Parent's Guide to STEM

STEMx™ BATTELLE greater cincinnati Stem collaborative

WELCOME

The Parent's Guide to STEM (Science, Technology, Engineering and Math) is a tool that all parents can use to remain active in their students' lives as you seek to provide your child with the best possible future. You want to guide them through educational decisions. We're here to support you.

This guide answers the questions parents often ask about how to get involved in their STEM community. To do this, we started with the STEM Companion Guide for Parents compiled by the Greater Cincinnati STEM Collaborative. Then, we added the expertise and resources compiled by STEMx network members and Battelle.

We kept answers brief and user friendly with a focus on national statistics and meaningful research. We also provided online links if you want more information on any of the resources discussed. There's a lot here, so we suggest you skip to the questions that interest you, listed in the table of contents. Don't feel you have to read it all at once.

We believe STEM can grow children into problem solvers and critical thinkers through grabbing their interest with hands-on programs. If you're a big STEM fan already, great! If not, we hope this guide sparks your interest.

As the greatest influence in your child's life, you can open the world of STEM to them in these simple steps:

1. Talk to your child about STEM;
2. Encourage your child in STEM classes at school; and
3. Expose your child to STEM activities outside of school.

To provide an example of the value of STEM education, we have included the story of a young STEM professional - Sarah. She blended her love of nature, need for variety and desire to travel into an exciting and rewarding STEM career. Without supportive parents and teachers exposing her to STEM activities and education, she would not be living her dream. Her route was not direct, yet early STEM experiences and encouragement pushed her to succeed. We hope she inspires you as she has inspired us.

If you have additional questions or feedback, please contact us at www.stemx.us/parents.

Thank you for your interest,

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HELLO FELLOW PARENTS,

Hi, I'm Elaine Williams, and I am the parent of two children, an eighth grader and a freshman in high school. I have worked in education for over 15 years and have always volunteered by tutoring, making phone calls, coaching sports, fundraising, serving on committees, or finding resources and programs for other parents to assist their children in school. I know that staying involved with their child's school and becoming a true partner will enhance your child's learning and success.

The Parent's Guide to STEM is one of those resources that everyone can use to assist with educating the children you care about. It is easy to understand and you can apply the concepts to your children through your daily routine. You may realize you are already using STEM in your everyday interaction with your children. I did, and I am no rocket scientist.

I hope you enjoy this STEM guide for parents. From my personal experience, I know how valuable STEM can be.

-Elaine Williams

TAMRA'S STORY

Strict standards, falling in love with math charted unusual path

Tamra's mother was vigilant about her daughter succeeding in math, grounding her if she brought home less than an 85 percent. *"My mother was serious, but also very inspiring. She believed in me and said anything worth having is worth working for. She told me I was smart, but she always focused on the work."*

Learning from example, Tamra built grit after taking algebra I, II and pre-calculus twice in high school. *"A lot of people believe that if you are a math teacher or professor (as she has been) that it comes easily. For me, that is furthest from the truth. I struggled mightily."*

In fact, Tamra failed a number of times, but always rebounded. A fresh-faced teacher caught her attention with geometry, *"where I experienced a love of learning math, even though it was a challenge."* She was named most-improved student. To follow the teacher the next year into an honors class, Tamra enrolled in a summer community-college course, but was placed in the lowest class. As a result, she insisted on transferring to public school, where, with few students and much teacher attention, she persevered, earning an A.

Again placing in pre-calculus on a college math-entrance exam, she *"decided then and there to get an A. There was a behavior change and I didn't blame my teachers as I had. I sat in the front of the class, took notes, re-wrote those notes, used different colors, created note cards and drilled myself. I did my homework the day it was assigned so I had time to see my professor, but the biggest benefit was the small cohort I traveled in from class to class. Studying together was a great support system."*

For her, the choice of a Historically Black College/University, Kentucky State University, was crucial to success. Tamra is bi-racial, identifying as African American. *"The math department chair, Dr. David Adams, would sit with me for 45 minutes and let me work through many questions. That was the difference between a small college versus a large university."*

(Above) Tamra with her mother, Yvonne Curington, and sister, Shelly Ragland, at her 2012 UC Ph.D graduation ceremony. Her early math failures taught her persistence.

Originally enrolled in engineering, Tamra switched to math *"due to my frustration with physics and circuit theory. Math made sense because I had taken so much."* It was then she vowed to pursue a Ph.D.

Parenthood after graduating altered her path. *"I went home to Dayton to figure it out and started subbing. In a high school one day, I was giving a test and saw how apathetic the students were: some were not even attempting the test, some fell asleep. I thought then I could be a teacher who could help."* She completed a master's at Wright State University, then taught in Dayton Public Schools. *"It's an interesting thing to have been a student, a teacher, then a professor preparing future teachers and also a mathematics-education researcher for in the same district.*

Fast forward several years and Tamra selected a doctorate in education program *"with an emphasis on math teaching and learning because I wanted to be the math supervisor of an urban district."* She completed her coursework over ten years at the University of Cincinnati "researching four African-American girls taking algebra I as ninth graders, their experiences and perceptions, comparing them to my own" for her dissertation.

As a society, Tamra believes we discourage girls from pursuing math. *"We have these beliefs about math and engineering and the stereotype that they are for white males and Asians. Girls and minorities don't do math. Sometimes we pass along implicit biases unaware."*

She works to combat that message as well the misconception of a math gene in her duties as Winton Woods City Schools supervisor of curriculum and instruction. She handles math, science, English as a second language and gifted teaching and learning for the entre district.

"A math brain does not exist," according to Tamra. *"Math requires time, experience and practice. Teaching math is like when I played high school basketball. The test is the game, homework and class work, the practice. It's okay to make mistakes as long as we learn from them before we play the game."*

The math expert who once fumbled considers math *"the language that opens the door, answering the questions of why it is important to learn, what does it do?"* She has students gather clues from Edgar Allen Poe's creepy classic, *"The Pit and the Pendulum,"* to measure how much time the victim has to escape or grabs their attention, asking them to figure how much time they really (don't) have to safely text and drive.

"Some people can live without being able to calculate the equation of an ellipse – the path of the sun. Like going to a foreign country and not being able to speak, you can live without it, but won't appreciate what's going on around you. You won't understand the beauty and mystery behind all of these things or, possibly, have as much fun."

TAMRA
Using hands-on, visual equations with 7th and 8th graders in a Women-in-STEM day she organized in her district. She wants to nurture a love of math with fun and real-world connections.

Collaborates with other educators in a project that combines math, physics with literature that asks students to create an evidence-based public-service announcement on texting and driving

Parent Tips:

1. **START** with your child's teacher first, then your school district to uncover all the STEM enrichment to interest your child. Hands-on experiences and real-world applications are essential.

2. **SUPPORT** your child's natural exploration. Parents have to be willing learners to have a conversation. It doesn't have to be high level; ask where they think the bug lives, count its legs and wings.

3. **FIND** a tutor if your child is struggling, don't wait.

4. **ENCOURAGE** them to play an instrument. By counting whole, half, quarter, eighth and sixteenth notes, they learn fractions and how to add different denominators. Music provides several math applications.

5. **FOCUS** on developing a growth mindset in your child. Let them know that failure and mistakes are valuable parts of this process.

Tamra as a baby with the mother who would inspire her to keep trying.

6. **ENCOURAGE** them to believe in themselves. Depth is more important than speed. Faster is not smarter. Mathematicians often think very slowly, yet deeply.

MAPPING MATH
BEFORE HIGH SCHOOL

> GRADES K-3
Foundations of Learning Basic Facts,
How to Add, Subtract, Multiply and Divide.

> GRADES 4-6
Applying and
Extending those Facts

> GRADES 7-8
Algebraic Thinking
and Proportional Reasoning

MASTERING STEM BASICS

SARAH'S STORY | Perfect STEM career product of supportive parents, right placement

Twenty-four-year-old Sarah, a Cincinnatian, dreamed of working outdoors. Always. And of traveling the world, being physically active and making a difference. She couldn't help it. Her parents loaded her in a front pack as an infant and trekked Mt. LeConte, the highest point in the Smoky Mountains. Her family visited national parks, camped and hiked. They've ticked off an impressive list.

"I was 100 percent looking at jobs that were NOT sitting at a desk," Sarah says. *"I wanted a career that got me outside and had me constantly moving, that would take me places in the world to discover new things. That really narrowed my choice to geology, where you have to travel or you only know the local geology. You literally study the world, know the distinctive parts, how they connect, how they are different and how they work together."*

"When I was 11, we went to Yellowstone National Park and I learned about super volcanoes, magma and geothermal activity," Sarah remembers. *"It was the first time I ever went to an active volcano and it was so big, mysterious and unknown. I had no idea then it would be my future."*

Sarah just graduated with her master's in geophysics from Pennsylvania State University and landed her dream job: deformation geophysicist for the US Geological Survey - Hawaiian Volcano Observatory on Hawaii's Big Island. Translation: she hikes the volcano to measure its activity.

(Above) Sarah in her gear at the volcano rim. Photo Courtesy of USGS-HVO

What is STEM anyway?

STEM is short for science, technology, engineering and math. STEM teaches science, math and engineering as a whole, using technology to relate learning to the real world. STEM education and training increase the number of college science and technology graduates entering a growing workforce. Students succeed with in-demand STEM jobs!

STEM challenges students with projects, concrete knowledge and experience. For example, a digital-drawing program may be included in a geometry lesson. STEM is hands-on, mind-on and feeds natural student curiosity when they are most ready to learn.

STEM is also known as STEMM (STEM + Medicine) or STEAM (STEM +Arts). Medicine is a science combining technology, bioengineering and math. The arts include design, which is how STEM interacts with the world, so we often group arts as a family member too. STEM appears here as the most commonly used term.

Why is STEM important, what's the fuss?

STEM is everywhere, shaping our daily lives. Walk outside into nature (science), pick up technology in your cell phone, drive a car designed by engineers or bake brownies using math to measure, select the correct oven temperature and timing. We are a technology-driven society and those with STEM skills better meet challenges, enjoy a higher quality of life and greater income. STEM careers are also "helping" professions that solve the problems facing our communities with rewarding work.

Promoting STEM does not necessarily mean every child will become an engineer. However, STEM is for everyone and grows children in these ways:

1. **STEM** prepares children for an ever-increasing technological world. From the Internet to inventions we can't yet imagine, those comfortable with technology hold an advantage.
2. **STEM** teaches kids how to analyze and problem-solve, developing critical thinkers. The thought patterns math and science develop also apply to the many challenges of work, career and life.
3. **STEM** builds creativity. Brainstorming, designing, tinkering, collaborating, contributing & communicating opens our children to more possibilities in the lab or architecture studio, 3-D printing, industrial, gaming and web-design fields.
4. **STEM** education develops "soft 21st- Century skills"* to increase emotional intelligence and build stronger relationships. STEM education uses group activities, where students learn to listen, empathize, express and promote themselves and draw parallels between learning and the larger world.
5. **STEM** builds grit. STEM and math, in particular, are challenging. As children struggle, they increase their skills and learn not to give up. Intelligence is created through effort.
6. **STEM** creates confidence when students overcome the challenges of difficult tasks or subjects. As a result, they become lifelong learners able to tackle new demands.
7. **STEM** offers growing and higher-paying work and careers. The U.S. Department of Labor projects that by 2018, 9 of the 10 fastest-growing jobs with a bachelor's degree will require greater science or math training
8. **STEM** inspires innovators & inventors. Entrepreneurs who create products and services that improve our lives are the single, largest source of new jobs for our economy.
9. **STEM** will improve our world standing. In the latest tests of 15-year-olds from around the world, American kids ranked #31 in math and #23 in science – far behind many other industrialized nations.
10. **STEM** solves the world's problems with research that cures diseases, engineering that modernizes decaying transportation systems and technologies that produce new jobs. STEM talent will fix global problems and improve our lives.

Let's not forget that STEM is just plain fun, tapping our natural curiosity, the joy of discovery and learning about the world.

* Defined by The Partnership for 21st Century Skills, these are a set of abilities that students need to develop in order to succeed in the information age and include:

- **Learning Skills:** critical thinking, creative thinking, collaborating and communicating.
- **Literacy Skills:** information, media and technology literacy.
- **Life Skills:** flexibility, initiative, social skills, productivity and leadership.

More information: https://k12.thoughtfullearning.com/FAQ/what-are-21st-century-skills

Why should parents be involved in STEM?

Your focus on STEM shows that you care about your child. You are their first teacher, a role that doesn't end when school starts. You have the most influence on them.

When parents play an active role, their children are better learners, regardless of income, race or the parents' education, according to research. Teachers also encourage participation. The National Science Teaching Association believes parent or caregiver involvement increases children's interest in and ability to learn science. Children of engaged parents are more confident, do better in math and are more likely to choose and stay in STEM careers.

Not surprisingly, your children value your opinions and attitudes. In a national survey of students in STEM fields, 32 percent said a parent had the most influence on the decision to study STEM and 73 percent said that a parent had some influence on their decision.

How do I talk to my children about STEM?

A strong strategy includes a discussion of STEM and future careers. Please do not feel overwhelmed if your child dislikes STEM classes or can't yet look ahead. The earlier you talk about it, from elementary to high school, the more easily your child will choose STEM. These tips, along with those in our resource section, will:

1

UNPACK THE MEANING OF STEM.

Start with the simple definition (science, technology, engineering, math) and share examples they know. Tell your story or of someone who works in a STEM field, what they do and why it matters. Using one of your child's interests, like watching TV, talk about how STEM makes it work.* Explain STEM is a helping choice that improves lives around the world with safe drinking water, devices for better hearing and vision and communication to distant places.

2

PUSH YOUR CHILD'S NATURAL CURIOSITY.

Remember their early why-why-why questions? Children are born curious; discover their interests and strengths by exploring their questions as they respond to the world around them. You encourage their natural curiosity with your own why-does-this-happen and how-does-that-work questions. Share and support your child even if you don't know the answers. Google, libraries and people you know are good resources.

3

HOLD UP A STEM MIRROR, SO THEY SEE THEMSELVES.

Point out how their natural interests relate to STEM. A nature and outdoor lover could become an environmentalist, maybe the young artist is a promising digital designer. Identify your child's strengths that relate to STEM. Kids are naturally drawn to STEM when they build forts, collect bugs and play computer games; point this out. Reinforce that the world depends on their minds, skills and talent to fix big problems for people everywhere. Next time your child is asked what they want to be when they grow up, steer them toward STEM, part of almost any career they can imagine. Children see themselves as STEM learners in STEM fields when we show them how STEM involves those choices. We move them closer to their dream and a fulfilling life.

STEM COMPANION:
What advice would you have for parents in getting their kids on the STEM or math/science pathway?

SARAH:
It was important to me that my dad always spent time with me and it wasn't always about getting the homework done. He wanted to show me projects, like cars, electricity and water and how they related to other things in the house and life. My mom found lots of activities around the city for us to do. We were always at the Cincinnati Museum Center and in scouts I tried a lot of different things. Trying many things is just who I am.

What tips do you have for engaging my child in STEM?

The possibilities are almost endless at home, school and using local STEM resources. Many communities, even some you might not think, have some local STEM program. It is important to bring those activities home and engage further with your child. See what they enjoy and bring that excitement into your household. As they play and learn, make sure you engage with them about their growth. If they feel that you are excited about their work, they will continue to play, learn and develop their STEM skills.

AT HOME

1. Do experiments and simply explore
2. Ask "Why did that happen?"
3. Ask "How does that work?"
4. Provide STEM-oriented toys & games
5. Watch STEM movies or shows

AT SCHOOL

1. Enroll them in STEM clubs or after-school activities
2. Encourage teachers to provide hands-on activities in the classroom
3. Suggest taking STEM classes in middle, junior and high school

IN THE COMMUNITY

1. Get into nature and the outdoors
2. Visit a museum
3. Experiment in a maker space
4. Suggest taking STEM classes in middle, junior and high school

When do I engage my child in STEM?

You can never begin too early or too young to tap that natural attraction to rocks, dirt and questions. Sixty-five percent of scientists and STEM-graduate students say they developed their interest in elementary school, according to a study in the March 2010 International Journal of Science Education. Another study shows that students decide as early as second grade whether they like and are good at math. Without early support, many narrow their work choices well before middle school, missing promising and rewarding professions.

There are also late bloomers who discover their STEM interest in high school and college. No matter your child's age or range of interests, simply plug them into STEM information and activities. It is never too late.

MASTERING STEM BASICS

SARAH'S STORY | Sticking with math and engaging teachers inspired STEM path

Sarah's STEM path was neither straight nor clear, but nurtured by an appreciation for nature, inquisitiveness and a flare for the drama of erupting volcanoes.

"My dad's an engineer and always wanted to teach me about how things work and problem solving," Sarah says. "I learned a lot about cars, even though it wasn't an interest of mine, but it taught me about hobbies and knowing about one thing.

"He helped me with my math homework, which wasn't always my strong suit. I was decent at it; I could see numbers, connections and patterns, but still needed help. Math after eighth grade gets hard and is hard to teach. I don't think there is a math brain. I was never a straight-A math student, yet my whole job revolves around it. Math is meant to be hard and the biggest hurdle is being persistent and working at it."

A junior-high biology teacher baited Sarah with an unusual request. *"I wasn't good at memorization, but Mr. Jones was always interactive and talked me into watching this snake for the summer. It didn't work out so well, I was scared, but I really liked Mr. Jones and wanted to know more about science. He was able to get me to do something I didn't think I could."* Her ninth-grade chemistry and 11th- grade AP chemistry teacher Mr. Ignatz was equally enthusiastic *"like Bill Nye and really helped me remember. I gained a good foundation that helped me get A's in college chemistry. We had fireproof tables and he would take gas and create a ring of fire and play the Johnny Cash song 'Ring of Fire.' He would keep us awake and hold our attention – no boring PowerPoint presentations. Mr. Ignatz always made science relevant to other classes. I took environmental science at the time, which integrated math and writing. It made me a good writer. A teacher makes or breaks you. And, until you make connections between things and find ways to connect to your daily life, it doesn't stick."*

Sarah studied a lot of science in high school, including astronomy and geology. *"The teacher suggested doing my undergrad degree in geology because she could see I was an outdoorsy person and that can really influence your job."*

(Above) Sarah's dad introduced her to cars and hobbies which taught her to learn all about one thing as well as how cars work. She's in back of their beloved Plymouth Fury.

What about the arts?

It's not a choice between STEM and the arts (STEAM). We need both as they work together to create new products and services, a healthy economy, job growth and, most importantly, a well-rounded person. Working both sides of the brain, logical and creative, STEM and STEAM ask the same, bold questions: What is true? Why does it matter? How can we move society forward? Both search deeply for meaningful answers.

Many famous inventors and scientists were also musicians, artists and writers: Galileo drafted poetry and Einstein plucked the violin. How can you encourage your child in opening to both sides of their brain?

STEM is not exclusive and blends easily with other subjects. For example, psychology heavily uses math and statistics; history teaches us the past and, when we apply those lessons, develops critical thinking. Spoken and written language unlock our understanding of STEM so we can relate it to our lives. Together, these subjects draw a more complete picture of the world, building a stronger base for solving problems.

Our primary STEM focus feeds a society hungry for more technology that has, until recently, left behind math and science. As a result, we almost all identify as readers, but rarely as good in math. We don't want to set STEM above other subjects, but it can't be less. STEM can drive our economy and solve big, worldwide problems.

What if I am not a STEM person?

Everyone has some STEM skills. You may not be an engineer, but you can fix things around the house. You may not be a chemist, but you can cook. Even if you only know some things about STEM, you can always learn with your child. When you guide your child toward finding the answer, you model that we continue to learn at every age..

My child hates math, now what?

As mentioned earlier, your child will see a STEM future when they feel strong in math. This is key. If they struggle with math or other schoolwork, remind them that they don't need to do it perfectly, especially not ALL at once. However, if you sense there's a deeper problem, maybe a lack of interest, check with your child's teacher, who can offer tutoring or more challenge.

The "math brain" does not exist. The genes that set academic talent control ALL subjects. Math is difficult at some point for everyone! Struggling a bit, even getting the wrong answer, is how we truly learn. We gain more from our mistakes than being perfect. Failure feeds determination, sticking to it and grit that predict educational success. With steady effort, a child can do just as well in math as any other subject.

Share with your child that math includes abstract thinking. Looking at ideas instead of facts or what is right in front of them may be a new skill, mastered with practice. Drive their enthusiasm by making meaningful connections between math, their interests and what they care about. Younger students may not realize they are doing math when counting money and telling time. Point that out. Ask older students to explore how math may be part of a college, work or occupation goals.

> **"The only way I can remember what I learn is to find a connection that has to do with my life or make a mnemonic that stands for each letter of a word. I can't just flat out memorize things. I still remember the quadratic formula because of a song a math teacher taught me. I would sing it during multi-variable calculus class in college and other students would ask me how I could remember it."**
>
> – Sarah | *US Geological Survey Geophysicist*

MATH CHALLENGE

To demonstrate that math is relevant to everyday life, challenge your family to go a whole day without using math. You'll become aware of the numerous (pun intended) ways we automatically incorporate math into daily life!

What about opportunities for girls in STEM?

STEM is wide open for girls who share big dreams for making the world better, if we shift false stereotypes, negative messages and their own views. While women make up over half the U.S. workforce and hold the majority of college degrees, there are very few in STEM education (20 percent in engineering, computer science and physics) and careers (25 percent).

The truth is girls and boys are equally smart in STEM, and high-school girls earn even more math and science credits and have higher GPAs.

Girls draw their attitudes from how they view themselves instead of their real ability. When they believe in themselves and that hard work and effort increase intelligence, girls improve their math and science scores. They do less well when they believe boys are better at math, research says. However, when told they are equal in talent, they score equally. Girls may have these incorrect assumptions, blocking their full potential in math and science.

Girls with the same abilities as boys are more likely to give up on difficult material and lose interest in STEM by middle school when they believe these subjects are too hard. As STEM parents, we must reinforce the message that struggling is often how we learn, especially in math, and that girls can do well in STEM subjects.

Some parents and teachers unknowingly discourage girls with lower expectations. Research studies show that:

Teachers expect more in math and science from boys, guiding them to find solutions, than from girls, to whom they give answers.

Mothers encourage their sons more than their daughters in hands-on activities in science museums.

Teachers call on boys more than girls in science and math classes.

Once we become more aware, we can be sure to provide proper and equal encouragement.

We all must become more aware and more active in encouraging girls in STEM by:

More than anything else, parental support can move a girl toward STEM. ALL children benefit from exposure to STEM activities, STEM role models and mentoring. When we stress STEM for girls, boys respond positively too and understand that STEM is for everyone.

Read how girls are working to overcome challenges facing them in STEM careers in "Girls, STEM & Careers" a recent report by Ruling Our eXperiences (ROX) a national non-profit provider of programming, research and education focused on girls: ***https://rulingourexperiences.com/impactreports***

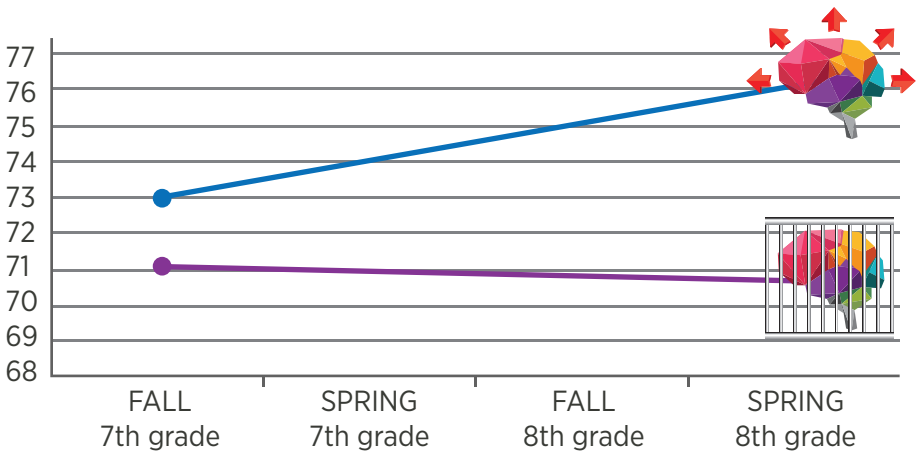
I hear a lot about "mindset," how does that relate to STEM?

When students believe hard work and practice increase their basic talent, they shine. Researchers Carol Dweck and Jo Boaler call this a growth mindset that covers all learning as well as STEM subjects. Intelligence and talent are starting points. Students with growth mindsets learn more and improve from challenges and failures. This is also a life lesson. Amazingly, the brain grows just as any other part of the body when exercised.

You can easily practice growth mindset by praising your children for their effort over abilities, guiding them to work through difficult problems. Children with teachers and parents who understand the growth mindset benefit most. Teachers with a classroom growth mindset report greater student progress.

GROWTH MINDSET EXAMPLE

In one study, seventh-grade math students were given a survey to measure their mindset, then researchers followed the students over two years to monitor their mathematics achievement. The results were dramatic, as the success of the students with a fixed mindset stayed constant, but rose for those with a growth mindset. (Blackwell et al., 2007)



Homework, Help!

We've all been here: overwhelmed by our children's math and science homework. Don't panic; their classes are more advanced than ours were at the same grade. Fortunately, there are resources. First, speak with your child's teacher. Children often don't seek help on their own. If the teacher isn't available, your local public library may have resources that can provide homework aid in person, by phone, e-mail and internet. These services are typically offered at no cost to you.

An online source, Khan Academy, listed below, posts coaching videos on most subjects.
https://www.khanacademy.org/

DIVING INTO STEM
IN/OUT OF SCHOOL

SARAH'S STORY | Desire, advanced education, experience and mentor land rare STEM job

Sarah almost didn't graduate from high school. She struggled with attendance her senior year after experiencing the death of a close friend. Thanks to persevering parents and the desire to go to college, Sarah pulled herself together. She enrolled in geology at a local college, which wooed her with good scholarships, then switched her major to nursing to appease her father. She discovered she had no tolerance for blood, then begged her parents to transfer to Utah for skiing, sunshine and her real love: geology. She headed off the second year and never looked back. She uncovered departmental scholarships to erode the cost of out-of-state tuition and snagged a summer volcano experience in Hawaii, where she met her mentor.

"I found the internship doing a Google search," Sarah says, "and spent the summer between junior and senior years at the Hawaiian Volcano Observatory, which was the most fun I ever had. I wanted to wake up and go to work. I knew those jobs were hard to come by, so I made a point to say hello to everyone and introduce myself and make connections."

One of those was with her summer supervisor. "Mike helped me with everything, including learning to code. He is a phenomenal teacher and always took time with me so I was never afraid to ask questions. We co-authored a paper for the Journal of Volcanology & Geothermal Research and he helped with my thesis. He was so insightful in learning about work relationships, which are completely different from those in graduate school. I would not be where I am today without Mike."

She left the island, completed her bachelor's degree and, "when looking at graduate programs, wanted to study Kilauea, the most active volcano in Hawaii, where the observatory is right on the crater rim."

(Above) Flying over the lava field is one of a variety of duties in Sarah's new job as a geophysicist for the Hawaiian Volcano Observatory. Photo Courtesy of USGS-HVO

The volcano became the subject of her master's-degree thesis. As she was finishing, "the job opened up, but I wasn't done with school and thought I'd apply anyway. I look at everything as an opportunity – there's no such thing as a waste of time. Hundreds applied for the job, a select few were qualified and they interviewed three. The internship really helped because it was doing exactly what my job is."

Sarah's new job is the one her mentor just left.

How does STEM relate to state & national educational standards?

Common Core standards list what students in kindergarten through 12th grade (K-12) should know in english/language arts and math at the end of each grade. The Next Generation Science Standards detail what should be taught in K-12 science. Both are used in Ohio and Kentucky. Indiana has created its own set of educational standards.

How do you measure a school in general as well as for STEM? While there are several ways, the most direct is to speak to a school official. Teachers we spoke to suggest parents ask:

TIP

Consider recommendations from other parents and exploring this website: *https://www.noodle.com/articles/what-to-look-for-in-stem-education-at-every-grade-level*

Are there schools that focus on STEM in our area?

There are many schools across the country working on valuable STEM programming. Battelle recently published an in-depth study of a public STEM school, Metro Early College. Download the Metro Model Guidebook for free: *https://www.battelle.org/battelle-stem/battelle-education/metro-model-guidebook*

TIP

Many STEMx member states evaluate and designate quality STEM school. Identify each STEMx member states through our map: *https://stemx.us/about/*

GUIDING PRINCIPLES	CORE PRACTICES
Personalization	Mastery Flexible Scheduling Advisory
STEM Literacy	Design Challenges
College and Career Readiness	The Metro Habits Internships Early College Experiences
Student Autonomy	Portfolio Roundtable Gateway
Cultural Competency	Nonselective Lottery Admission Culturally Informed Practices Social and Emotional Supports

What STEM clubs and activities exist at schools?

After-school activities involve your student in STEM with others the same age and, often, mentors in an informal, fun and relaxed setting. Most schools offer something for those with an interest in STEM from math and science clubs/fairs to academic teams and groups for chess, engineering and computer science. The Greater Cincinnati STEM Collaborative sponsors STEM Bicycle Clubs and 3-D Printer Clubs, which increase interest and confidence in STEM. Learn more at: http://greatercincystem.org/gcsc-in-action/. If you are not satisfied with STEM opportunities at your school, talk to your school's administrators and the parent-teacher organization.

What activities are available for families outside of school?

You won't have to roam far for a local STEM adventure that plays on kids' natural curiosity. Beyond books and experts, your local library is stocked with free information, activities, computers and books/DVDs with STEM themes.

Every state has afterschool programming that offers students the opportunity to enjoy learning outside of the classroom. The Afterschool Alliance has developed a database of helpful afterschool programs around the country that can be found: ***http://www.afterschoolalliance.org/policyStateMap.cfm***

Makerspaces are devoted to STEM/STEAM exploration on state-of-the art equipment. Maker spaces use these resources to teach classes on 3-D printing, sewing, vinyl and laser printing and cutting, bookbinding, and audio and video. For example, the Northern Kentucky Maker Space in Burlington tempts kids with engineering, robotics and coding, idea design, audio-visuals and a make-your-own area. Here, you get the full STEAM experience, pushing your child's creativity, inventiveness, project solving abilities and skills. For more diversity, check out the largest natural lab, Mother Nature, within your local park systems, their camps, exhibits and hikes.

The rewards of STEM experiences are long-term and long-lasting.

Learn more at:
http://www.afterschoolalliance.org/policyStateMap.cfm

STEM COMPANION:
What advice do you have for students about a STEM path?

SARAH:
Take a class that you aren't required to take. High school has more options and I took a geology class that wasn't required and it ended up being the best decision of my life all because someone told me I was good. Take a science elective. Not all science classes have to be hard. Don't be shy because you think it will be more work.

We all have a natural curiosity and science is such a broad range of subjects that accompanies us in our daily lives. Explore more in the sciences because you never know what you may end up liking.

How do I evaluate a STEM club or program?

The best STEM program interests your child and fits your lifestyle. When choosing, consider one that:

GREAT!

- Includes hands-on activities
- Ties activities to real-world
- Teaches a key science or technology point
- Encourages students to try challenging activities
- Celebrates failures (that's learning!) as well as successes

EVEN BETTER!

- Is supported by mentors who are professionals in their field and can be role models
- Involves parents in some way
- Shares how it connects to STEM careers

GCSC STEM Bicycle Club Photos

STEM BEYOND HIGH SCHOOL

COLLEGE, JOBS AND CAREERS

SARAH'S STORY | Balance: hiking, helicoptering & coding during the week, beaching on weekends

Working for the government as a geophysicist is anything but boring, according to Sarah. "I absolutely love it and am always doing something active, different and interesting. One day I may be in a helicopter flying over lava fields sampling and the next day I may be coding and processing satellite data."

Sarah "monitors the high-precision GPS network on the island to make sure everything is working and, if it's not functioning, I go fix it and collect data. InSAR (Satellite Remote Sensing System) allows us to monitor the deformation," swelling, sinking or cracking of a volcano's ground surface, that indicates what's happening below and warns of eruption. She downloads and accesses that data to inform the observatory.

"You can't go wrong in Hawaii, where I spend the weekend by the beach eating poke, a Hawaiian dish of raw tuna."

> **"Geology was always on the back burner, but my dad really wanted me to be a nurse. I started in geology, then got pulled into nursing for a quick second. When I realized I would be cooped up in a hospital and not be outside, I returned. It's not always about the money."**
>
> – Sarah | *US Geological Survey Geophysicist*

(Above) Climbing is one of Sarah's passions because it gets her moving and outside.

What about STEM jobs?

STEM jobs are in demand, growing around the globe, nation, state and region. Pure STEM accounts for 20 percent of U.S. jobs, while 80 percent of all work requires some STEM skills. The same is true for Greater Cincinnati; however as jobs rise, half of STEM positions remain open. Local employers blame fewer employees with technical skills – good news for the next generation. Currently, over 2.4 million STEM positions are sit vacant without qualified candidates.

Ideally, we want our children happy, independent, with enough money and in steady jobs. Those in STEM enjoy higher pay, career growth and long-term employment over other fields.

What degrees are required for STEM jobs?

Education is key to success in STEM professions. Ninety-five percent of jobs paying a livable salary will require some combination of education beyond high school, on-the-job training, and/or work experience over one year. A bachelor's degree or higher is necessary for over 30 percent of these higher-paying jobs. The bottom line is those with only a high-school education are likely to remain in low-paying jobs.

https://ssec.si.edu/stem-imperative
****https://www.bls.gov/emp/tables/stem-employment.htm***

Healthcare, information technology and advanced manufacturing STEM jobs are the most in demand in Greater Cincinnati.

Employment in STEM Occupations, 2018 and Projected 2028

by Employment Projections program, U.S. Bureau of Labor Statistics

	Employment in 2018	Projected employment by 2028	Percent growth	Median annual wage in 2018[1]
Non-STEM Occupations	151,329,400	158,869,100	5.0%	$37,020
STEM Occupations[2]	9,708,300	10,566,800	8.8%	$84,880

If your child is interested in one of these high-demand professions, but not a four-year degree, there are shorter, associate nursing programs and certifications in Information Technology (IT), construction, electrical and plumbing that lead to steady jobs with good pay. Even if STEM is not your child's career choice, sharpening their STEM skills can make them more competitive.

> **I chose Penn State for graduate school because it was highly ranked with many different programs in the geophysics department and because my advisor was studying exactly what I wanted to do. I felt like I wasn't done learning and doing research was important. I chose a master's program over a Ph.D. because I wasn't quite yet ready to commit to five years and it seemed like a good bridge into working.**
>
> – Sarah | *US Geological Survey Geophysicist*

How can I help my child decide on a career?

Kids are always asked: "What do you want to be when you grow up?" They usually respond based on the books, TV and people they know. These early ideas are formed from limited information, not reality. Very few make the NFL draft to play pro football, or are cut out for the brutal road to becoming a medical doctor. As parents, we often expect school counselors to guide our children's work, college and occupation choices. Realistically, counselors are overwhelmed by large numbers of students. Remember, you know your child best, want the best for them and hold the greatest influence in their lives.

Footnotes from U.S. Bureau of Labor Statistics:

(1) Data are from the Occupational Employment Statistics program, U.S. Bureau of Labor Statistics. Wage data cover non-farm wage and salary workers and do not cover the self-employed, owners and partners in unincorporated firms, or household workers.

(2) Science, technology, engineering, and math (STEM) occupations include computer and mathematical, architecture and engineering, and life and physical science occupations, as well as managerial and postsecondary teaching occupations related to these functional areas and sales occupations requiring scientific or technical knowledge at the postsecondary level. For more information, see https://www.bls.gov/oes/topics.htm#stem.

Career decisions are often mind-boggling, difficult and depend on interests, skill, desired income, location choice and job availability. Pulling this together takes effort, thought and your support. Information, role models and experiences create better decisions. Use every tool you have: school career-test results, exploring your job with your child and introducing them to STEM professions. Relationships and experiences are the most meaningful in creating your child's future.

Most students experiment before finding the right direction and, even then, may change. That is OK. Research shows almost everyone picks a pretty good fit in the end. The upshot: don't worry if your child is not yet in college and/or doesn't know what they want to do when they graduate.

Be mindful that early exposure to careers improves how well children do in school and how much they value education. A study of 15-year-olds with job-related experiences (internships, job shadowing, job fairs or school advising) showed positive attitudes about education. Career coaching, STEM studies and exploration build a solid future for your child.

> **It has been hard to be a woman in a male-dominated field, but it's gotten better and there are so many scholarship opportunities. It was a little uncomfortable in field camp with 40 men and three women, but you get used to it. I never felt limited and there was never any bullying.**
>
> – Sarah | *US Geological Survey Geophysicist*

TIP
Find current workforce statistics including highest-paying professions, fastest-growing professions, and careers with the newest jobs
https://www.bls.gov/ooh

SARAH'S PARENTS POINT OF VIEW | Engagement + Problem-Solving Play + Mentors = STEM Success

"Sarah always had a mind of her own. At three, she didn't want me to dress her and often fought parental suggestions, so I learned to guide her," her mother, Carolyn, says.

When a group hiked the steep Chimneys in the Smoky Mountains and half turned back, "Sarah wanted to continue with the adults," her dad, Andy, recalls. "I thought she could do it, but she was only four or five and I wasn't sure she should." Sarah victoriously persisted.

"Our philosophy was to let our girls spend time outdoors, not be so busy and have the opportunity to daydream and be creative," according to Carolyn. "Andy would draw big chalk mazes they would ride their bikes through, they built forts and, in winter, connected cardboard boxes inside to make tunnels. They learned problem solving early." Sarah's older sister, Amanda, teaches fifth-grade math and English.

Later, in scouting her daughters participated in a comprehensive skill-and-gifts survey that also focused on building character. "It helped her see early where her strengths were." That knowledge, engaged parents who shared their careers and many mentors launched Sarah on a strong STEM pathway that suited her drive, ambition, talents, quirks and aptitude.

"Math has been essential in where she is right now," her mother says. Andy travels as an engineer, so he'd often get calls or faxes on the road from Sarah with math-homework questions.

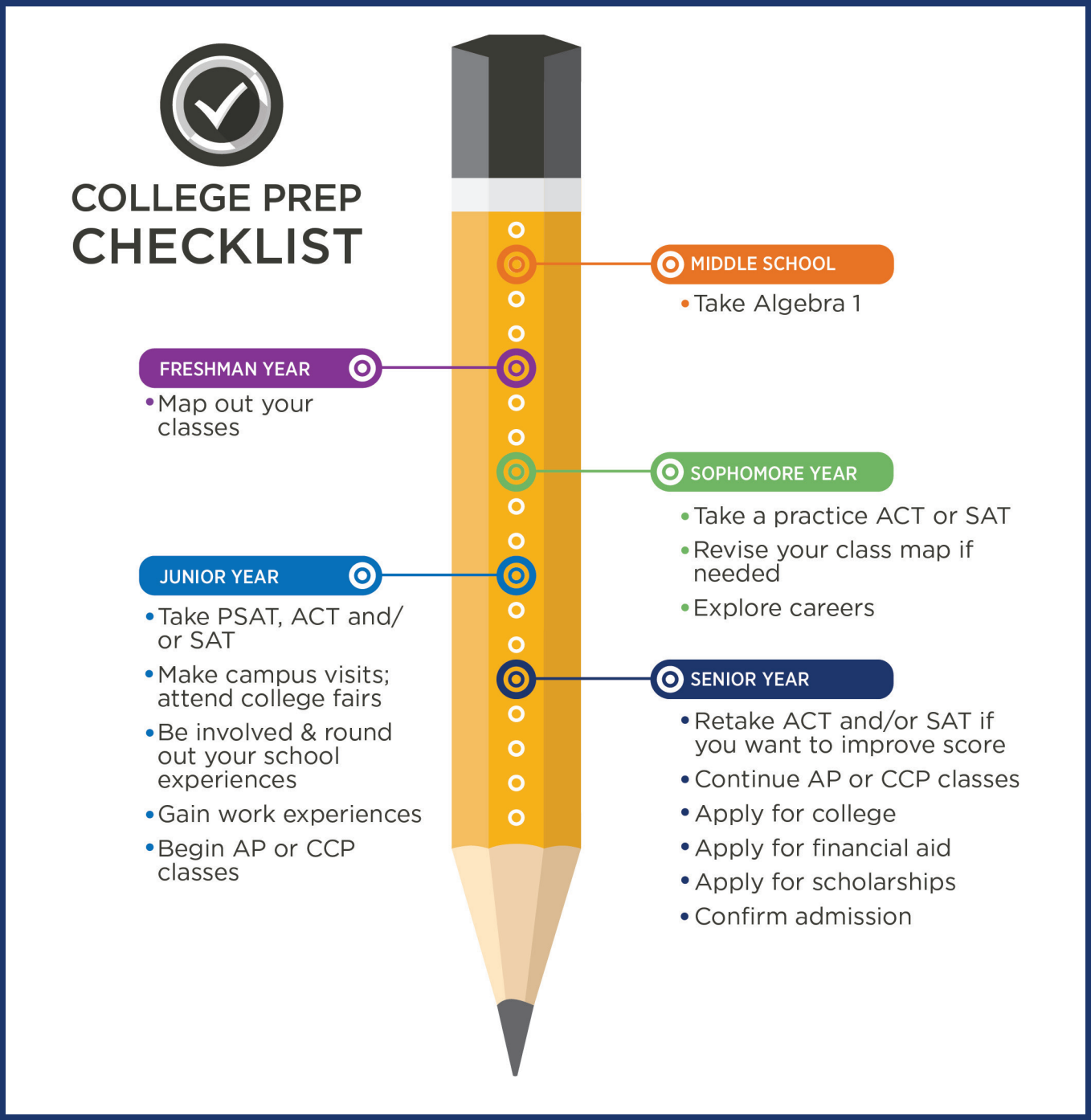
"However, it's the right combination of field, office work and independence, the three components she needs," Carolyn adds.

(Above) Sarah's family (left to right: her dad Andy; Sarah; sister Amanda, a fifth-grade math teacher; and mom Carolyn) visiting the Gates of the Arctic National Park and Preserve in Alaska.

In Summary

Whether you are a parent, caregiver or a concerned adult, we appreciate your interest in STEM. Working together, we create a brighter future for our children, our families and our nation. STEM builds critical thinking skills for all careers. Together, we are fostering a new generation of leaders. This new generation of citizens will create new businesses, jobs and prosperity. All of this is possible only with the support of parents and the example of role models for our children. You make STEM relevant, you make a difference and you inspire our next generation.

From all of us at the STEMx network, Battelle, and STEM educators across the world, thank you.



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