be realigned. The STEM Road Map provides a foundation and schools and districts will have to determine how they can best use the ideas presented. To learn more, read about the STEM schools featured in Box 4.11.

Integrating STEM with policy issues can also help girls see connections to complex challenges facing our nation. The Keystone Science School offers several programs designed to create leaders ready to address these 21st-century challenges (see Box 4.9).

BOX 4.9. IN THE SPOTLIGHT:

Keystone Science School (KSS)

Keystone Science School is a 23-acre campus in Keystone, CO. KSS provides diverse and accessible programs around leadership development, STEM-based education, health and nutrition, teacher professional development, and experiential learning. KSS's programs prepare future leaders to address the increasingly complex issues our society faces.

In early 2015, KSS kicked off the Girls in STEM program to give young women the opportunity to explore the fields of science, technology, engineering, and math through games, experiments, and group activities. High school girls serve as student volunteers at Girls in STEM day programs.

KSS piloted an overnight retreat for upper-middle school and high school girls. This program is based loosely around the concept of "Start-up Weekend" with a focus on coding/apps/tech to have the girls work in teams and develop a marketable prototype.

Opportunities for high school students at KSS also include Basin Voyage, which is an application program open to students all over the country to delve into environmental education and issues while doing some outdoor education as well.

To learn more about upcoming events, visit <http://keystonescienceschool.org/>.





Girls can also benefit from integrated STEM learning experiences in summer programs or programs beyond the school day. CU Science Discovery offers a wealth of programming for students of all ages (see Box 4.10).

BOX 4.10. IN THE SPOTLIGHT:

CU Science Discovery- High School STEM Academies

The University of Colorado Science Discovery program's mission is to heighten interest and increase literacy in science, technology, engineering, and math by providing hands-on experiences that connect students and teachers to current CU science. Science Discovery capitalizes on CU-Boulder's scientific resources, facilities, and expertise to excite students about STEM, expose them to a variety of STEM careers and professionals, and inspire a future generation of scientists and engineers.



One of the programs Science Discovery offers allows students to have a STEM research experience during the summer months. Students in this program get to see firsthand what it is like to perform research at the university level. Last summer, one of their students, April, said: "From what I've seen over the past few weeks and have experienced, this might have to be one of the most exciting things I've done in my life. My research experience has been outstanding since I've gotten to work with kids and create things I couldn't even dream of. This whole experience has really opened my eyes to see what kind of new creations are created and just waiting to be made."

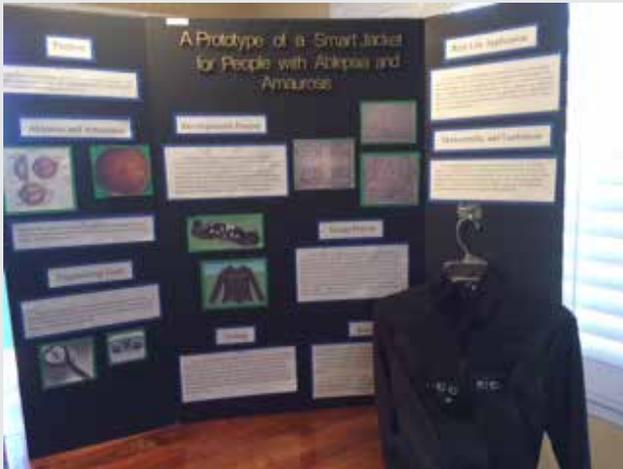


For more information, visit

<http://sciencediscovery.colorado.edu/>.



BOX 4.11. IN THE SPOTLIGHT:



Descriptions and Illustrations - Jacket



STEM School And Academy

The mission of the STEM High and Middle Schools in Highlands Ranch, CO is to provide an integrated educational system to engage all students in an academically rigorous core curricula, promoting a strong foundation in the sciences, technologies, engineering, and math, relevant to real-world contexts and building on student character and community assets to prepare students for successful post-secondary endeavors.



The student project above shows a prototype piece of clothing designed for people who suffer from Ablepsia, to help patients become aware of their surroundings, and for visually impaired individuals. The team of two brainstormed possible solutions considering the restrictions and availability of materials. Then, they selected their best option and created a prototype of the solution. Their jacket design was entered into the Technology Student Association competition.

Learn more at <http://www.stemhigh.org/>.



HOW CAN STUDENTS LEARN MORE ABOUT STEM CAREERS WHILE IN HIGH SCHOOL?

Incorporating career exploration in any STEM learning activity helps girls see a direct connection to the professions they can pursue in the near future. Mentors and role models, as discussed previously, can share their own pathways to STEM careers with girls. Exposing girls to a variety of STEM professions shows them the breadth of opportunities available to them. For example, girls may not be aware that there are many types of scientists and engineers. They may hold

on to stereotypes that reinforce the misconception that scientists are white men with crazy hair and glasses.¹⁷ Providing examples that counter this idea helps girls build a sense of identity or a STEM persona.

Girls can learn about STEM careers through direct exposure throughout the year as part of the units of study in their courses. They can also explore specific pathways as they build more confidence and realize that STEM skills can be improved over time. Internships and apprenticeships, described earlier, can be a great way to expose

young women to STEM careers. In addition, opportunities to shadow or to participate in research programs can also be great ways to expose girls to STEM.

Shadowing Or Externships

Job shadow opportunities introduce students to “a day in the life” of any given profession. This is typically a short event, which can last from one hour to a full day. Externships might last for a couple of days and are typically unpaid. The goal of externships is to give girls quick exposure so that they can decide if they want to pursue work in a specific field or with a specific company. These experiences offer great opportunities for girls to see women in the field and understand what their work is like.

Companies without the resources to host students for an entire summer and who want to expose students to their work and their employees in a real setting may find shadowing opportunities fit their goals. The commitment involved is minimal, and students, employers, and employees may decide to continue to work together if job shadowing experiences are successful.

Research Programs

Research programs share many characteristics with internship programs; students have the chance to contribute to an existing research project or to develop a question that they are interested in exploring. Research programs in the summer usually last six to eight weeks. During this time, students work alongside scientists or research engineers to test questions or develop solutions to problems. Research programs can also take place during the academic year, though these are more common for undergraduate students. Many universities also offer summer research programs for local students and may open up experiences for students across the nation.

Documenting Experiences

All students in Colorado are required to have an Individual Career and Academic Plan (ICAP). An ICAP is a central document with all academic and career-related activities. As students document their accomplishments, developing interests, and existing gaps in their education, they are better able to plan for future careers. College in Colorado also helps students with career planning (see Box 4.12). Having a record of programs and experiences they’ve participated in is a great asset for girls as they apply for college or pursue other pathways to reach their goals.

BOX 4.12. IN THE SPOTLIGHT:

College In Colorado

College In Colorado serves the state of Colorado by promoting access to, affordability of, and success in higher education for all students. College In Colorado provides services to help all Coloradans explore career and education pathways, break down barriers to post-secondary attainment, and create a plan for their post-secondary and workforce success.

By utilizing the College In Colorado portal, parents and students have access to a one-stop resource to plan, apply, and pay for college.

The College In Colorado team reaches out to students, parents, educators, and workforce centers through ongoing events and training opportunities, as well as providing practical tools to assist every student in Colorado in furthering their education past high school.¹⁸



To get started, visit

<https://www.collegeincolorado.org/>.

Girls can benefit from one-time career exploration events. Such events can cover a breadth of careers and help girls disrupt preconceived notions about what engineers or information technologists do and what they look like. While these events may provide initial introductions to STEM fields, they may not provide enough exposure to help girls see themselves as future STEM professionals capable of solving 21st-century challenges. Programs, such as Big Hair, Bigger Dreams (see Box 4.13), that develop longer lasting relationships through multiple touch points improve girls' STEM skills, inspire them, motivate them, and create a sense of belonging that girls may not otherwise experience on their own. These tools of empowerment will be critical for girls as they continue on their STEM journeys. The more confident, capable, and motivated girls become, the more likely it is that they will persist in STEM, even if the waters get rough.

BOX 4.13. IN THE SPOTLIGHT:

Big Hair, Bigger Dreams

Big Hair, Bigger Dreams is a nonprofit organization in Denver, CO that helps African American high school girls realize their potential by eliminating the barriers to their dreams. Through collaborations with organizations such as [CompuGirls](#), [TechnologyForAll](#), and [The JEKL Foundation](#), girls explore social justice issues by using technology tools to create webpages, videos, and apps. The organization creates culturally responsive programming with the whole girl in mind, relying on peer mentors who are graduates of past camps to connect with and inspire younger girls.

 [Learn more at
http://www.bighairbiggerdreams.org/.](http://www.bighairbiggerdreams.org/)



WHAT DO GIRLS NEED TO BE READY TO PURSUE POST-SECONDARY STEM OPPORTUNITIES?

We have shared many ways parents, educators, and community organizations can connect girls to different STEM opportunities. Girls benefit from exposure to career pathways early in high school so they can understand how to prepare for, enter, and advance in STEM fields. In addition to developing 21st-century and STEM skills, deep content knowledge, and real-world experiences, girls need to understand the various certificates and degrees that can help them land a career in a STEM field or prepare them to become entrepreneurs and job creators. You can read about a joint effort to expand access to certifications, training, and career pathways in Box 4.14.

BOX 4.14. IN THE SPOTLIGHT:

STEM Career Pathways

The Women's Foundation of Colorado and JPMorgan Chase funded the development and expansion of STEM career pathways in Delta School District and Poudre High School to serve more than 450 students. The [Colorado Workforce Development Council](#) (CWDC) and the [Colorado Education Initiative](#) (CEI) partnered to support these sites to ensure they are industry-driven pathways that align with local needs.

After a rigorous evaluation and selection process, CEI selected Poudre High School and Delta School District. Both sites are developing career pathway programs driven by local Sector Partnerships and the grants are enabling them to focus on expanding participation by female and low-income students.

Poudre High School expects an increase in female participation in its pathway classes from 20 percent to 50 percent and an increase of low-income students from 40 percent to 45 percent. It will implement a recruitment strategy to engage under-represented populations, expand internship opportunities at local businesses, create a CAD certification pathway, and upgrade a welding lab. Delta School District will implement a pathway program in each of its four high schools with a focus on supporting teachers with professional development and solidifying partnerships with local businesses to offer internship experiences for students. It expects to see increased participation of under-represented students, with a goal to have a student population that is 35 percent female and 40 percent low-income.

Additionally, the research and impact team at CEI is conducting an evaluation of the impact of the career pathway program on student outcomes and increased participation of female and low-income students. The team will conduct focus groups with administrators, teachers, and students to understand the strategies that supported program outcomes. Student outcome data will also be evaluated once available to understand impact.

In high school, students can prepare for various certificate, diploma, and degree programs. As early as 9th grade, a girl needs to ask herself if the course load she is taking is the most challenging for her. As girls navigate high school, they will notice many types of programs that may or may not lead to a degree. Understanding the difference between all of these programs and how they fit with their goals will help students make informed decisions. For example, some girls may want to pursue certificate programs or associate degrees through concurrent enrollment so that they can enter the workforce immediately after high school. Other young women might want to attend one of the newly approved Pathways In Technology Early College High Schools programs in the state (see Box 4.15). Girls may later decide to continue post-secondary education in a four-year degree program. The more information girls have about different educational options, the better prepared they are to pursue career opportunities.



BOX 4.15. IN THE SPOTLIGHT:

Pathways In Technology Early College High Schools (P-TECH) In Colorado

A 2016 press release from the Colorado Department of Higher Education and Colorado Department of Education indicated that two new P-TECH schools had been approved. The two new schools, located in St. Vrain Valley School District and El Paso County School District 49, are innovative, public, six-year high schools where students can earn an associate degree in a STEM field while simultaneously earning a high school diploma.

Learn more at <http://www.cde.state.co.us/postsecondary/p-tech>.



“The more information girls have about different educational options, the better prepared they are to pursue career opportunities.”

Concurrent Enrollment

The Concurrent Enrollment Programs Act, passed in May 2009, created opportunities for students to take one or more courses at post-secondary institutions before they receive a high school diploma. This means that students in Colorado can enroll in a local education agency (high school) and take post-secondary academic courses and career and technical education courses at the same time. The act also included the creation of a “5th year” program, ASCENT, in which students can take these courses for one year following the 12th grade. You can learn more about concurrent enrollment programs [here](#).

Advanced Placement And Mentorship

Students can also gain college credits through Advanced Placement (AP) courses. Students of color who are under-represented in STEM fields are also under-represented in AP courses.¹⁹ The lowest participation rate in STEM areas is in computer science and AP computer science courses also have among the lowest participation rates for students of color. Colorado Legacy Schools is seeking to change AP participation for the most under-represented groups by providing extensive training for AP teachers as well as coupling their program with a mentorship opportunity for students (Box 4.16).

BOX 4.16. IN THE SPOTLIGHT:

STEM Mentorship at Colorado Legacy Schools

The Colorado Education Initiative is partnering with companies to provide students with real-world understanding of STEM careers – especially girls and minority students who are under-represented in the STEM field. Through the STEM Mentor Program, industry leaders mentor students in Advanced Placement (AP) high school courses at participating Colorado Legacy Schools.

Specifically, the STEM Mentor Program is meant to support students that are typically under-represented in AP STEM classes. Pueblo Centennial and Abraham Lincoln high schools host STEM Mentors who share their personal career pathways, demonstrating the practical value of the skills developed through AP coursework and highlighting the obstacles they have overcome to succeed in male-dominated industries.

These STEM Mentors first meet AP students during class time then the bulk of the volunteer experience occurs outside the classroom. Throughout the school year, STEM Mentors engage small groups of students and develop students' relationships with STEM careers by meeting outside of class in informal sessions, connecting at Legacy School events, providing opportunities for students to observe STEM careers during organized site visits, and collaborating with AP teachers to host motivational events.



The following toolbox lists activities that girls should experience by the time they exit high school and pursue post-secondary opportunities. Parents, caregivers, educators, or community organizations can give this list to teenaged girls so that they can check off items on the list through their high school years.



TOOLBOX

Empowerment Strategies For Girls 14-18

- Educate yourself about the barriers women face in STEM fields, including in STEM classes and the workplace in general.
- Learn how to recognize bias and speak up against it.
- Know when to ask for help—this may include situations where you have been denied an opportunity because others assumed you were not interested. Ask for it. Also, ask your parents, caregivers, and friends to be your advocates and teach them how to recognize bias and micromessages so they can always watch your back.
- Learn about different careers.
- Meet and shadow STEM professionals.
- Learn about STEM pathways and STEM affiliated pathways by exploring [career clusters](#).
- Learn about skills necessary to pursue different pathways.
- Find an internship locally, or somewhere else in the nation or the world! You can start by visiting <http://www.internshipprograms.com/>. There are many other sites that can help you find internships in STEM.
- Join a STEM organization, such as the [Technology Student Association](#) (TSA).
- Enter a competition or a challenge.
- Take advantage of online courses or free learning platforms, such as [Khan Academy](#) or [code.org](#).
- Find funding, like STEM scholarships. Set aside two or three hours on Saturday or Sunday and dedicate this time for scholarship applications and researching post-secondary opportunities. If you have attended DPS for four years, check out the many options through the [Denver Scholarship Foundation](#). For other opportunities around Colorado, visit the resources listed in the [College In Colorado](#) site.
- Immerse yourself in a summer STEM experience. Do research through programs for high school students at a university across the state or the nation. Search for programs at the [Pathways to Science](#) advanced search page. There are also opportunities to conduct research at scientific and cultural organizations, such as the Denver Museum of Nature and Science (see Box 4.17) or Denver Zoo.
- Volunteer or travel across the nation or to another country to develop your STEM skills.
- Plan your own BioBlitz or participate in one!
 - What is a BioBlitz? “A BioBlitz is an event that focuses on finding and identifying as many species as possible in a specific area over a short period of time. At a BioBlitz, scientists, families, students, teachers, and other community members work together to get an overall count of the plants, animals, fungi, and other organisms that live in a place.”²⁰ Learn more at <http://www.nationalgeographic.org/encyclopedia/bioblitz/>.

BOX 4.17. IN THE SPOTLIGHT:**Teen Science Scholars @ DMNS**

The Teen Science Scholars (TSS) internship provides high school students opportunities to work in the Archives, Anthropology, Earth Sciences, Health Sciences, Museum Conservation, Space Sciences, and Zoology departments at the Denver Museum of Nature and Science. Selected students will be involved with various aspects of their mentors' research and/or collections programs. Students present overviews of their TSS work at an annual symposium held at the Museum at the end of the summer. This program introduces students interested in science careers to various aspects of museum research and/or collections work and helps strengthen investigative and communication skills. The internship program is open to students who will be entering their junior or senior year of high school.

This program has provided over 140 high school students the opportunity to be mentored by Museum scientists and collections staff since its beginning in 2006. Students who have completed this program have gone on to study science at universities such as MIT, Duke, and University of Denver. The program also provides a networking system for TSS alumni who help support students after the end of their internship.



**“The Teen Scholars Program really has given me that exposure
that I needed to really pursue a science career.”**

- Teen Science Scholar Georgina Romero

BOX 4.17. IN THE SPOTLIGHT: *CONTINUED*

Teen Science Scholars Reflection

In 2014, the Denver Museum of Nature & Science Health Sciences Department received an extensive histology collection from retired pathologist Dr. Robert H. Shikes. Following the work done in 2015, new Teen Science Scholar Georgina Romero and returning Scholar Ashley Hernandez set out to take the histology collection project to its next stage.

The goals for the collection were to create an easy-to-use database of all the slides and related notes. Ashley and Georgina dug into Dr. Shikes' teaching slides and affixed new Museum catalogue numbers printed on archival paper to facilitate future scientific research. They reviewed his slide keys in an attempt to match up his documentation and diagnoses to the slides. The database of diagnoses was then sent to colleagues in the Pathology Department and the Modern Human Anatomy program at the University of Colorado Anschutz Medical Campus, where the Museum would be given a professional opinion on the condition and medical value of the slides.

"For a couple of months, I felt like the Museum had always been a part of my life. I learned and matured more in two months at the Museum than I have anywhere else," Hernandez said. "That is the biggest thing I owe and thank this internship for: my personal growth. I learned the value and importance of community and teamwork."

"The Teen Scholars Program really has given me that exposure that I needed to really pursue a science career. I got to experience such new things on such an early stage of my school career," Romero said. "One of my favorite experiences from this program was going to Anschutz Medical Campus and learning how to properly digitize Dr. Robert H. Shikes' pathology slides."

The TSS application closes mid-spring each year. To apply, visit <http://www.dmns.org/about-us/jobs-and-internships/internships/>.

The following list provides a taste of books that feature girls in STEM roles. Share with your adolescent girls (and boys). Seeing other young women as heroines and problem solvers can help boost girls' confidence and inspire them to see themselves as creative, innovative thinkers who can design solutions for our most challenging 21st-century problems.



READ ALL ABOUT IT!

STEM Books for Adolescent Girls:

- [*Headstrong: 52 Women Who Changed Science – And The World*](#), by Rachel Swaby. This book shares the stories of 52 inspiring women who made contributions to science.
- [*101 Things You Wished You'd Invented–And Some You Wish No One Had*](#), by Richard Horne and Tracey Turner (Fiction). This book encourages readers to write their own ideas and to explore how certain inventions were created.
- [*Temple Grandin: How the Girl Who Loved Cows Embraced Autism and Changed the World*](#) by Sy Montgomery. This book is about Dr. Temple Grandin, a professor at Colorado State University, Fort Collins and an autism advocate.
- [*3:59*](#), by Gretchen McNeil. This science fiction horror story will keep young readers engaged 'til the end.

For additional STEM books for teens, visit:

[Young Adult Library Services Association](#)

[STEM Girls: Books with girls rocking science and math](#)

[A Mighty Girl](#)

Better STEM learning experiences can give girls more positive views about STEM fields and help them see themselves as future STEM professionals. Girls enjoy hands-on learning that is challenging and engaging. They want to know why things happen and are not engaged by rote memorization. Raising girls' awareness about the types of STEM opportunities available, while at the same time assuring that girls successfully graduate from high school, can open many doors for STEM opportunities. This action and awareness in turn prepares girls to help to solve the problems of the 21st century. Society often sends girls the message that they should pursue careers that serve others; interestingly, STEM professionals do just that, solving complex problems and creating tools that make our world a better place. These high-demand, middle- and high-skill STEM careers can help girls prepare for lives in which they can both earn family-sustaining wages and contribute to solutions to local and global problems.

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CHAPTER 5

I AM THRIVING... I AM CHANGING THE WORLD

“We have the opportunity to create the future and decide what that’s like.”

Mae Jemison,
The first African-American woman
to travel in space



Violeta García, PhD
Akaxia Cruz

Young adulthood is a time of transition and a time of rapid change. In this chapter, we provide information about resources and tools that help young women enter STEM training programs and career pathways that lead to family sustaining wages. Women age 19 and older benefit from professors and trainers who are willing to challenge their own biases to create equitable, inclusive spaces that support women’s skills and abilities. Young women can also get a boost from opportunities that help them build their self-confidence and from opportunities to lead. They need to learn about, explore, and understand the preparation required for the

many pathways that lead to STEM careers. During this stage in life, young women must prepare to enter the workforce with the skills and abilities they need to succeed and thrive in STEM fields.

In this chapter, we focus on topics and issues that impact young women and their entrance to, participation in, and retention in STEM careers. Critical issues for women between the ages of 19 and 30 include impostor syndrome, gender bias, low self-concept, self-doubt, childbearing expectations, and balancing a tight rope between being perceived as too feminine or too masculine.



OUTCOMES FOR WOMEN BEYOND 19 YEARS

As women enter adulthood, including women from diverse backgrounds who have been historically under-represented in STEM, they enter the STEM workforce or post-secondary STEM programs at rates that represent the diversity of all populations in the U.S. They:

- Understand on- and off-ramps for STEM careers and how to navigate the post-secondary space
- Access internships and apprenticeships
- Access mentorship programs
- Are aware of the STEM skills needed to succeed in post-secondary education or in workforce training programs
- Are aware of, prepared, motivated, and encouraged to obtain advanced degrees
- Can solve daily challenges in the workplace
- Can apply STEM skills to be engaged, contributing members in their community
- Use STEM skills to solve 21st-century challenges
- Are entrepreneurs or work in STEM fields that require mid- and high-level STEM skills
- Are self-sufficient and earn family sustaining wages through STEM careers
- Have opportunities for career advancement in STEM fields

A BRIEF LOOK AT ISSUES IMPACTING WOMEN'S PARTICIPATION IN STEM

Researchers have thoroughly documented women's participation in STEM in recent years. Reports such as [Why So Few?](#)¹ and [Solving the Equation](#)² by AAUW and [Double Jeopardy?: Gender Bias Against Women of Color in Science](#)³ paint a grim picture of the many issues that women face during these career-forming years. To begin, there are societal expectations that put a lot of pressure on women to have children while they are young.



EXPECTATIONS FOR CHILD BEARING

Women may face societal or community expectations to enter motherhood within a certain timeframe and they do not necessarily need to conform to those external expectations. Women working in STEM fields may face some bias regarding their decision to have or not have children, including biases regarding women of child-bearing age. Educators and employers may fear that there will be productivity losses or weakening commitment when women become pregnant, and opportunities for women to receive assignments that offer challenges and chances to grow may become limited. Collectively, the barriers women face as they enter child-bearing age and motherhood are referred to as the Maternal Wall.⁴

Ms. Ascencio landed her first job as a science teacher when she was 23. During a brief conversation with her female students, ages 14-16, they asked her, "How come you don't have kids yet?" Ms. Ascencio was caught a little off guard but promptly replied, "Because I want to continue my own studies and finish graduate school. Not all women have to have kids right after they graduate from high school or from college. I want to travel the world, then I'll decide if I want to get married and if I want to have kids. I've been to 19 countries so far! I love to travel." The girls went on to ask her about the places she had traveled to around the world.

Ms. Ascencio's experience highlights one of many issues that young women grapple with early in their careers. Societal expectations can send messages that women are expected to stay home and have children. It's important to teach girls and young women that they have the opportunity to pursue a career before having children. Ms. Ascencio's experience with her students highlights this childbearing expectation and she counters the expectation by sharing a different story of what she has chosen for her career path. Some women may choose to have children, others may not. Sharing her experience showed her students that there are options for them.

In addition to changing her students' expectation of roles in society, Ms. Ascencio noticed that her students did not have a clear understanding of careers and career paths, and their parents did not understand the idea of career pathways either. She created a space for her students to consider a wider range of post-secondary options other than having children as the first step after graduating from high school. She helped them establish goals and think about careers that

would help them earn family-sustaining wages so they could afford to support their future children with a higher quality of life.



HOW CAN WOMEN WITH CHILDREN SUCCESSFULLY NAVIGATE A STEM CAREER?

As educators, parents, and community organizations work to help advance young women in STEM, they can help them know and understand the following: (1) she can have a STEM career whether or not she has children, (2) she does not have to conform to external expectations regarding when she will start her family or have a family at all, and (3) if she does decide to have a family as she is navigating a career path, it may be helpful for her to know she may encounter biases and learn about effective ways to advocate for herself.

Ways to advocate can include having conversations with supervisors about career aspirations and mapping out an approach to fulfill those goals. When women are proactive about initiating those conversations and are clear about how much they want to take on, educators and employers may be more willing to help them reach their goals. Mentors can also encourage women who choose to have families to advocate for themselves when it comes to their employment compensation packages and to advocate for family-friendly policies that have been shown to support women's long-term success in STEM fields.

Mona was a graduate student completing her doctoral degree at a research institution. Initially, she was afraid to share that she was pregnant with her supervisor for fear that he might see her with differently or change his expectations. Sure enough, in preparation for her leave, her supervisor commented, "Don't worry, we'll go easy on you when you return."

Mona's story shows the importance of having conversations with her supervisor to share career aspirations and her desire to continue to advance in her career as well as being a parent. Regular opportunities to check in will remind her supervisor that this is her decision and she would like his full support in achieving her goals without lowering expectations of her potential.

The following section delves into gender bias and offers strategies parents and educators can use to change behaviors.



GENDER BIAS

Bias refers to the preferences every person has for certain things. This can be bias for a particular food type or a specific beverage. In school and in the workplace, this translates to bias for some students, a specific classroom, or the type of people with whom we prefer to interact, often subconsciously. Even scientists who pride themselves on having objective perspectives are inherently biased. In a study where scientists were asked to evaluate applications to hire a laboratory

manager, scientists preferred male candidates to female candidates. The applications were identical on paper, except for the names used: John vs. Jennifer. Both male and female scientists viewed female applicants as less desirable or less competent. Researchers found that science faculty members, regardless of gender, equally discriminated against female applicants.⁵ Biases are a result of stereotypes we have, such as, "Women are not well-suited to science."⁶ Researchers also found that "a belief in one's objectivity may increase biased behavior."⁸ Acknowledging that we all have biases is a vital step in understanding how it impacts our interactions with young women.

Paula consistently scores as high as her male classmates in her upper-division mathematics courses. One day during a math workshop Paula and her classmate Alex are reviewing concepts; Paula continues to help her peer understand the material at hand. When the workshop comes to an end, the organizing professor asks Alex to compete in a math contest. As a lover of math, Paula asks if she can participate in the contest also. The professor overlooks Paula and says that he doesn't think it is something she will be interested in. Although Paula is a mathematics major and scores just as high on exams as her male classmate Alex, her professor only extends the opportunity to Alex.

Paula and Alex's professor is exhibiting bias. This professor may not be aware of his bias towards female students. You can take Harvard's [Implicit Bias Test](#) online to find out what preferences you have and then reflect on the potential implications of these preferences. You may find that you, too, have a bias towards males in science or for females in humanities.

The first step in striving for equity is to acknowledge our biases as parents, as educators, and as humans. One strategy educators can employ to promote inclusive practices is conducting blind grading sessions. This is a process where the names of students are hidden, either written on the back of exams or concealed through the use of a random assigned code. The professor grades the exam and it is not until the very end that she finds out to whom the exam belonged.

Parents or caretakers can reduce gender bias by offering opportunities to their female and male children alike and praising choices based on interest rather than on gender. For example, when Marie came home to tell her dad that she wanted to major in engineering, her dad smirked and said, “What are you doing in a man’s field?” This statement can be a deal breaker for girls in Marie’s position. For her it became a challenge,

a goal that she was striving even harder to achieve. Her father’s bias did not stop her. However, he could have used supportive words such as, “How exciting! I bet you will have to work very hard, but I’m sure you can do it. I’m so proud of you for leading the way for other female students to follow.”

In addition to parents, counselors play a vital role in communicating expectations for girls. When discussing career options with young women, counselors may inadvertently dissuade girls from entering STEM pathways by not offering those pathways as possibilities. The National Alliance for Partnerships in Equity (NAPE) has developed a counselor toolkit to get people started with messaging that will improve outcomes for students considered non-traditional in certain career paths (see Box 5.1).

BOX 5.1. IN THE SPOTLIGHT:

National Alliance For Partnerships In Equity (NAPE)

The National Alliance for Partnerships in Equity (NAPE) is a consortium of state and local agencies, corporations, and national organizations. Through its four lines of business—professional development, technical assistance, research and evaluation, and advocacy—NAPE strives to achieve its mission of building educators’ capacity to implement effective solutions for increasing student access, educational equity, and workforce diversity. Project areas include:

- Strategies for special populations’ success
- Nontraditional career preparation programs
- [STEM Equity Pipeline™](#) focuses on STEM, including STEM-related career and technology education (CTE) through:
 - ◆ [Program Improvement Process for Equity in STEM](#) (PIPE-STEM™): Promoting institutional change program that improves enrollment, retention, and completion of students in STEM.
 - ◆ [Micromessaging to Reach and Teach Every Student™](#): Training teachers to use pedagogy to improve enrollment, retention, and completion of STEM students.
 - ◆ [Focus on Counselors Initiative](#): Coaching counselors to encourage girls and under-represented populations in STEM careers.
 - ◆ STEM Equity Tools and Resources: Providing tools to support the three programs including [webinars](#), research-based materials, and resources.

To learn more about NAPE visit <http://napequity.org/> 

Bias, coupled with societal expectations for women and their sense of belonging, can make some women feel inadequate in certain STEM professions. Women may feel they don't belong. Building a cadre of support and joining affinity groups may help women learn from people who may be experiencing similar situations. Teachers and professors as well as employers benefit from training to identify bias in the classroom and in the workplace. Strategies used to combat bias include blind review for selecting employees to work in labs or in permanent positions as well as developing inclusive spaces.

IMPOSTOR SYNDROME

Impostor syndrome or impostor phenomenon refers to a fear that accomplished women have that they may be “found out,” because they think that they do not deserve the success they've worked hard to achieve. This fear may sometimes be accompanied by self-sabotaging behavior that may hurt women's advancement in their chosen field.⁹ In the following example, Aryiah's doubt about her acceptance to graduate school has pushed her thoughts to a space where she feels like an impostor.

Aryiah was recently accepted into a PhD program for Theoretical Physics. The university she was admitted to offered her full-tuition funding; medical, vision, and dental insurance; a departmental fellowship; and a teaching assistantship to pay for housing and living costs during her first year of graduate school. After visiting the university, meeting professors and students, and being welcomed into the university, Aryiah still thinks that she does not deserve such a generous offer and continues to not let her current professors know that she was accepted into a program. She is afraid that the university will realize they made a mistake

and withdraw their offer. Only when she finally receives the list of incoming physics graduate students from the department does she believe she was truly accepted into the program.

Aryiah is afraid to express her successes because she is struggling with impostor syndrome. She fears she may be “found out” and the school might figure out she is a “fraud.” Aryiah can benefit from several strategies to counter these negative emotions. She can definitely “fake it 'til she becomes it.”¹⁰ By pretending to be more confident and knowledgeable than she perceives herself to be, she will gain the tools that will help her develop the skill set she needs and eventually recognize her own abilities as well. Increasing her confidence translates to a belief that she really does belong. In addition, the more Aryiah is recognized by her peers and the community of scholars once she is in graduate school, the better her self-concept will be and she will begin to embrace a stronger science persona. As Aryiah builds her skill set and her reputation, people respected in her field will also begin to recognize her abilities and she will feel a greater sense of belonging.

SELF-CONCEPT

Self-concept refers to the belief we have about our own abilities, including academic abilities.¹¹ Research has shown a strong correlation between academic self-concept and academic achievement. In other words, students who believe they are strong at math, for example, tend to perform better than those who have a low self-concept for that discipline.¹²

When Mayra was working on her undergraduate degree in computer science (CS), her experience included many setbacks and negative encounters that left her feeling demotivated. When she found herself to be the only woman in

her CS courses, she felt isolated, doubted whether she belonged in these classes, and wasn't sure if she would complete her degree. One professor reached out to her and pointed out the strengths he saw in her work which helped her make a 180-degree turn toward a more positive experience. As a student, Mayra also volunteered for an afterschool coding camp for children. She felt very confident in teaching computer skills to young children. She also became an upper class ambassador to talk to incoming students about her experience. She performed really well and took challenging classes with a more positive attitude.

Mayra's low self-concept regarding her ability to perform well in her undergraduate computer science courses was a self-fulfilling prophecy. She didn't believe she could do it, so she did not perform well. Her professor's positive reinforcement

helped change Mayra's perception of her abilities. She was able to perform well and successfully finish her degree program.

Educators can encourage young women by focusing on what they are doing well and build on their strengths. The messages that professors send can help or hinder young women's performance. Encouraging messages can lead to positive changes and help them develop a more confident and capable self, thus increasing their self-concept. Over time, this strategy can add affirmations that often help girls persist in these environments. In turn, young women in these programs can start to build up the value of self as a STEM professional. If a young woman does not see herself as belonging in these careers, she might not complete the program. It is imperative that the professionals who work with young women create opportunities for them to be part of these learning spaces to change the representation to be inclusive of our diverse society.



TOOLBOX

Helping Young Women Develop Strong Self-Concept

Women may have different motivating factors for pursuing STEM careers than their male counterparts. To create inclusive environments for women to feel a sense of belonging and to develop a belief that she has the skills and abilities to succeed, practitioners can take advantage of the research in motivation for women and men (Beier & Rittmayer, 2008).¹³ The following list includes strategies helpful for developing strong self-concept in young women:

- ✓ Educators can help create learning environments where women's interests are reflected in her environment and where education is engaging.
- ✓ Educators and workplaces can value women's contributions.
- ✓ Both educators and women benefit from understanding causal attributions (i.e. whether a student attributes her success to internal or external actions, how students perceive others' attitudes towards them, and how students perceive their capabilities compared to others).
- ✓ Educators can develop interventions which include classroom management.
- ✓ Educators and workplaces can increase access to and affordability of STEM-focused summer programs.

The next issue that we will discuss connects self-concept with the idea that no matter how good a woman is at a particular skill, her professors or colleagues do not quite believe it, so she has to prove her abilities over and over again.



PROVE IT AGAIN...AND AGAIN

Lisa was ecstatic! She was awarded a three-year fellowship by a scientific organization to complete her doctoral degree. When Lisa shared the news with her department chair, the department chair replied, "How did you get that fellowship?" Lisa was dumbfounded. She could not believe she had just been asked that question.

Lisa's hard work, excellent grades, and dedication to her research were not enough proof that she had earned this honor. She had to constantly prove her merit every time it was questioned or doubted. In a survey administered to 557 scientists, close to 65 percent of Latinas, and 77 percent of Black women report having to provide more evidence of competence than their colleagues.¹⁴

For women, spending extra energy proving their competence over and over can eventually lead to a subtle push out of the system. Another factor

that can push women out is impeded performance as a result of stereotype threat.

STEREOTYPE THREAT

Stereotype threat refers to an anxiety or "a fear of confirming a negative stereotype about your group."¹⁵

The day before a chemistry exam, Kesha was in a review session with her peers and the professor of the class. Near the end of the session, Kesha approached her professor and asked a question about an area to be tested on the exam. The professor responded by saying that she shouldn't worry about it, so Kesha asked if the concept in question had been removed from the exam. The professor responded by saying that it hadn't been removed, but that Kesha shouldn't worry because she likely wouldn't do well on the exam anyway since, "Girls just aren't very good at chemistry." Kesha walked away discouraged. The next day when she went in to take her test, all she could think about is the comment her professor made about girls being bad in chemistry. She focused all of her energy on her negative emotions and could not focus on the test itself. As a result, Kesha scored below the class average on the exam.

This constant tax on performance places women at a serious disadvantage compared to their male counterparts. A reduction in stereotype threat can lead to positive achievement in young women. Therefore, educators, including counselors, can benefit from professional development focused on creating supportive learning environments for female students.¹⁶



TIGHT ROPE

Supportive learning and workplace environments can offer opportunities to create more inclusive spaces for women. Some women are walking a tight rope between their own gender identities, being perceived as too feminine to be competent and taking on traditionally male characteristics as a means of workplace survival.

BALANCING A TIGHT ROPE

Defined masculine and feminine characteristics are often both societal and subjective. The story below of Larissa's experience in a mathematics department is just one illustration of how such norms may be perceived.

Larissa began her first day of classes by wearing jeans and no makeup, although she personally prefers to wear dresses. She also loves to wear fun eyeshadow colors and take time to do her hair. However, when she entered graduate school for mathematics, she thought her professors and peers would not take her seriously if she showed up on the first day of classes wearing a dress and eyeshadow to match. Larissa continued to silence her expression

of femininity throughout graduate school because she wanted to be respected as a mathematician. She felt that if she embraced her feminine side, her professors and peers would view her as less credible. As time passed, she connected with more females in mathematics, and realized that she could embrace her authentic self; as a result her confidence improved.

Larissa feels she has to take on more stereotypically masculine characteristics for her work to be respected. This type of bias can be very damaging to the development of a positive STEM identity where being a female STEM professional is widely accepted. Norms and expectations can change as more women enter and remain in STEM fields and as young women have more opportunities to connect with female STEM role models. Research shows, however, that if female role models are perceived as overly feminine it can backfire.¹⁷ Girls may not perceive combining stereotypical femininity and STEM success as plausible options for their future.

The issues presented above are detailed in a way that assumes that women have already entered a STEM space. This is not the case for many women ages 19-30. The second half of the chapter focuses on access to STEM careers and offers strategies for personal advocacy for women, for their parents, and for community organizations serving early-career women.



ACCESS AND EQUITY

By the time women reach age 19, they may have opted to pursue a STEM pathway, self-selected out of a STEM pathway, or realized that they did not have enough information to understand the benefits of entering a STEM career. In certain circumstances, they may also have been unconsciously pushed into non-STEM

career pathways. Self-selection out of STEM pathways can occur due to a lack of preparation, including courses unavailable in high school or early college years. Women might not be aware of the opportunities offered through STEM careers. However, because women enter the workforce at multiple stages (i.e., out of high school, after college, somewhere in-between, or as a career change) there are opportunities to re-engage even if a STEM career was not necessarily on their initial career plan.

CAN WOMEN ENTER A STEM CAREER IF THEY DID NOT GRADUATE FROM HIGH SCHOOL?

Employment choices in STEM are available for women who did not graduate from high school, including construction manager, bus and truck mechanics, wholesale and manufacturing jobs, electricians, machinists, maintenance and repair workers, and home health aides.¹⁸ Over a lifetime, women who did not graduate from high school will make an average of \$973,000.¹⁹ The top earning occupations with less than a high school diploma are in middle-skill STEM jobs (Figure 5.1). All of these employment options would result in higher pay if a worker completes high school and even bigger salary boosts after additional post-secondary education. For more information on STEM salaries and career resources visit <https://www.bls.gov/careeroutlook/subject/stem.htm>.

FIGURE 5.1. FIVE TOP-EARNING OCCUPATIONS FOR PEOPLE WITH LESS THAN A HIGH SCHOOL DIPLOMA²⁰

Lifetime earnings in 2009 dollars		
Less than High School	First-Line Supervisors/Managers of Construction Trades and Extraction Workers	\$1,741,000
Less than High School	Construction Managers	\$1,549,000
Less than High School	Industrial and Refractory Machinery Mechanics	\$1,494,000
Less than High School	First-Line Supervisors/Managers of Production and Operating Workers	\$1,474,000
Less than High School	Construction Equipment Operators, except Paving, Surfacing, and Tamping Equipment Operators	\$1,435,000

ENTERING STEM CAREER WITH A HIGH SCHOOL DIPLOMA OR ITS EQUIVALENT

A high school diploma increases the potential for higher pay, but the lifetime salary range is about half of what women could make in a lifetime if they pursue additional post-secondary education. Careers include work in construction trades and as electricians. Figure 5.2 highlights the top five occupations for people with a high school diploma.²¹

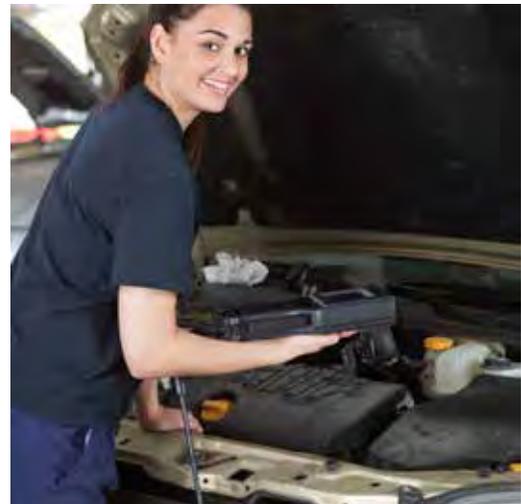
FIGURE 5.2. FIVE TOP-EARNING OCCUPATIONS FOR PEOPLE WITH A HIGH SCHOOL DIPLOMA

Lifetime earnings in 2009 dollars		
High School Diploma	General and Operations Managers	\$2,156,000
High School Diploma	Construction Managers	\$2,004,000
High School Diploma	First-Line Supervisors/Managers of Construction Trades and Extraction Workers	\$1,975,000
High School Diploma	Miscellaneous Managers, including Engineering, Funeral Directors, Postmasters and Mall Superintendents	\$1,876,000
High School Diploma	Electricians	\$1,834,000

EDUCATIONAL AND CAREER PATHWAYS

The variety of STEM occupations creates many opportunities for women in STEM. To take advantage of these opportunities, women need to know about and understand on- and off-ramps for STEM careers. For example, a young woman who did not complete high school can enter a STEM occupation, but staying at an entry level may not provide a livable wage. When women enter STEM occupations at this level, they benefit from understanding the steps they can take to learn additional skills and access opportunities to secure better wages.

Women can access middle-skill STEM jobs with various types of post-secondary education including certificate programs, associates degrees, and on-the-job training. They can also access STEM opportunities through four-year bachelor's degree programs and post-graduate education. The combination of experience and training can pave the way for stackable credentials that help women achieve industry certifications. The term 'stackable credential' refers to a component of a sequence of



credentials that can be attained to build up an individual's qualifications to help them advance in a career pathway to access different and potentially higher paying jobs.²² Industry certification refers to programs developed by various industries with specific objectives determined by industry professionals to meet the needs of that particular industry. This type of certification shows workers' skills, abilities, and competencies. This can be in the form of course completion, examinations, and the issuing of professional licenses in the given field.²³



Women can earn money on their way to completing a four-year post-secondary degree.²⁴ Those who have some college training or have finished short degree or certificate programs can access middle-skill STEM jobs and can choose to continue to learn more skills to access additional opportunities. On-the-job training, which can take a year or more, is also an option.²⁵ Understanding the many paths women can take on their way to earning a bachelor's degree can help them make better career decisions. For example, women can take advantage of apprenticeships and internships. They can earn an associate degree and earn industry-based certifications or post-secondary certificates.

There are middle-skill STEM career pathways that would be a good fit for those who choose these paths. Earning an associate degree takes approximately two years when attending full-time and can lead to high-paying STEM job opportunities. STEMJobs.com published a [list](#) of job possibilities. We acknowledge that those pathways also offer a good way to have on-the-job learning opportunities while continuing to work towards a bachelor's degree if a woman so chooses.

Bachelor's degrees are typically four-year degree programs offered at colleges and universities. STEM jobs like petroleum engineer, computer and information research scientist, marine architect, and business intelligence analyst require bachelor's degrees. For most advanced degrees in STEM, a bachelor's degree is a required prerequisite for graduate school.

Women continue to be under-represented in STEM majors in college. Only 6 percent of women entering college after high school graduation intend to major in engineering, 1 percent of women pursue majors in chemistry, 1 percent in computer science, 1 percent in mathematics/statistics, and 0.3 percent intend to major in physics. The highest percentage of women intending to major in a STEM field after high school is in biological and life science at 16 percent.²⁶ The largest gap between genders is in engineering (6 percent female vs. 19 percent male) and computer science (1 percent female vs. 6 percent male).²⁷

Students who entered a STEM field at a highly selective school are more likely to complete a four-year degree program. On average, the national retention rate is 60 percent for engineering and 40 percent for computing. While an increased number of women have completed engineering degrees, going from 1 percent in the 1970's to 19 percent in 2013, we have a lot of work to do to better understand why women stay in a given field and why they leave. For an in-depth exploration of gender bias that impacts women, read [Double Jeopardy?: Gender Bias Against Women of Color in Science](#).²⁸ Among the list of [10 best colleges for females in STEM](#) is Harvey Mudd. This school increased female participation in computer science fourfold, from less than 10 percent to close to 39 percent. Harvey Mudd has taken steps to make learning more relevant to female students and to place them in workplace environments where they can thrive.

This includes offering an introductory Computer Science course to all entering students that counts towards their general requirements, which solidifies a foundation for success in later courses.

Some of the best opportunities for women, including women of color, with bachelor's degrees in STEM fields are in engineering and computer science. These fields offer a higher

return on investment and numerous high-quality job opportunities where women can earn family-sustaining wages. See Figure 5.3 for a list of the top five earning occupations for people with a bachelor's degree. The gender pay gap in these professions is also much smaller than in non-STEM professions with women earning 88 to 91 percent of what men make, compared to 78 percent for the female workforce outside of STEM.²⁹

FIGURE 5.3. FIVE TOP-EARNING OCCUPATIONS FOR PEOPLE WITH A BACHELOR'S DEGREE

Lifetime earnings in 2009 dollars		
Bachelor's Degree	Chief Executives and Legislators	\$4,843,000
Bachelor's Degree	Computer and Information Systems Managers	\$3,721,000
Bachelor's Degree	Aerospace, Biomedical, Agricultural, Chemical, Computer Hardware, Environmental, Marine, Materials, Petroleum, Mining, Geological Engineers	\$3,558,000
Bachelor's Degree	Computer Software Engineers	\$3,554,000
Bachelor's Degree	Marketing and Sales Managers	\$3,494,000

Careers in natural resources have entry points at multiple educational levels. To learn more about careers in natural resources, see Box 5.2.

BOX 5.2. IN THE SPOTLIGHT:

A How-To Guide For Pursuing A Career In Natural Resources (College And Young Adults)

Considering a natural resource career? The "How-To Guide for Pursuing a Career in Natural Resources" provides: (1) an exploration of the variety of fields and careers available in natural resources, (2) outlines of the education and training needed for those careers, (3) detailed instructions for navigating the federal application process and tips for applying for a federal job, and (4) insight into state and local natural resource careers, where and how to apply for open positions, and how to be a successful candidate.

<http://www.getoutdoorscolorado.org/jobs/career-planning-resources>



ADVANCED DEGREES

No matter what the entry point to a STEM career, women benefit from understanding opportunities to advance and pursue leadership positions. This can be through on-the-job training opportunities or opportunities for women to continue to pursue and complete post-secondary degrees. Many companies offer tuition reimbursement programs where employees can pursue advanced degrees, such as business administration, or even bachelor's degrees, such as Starbucks' [College Achievement Plan](#). As women enter the workforce, they should consider if their employers offer these types of benefits in addition to other benefits commonly offered, such as health and dental plans.

There are many ways for women to pursue advanced degrees without creating a financial burden. Many scholarships and fellowship programs seek to increase the participation of women and women of color in STEM fields. For example, the National Science Foundation's Graduate Research Fellowship Program ([GRFP](#)) and individual fellowships through the National Institutes of Health ([NIH](#)) are good options for women seeking to have a broader impact in their communities through STEM occupations. Graduate students can also seek teaching assistantships or research assistantships to help pay for advanced studies.

“When young women understand the expectations of their positions and the performance indicators that will be used to gauge their progress, they are more likely to meet those expectations and to be compensated in an equitable manner.”



WHAT ARE OPPORTUNITIES FOR CAREER ADVANCEMENT IN STEM FIELDS?

Opportunities for advancement in STEM occupations come as a result of advanced training, whether on the job, through formal post-secondary degrees, or certificate programs. Advancement opportunities can also be achieved by pursuing training in complementary fields, such as a master's degree in business administration. This type of degree can help a medical professional, consulting engineer, or anyone looking to start a business. It is not necessary, but it is certainly helpful.

To advance in STEM fields, it is also important to have a clear understanding of performance indicators on the job. For example: Do women have a clear understanding of performance indicators that will be used to rate their progress? Are they written down in the performance plan? Are these measures or indicators reasonably attainable? When young women understand the expectations of their positions and the performance indicators that will be to gauge their progress, they are more likely to meet those expectations and to be compensated in an equitable manner.

WHAT ARE SPECIAL CONSIDERATIONS FOR EARLY CAREER WOMEN? HOW CAN WE BEST SUPPORT THEM?

The issues presented at the beginning of this chapter trickle into the workplace. Bias, for example, is an issue that we all know needs to be addressed, but poses uncomfortable conversations among colleagues. Often, women, especially women of color, feel isolated in workplaces that are dominated by values and interests that may be different than their own. Stereotypes, feelings of isolation, and having to prove their abilities over and over take a toll on women. Therefore, creating inclusive workspaces is an essential step if we want to retain women once they enter the STEM workforce.

Inclusive spaces are those where women feel welcome and a sense of belonging, where women feel they are part of the team, their ideas are valued, and their expertise is recognized. In inclusive spaces, women are provided with opportunities to lead just as often as their male counterparts. They have mentors and sponsors who can help them navigate the system. Their supervisors have set clear performance review expectations. All of these components are essential to supporting women and increase the chances of retaining them in the STEM workforce.

The following toolboxes have been created for specific groups: women, parents or guardians, and community organizations. They offer ideas so that we can, together, change the representation of women in STEM occupations.



TOOLBOX

Be Your Own Best Advocate

- Know what you want and need.
- Ask for what you want and need.
- Take risks. Create your own path if one does not yet exist.
- Embrace empathy. Listen to others and create a different culture, one that is more inclusive of women, including women of color, in STEM fields. People want to be heard. Acknowledge people's contributions, especially contributions by other women, so you and others can see their value and bring it to the forefront.
- Find mentors: Because a large percentage of the STEM workforce is comprised of white men, chances are you will have a man as a mentor. Take the time to get to know them. Also consider seeking out female mentors when possible. You may find that having role models who look like you will help to enhance the belief that you can achieve what you set your mind to and develop the skills you need to succeed.
- Treat men as allies. Don't discount efforts by men to help you on your path to success.
- Know how to accept praise. Practice saying, "Thank you so much for recognizing my hard work." or "Thank you, I worked hard to accomplish these results." Don't downplay your accomplishments by dismissing them.
- Be sure you understand the performance indicators to which you will be held accountable.



TOOLBOX

Parents/Guardians of Young Women

- Talk with your daughter about her accomplishments and her struggles. Serve as a cheerleader to support her efforts and offer your emotional support even if you might not understand the technical aspects of her educational program or future career.
- Ask questions to learn more about your what daughter does or what she is training for.
- Ask for a tour to see what she does at school and at work.
- Teach your daughter how to thrive and then let her use those skills. In the post-secondary space, it is her turn to put life skills into practice. Let her manage her own time, plan long-term projects, etc.



TOOLBOX

Community Organizations Serving Young Women (Ages 19-30)

- Train mentors and mentees embarking on a mentoring relationship.
- Train staff on best practices to create inclusive spaces for women and girls.
- Connect women to STEM opportunities.
- Connect young women to mentors or role models.
- Showcase the work of female STEM professionals through your communication channels.
- Provide tools for parents and educators to spread the message of the importance of girls pursuing STEM careers.

EDUCATORS

Counselors and instructors at all levels can benefit from learning about the wide range of STEM career options. All the vignettes presented at the beginning of the chapter highlight an important need: to create awareness that an issue exists (i.e., gender and/or racial bias) and to provide tools and trainings to change behaviors.

Counselors can help young women explore careers that are nontraditional for their gender. They can help young women by connecting their individual interests and passions with opportunities to pursue them through STEM careers. To do this, counselors can familiarize themselves with messaging that works to engage female students in STEM. Counselors and instructors can also examine their own perceptions and take the [Implicit Bias Test](#) so they understand their own biases and consider if they are behaving in ways that marginalize certain students. Check

out the resources at the National Center for Women & Information Technology, Counselors for Computing ([C4C](#)), and the National Alliance for Partnerships in Equity [Focus on Counselors Initiative](#).

Educators can also help young women identify the skill set needed for different occupations and how those skills translate into a degree program that they can pursue. Organizations like Skillful can help educators understand what employers are looking for.³⁰ When young women know the skill set needed in a given field, they can identify gaps in their learning and focus on the specific skills they need to master. Take Pia's story for example (Box 5.3). Pia was able to identify the gaps in her learning and gain those skills with the help of online resources and specialized programs. MotherCoders is not yet available in Colorado at the time of this writing, but it offers an inspiring example of an organization helping mothers pursue careers in information technology.



BOX 5.3. IN THE SPOTLIGHT:

MotherCoders – Pia’s Story

Two years ago, I was one of six women picked to be part of MotherCoders, a tech orientation program for moms. For six Saturdays, we learned the basics of web development and gained an understanding of the tech landscape through female speakers from different sectors of the industry. That experience gave me the courage to start a new career as a web developer.

As a mom I was looking for flexibility in my work schedule so that I could be more available to my children. I also wanted to do something that made use of my creative flair, technical propensity, and passion for fashion. So I set out to gain the skills and experience necessary to be a web developer in the fashion e-commerce space. And now I am a web content developer at Gap Inc., where I get to work from home most days of the week. This gives me the flexibility I need to care for my family and I get to work on exciting things with smart and creative people.

It took me two years to transition into this new career. I was pregnant with my third child during my time at MotherCoders. I also had to keep my full-time job as a clinical lab scientist in order to afford living in San Francisco. I learned HTML and CSS in my spare time through online classes like Skillcrush, Code School, Code Academy, and Treehouse. I started making websites for my family, small organizations, and for myself. I also networked through Facebook groups and attended local Women Who Code events.

Last year, I was accepted into TechSF’s front-end web development bootcamp for women at no cost. For three months, I attended class every weeknight. At this point, I reduced my hours at work so I could manage my class load and still have time for my family. There, I strengthened my skills in HTML, CSS, and learned JavaScript. Shortly after graduation, I started working for a local startup and then at Gap Inc.

This journey has been full of obstacles, yet it was not impossible. I am truly grateful for the resources, opportunities, guidance, and support given by friends, families, and the tech community.

Visit <http://www.mothercoders.org/> to learn more about MotherCoders. 



Counselors and other educators can also help connect women to mentors, near-peer mentors, and role models, so early career women can explore the various pathways to access STEM careers. Young women benefit from seeing and interacting with women who are in the occupations they aspire to pursue.

MENTORING PROGRAMS

Mentors serve as windows to the future for young women. With adequate preparation, mentors can connect young women to many future career opportunities. Access to training for mentors and mentees and selecting mentors (including professionals who have work/life integration) that portray a positive image of females in STEM is important to the success of mentoring programs.³¹ Young women can find mentors by connecting with professionals in their local communities or by going through a formal organization, such as [Million Women Mentors](#).

Every community has different opportunities. One of the best ways for young women to get to

know what's happening in their local community may be through networking events at their school or throughout the community. Educators can share information about these events with their students or seek out local employers and work with them to connect their employees with local students. Employers can encourage their employees to engage with the community and spread information about the impact of STEM work in their industry.

When professionals become part of young women's networks, young women will see that it is important for them to give back, too, once they enter the workforce or the next stage in their educational continuum. STEM Connect aims to link role models to younger girls of color interested in STEM careers (see Box 5.4).

BOX 5.4. IN THE SPOTLIGHT:

STEM Connect

STEM Connect creates opportunities for role models, mentors, and STEM professionals to support the Dr. Justina Ford STEM programs. Exposing girls of color to STEM careers boosts representation of diverse women in the workforce.

Girls who participate in the Dr. Justina Ford STEM Institute and summer program have the opportunity to strengthen their understanding of math and science concepts.

Mentors in STEM fields interact with participating girls to build awareness of careers and career pathways so that all girls can reach their full potential and pursue STEM occupations.

To learn more about getting involved in the Dr. Justina Ford STEM Institute and become a STEM Connect Mentor or Role Model, visit <http://www.jfsteminstitute.com/>.



Long-term mentoring relationships benefit young women early in their careers. However, if young women can't have mentoring relationships, they can certainly benefit from shorter interactions with role models and hearing their stories. [Careergirls.org](http://careergirls.org) has over 7,000 profiles of female role models, most of them in STEM careers.

Women veterans face unique challenges as they integrate into the civilian workforce, so it is especially important that they find opportunities to meet women mentors who have entered and persisted in STEM careers (see Box 5.5). You can read about inspiring Latina women in military service, both active and civilian in this [Latina Style feature](#).

BOX 5.5. IN THE SPOTLIGHT:

Women Veterans Of Colorado

Theresa Z. Blumberg, co-founder of Women Veterans of Colorado, recognized that there is a distinct adjustment women have to make as they move from military to civilian lives. As a result, she created a space where women can connect with resources, including ways to utilize their well-earned benefits, prevent homelessness, and assist them to enter career paths where women veterans can realize their full potential. This volunteer organization partners with community resources such as Salute Colorado, government agencies, and nonprofits to realize their mission. For more information, visit Women Veterans of Colorado at <http://womenveteransofcolorado.org/>.

[Salute Colorado](#) is a two-year program intended to provide veterans of the U.S. Armed Forces with specialized services to meet their individual needs. Veterans are assigned a mentor who provides personalized advice and helps them with the transition to civilian life. The mentor helps the assigned veteran with career development, including exploring entrepreneurial career paths. At the time of this writing, Salute Colorado serves Boulder and Denver residents with plans to expand in the future.

Young women can meet mentors through internship or research experiences at organizations such as UCAR/NCAR (see Box 5.6) and other [national labs](#). Another way to connect with a mentor is through professional organizations in the specific discipline of study such as the American Physical Association's [Women in Physics](#) program or through professional organizations seeking to advance under-represented students in STEM (see Start Here! - Professional Organizations & Networks on page 152)

BOX 5.6. IN THE SPOTLIGHT:

NCAR/UCAR

The University Corporation for Atmospheric Research (UCAR) is a nonprofit consortium of more than 100 North American member colleges and universities focused on research and training in the atmospheric and related Earth system sciences. UCAR manages the National Center for Atmospheric Research (NCAR) with sponsorship by the National Science Foundation. Through its community programs, UCAR supports and extends the capabilities of our academic consortium.

UCAR/NCAR offers a wide range of opportunities throughout the year, including summer programs for college, university, and graduate students.

For full details on undergraduate opportunities at NCAR/UCAR, visit <https://www2.ucar.edu/opportunities/undergrads>.

Organizations focused specifically on creating awareness, inspiring, and preparing students from demographics historically under-represented in STEM careers can be beneficial. Some of these organizations address issues relevant to students with intersectional identities, such as being African American and female or being Latina and first generation. For resources pertaining to women with special abilities, visit the AbilityLinks.org [blog](#).





START HERE!

Professional Organizations & Networks Serving Women, Including Women From Under-Represented Groups, In STEM

- American Association of University Women ([AAUW](#))
- American Indian Science and Engineering Society ([AISES](#))
- Association for Women in Science ([AWIS](#))
- Association of Black Psychologists ([ABPsi](#))
- Black Data Processing Associates ([BDPA](#))
- Black Engineer of the Year STEM Conference ([BEYA](#))
- Great Minds in STEM ([GMIS](#)), formerly Hispanic Engineer National Achievement Awards Conference (HENAAC), promotes Science, Technology, Engineering, and Math careers especially in underserved communities.
- Latinas in STEM ([LatinasInSTEM](#))
- Latinos in Science and Engineering ([MAES](#))
- National Action Council for Minorities in Engineering ([NACME](#))
- National Association of Multicultural Engineering Program Advocates ([NAMEPA](#))
- National Consortium for Graduate Degrees for Minorities in Engineering & Science, Inc. ([GEM](#))
- National Society for Minorities in Agriculture, Natural Resources and Related Sciences ([MANRRS](#))
- National Society of Black Engineers ([NSBE](#))
- National Society of Black Physicists ([NSBP](#))
- National Society of Hispanic Physicists ([NSHP](#))
- SACNAS: Advancing Chicano/Hispanics and Native Americans in Science ([SACNAS](#))
- Society of Women Engineers ([SWE](#))
- Society of Hispanic Professional Engineers ([SHPE](#))
- Women in Engineering ProActive Network ([WEPAN](#))
- Women of Color STEM Conference ([WOC STEM](#))
- Women in STEM Knowledge Center ([WSKC](#))

Young women can find entry points into STEM careers while in high school, after earning a high school diploma, during college, after earning a two or a four-year degree, or upon completion of a graduate degree. At all stages, women need to examine where they are in their educational trajectory, to know what skills they possess, and to consider where they have gaps.

Yuliya's story is a good example of a single mom entering a health career after she divorced and needed to find a way to sustain her family (see Box 5.7). A conversation with a doctor sparked her interest in the medical field. She then had to figure out what her on-ramp to a STEM career would be and how to prepare for the occupation she wanted.

BOX 5.7. IN THE SPOTLIGHT:

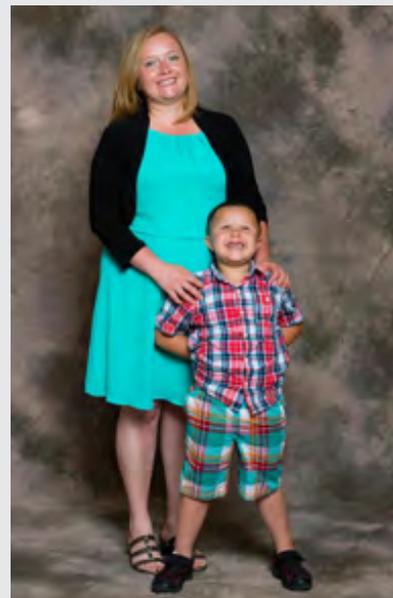
Project Self-Sufficiency – Yuliya Mozgova’s Story

My name is Yuliya Mozgova. I am originally from Ukraine. I am now a U.S. citizen. I came to the U.S. in summer 2006 for an internship in the business office at YMCA of the Rockies. I fell in love, got married, and had a handsome child who means the world to me. But things did not work out as I planned and I got separated from my husband. Later, I divorced and became a single mother in a foreign country with a 2-year-old boy and very limited resources for support. It was tough. I worked as a nurse’s aide in a local hospital in Estes Park, CO, and later as a medical assistant/phlebotomist in an urgent care. I had a really hard time emotionally, socially, and financially. I had no support system.

Following the divorce, I found myself in debt and working three jobs just to pay my debts and support my family. One evening, while assisting the doctor to suture a patient, I mentioned that I enjoyed the medical field and he said to me, “You should become a nurse.” That day, I came home and began researching nursing schools and decided to apply to Front Range Community College (FRCC). I met with nursing school advisors and things were looking good for me to start school in the fall of 2011, but I soon realized that driving from Estes Park to Fort Collins and having reliable child care was a problematic issue. I postponed my school until the next semester and then later pushed it back again. I was ready to give up on the idea of becoming a nurse.

My nursing school advisor was concerned that I did not start right away. I mentioned that I was not in a good spot and I did not know if I would ever be in a good spot to start nursing school. She told me about Project Self-Sufficiency (PS-S), a nonprofit in Larimer County, that supports single parents in becoming financially independent. The focus of PS-S is on improving the quality of life for parents and their children. I filled out the application and was accepted. I started in the PS-S program in July 2012. Working with my PS-S advisor, we built a solid career plan. I wanted to continue to work in the medical field as a medical assistant/phlebotomist and to go to school full-time, pay my debts, and apply for scholarships. My goal was to become a registered nurse and earn a self-sufficient wage for my son and myself.

PS-S helped me with scholarships, child care, and back-to-school clothes and extracurricular activities for my son along with Christmas gifts, a bike, dental care, counseling, and other unexpected expenses so that I could focus on school. In the fall of 2013, I moved from Estes Park to Loveland to be closer to school and got a job with UCHealth/Poudre Valley Hospital as a nursing assistant. In May 2015, I graduated from FRCC with an associate degree in nursing.



BOX 5.7. IN THE SPOTLIGHT: *CONTINUED*

I am now employed as a float nurse at UCHealth – Northern Region and I absolutely love what I do. My new career has made me more financially stable and secure; for the first time in my life I have a savings account and retirement plan and I can plan for my son’s college education. At six years old, he wants to be a veterinarian. I am now going on to get my bachelor’s degree in nursing from the University of Northern Colorado.

My motto in life: Have confidence in yourself. Have a strong sense of purpose. Always try your hardest for perfection. Never consider the idea of failing. Work extremely hard towards your goals. Be strong, and never give up.

-Contribution by Susan Polis Schutz

For more information about Project Self-Sufficiency, visit <http://www.ps-s.org>. 

Other women, including women graduating with degrees from Ivy League universities, may not know what their options are post-graduation. Arete’s Bridge (Box 5.8) has developed a training program to meet the needs of businesses that want a specific skill set in their employees, but are unable to find employees with that skill set. Businesses then hire Arete’s Bridge to train recent graduates to match the skills needed in their particular field.

BOX 5.8. IN THE SPOTLIGHT:

Some students are so excited to get into college that they may not think about what next steps may be. When they graduate from college, there may be a disconnect between fields of study and skills employers need. This is what prompted Arete’s Bridge to develop continuous training programs adaptable to changing technologies in real time for recent grads and for mid-career changers.

To learn more about Arete’s Bridge, visit <http://www.aretesbridge.com/index.html>. 



SOLVING DAILY CHALLENGES IN THE WORKPLACE USING STEM SKILLS

STEM graduates have problem solving, communication, and critical thinking skills. Even if women who major in STEM disciplines work in non-STEM fields, they bring a special skill set that may not always be found in graduates outside of these disciplines.

Women trained in STEM fields practice a set of competencies until they reach mastery. In the workplace, this translates to the ability to solve problems on a day-to-day basis and the ability to take large, complex problems and break them down into manageable pieces. The ability to apply the design process is very helpful when trying new ideas, seeing if they work, and quickly moving on to improve the idea if it does not work on the first try. Women apply what are commonly referred to as 21st-century skills in the design thinking process.



WHAT ARE 21ST-CENTURY SKILLS?

Twenty-first-century skills are a collection of skills that students need to be successful in life and in the workforce. The [Framework for 21st Century Learning](#) was developed with input from various community stakeholders and describes these skills:³²

Life skills: flexibility, adaptability, initiative, self-direction, social and cross-cultural skills, productivity, accountability, leadership, and responsibility.

Learning and innovation skills: creativity, critical thinking, communication, and collaboration.

Information, media, and technology skills:

information literacy, media literacy, and information, communications, and technology literacy.

For an in-depth description of each of the skills mentioned above, visit the link to the Framework for 21st Century Learning [site](#).

Entrepreneurship is closely connected to STEM opportunities. As such, it is important that STEM training introduce young women to pitching ideas and launching projects.

WHAT DOES IT TAKE TO BE AN ENTREPRENEUR?

Entrepreneurship coupled with 21st-century skills creates opportunities for women to create, innovate, and lead their own business ventures. The start-up world is yearning for female talent. To learn more about starting a business, visit [SCORE](#) for free small business advice, and contact an innovation hub, such as [The Commons on Champa](#) or [Innovation Pavilion](#) to learn about startups in their innovation spaces. Boulder and Fort Collins were recently listed in the top 10 of America's most innovative hubs by [nerdwallet](#). Sometimes innovation is born out of old ideas with a twist. Read about Brittany's venture in glass recycling (Box 5.9).

BOX 5.9. IN THE SPOTLIGHT:

Brittany Evans, Founder And President of Clear Intentions

Brittany is a trailblazer in Adams County, CO. She is a 27-year-old Millennial who had a vision to change glass recycling. She identified a problem: Glass is not recycled in single stream recycling processes. Brittany and her co-founder, Todd, have created a specialized waste management service focusing on glass. Their goal is to recycle all glass in Denver and greater Colorado. If glass is separated properly, all of it can be recycled. She has designed a solution that diverts glass from the landfill, creates a product called cullet, and sells that product which can be used as an aggregate for road base or for sidewalks. Brittany and her company aspire to change people's vision of recycling.

You can learn more about Brittany's company at <http://www.clearintentions.glass/>.

Issues of bias, stereotype threat, societal expectations, workplace culture, and impostor syndrome are very real to young women as they enter the post-secondary space or workforce. Mitigating the messages that women encounter that tell them that they do not belong in STEM fields is critical during this formative time. Educators and employers have to identify the ways in which their spaces perpetuate these negative messages and then work to create inclusive spaces where women feel they belong and their ideas matter. Young women can use tools, like the ones found in this chapter, to persist and lead change in this evolving STEM landscape.

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CONCLUDING RECOMMENDATIONS FOR ACTION

Violeta García, PhD

Our culture sends girls the message that they might not be cut out for STEM careers and should focus their energies on areas that are traditionally female. These messages lead many girls to drop out of STEM pathways before the end of high school. As a result, young women miss out on the chance to work in STEM fields, which include careers that generally pay better than non-STEM careers and provide livable wages.

As practitioners and parents, it is critical to have a guide to help focus how we can best support girls at all stages of their development and provide them with educational opportunities so they can enter and persist in STEM fields. Our job is to nurture their curiosity and provide opportunities for them to learn through play and their everyday environment. As curious children, they will have better opportunities to ask questions, shape their future, thrive in this ever-changing world, and ultimately, solve 21st-century challenges.



Parents, caregivers, and teachers can help young girls, newborn to age 5, develop their sense of curiosity. They can provide toys, like blocks, that promote thinking, creativity, and innovation. They can encourage girls to get dirty and explore outside and test their own age-appropriate hypotheses by seeing what happens when they jump in puddles and splash water. As early as 5 years of age, girls can write binary code with simple programs like Scratch. They can build, test, and share prototypes with their peers and community. They can also learn to manipulate 3-D objects, transform them in their minds, and develop strong spatial reasoning skills.



A curious child can learn to ask deep questions. As girls grow, they develop questioning skills that can help them define problems and seek solutions. From ages 6 to 10, girls need integrated STEM instruction in their classrooms from teachers who have had the chance to build math and science confidence, and who understand the design cycle. Instructors can offer hands-on learning and problem-solving opportunities that engage and excite girls. Girls at this stage begin to develop interest in STEM through extracurricular activities. Community organizations play a critical role in providing experiences that can ignite curiosity and help girls form a STEM self-identity.



As girls enter early adolescence, from ages 11 to 13, access to opportunities can shape their future. It is during this stage that girls begin to recognize the often-negative messages that society delivers regarding science, technology, and a woman's place within STEM. Often, adults promote more opportunities to create, build, and test for boys, so girls need to acquire the tools to advocate for those opportunities. Implicit bias also plays a role. Adults often perpetuate the message that girls do not belong in STEM. Parents and teachers need to provide tools of empowerment so girls themselves can be agents of change. Adults can also bring about changes by making certain girls benefit from the same STEM educational experiences as boys.



In adolescence, from ages 14 to 18, girls face challenges that hinder their ability to prepare for STEM careers, such as doubt in their own abilities. Adults must counter these messages by helping young women understand that people are not born with STEM skills, but develop them over time. Girls need tools of empowerment during their teenage years to defend their STEM interests while preparing themselves academically to graduate from high school. Girls can build confidence and benefit from opportunities that prepare them to solve problems with 21st-century skills. They also need access to work-based experiences so they can eventually have financially sustaining careers in STEM fields.



Beyond 19 years of age, young women need the chance to thrive in STEM fields and contribute to potentially world-changing developments in areas like engineering, computer sciences, and medicine. Young women need tools to help navigate the complex educational journey in the post-secondary space. Some STEM careers require mid-skill training and other STEM opportunities are high-skill careers. Understanding the on-ramps and off-ramps to access STEM opportunities early in their careers, and how to retrain if necessary, helps women stay in, and succeed in, STEM fields.



VISION

The resources, strategies, and activities in this guide can change the environment for girls from one that throws up barriers and limits their career options to one that opens up pathways to STEM. Parents and caregivers, educators, and community organizations that serve girls must promote opportunities so girls see themselves as capable of pursuing a STEM career and so that they are STEM-ready. In STEM fields, girls will find careers that pay a living wage and give them the chance to make the world a better place with their ideas and innovation. By changing the way we interact with girls in the classroom, at home, and in other learning environments, adults can expand girls' opportunities so that they really can be anything they want to be.

SUMMARY OF RECOMMENDATIONS

STRATEGY 1

Provide opportunities for mastery experiences.

- Girls underestimate their abilities, especially as they get older. Help them recognize what they can do and recognize their work.
- Have girls take ownership of their decisions and help them with language so that they can advocate for themselves.

STRATEGY 2

Provide opportunities for girls to learn by observing others.

- Female role models and mentors can help girls see themselves as future STEM professionals.
- Seeing female role models and mentors in action inspires girls.

STRATEGY 3

Provide opportunities for girls to be recognized as innovators by their peers and their community.

- Empower girls to lead teams so boys and girls alike recognize them as creators.

STRATEGY 4**Take a holistic approach. Help girls cope with the misconceptions and biases that stand in the way of STEM engagement.**

- Teach girls about growth mindset and how it impacts their sense of self.
- Educators and caregivers can be mindful of their own behavior and challenge biases that can stand in the way of STEM experiences and engagement for girls.

STRATEGY 5**Educators and community organizations can provide opportunities for parents/caregivers to see their daughters practicing science, technology, and engineering skills and solving problems using math.**

- Design events, such as family STEM nights, and put girls in charge. Parents will feel proud of their girls and expand their understanding of what their daughters are capable of doing.
- Put girls in the spotlight whenever parents come to school. This can be through community nights, in design or science labs, in school gardens, or by integrating STEM into other parent-related activities in which girls take the lead.

STRATEGY 6**Give parents/caregivers ideas about how they can continue STEM learning at home with their children.**

- Parents/caregivers can influence a girl's career trajectory and expose their daughters to a variety of STEM learning opportunities.
- Teachers can provide tools for parents to continue working on STEM learning at home. Develop age-appropriate STEM learning idea sheets to get them started.
- Community organizations should make a commitment to reach out to parents to continue STEM learning at home. Extracurricular opportunities can set the foundation for girls to explore STEM opportunities.

STRATEGY 7**Educate parents/caregivers on how best to advocate for advanced STEM opportunities for their daughters.**

- Parents need tools to understand different types of STEM opportunities that may be available so that they can advocate for schools and community organizations to bring those opportunities to their community, if they are not yet offered.
- Invite parents to connect with teachers and school leaders about implementation of the latest educational policies as they pertain to women and girls.
- Parents can also build relationships with elected officials to share their thoughts about STEM education and career opportunities for women and girls in their communities.
- Parents and community members can advocate for internships and apprenticeships with STEM employers.

STRATEGY 8

Show parents and caregivers where they can find STEM opportunities for their girls.

- Community organizations can work together to have one database to list all programs by location and type of opportunity, such as [The Connector](#), and keep information current.

STRATEGY 9

Educators and community organizations can provide multi-faceted communications about how STEM relates to students' daily lives and everyday experiences.

- Offer opportunities for families to engage in citizen scientist programs and develop programs for families with multiple touch points. These can include field studies, family STEM nights, and community share-out days.

STRATEGY 10

Help educators access and share STEM resources.

- Educators need resources that build their understanding of integrated STEM education, such as the chance to see what a great STEM classroom looks like and how great STEM teaching can tap into their students' potential.
- Teachers can find funding opportunities for professional development through resources like the National Science Teachers Association.

STRATEGY 11

Provide training and resources for educators to develop curriculum that is inclusive of girls, including girls of color.

- We all have hidden biases. Uncovering our hidden biases can help us discover steps to take so that we do not unintentionally exclude certain students from STEM experiences.
- Parents can examine how they treat girls and boys, and thoughtfully consider if they offer different types of toys or experiences to girls that do not foster STEM skills.

STRATEGY 12

Link educators with industry partners so they can see and experience the work of STEM professionals.

- Educators can use STEM professionals and their experiences to create meaningful, engaging units of studies for students.
- Girls then benefit from hands-on learning and educators can help their students explore authentic problems in STEM.



THE WOMEN'S FOUNDATION OF COLORADO HOPES THAT IN THE NOT-SO-DISTANT FUTURE...

STEM professions reach gender parity, with women across the nation equally represented in STEM careers.

Women in STEM are sought out as experts and developers of new technologies.

STEM professions have the prestige and status equal to famous athletes and movie stars and get paid accordingly.

STEM professions attract from a pool representative of the racial and ethnic diversity of the United States.

STEM education is included as part of in-school and out-of-school learning experiences for all students, including students in rural Colorado.

Women in STEM contribute to innovations and policies that improve the human condition.

Women in STEM celebrate their professions and are recognized by community leaders for their problem-solving skills and innovation AND their passion and enthusiasm.

AUTHORS, CONTRIBUTORS, AND SUPPORTERS

AUTHORS AND CONTRIBUTORS

Yeni Violeta García, PhD, is the STEM consultant for The Women's Foundation of Colorado. For more than 12 years, she has provided educational services experience specializing in STEM program development and educator professional development in formal and informal settings, linking her passion for science and education to prepare our next generation of leaders to solve 21st-century challenges. At The Women's Foundation of Colorado, she provides expertise to advance more girls and women on the path to educational and career success in STEM fields.

Dr. García earned her doctorate in Biological Education from the University of Northern Colorado with a minor in applied statistics and research methods. She earned her Masters in Education from the University of California, Los Angeles, and her Bachelor of Science in Biological Science from the California State University at Fullerton. Her expertise in linking science and education is essential in creating opportunities for women and girls and groups under-represented in STEM fields that increase their lifetime earning potential.

Before her consultancy at WFCO, Dr. García was a principal consultant at the Colorado Department of Education, where she initiated the development of Colorado's Vision for STEM education. She continues her work in advancing STEM opportunities through her business, STEM Learning by Design. Nationally and locally, Dr. García is a sought-after expert, as well as an influential connector who facilitates collaboration and partnerships among industry, education, and community stakeholders. She is a systems thinker; she loves disrupting outdated ways of thinking and believes that all students should have access to high-quality, culturally relevant, and culturally responsive learning experiences.

Born in Santa Ana, El Salvador, and raised in Los Angeles, CA, Dr. García moved to Colorado to join her husband Juan Coronado in 2006 and they currently live in Denver with their two daughters.

Ruth Catchen received her Bachelor of Music degree from American University and her Master of Music degree from The Catholic University of America in Vocal Performance and performed with many distinguished opera companies, conductors, and orchestras in the United States. She received her second master's degree in 2007 from the University of Colorado at Colorado Springs in Curriculum and Instruction/Leadership. Currently, she focuses her attention on public education hoping to better its quality and depth. Catchen develops arts-integrated STEM/STEAM curriculum programs for both in-school and enrichment that bring educational opportunities to disadvantaged youth and other non-profit organizations. Her passion is to promote excellent instruction that supports teachers by connecting the arts to other core academics. Along with being the Artist-In-Residence at Jack Swigert Aerospace Academy in Colorado Springs, Catchen has been published multiple times in the peer-reviewed *The STEAM Journal* and is currently working on best practices for P-20 STEAM education. Catchen serves as a resource for many prominent STEM curriculum writers and publications, including in the recent release *STEM by Design* by Anne Jolly. Catchen is actively sought as a program and curriculum developer writing curricula for a wide range, from Pre-K-12 to modules for teacher preparation programs.

Akaxia Cruz is passionate about bringing STEM concepts to life and pushing boundaries while acting as a social justice leader. She is at the beginning of her career in theoretical physics and is actively involved with a local initiative to expose historically under-represented girls to the STEM fields. Ms. Cruz is passionate about the intersection of art and science and loves to explore it while creating curriculum and facilitating hands-on workshops. She hopes to act as a role model, a source of inspiration, and a mentor to girls struggling with identity and confidence in STEM spaces. Cruz graduated with her BA in Physics and Mathematics from the University of Colorado Boulder and is currently a PhD student at the University of Washington, Seattle.

Patricia Kincaid (BS – Illinois State University, MA Ed - University of Northern Colorado (Math, Science and Technology), Principal Licensure – University of Denver) most recently served as Science Coordinator for Denver Public Schools (DPS), focused primarily on grant implementation. To support the work of DPS science teachers, she networked and partnered with informal institutions, community groups, and higher education institutions. Previously, she served DPS as Secondary Science Coordinator. Prior to joining Denver Public Schools she served as District Science Coordinator and teacher for the Cherry Creek School District in Greenwood Village, Colorado, and as adjunct professor of Secondary Science Methods at the University of Denver in the Teacher Education Program. Professional credo: Providing experiences and opportunities to learn can help to fill the “gap.”

Becky Peters graduated with a Bachelor of Science in Pre-Medicine before traveling abroad to teach English in Seoul, South Korea and Santiago, Chile to preschool-aged children through adult learners. If Becky's profession could be "lifelong student," that's what she'd have on her business card. Having many interests across all disciplines can be a difficult way to focus one's career, but it also lends itself well to the study of STEM fields and the advancement of STEM instruction in K-12 education. Peters has studied medicine, marketing, education, psychology, and business, while trying to discover more about the space where education intersects cognitive and social science. She has experience in marketing and public relations, non-profit development, business administration, finance, human resources, education, and management. In 2014, Peters started at the Innovation Center in St. Vrain Valley School District as its Program Manager, responsible for K-12 STEM integration and alignment as well as data tracking and analysis for the grant. She is originally from the suburbs of Chicago, but has been a happy resident of Colorado since 2006.

PARTNERS FOR THE DEVELOPMENT OF THIS GUIDE

WFCO developed this guide through the collaboration of more than 30 partners. Collaborators were selected based on their experience working with particular age groups in conjunction with organizational expertise in integrated STEM programming. Each collaborator received a survey with a draft outline of the chapter they would contribute to depending on their expertise. The survey asked collaborators to contribute ideas for additional outcomes, resources, and recommendations of additional information they would like to see in this guide. Collaborators also reviewed the chapter(s) relevant to their age group expertise. Additional collaborators were called upon for specific areas of expertise, to contribute special features within the chapters, and to review chapters as needed.

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This Is What STEM Looks Like! How To Get And Keep Girls Engaged In Science, Technology, Engineering, and Math contains links and references to many resources, including websites, articles, books, etc. The list of resources included in this guide is not intended to be exhaustive, and opinions expressed in the various resources referenced should not be interpreted as an endorsement, opinion, or the position of The Women's Foundation of Colorado or any of the contributors to the guide. The Women's Foundation and contributors to the guide make no representation or warranty as to the accuracy of the references or the opinions expressed therein.

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