What is STEM Education and How Do I Teach It?

For Parents

By Mary-Eileen Gallagher
Welcome to the world of STEM

If you’re like a lot of parents who may be newly homeschooling your elementary-aged kids, you’ve heard a lot about STEM education lately. Maybe you’re looking for ways to incorporate STEM (science, technology, engineering, and math) learning into the curriculum provided by your child’s teacher, or you’re looking for educational enrichment you can do to bring STEM home.

Here at Kid Spark Education, we’re passionate about building student’s STEM identity and technology fluency. We also understand the challenges you face in implementing STEM curriculum at home. Whether it’s a lack of resources, the need for more training, or general uncertainty about where to start, we get it and we’re here to help.

We’ve put together this comprehensive guide to take the guesswork out of STEM education for kids, and give you the confidence and tools you need to get started today.

In this article we’ll cover:

• What is STEM?
• Why is STEM education important?
• 3 things students need to be successful in STEM
• Structures to support STEM learning
• 8 simple STEM activities for elementary-aged kids
• How STEM supports a growth mindset

If you have questions after reading this guide, don’t hesitate to connect with us. Now, let’s get started!
What is STEM?

STEM stands for Science, Technology, Engineering, and Math. But don’t let this basic definition lead you to think that STEM is about teaching these subjects separately and in isolation from one another. Instead, think of STEM as an integrated and interdisciplinary approach to learning. It engages kids in meaningful and collaborative work that mirrors real life. Through the integration of science, technology, engineering, and math, kids learn to look at the world with curiosity, think critically, and apply practical knowledge to solve problems. These are 21st century skills that will serve all kids well in every corner of their lives.

STEM moves beyond the basic levels of remembering and understanding to engage kids in higher forms of thinking such as analyzing, synthesizing, evaluating, and creating. STEM also helps bridge the gap between school, the workplace, and the broader economy by highlighting the kinds of problems people are paid to solve every day.

Let’s take a closer look at each discipline in STEM and explore how they’re connected.
“STEM helps bridge the gap between school, the workplace, and the broader economy.”
Science

Science is the **study of the physical and natural world**. It includes basic facts about the world, as well as the process for discovering new things through the scientific method. At the heart of science is evidence and experimentation. Through observation, trial and error, scientists test their ideas, collect and analyze data, and refine theories. They use evidence to explain natural phenomena and understand the physical world.

Scientists study a broad range of things including weather and climate, animal behavior in the wild, micro-organisms and cells, how the human body works, and where diseases come from.
Technology

When you hear the word technology, you likely think of computers, iPads, and touchscreens. But these are just a few examples of very modern technology.

**Although technology comes in many forms, its main purpose is to create tools that reduce effort, save time, and increase comfort and efficiency.** Once a problem is identified, a person uses their understanding of the natural world, based on science, to design and create a solution through engineering, which requires math. This requires observation, many rounds of experimentation, and an understanding of scientific and engineering principles. The ability to apply math and abstract reasoning is also crucial to this process.

As you can see, these disciplines are intimately connected.

Examples of major technological breakthroughs in human history include the wheel, the printing press, the steam engine, the lightbulb, the automobile, and the airplane. Your home also holds many examples of technology. From scissors and glue, to markers, paper, and stickers, ordinary materials solve problems for kids and parents every day.

**Things we often take for granted, like alarm clocks, forks, velcro, and windshield wipers, are all examples of technology.** How do you use technology to solve your biggest challenges throughout the day?
Engineering

Engineering is the process of designing and building technology (tools, systems, and processes) that solve a problem. Engineering comes from the Latin words _ingenium_, which means cleverness, and _ingeniare_, which means to design or devise. Engineers are practical problem solvers concerned with form and function. They focus their design cleverness on how a machine, tool, or structure can be created or made more efficient and reliable.

Engineers rely heavily on science and math to ensure that a tool will work as it is intended. For example, an architect might propose constructing a building made out of new materials invented by scientists. An engineer’s task is to figure out how to build the structure to last and function properly in all conditions.

While science is focused on understanding and explaining the natural world, engineering takes this understanding and uses it to improve human technology. Like scientists, engineers test designs and collect and analyze evidence. However, they are interested in modifying designs in order to improve performance, rather than refining theories.

Examples of engineering achievements in human history include the pyramids, the Great Wall of China, the Roman aqueducts, farm irrigation, and central heating.

Scientists and engineers are similar, but they differ in a few important ways:

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<th>Scientists...</th>
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<td>Ask questions and build theories.</td>
<td>Find practical purposes for scientific discoveries.</td>
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<td>Want to understand and explain things.</td>
<td>Create and build things based on science and math.</td>
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<td>Study why things are the way they are.</td>
<td>Study how things work and can be useful.</td>
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Math

Math is an integral part of science, technology, and engineering, as well as an important subject in its own right. We often reduce our definition of math to the basics of addition, subtraction, multiplication, and division, and consider speed at these calculations to mean a person is good at math. But math involves far more than this. A deep conceptual understanding, not speed of calculation, is the mark of a mathematician.

When kids participate in high-quality math programs, they develop logical thinking, reasoning, and problem-solving skills. Through math practice, kids gain important skills such as flexible thinking, self-regulation, and sustained focus.

Scientists and engineers rely on excellent math skills and a strong math mindset in order to follow logical steps, persevere in problem-solving, communicate arguments clearly, and think outside the box for unique and creative solutions.

Being skilled in math is required in professions such as accounting, financial planning, building, plumbing, and nursing.
Why is STEM important?

STEM is important because through the integration of science, technology, engineering, and math, students develop a unique perspective about the world. STEM thinkers explore the world with curiosity, seek to understand how and why things work, and design technological solutions to improve our everyday lives.

STEM education also builds what are commonly referred to as 21st century skills and include the following:

- Critical thinking
- Creativity
- Collaboration
- Communication
- Technology literacy
- Leadership
- Flexibility

It’s important to remember that teaching STEM is not just about preparing kids for careers in STEM. We don’t teach writing so that all students will become professional writers, and we don’t teach reading so that all students will become literature professors.

Similarly, we don’t teach STEM so that all kids will become scientists and engineers. We teach STEM so that students will learn how to learn and lead productive adult lives in any field they choose. The future is unpredictable, but education experts, business leaders, and policy makers agree that STEM equips students with the 21st century skills needed to be successful and productive members of society, regardless of their career choice.
“WE TEACH STEM SO THAT STUDENTS WILL LEARN HOW TO LEARN AND LEAD PRODUCTIVE ADULT LIVES IN ANY FIELD THEY CHOOSE.”
The 3 things students need to be successful in STEM

Students need a STEM identity, technology fluency, and STEM mentors in order to be successful in STEM education.

#1: A STEM identity

A STEM identity simply means that kids see themselves as being capable and successful in learning and understanding science, technology, engineering, and math. To develop a STEM identity, it’s important for students to engage in STEM as early and often as possible. Kids’ brains develop most substantially when they are young. Research tells us that introducing STEM early can have positive long-term effects on a child’s interest and achievement in STEM—in other words, when kids engage in STEM early and often, they’re more likely to develop a STEM identity.

Imagine what it would be like if we didn’t start reading to kids until they started school. STEM learning can and should be accessible for kids at every age.

A common misconception that leads to delayed STEM education is the belief that young kids are just not capable of participating in complex STEM topics. This couldn’t be further from the truth.

Young kids often engage in complex scientific and engineering practices, but at their own developmentally appropriate level. Kids are naturally curious and intentionally explore their environments in a rigorous and scientific way. Kids readily make observations, test out hypotheses, collect and interpret data, and make conjectures.

For example, when babies repeatedly drop objects from their high chairs, they are engaging in the scientific method. When they devise ways to escape their cribs, they are engineering and authoring with technology in order to solve a problem. Similarly, preschoolers who build elaborate forts and play in a sandbox engage in multi-faceted STEM practices appropriate for their age group.

Developing kids’ STEM identity is about naming the STEM practices they already do naturally, teaching them how to apply their knowledge and skills across different disciplines, and giving them hands-on experiences and mentoring to explore new STEM concepts.
#2: Technology fluency

When kids possess technology fluency, it means they have the **confidence and skill to creatively author with technology to solve real-world problems.**

Developing technology fluency is similar to learning a foreign language in that it takes time and practice to build proficiency. To be fluent in a foreign language requires knowledge of diverse parts of speech, and the ability to put them together to communicate ideas. In the same way, technology fluency requires the application of science, technology, engineering, and math skills to create technological solutions. **Kids with technology fluency will persevere in the face of challenges and seek out creative ways to solve problems.**

Technology fluency boosts a kid’s STEM identity and leads to increased confidence and proficiency in STEM. It’s only through hands-on experiences, multiple failures and successes, and ongoing support that students develop technology fluency and a STEM identity.
#3: STEM mentors

While all kids are natural designers and explorers, they need to learn to think like scientists and engineers. That’s why your role as an encouraging parent is so important.

It’s natural for parents to feel nervous about teaching STEM if they don’t feel confident in their own STEM abilities. The good news is that you don’t need to be a STEM expert to successfully teach STEM and foster your kids’ STEM identities.

Instead of thinking that you need to be a STEM specialist, consider your role as being a STEM mentor. Your job is not to have all the right answers, but rather to ask the kinds of questions that deepen kids’ thinking and provide lots of hands-on STEM opportunities.

Your attitude toward STEM can affect how your kids think about STEM and the identity they develop. Ultimately, this means you have an opportunity to be the STEM mentor you may never have and to give your kids STEM experiences that could potentially inspire a lifelong passion.
Tips for being a good STEM Mentor

When a child says, “Look at my tower. Do you like it?” here are five ways you can respond to support a STEM identity and build 21st century skills:

1. “Can you tell me exactly how you made it?” Asking kids to articulate their process step by step builds communication and logical thinking skills.

2. “What do you think would happen if...?” Encourages kids to apply their current knowledge to an unknown situation based on evidence and experience.

3. “What was the hardest part? What did you do to overcome it?” By reflecting on a challenge and how they solved it, kids develop confidence and see themselves as problem-solving engineers.

4. “Can you draw and label a picture of your creation so we can hang it up for others to see and learn from?” Highlights the community aspect of STEM and develops the skill of drawing a model to communicate an idea.

5. “What advice would you give to a friend who wanted to build this?” Challenges kids to combine information, evaluate the most important aspects, and communicate clearly. If you ask kids to write down their advice, this integrates STEM and writing to build critical thinking and communication skills across disciplines.

Kids don’t need to learn STEM from expert scientists or engineers any more than children need their swim instructor to be an Olympic gold medalist. Kids need to learn STEM from the people who nurture them and know them well.
“Kids need to learn STEM from the people who nurture them and know them well.”
Structures to support STEM learning

There are two structures you can use to introduce STEM projects to your kids. There is convergent to divergent learning and the Design & Engineering Process. Here’s an overview of each one.

**Convergent Learning**

When people talk about STEM, they often use terms such as “open-ended,” and “project-based.” You rarely hear STEM described as direct instruction. However, step-by-step explicit instruction is an important part of STEM education for kids. We call this convergent learning.

**Convergent learning is when kids study material, build models, and arrive at a conclusion.** For example, kids could follow instructions to build a hammer with given materials. Through building a hammer, kids learn the foundational STEM concept of how to make something strong by using a brace. Convergent learning ensures that all kids gain foundational knowledge and experience success.

**Divergent Learning**

Once kids are familiar with the basic concept, they are ready for divergent learning. **In divergent learning, kids apply what they have learned through a design challenge that has many possible solutions.**

For example, after building a small bridge through convergent learning, kids could be tasked to build a bridge that spans a long distance and will support the weight of several cars. Through this challenge, kids will use their knowledge of how to make things strong and could come up with any number of successful bridge designs that meet the criteria.

**Convergent to Divergent Learning**

Starting with convergent learning and progressing to divergent learning is a helpful teaching strategy that ensures kids gain mastery of key STEM concepts. **It gives kids the opportunity to apply their knowledge in a way that builds problem-solving and critical thinking skills.**

Convergent learning is an important equalizer in STEM learning. **Explicitly introducing STEM concepts through convergent to divergent learning ensures that all kids gain foundational knowledge and are able to participate.**

As you plan and design STEM activities for your kids, think about how you might use convergent learning to build skills and divergent learning to show mastery and application. Kids need lots of experiences in convergent and divergent learning in order to develop a STEM identity and technology fluency.
The Design & Engineering Process

In case you haven’t heard of the Design & Engineering Process, we want to take a moment to define and describe it for you. It’s a great way to structure STEM activities and it teaches kids how real engineers identify and solve problems. Through a step-by-step process, engineers design, build, test, and refine their solutions.

The engineering design process has five basic steps:

**Step 1: Identify the challenge**
Define and understand the problem and ask questions to understand it better. The problem can be presented by you, or your kids can identify the problem themselves.

**Step 2: Brainstorm ideas and solutions**
Next, imagine solutions and brainstorm ideas, even ones that seem impossible.

**Step 3: Build a prototype**
Select one idea and create a plan. The plan can include drawing a model, collecting materials, and thinking about how to design the solution. Then create a prototype (a model) from that plan so you can test it out.

**Step 4: Test and improve the design**
Try it out! Does your plan work? Analyze and evaluate the test results. Based on the test results, improve the design to make it more successful. Test it again and again and make improvements.

**Step 5: Explain the design**
An important part to designing & engineering new things is the ability to demonstrate and explain to others how a design works. This is also a chance to revisit why certain design features have been included and to confirm the ways that your design helps solve the original problem.

The Design & Engineering Process is an iterative process, which means engineers typically go through it multiple times (particularly steps 3-5) in order to create the best solution. In this process, engineers develop empathy, learn from failure, and become creative problem solvers.

Don’t forget Step 6: Celebrate your success!

**Step 1:** While playing with blocks, kids decide to build the tallest tower.

**Step 2:** They come up with different ideas on how to do it.

**Step 3:** A plan is chosen, verbally or nonverbally, and materials are selected.

**Step 4:** Kids start to build. Blocks fall. Things do not go as planned.

**Step 5:** Improvements and adjustments are made. New strategies are tried.

You can help to more intentionally use the Design & Engineering Process to introduce and structure STEM activities for kids.

For example, you can present a problem to your kids, and together you can brainstorm solutions. Kids can choose a plan, draw a model, gather materials, and articulate their plan. **Be sure to provide lots of time for kids to build their designs.**

Once their designs are built, you can test them. Have students reflect on the testing process, analyze their results, and brainstorm ways to improve their designs. And then the process repeats itself with more time to build and re-design.
8 simple STEM activities for elementary-aged kids

Here are 8 engaging engineering activities to try with your kids. As you read through these ideas, think about how you might incorporate convergent and divergent learning and the Design & Engineering Process. These are general ideas and we know you will use the materials and resources you have on hand and adapt them to meet the unique needs of your kids.

#1: Nature walk

Taking your kids on a nature walk is a wonderful way to introduce them to STEM. Think of nature as a huge laboratory where kids can practice being scientists by making careful observations and asking questions. You can bring materials such as magnifying glasses, digging tools, paper and crayons for bark rubbings, a camera, binoculars, and nature journals.

Kids will also enjoy creating their own pair of binoculars using tape, toilet paper rolls, and string. Although it won’t actually magnify anything, it will help focus kids’ attention on nature and build their STEM identity.

If you survey the habitat before visiting with kids, you can create a nature scavenger hunt. And don’t forget that humans aren’t the only engineers on this planet—animals are engineers too! Ask kids to look for ways that animals design solutions to solve their problems of finding food, avoiding predators, seeking shelter, and rearing young.

When you return home, kids can record their observations, make scientific drawings, and write down questions.
#2: Engineering with fairytales

Classic fairytales such as Goldilocks and the Three Bears, The Three Little Pigs, Hansel and Gretel, and Rapunzel can be used to introduce STEM and the Design & Engineering Process.

Let’s use Goldilocks and the Three Bears as an example. After reading the story, present the problem to kids—Goldilocks broke Baby Bear’s chair and Baby Bear won’t stop crying until he gets a new chair. Tell kids that their engineering design challenge is to build a new chair for Baby Bear that is comfortable, strong, and the right size. You can use materials you may already have on hand to complete the challenge.

After brainstorming ideas, kids can choose one idea and create a plan. Kids can draw a model of their idea and describe it to you. Then give kids a variety of materials to use and time to build. To test the chairs’ strength, kids can stack pennies or weights on their chairs to see how much it can hold. Based on the results, kids can make adjustments and improve their design.

With so many fairytales to choose from, you could create a fairytale STEM challenge as often as you want. Fairytales make great STEM activities for kindergarten and first grade because of the interdisciplinary connections to literacy.

#3: Paper airplane challenge

Making paper airplanes is another great activity that engages kids in the Design & Engineering Process. You can use convergent learning to show kids a few different foundational folding techniques and divergent learning to setup different design challenges such as longest flight, highest peak, and loop-the-loops.

Provide kids with a chart to record the results and distances of each throw to integrate science and math.
“USING THE DESIGN & ENGINEERING PROCESS, KIDS DEVELOP EMPATHY, LEARN FROM FAILURE, AND BECOME CREATIVE PROBLEM SOLVERS.”
#4: Egg drop STEM challenge

In the egg drop challenge, kids design a container that will prevent a raw egg from breaking when dropped from a designated height. Kids of all ages love this challenge, including watching numerous eggs explode in the process. (Pro tip: have plenty of towels handy for the clean up process!)

Through this project, kids learn to see failure as just a step in the Design & Engineering Process. Kids learn from failure, modify their designs based on tests, and find effective ways to keep the egg safe.

#5: World famous architecture with blocks

Through block play, kids learn STEM concepts related to shape, size, weight, and location. They discover and repeat patterns, which is a math skill, and build engineering knowledge about structure, proportionality, and balance. While it is essential that kids have time to self-initiate their own projects with blocks, you can also provide fun STEM challenges.

Print out color photographs of famous architectural structures from around the world such as the Empire State Building, Taj Mahal, Eiffel Tower, Pantheon, Leaning Tower of Pisa, and the Golden Gate Bridge.

Kids can use these photographs to inspire their own building designs and experience the challenges real engineers and architects face. The importance of block play in early childhood cannot be overemphasized as kids learn many foundational STEM concepts.
#6: STEM challenges with stuffies

If you want students to absolutely fall in love with STEM, let kids use their favorite stuffie (stuffed animal).

Here are three stuffie-inspired STEM challenges to help get you started.

1. Your stuffie gets to have a special sleepover. Build a bed for your Stuffie so it can sleep comfortably.
2. Oh no! Your stuffie climbed to the top of the cabinet and is too scared to climb back down. Design a solution to get your stuffie back on the ground safely.
3. Your stuffie hasn’t been sleeping very well at night because one of your other stuffies snores very loudly. Design a solution so your stuffie can get a peaceful night’s sleep.

#7: The tallest structure challenge

Kids love building tall things, especially if they can build it taller than themselves! For this STEM challenge, give kids a bag full of materials such as toilet paper rolls, cups, paper plates, straws, and balloons. The challenge is to create the tallest free-standing tower possible.

#8: Students design their own STEM challenges

You can have kids complete the entire Design & Engineering Process from start to finish on their own by identifying a problem that is meaningful to them from their own lives. Examples might be designing a way to keep their crayons organized or a device that prevents their cat from scratching them.

Once kids have identified a problem, lead them through the Design & Engineering Process to arrive at a solution. At the end, you can turn a room in your home into an “Invention Museum” to showcase your kids’ STEM work.
How STEM supports a growth mindset

STEM activities like the ones listed above as well as the ones you find in Kid Spark’s curriculum are a great way to teach kids to have a growth mindset. In case you’re not familiar with this term, growth mindset is the belief that we can develop our talent and abilities through hard work, learning from failure, and help from others. In contrast, fixed mindset is the belief that intelligence, talent, and ability are fixed traits that cannot be improved upon. These concepts were developed by Carol Dweck, researcher and professor of Psychology at Stanford University.

STEM is a great way to teach students about having a growth mindset because making mistakes are part of the Design & Engineering Process. When students understand that STEM is supposed to be challenging and that failure is something to learn from, they will work hard, persevere, and try new strategies when things don’t go as planned.

Go forth and teach STEM!

We know that introducing STEM during home learning can feel daunting at first. But we also know that with a little effort and support, it can easily and quickly become one of the most rewarding and enjoyable parts of homeschooling. Through STEM, kids build confidence as creators and innovators and learn how to be successful and flexible in our increasingly complex world.

And remember, as long as kids are learning and growing through experimentation and play, the principles of STEM are shining through.
Written by Mary-Eileen Gallagher

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