Closing the STEM Gap

Why STEM classes and careers still lack girls and what we can do about it
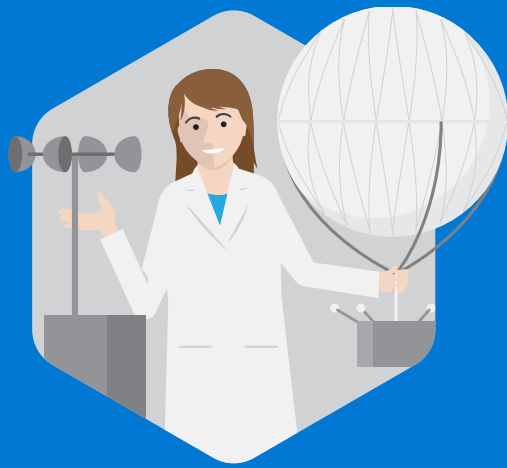
Microsoft
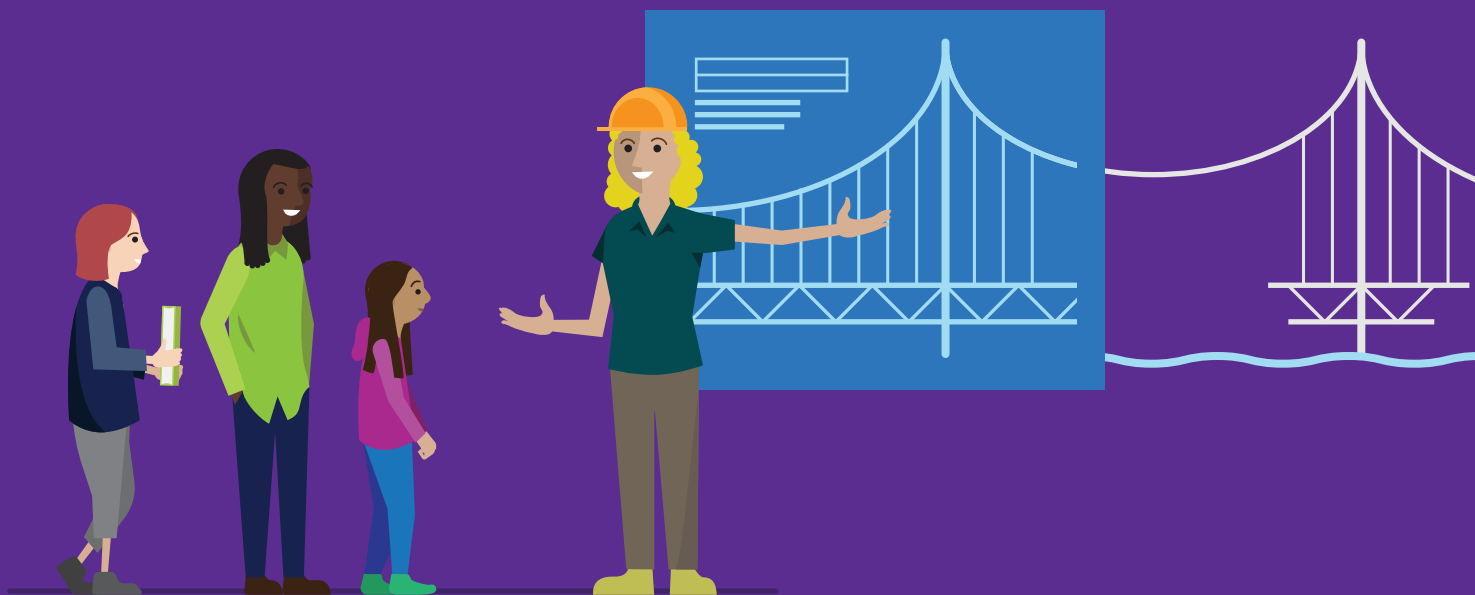
Table of Contents

Foreword

by Dr. Shalini Kesar, Associate Professor
Department of Computer Science & Information Systems, Southern Utah University

My parents used to tell me that, "even if you are one drop of water in an ocean, it is those drops combined that make the ocean." Across southern Utah, I see a domino effect: when one girl sees the power in STEM and computing, she becomes a role model for her friends and community.

For years, girls and young women have been a critical missing part of Science, Technology, Engineering and Math (STEM) studies and careers. The stubborn gender disparity in STEM fields has sparked important debates on the underlying reasons. Some attribute the gender disparity to social and infrastructural factors, lack of mentors and role models, and lack of awareness about what these fields offer in terms of educational and career opportunities. Others point to studies that indicate traditional mindsets of computing as "boring" and "only for boys" as a major reason why girls and young women do not consider a degree or career in this field.

That's why I was proud to collaborate with Microsoft on this research, which quantifies many of my observations from over 20 years of working to increase the participation of girls and young women in STEM and computing. This work is an essential step forward in helping us learn more about how girls and young women currently perceive STEM and computing. The results of this research provide guidance on how to show girls that these fields give them opportunities to be creative and do good for the world.

I hope you'll find the results as interesting as I have and that you'll join me in advocating for the importance of inclusion and diversity in STEM and computing, as well as seeking formal structural changes or policies and programs to help ensure that as a society we realize the full potential of girls and young women.

Introduction

Despite the high priority placed on science, technology, engineering and math (STEM) and computer science education across the United States, the fact remains that only a fraction of girls and women are likely to pursue STEM degrees and careers. The U.S. Bureau of Labor Statistics predicts that technology professionals will experience the highest-growth in job numbers between now and 2030. Failing to bring the minds and perspectives of half the population to STEM and computer science fields stifles innovation and makes it less likely that we can solve today's social challenges at scale.

Microsoft commissioned this research to understand better what causes girls and women to lose interest in STEM subjects and careers, as well as what strategies and interventions have the greatest potential to reverse this trend. Our goal is to inform our own work in this area and to share our learnings with schools, government leaders, nonprofits, employers and others.

What we learned is that conditions and context can make a significant difference to girls, young women and their interest in STEM. And the solution doesn't necessarily require a curricula overhaul. We may be able to make significant strides just by showing girls and young women how STEM knowledge is applicable outside of the classroom, and how it can power their aspirations to make the world a better place.

Our main research findings show that:

- Girls and young women have a hard time picturing themselves in STEM roles. They need more exposure to STEM jobs, female role models, and career awareness and planning.

- Girls don't initially see the potential for careers in STEM to be creative or have a positive impact on the world. But even a little exposure to real-world applications of STEM knowledge dramatically changes their outlook.

- Girls who participate in STEM clubs and activities outside of school are more likely to say they will pursue STEM subjects later in their education. The kinds of experiments and experiences girls are exposed to in these activities can provide insights for how to enhance STEM instruction in the classroom.

- Encouragement from teachers and parents makes a big difference in girls' interest in STEM—especially when it comes from both teachers and parents.

- Educators can foster a "growth mindset" among their female students by tapping into their willingness to work hard for results.

We hope that insights gained from this research will help policymakers, educators, parents and employers like us better understand and overcome the challenges girls and young women face when it comes to pursuing STEM studies and careers. Our current demographics show that there's no easy path to achieving a more diverse workforce. That's why we're committed to continued investment in STEM programs to help bolster the talent pipeline with more talented young women.

Our approach

Following our 2017 research that examined the reasons why Europe's girls and young women lose interest in STEM, we sought to undertake research in the U.S. that would illuminate ways in which policymakers, educators, nonprofits, parents, and communities can support and encourage girls and young women in STEM stateside.

This research builds upon and lends new insights to the research about girls and young women in STEM that has already been conducted by many dedicated researchers and organizations before us. At the onset of our work, we conducted a comprehensive review of 61 articles and studies in the topic area, and from that compiled a literature review of 43 articles and studies that were representative of the breadth of U.S. research on girls/young women and STEM.

To gain insight into girls' attitudes towards STEM subjects, we conducted focus groups with 44 middle and high school girls from urban, suburban, and small town/rural communities in the United States. The girls candidly shared with us their views, experiences, and feelings towards STEM and computer science; and insights from

these focus groups laid the groundwork for a quantitative survey we wrote with the support of Dr. Shalini Kesar of Southern Utah University. The quantitative survey of 6,009 girls and young women from ages 10-30 examines attitudes towards STEM, school, and the workforce throughout the pipeline—from pre-adolescence through the teen years, into early adulthood and all the way through the 20s—the years during which girls and young women decide which subjects they want to study and what career path they want to pursue. We further bolstered the research through a number of interviews with subject matter experts who have dedicated their careers to supporting girls and young women in STEM.

We hope that, like in Europe, the insights gathered from this research will help us all understand how together, we can support girls and young women with STEM and computer science aspirations, and how we can convey the exciting, creative and world-changing opportunities STEM and computer science can present.
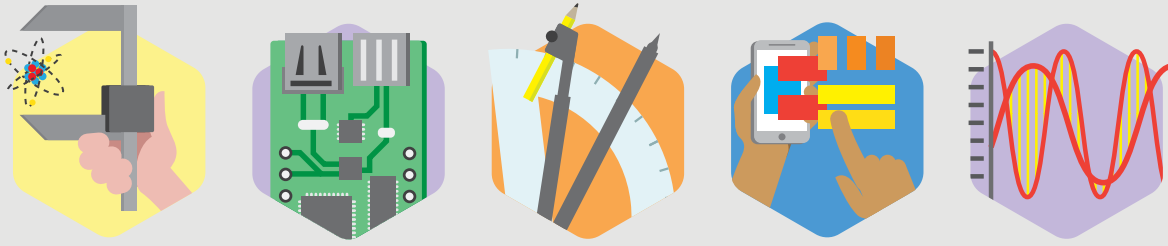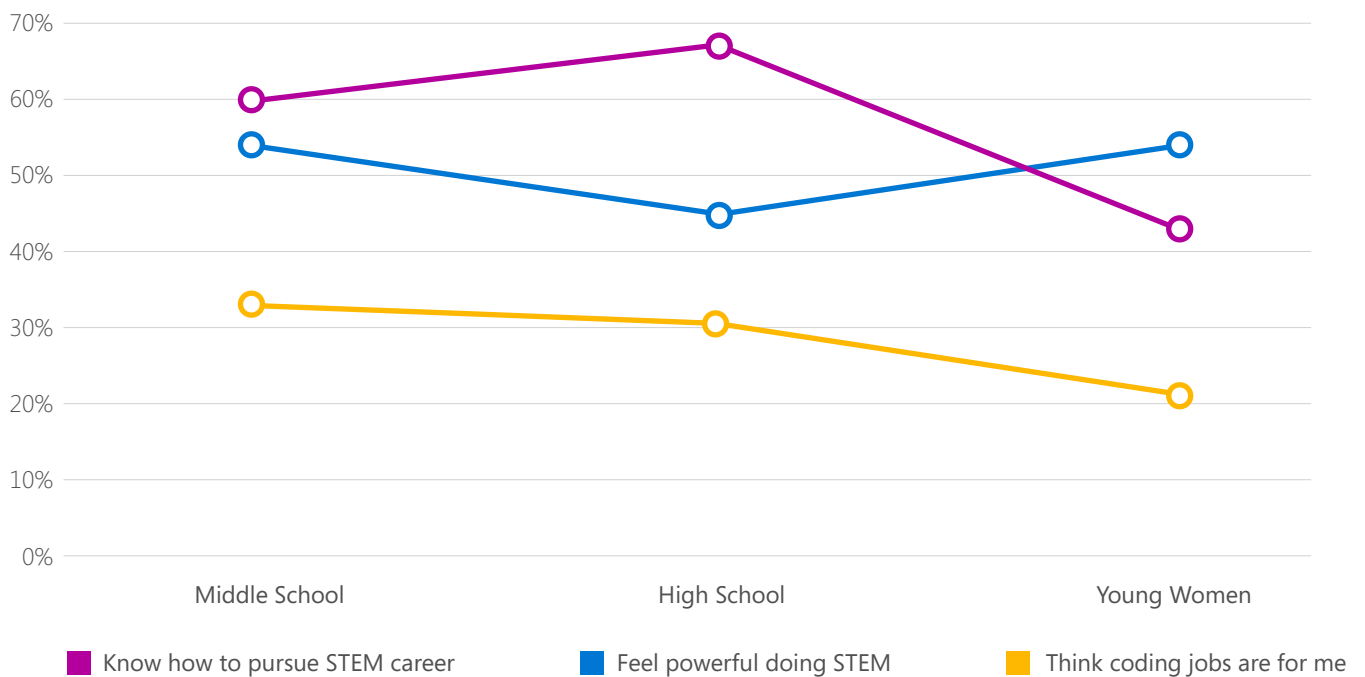
Provide role models

Girls lose interest in STEM and computer science as time goes on. In middle school, for example, 31 percent of girls believe that jobs requiring coding and programming are "not for them." In high school, that percentage jumps up to 40. By the time they're in college, 58 percent of girls count themselves out of these jobs.

A similar pattern applies to the prospect of continuing STEM and computer science beyond school. The young women least likely to know how they would pursue a STEM career are those enrolled in college—ironically, the ones who are closest in their lives to starting a career.

Do girls lose interest in STEM as they get older?

	Middle School	High School	Young Women
Know how to pursue STEM career	60%	67%	43%
Feel powerful doing STEM	54%	45%	54%
Think coding jobs are for me	33%	30%	21%

■ Know how to pursue STEM career   ■ Feel powerful doing STEM   ■ Think coding jobs are for me

How can we stop this decline? An important first step is to introduce girls and young women to positive female role models in these fields. Girls who know a woman in a STEM profession are substantially more likely to feel empowered when they engage in STEM activities (61 percent) than those who don't know a woman in a STEM profession (44 percent).

Unfortunately, most girls don't have any female role models in STEM to look up to. So it's no surprise that, when asked to describe a typical scientist, engineer, mathematician, or computer programmer, 30 percent of girls say that they envision a man in these roles. As do almost 40 percent of adult women—and 43 percent of women in STEM and tech fields.

> " It'd be really cool to see women in STEM careers on posters in the hall, in our history and science texts, and visit our classes. "
>
> 8th Grade Girl

What is the impact of female role models?
Girls, Grades 5-12

Legend:
- Girls who don't know a woman in STEM
- Girls who do know a woman in STEM

Category	Girls who don't know a woman in STEM	Girls who do know a woman in STEM
Feel powerful while doing STEM	44	61
Know how to pursue a STEM career	51	74
Understand how STEM is relevant and the jobs that are possible through STEM	53	73
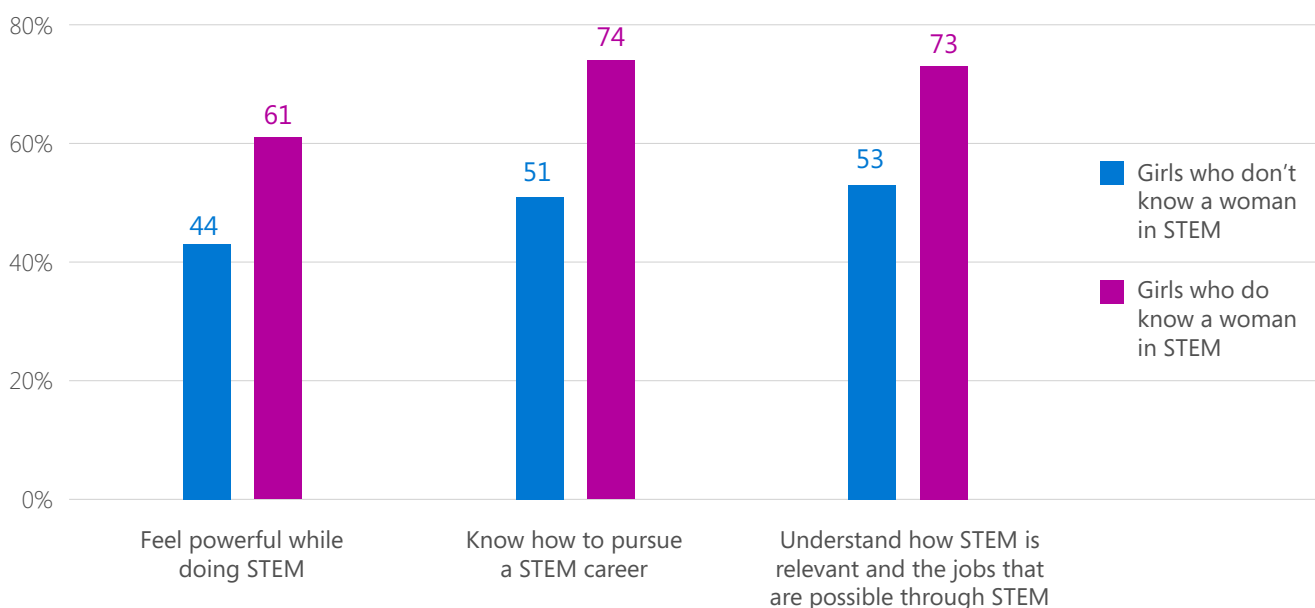
Generate excitement
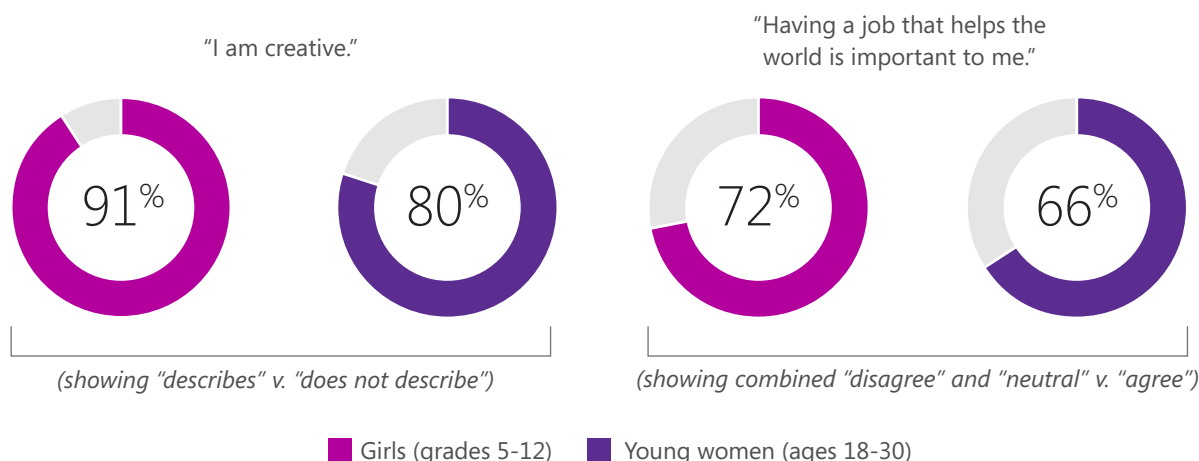
Another reason that girls don't identify with STEM is that they assume it doesn't align with their desire to be creative and make an impact in the world. In our study, overwhelming majorities of girls (91 percent) and young women (80 percent) describe themselves as creative.

Large majorities also say it's important to them that their job or career directly helps the world. But relatively few girls and young women associate STEM jobs with either of those things. We are missing opportunities to teach girls and young women about how varied, engaging and impactful STEM and computer science jobs can be.

What do girls and young women say about themselves?

"I am creative."

91%

80%

(showing "describes" v. "does not describe")

"Having a job that helps the world is important to me."

72%

66%

(showing combined "disagree" and "neutral" v. "agree")

■ Girls (grades 5-12)   ■ Young women (ages 18-30)

> " My teacher is making me build a rocket ship with some other students, so that got me interested in STEM a little bit because I like to build and create. "

Middle School Girl
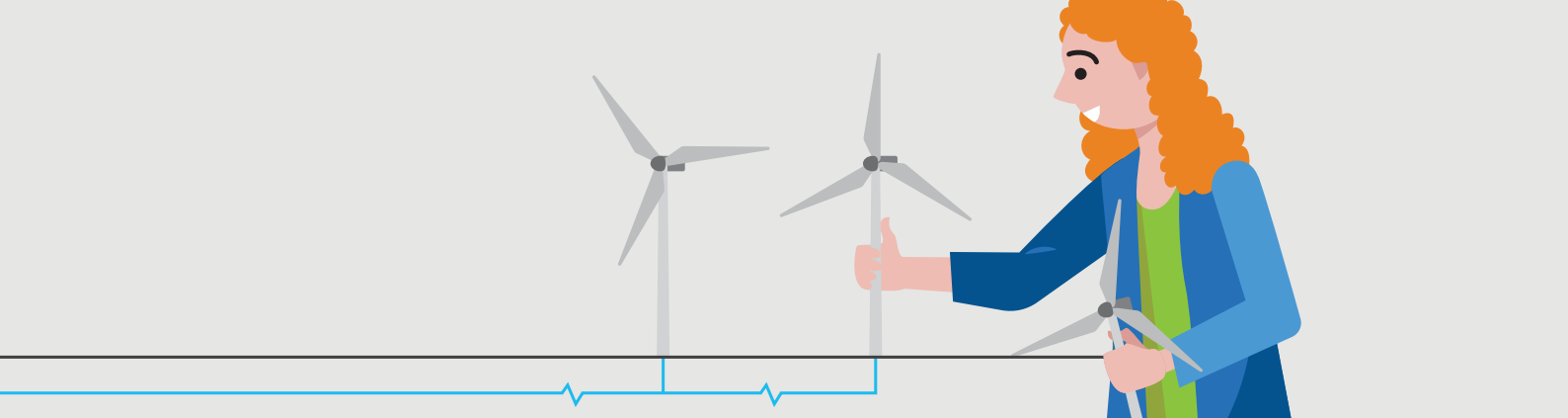
Perceptions of STEM and computer science careers can change quickly. In our study, after being presented with just a brief description of the real-world accomplishments of engineers, mathematicians, and computer scientists, girls' perceptions of those career characteristics changed dramatically. In some cases, the perception of the creativity and positive impact of STEM careers more than doubled.

How do real-world examples change perceptions of STEM?
Girls, Grades 5-12

	Gets to be creative at their job	Has a job that does good things for the world
How would you describe a COMPUTER SCIENTIST?	**+17%** 44% ⟶ 61%	**+33%** 41% ⟶ 74%
How would you describe an ENGINEER?	**+14%** 49% ⟶ 63%	**+28%** 46% ⟶ 74%
How would you describe a MATHEMATICIAN?	**+24%** 19% ⟶ 43%	**+32%** 25% ⟶ 57%

● Before Examples   ● After Examples   ● +/– Change

These more favorable perceptions align with how women who work in these fields feel about their jobs. Nearly two-thirds of women who work in STEM fields (64 percent) and tech (65 percent) feel that the work they do makes a difference in the world. This is 7 and 8 points higher than working women overall (57 percent).

The truth about STEM and computer science subjects and careers are that they are powerful creative outlets and opportunities to make a difference. They must be presented that way to connect with how girls see themselves and their futures.
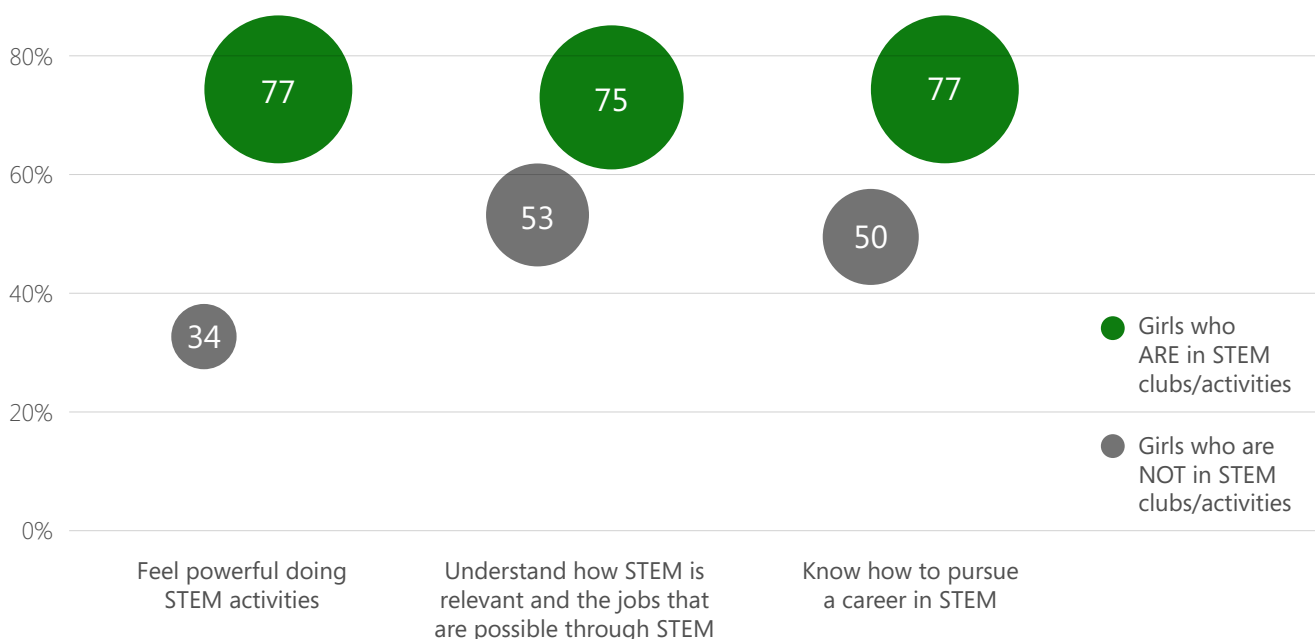
Provide hands-on experience

A powerful way for girls to learn about the creative and impactful ways that STEM and computer science knowledge is applied in the real world is to let them explore those applications firsthand. Almost a third (31 percent) of girls surveyed participate in extracurricular STEM clubs and activities. Compared to classroom instruction, these activities tend to be more hands-on and practical. That kind of exposure has a profound impact on how girls feel and what they know about STEM subjects and careers.

For example, 75 percent of girls who participate in STEM clubs and activities understand the types of jobs they could do with STEM knowledge, compared to 53 percent who do not participate in those activities. An even bigger difference comes through in their feelings of empowerment. Of girls who encounter STEM and computer science in the classroom alone, only 34 percent feel powerful while engaging with STEM. Among girls who also encounter STEM in activities or clubs outside of school, that feeling of empowerment is more than twice as common.

What is the benefit of STEM learning outside of the classroom?
Girls, Grades 5-12

	Feel powerful doing STEM activities	Understand how STEM is relevant and the jobs that are possible through STEM	Know how to pursue a career in STEM
Girls who ARE in STEM clubs/activities	77	75	77
Girls who are NOT in STEM clubs/activities	34	53	50

STEM clubs and activities also correlate with a girl's likelihood of pursuing STEM and computer science later in her education. Seventy-four percent of middle school girls who participate in these activities say they are likely to study computer science in high school, compared to only 48 percent of those who don't participate.
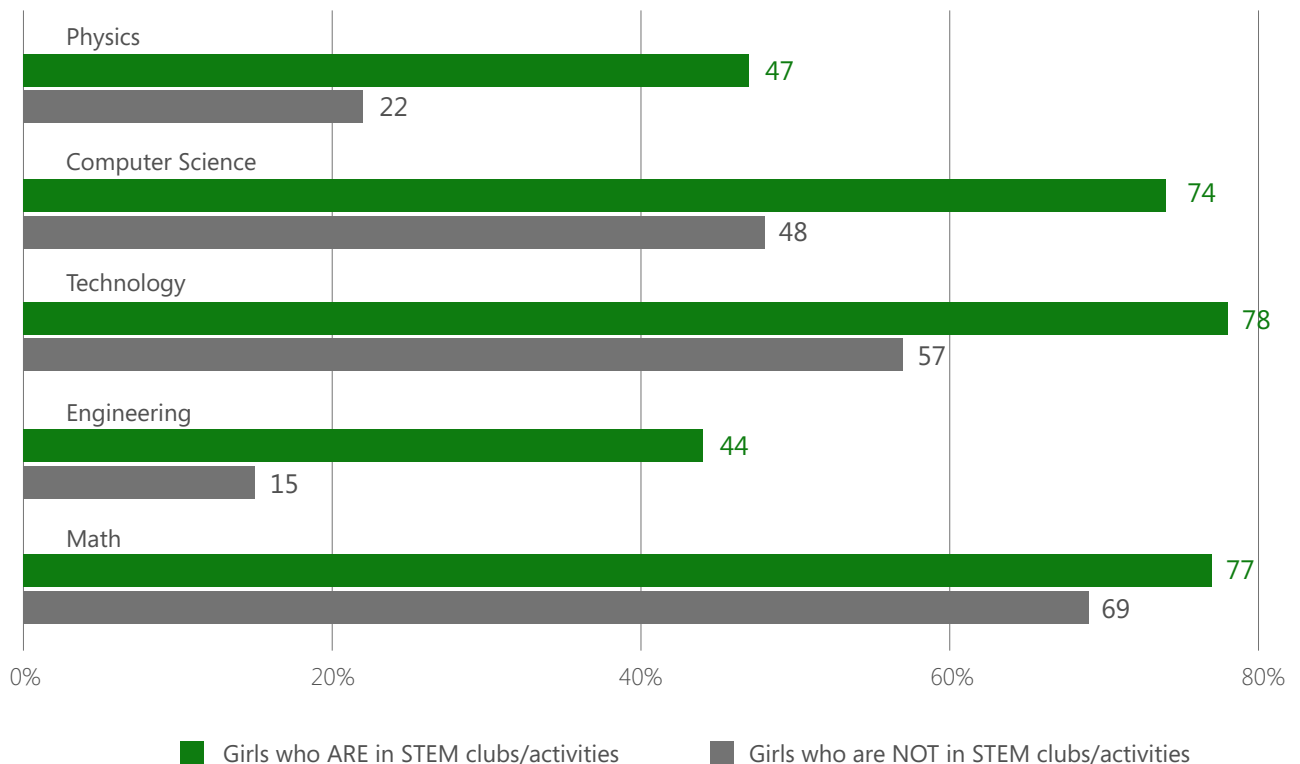
Middle school girls who participate in STEM clubs and activities are more than twice as likely to say they'll study physics in high school, and nearly 3 times as likely to say they'll study engineering. At the high school level, girls participating in STEM clubs and activities are over 2.5 times more likely to say they'll continue studying computer science in college.
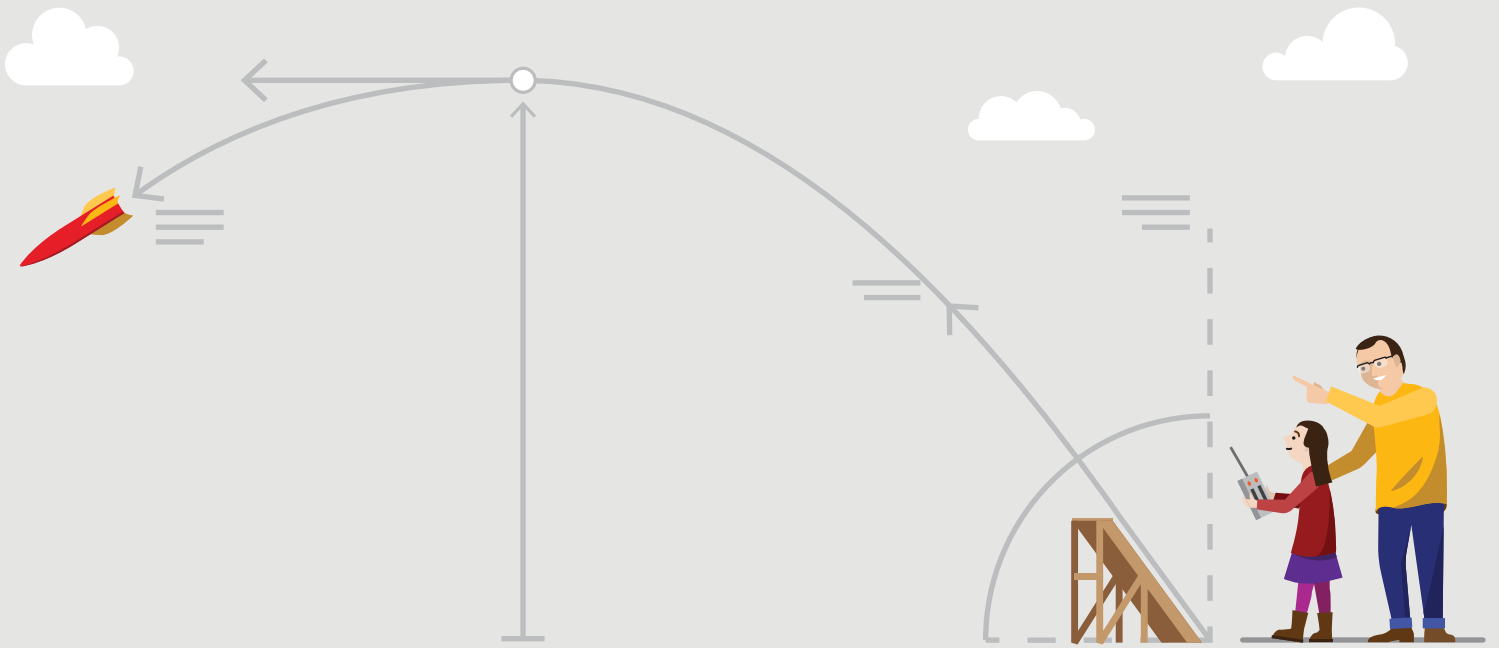
Not every girl participates in or has access to a club or activity devoted to STEM. We found that participation decreases the farther you get from city centers: 35 percent of urban girls participate in STEM clubs and activities, compared to 33 percent of suburban girls and only 27 percent of girls in small towns and rural communities.

However, what makes these activities effective is not the fact that they happen outside of school. It's the fact that they offer practical experience that brings STEM to life in compelling ways. So, while not every school can offer a STEM club, schools and teachers can explore ways of teaching STEM and computer science that provide similar experiences.

How likely are girls to choose STEM classes in high school?
Girls, Grades 5-8

Subject	Girls who ARE in STEM clubs/activities	Girls who are NOT in STEM clubs/activities
Physics	47	22
Computer Science	74	48
Technology	78	57
Engineering	44	15
Math	77	69

■ Girls who ARE in STEM clubs/activities   ■ Girls who are NOT in STEM clubs/activities

Provide encouragement

Teachers aren't the only ones in a position to motivate girls in STEM. The encouragement of parents is also extremely important. More than half of middle school and high school girls say they're often encouraged by their moms and teachers. Less than half, however, say their fathers offer encouragement.

It's important for fathers to step up their support. Encouragement from dads has a consistently positive influence on a girl's interest and likelihood to study STEM in the future. Because many girls still think of STEM as skewing male, it helps to have men in their lives saying, 'This is open to you, too.'

Who encourages girls in STEM?
Girls, Grades 5-12

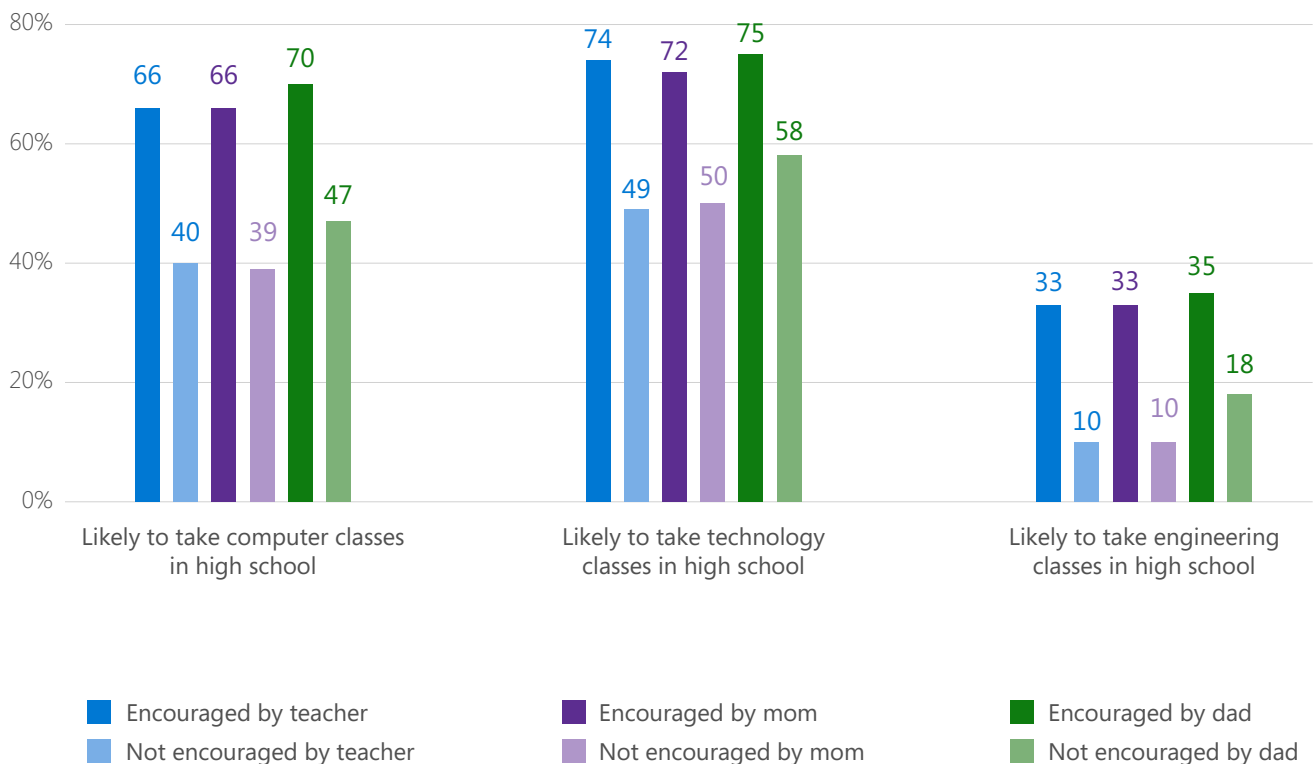|	Middle School	High School
Teacher	59	53
Mom	60	54
Dad	43	40

■ Middle School ■ High School
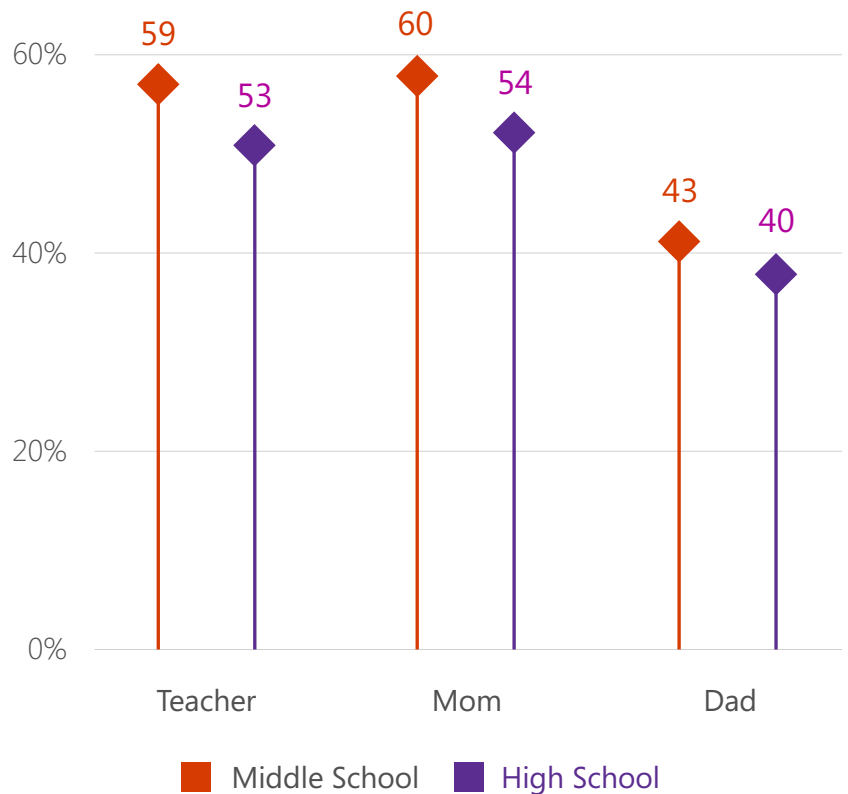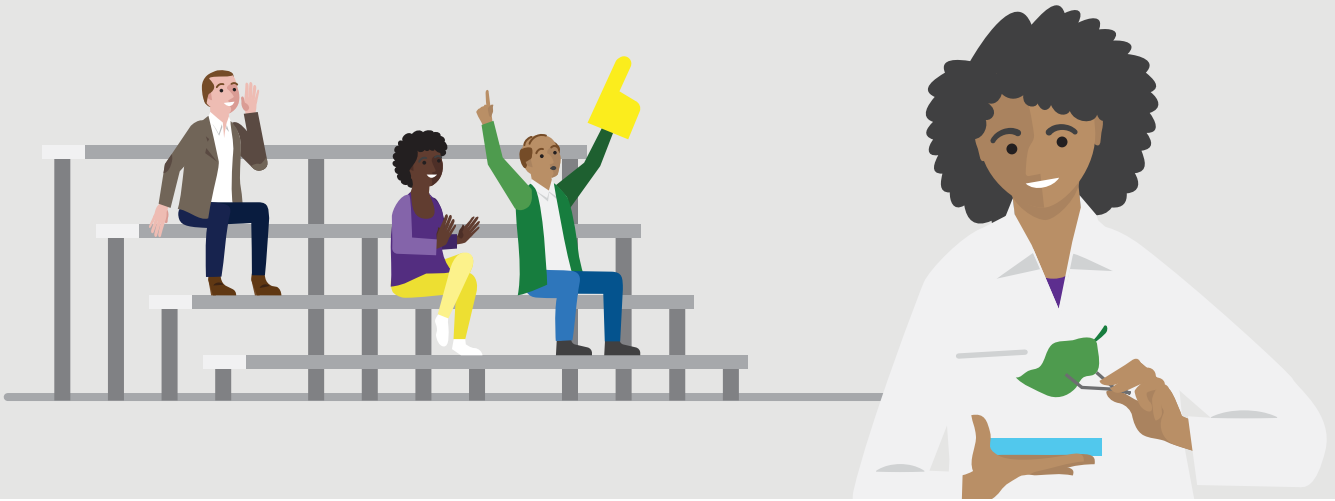
As they proceed to high school and college, girls who are encouraged by their parents and teachers are much more likely to take STEM and computer science classes than girls who aren't. For example, 66 percent of middle school girls who were encouraged in STEM by their teacher say they are likely to study computer science in high school, compared to 40 percent who haven't been encouraged.
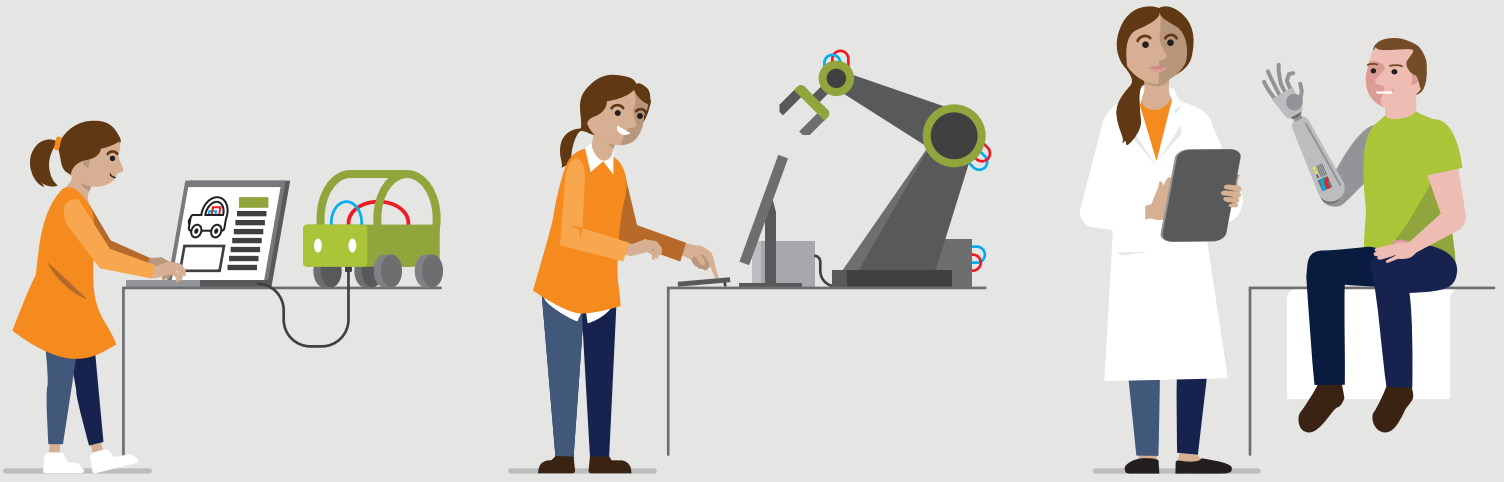
The numbers are almost identical for girls who have been encouraged by their moms, and slightly higher for girls who have been encouraged by their dads.

What difference does encouragement make?
Girls, Grades 5-8

	Likely to take computer classes in high school	Likely to take technology classes in high school	Likely to take engineering classes in high school
Encouraged by teacher	66	74	33
Not encouraged by teacher	40	49	10
Encouraged by mom	66	72	33
Not encouraged by mom	39	50	10
Encouraged by dad	70	75	35
Not encouraged by dad	47	58	18

Legend:
- Encouraged by teacher
- Not encouraged by teacher
- Encouraged by mom
- Not encouraged by mom
- Encouraged by dad
- Not encouraged by dad

An even bigger impact is possible when encouragement comes from both a parent and a teacher. This is true for 46 percent of girls—and ideally, it would be true for all.
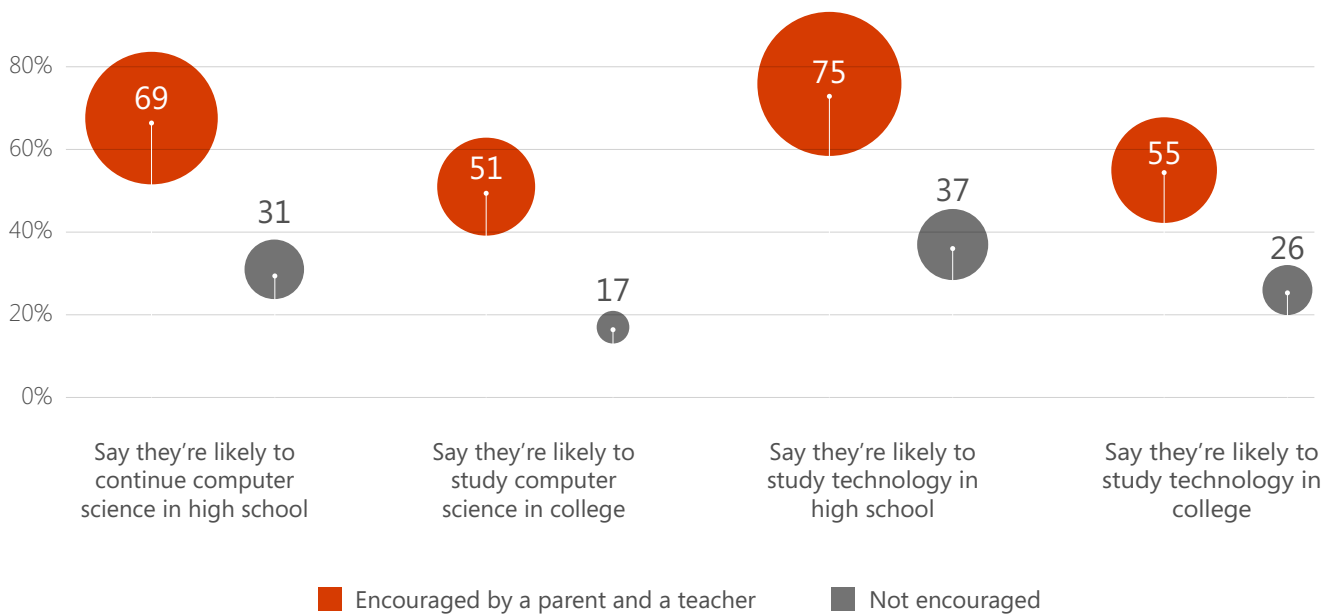
Because those girls are more than twice as likely to consider studying computer science in high school, and they're 3 times as likely to say they'll study computer science in college than those who have no encouragement from either a parent or a teacher.
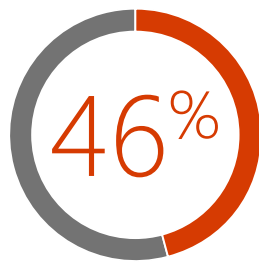
46%

of girls are encouraged by both a parent and a teacher
Girls, Grades 5–12

What happens when support is combined?
Girls, Grades 5-12

	Say they're likely to continue computer science in high school	Say they're likely to study computer science in college	Say they're likely to study technology in high school	Say they're likely to study technology in college
Encouraged by a parent and a teacher	69	51	75	55
Not encouraged	31	17	37	26

◼ Encouraged by a parent and a teacher   ◼ Not encouraged

Encourage a growth mindset

The front line of girls' exposure to STEM will always be the classroom. So it's important that classrooms cultivate the right mindset among students, particularly girls. That mindset is a "growth mindset," which Stanford professor Carol Dweck defines as one that is focused on continual learning and improvement, through a willingness to try, fail and inquire.

To develop that mindset, students need a supportive environment. Many of them have one, but many don't: 32 percent of middle school girls and 35 percent of high school girls don't feel supported by their teachers and classmates in STEM classes. Those percentages are higher among students in rural and small towns (36 percent).

How supported do girls feel?
Girls, Grades 5-12

Legend: Don't feel supported — Neutral
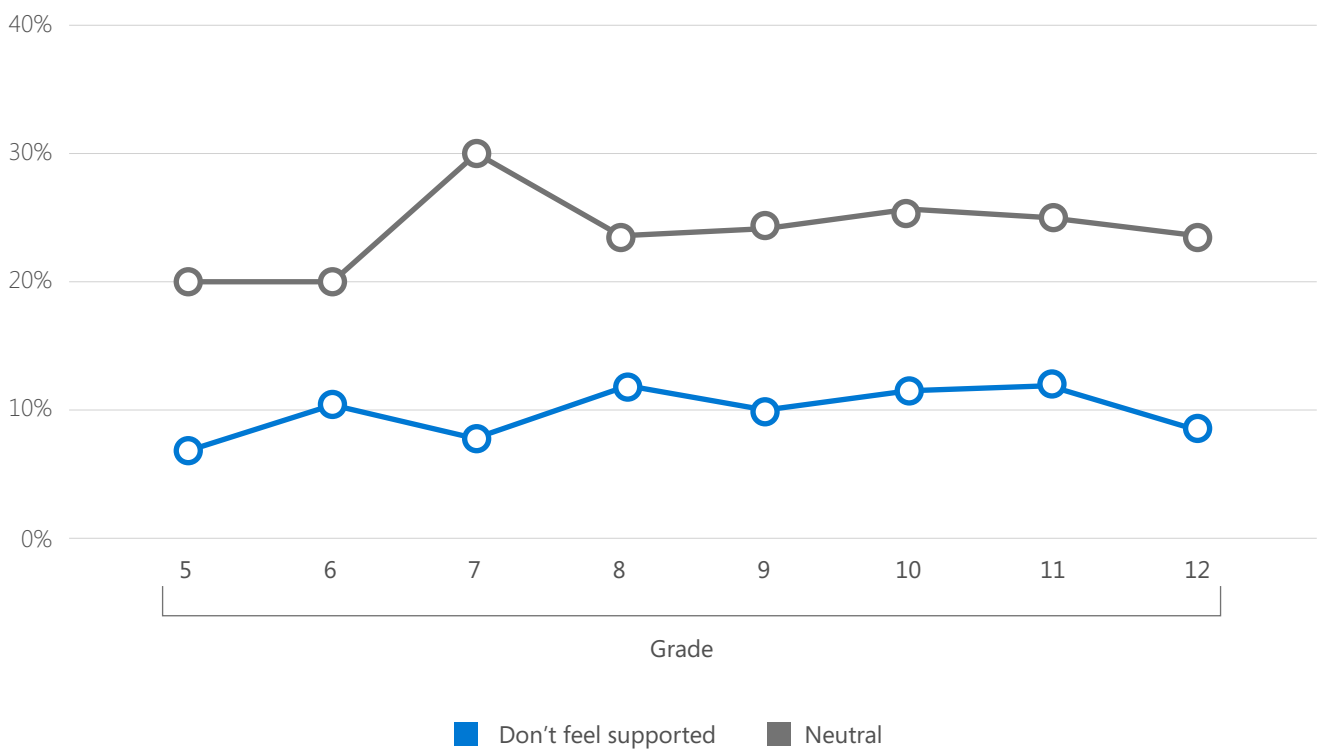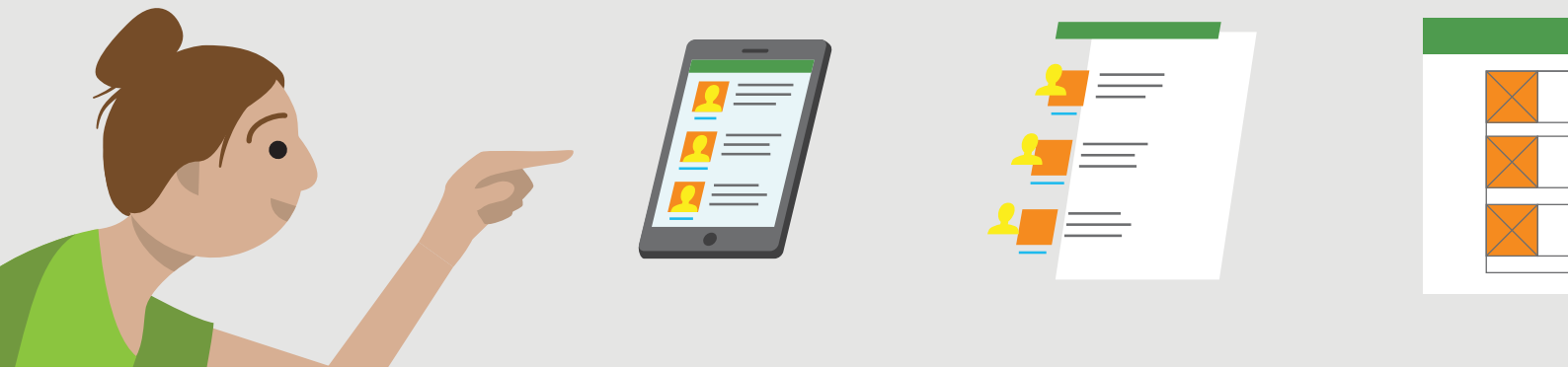
How can we support all girls in developing a growth mindset? One important way is to make classrooms a safe place for questions and vulnerability.
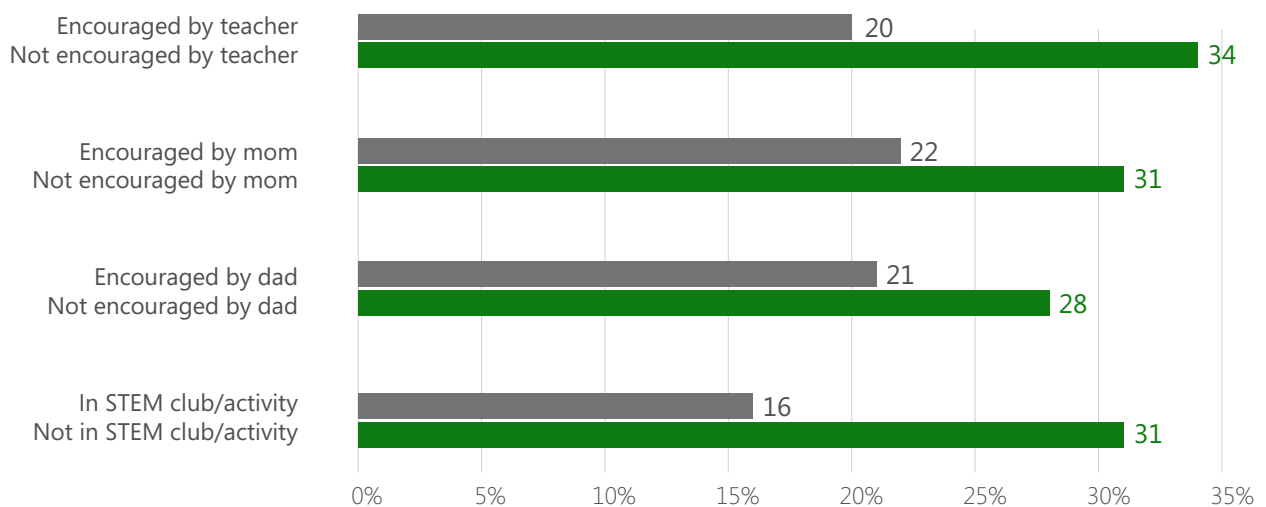
Twenty-seven percent of middle school girls and 21 percent of high school girls feel embarrassed to ask questions in their STEM and computer science classes because they feel like they're the only ones who don't understand the material. Not surprisingly, this tendency is more prevalent among girls who aren't encouraged by their parents and teachers and/or don't participate in STEM clubs and activities. It's also more prevalent in rural and small-town classrooms (26 percent) compared to urban (25 percent) and suburban classrooms (22 percent).

Holding back out of embarrassment is indicative of a "fixed mindset." Students with this mindset doubt their ability to grow, so if they don't know something right away, they may not embrace the learning that occurs when trying to figure something out.

Are girls embarrassed to ask questions in STEM class?
Girls, Grades 5-12

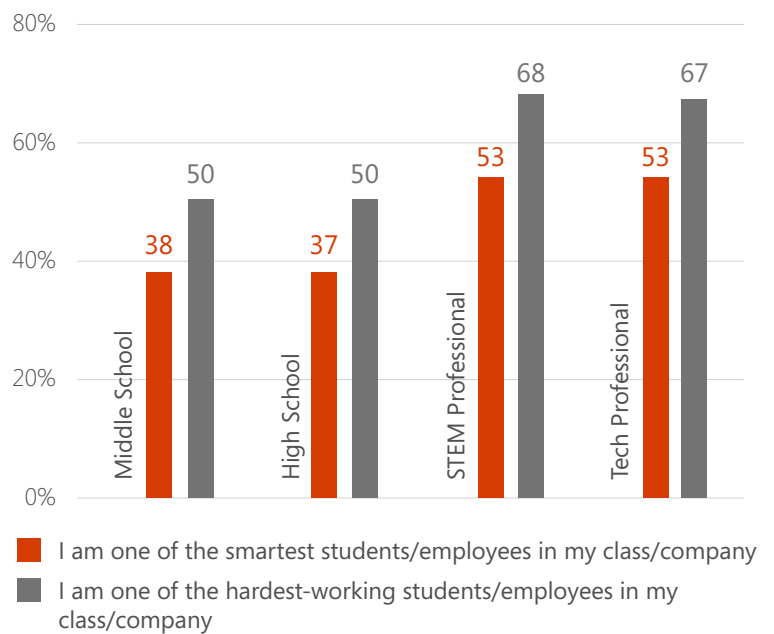|	Percent
Encouraged by teacher	20
Not encouraged by teacher	34
Encouraged by mom	22
Not encouraged by mom	31
Encouraged by dad	21
Not encouraged by dad	28
In STEM club/activity	16
Not in STEM club/activity	31

A fixed mindset is reinforced by exclusively rewarding results. A growth mindset, on the other hand, is reinforced by rewarding the process and effort of learning. This includes asking questions, making mistakes, and even being confused and frustrated sometimes.

Our research suggests that rewarding effort is a powerful way to support girls. Girls in middle and high school are more likely to view themselves as one of the hardest-working students in their STEM classes (50 percent) than as one of the smartest students (37 percent). This trend continues, in fact, among adult women with jobs in STEM.

This means that if teachers emphasize knowing the answer rather than diligently seeking it out, they could be discouraging most of the girls in the room. But if they make it clear that hard work is, in fact, how you expand your knowledge and discover new answers, they will speak directly to how girls already view themselves in STEM classes. They will encourage the growth mindset that students need to follow through and succeed.

What is the role of work ethic in STEM classes and careers?
Girls, Grades 5-12 and Women, Ages 18-30

Category	I am one of the smartest students/employees in my class/company	I am one of the hardest-working students/employees in my class/company
Middle School	38	50
High School	37	50
STEM Professional	53	68
Tech Professional	53	67

■ I am one of the smartest students/employees in my class/company
■ I am one of the hardest-working students/employees in my class/company

> " I just applied to the new STEM program at the local high school and hope I make it. I know there are lots of kids smarter than I am, but I believe in myself and know I can help make people better. "
>
> 8th Grade Girl
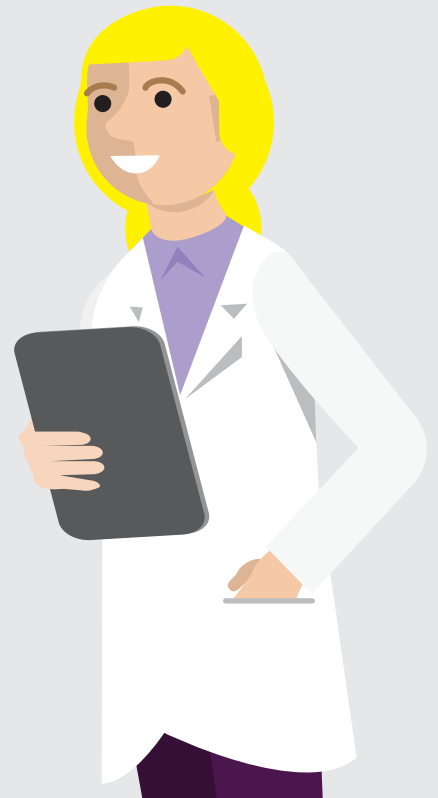
Turning insight into action

Through these insights, we know that there are immediate and practical steps that schools, parents, teachers, nonprofits and professionals can take today to enhance girls' engagement with STEM and computer science. These include:

- Provide more exposure to positive role models and mentors they can both relate to and aspire to be.

- Demonstrate a path forward in terms of turning an interest in STEM and computer science into success in school and in a career.

- Support extracurricular STEM activities that teach girls how to create and build confidence.

- Provide hands-on experiences and real-world examples.

- Emphasize the creative aspects of STEM and computer science.

- Demonstrate the dramatic impact that STEM and computer science jobs have on the world.

- Encourage parents, teachers and others influential in a girl's life to support and foster interest in STEM and computer science.

- Support teachers to develop strategies to engage students who are afraid to ask questions, be wrong or ask for additional help.

- Listen to what girls say about their challenges and desires.

The last bullet may be the most important. We know that some girls and young women thrive in STEM and computer science studies and careers, while others are stymied and choose not to proceed. As we continue to question why that happens and how to address those reasons, we have to keep our focus on the students and act on what they are telling us they need.

Microsoft Philanthropies

We're investing our greatest assets—our technology, people, grants, and voice—to advance a more equitable world where the benefits of technology are accessible to everyone. Technology should be an equalizing force in the world, not one that drives people further apart. Through our philanthropic investments and partnerships, we are working to create a better future that everyone can share in.

For more information about Microsoft Philanthropies, please visit:
microsoft.com/philanthropies

Find more resources to close the STEM gap at aka.ms/girls-in-stem

For information about Microsoft's diversity and inclusion programs:
microsoft.com/diversity

Media contact:
WE-MSWDGEDU@we-worldwide.com