How Kids Learn Foundation

TEMESCAL Associates
Building the capacity of leaders and organizations in education and youth development

STEM and STEAM

A Briefing Paper

By Sam Piha and Samantha Fasen

ABOUT THE AUTHORS

Sam Piha (he/him) has served as founder and president of Temescal Associates since 2007. Sam began his career in 1974 as an afterschool worker, an experience that led to 13 years of classroom teaching and work as a child and family counselor and school social worker. Between 1989 and 2006, Sam managed school-based youth programs at the regional and national levels. He later founded Temescal Associates and The How Kids Learn Foundation, both dedicated to improving the quality of afterschool programs. Sam served as editor and contributing author of several important practice guides and journal articles on afterschool programming. Sam holds a master's degree in Social Welfare.

Samantha Fasen (she/her) joined Temescal Associates and the How Kids Learn Foundation in 2019 and has fully embraced her work with the afterschool field. She helps to coordinate and develop marketing campaigns and multimedia elements to reach a wider audience and share with people the importance of out-of-school time and youth development.

Ren Daraio (they/she) brings over 35 years of experience working in the field of youth development as a facilitator, trainer, and coach. She has experience training and coaching diverse audience groups, from afterschool practitioners and parents to funders and technical assistance providers. Prior to her work with Temescal Associates, Ren was the Deputy Director at the Community Network for Youth Development and a consultant for the Institute for Research and Reform in Education.

ABOUT THE ORGANIZATIONS

Temescal Associates is dedicated to building the capacity of leaders and organizations in education and youth development.

The How Kids Learn Foundation (HKLF) is a 501(c)(3) organization. It is dedicated to improving the effectiveness of settings that support the education and healthy development of youth. This includes schools and out-of-school time programs. The HKL Foundation provides educational and training activities. Examples of activities include conferences, speaker forums, screenings of relevant films, training sessions, coaching sessions, the awarding of digital badges to acknowledge exemplar programs and the learning that happens within these settings. Activities also include the development and distribution of educational materials (papers, self-assessment tools, videos, program guides, etc.). You can see a catalogue of the resources we've produced for the afterschool field.

FRONT COVER PHOTOS: All photos from www.pexels.com.

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STEM and STEAM

Source: Resilient Educator

INTRODUCTION

One lesson of the cold war of mid-1900s was that the modern world going forward would rely heavily on innovation, technology, and creativity. Hence, the importance of knowledge and skills related to STEM (Science, Technology, Engineering, Mathematics). However, it was recognized that technical skills alone are often insufficient for modern innovation. Then came STEAM, adding Arts to STEM. By integrating arts with STEM subjects (STEAM) would develop more creative, innovative, and well-rounded problem solvers. This shift would encourage creativity, innovation, and "out-of-the-box" thinking, transforming technical, process-driven STEM learning into a more holistic, design-based approach.

This briefing paper explains STEM and STEAM and discusses why adding the arts changes teaching and learning. Note: It is not a list of STEM/ STEAM activities or a “how-to” guide for introducing activities into afterschool programs. To learn more about implementation, see the “To Learn More About” section below.

WHAT IS STEM?

“STEM is an acronym - Science, Technology, Engineering, Mathematics:

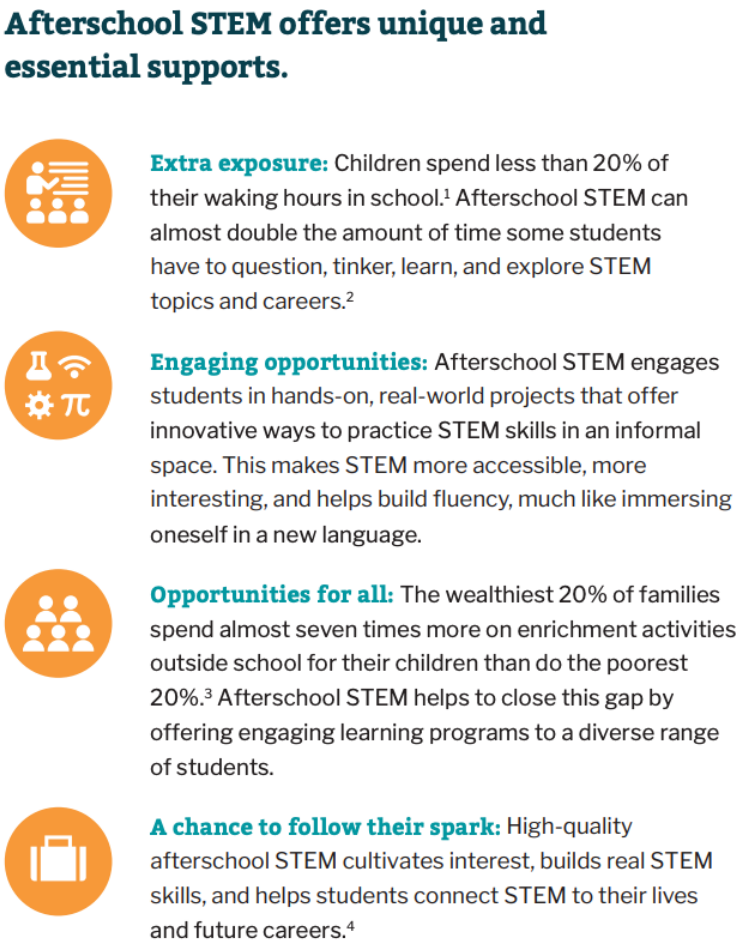
- Science – understanding natural phenomena
- Technology – tools and digital systems
- Engineering – designing and building solutions
- Mathematics – analyzing numbers and patterns.” [1]

The Origin of STEM

According to the Dottie Rose Foundation,

- “The Acronym (2001): The term STEM (Science, Technology, Engineering, and Mathematics) was officially coined in 2001 by Judith Ramaley, then-assistant director of education at the National Science Foundation (NSF).

- The Predecessor: Before 2001, the NSF referred to these fields as SMET (Science, Mathematics, Engineering, and Technology), but Ramaley reordered the letters to be more phonetically appealing.
- Historical Context: While the acronym is relatively new, its roots lie in mid-20th-century policy. The 1957 launch of Sputnik by the Soviet Union triggered a massive U.S. push for science and engineering education, culminating in the National Defense Education Act of 1958.
- Evolution (2009–Present): Under the Obama administration, initiatives like 'Educate to Innovate' aimed to increase STEM proficiency and diversity, solidifying the term in the national consciousness." [2]



Source: Afterschool Alliance

WHAT IS STEAM?

"STEAM Education is an approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking." [3]

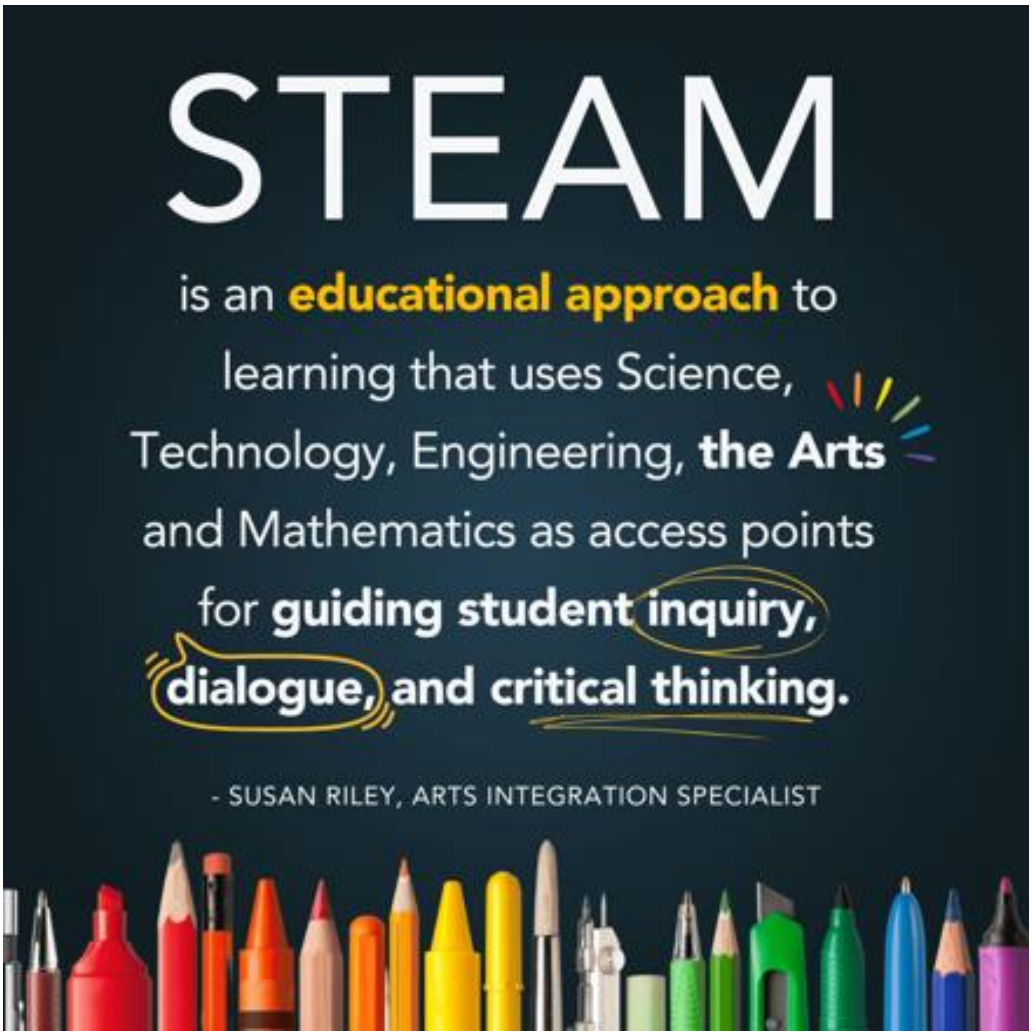
> ***"STEAM prepares students for the future by developing critical thinking, creative problem solving, collaboration, communication, innovation, and resilience. It increases engagement by making learning fun, meaningful, and connected to real-world challenges."*** - Rebecca Hawley, Executive Director, San Francisco STEAM Academy

The Origin of STEAM

- "The Addition of Arts (2006): The transition from STEM to STEAM—adding 'Arts'—was pioneered by researcher and educator Georgette Yakman in 2006.
- The 'A' Definition: Yakman's framework defines the 'Arts' broadly, including fine arts, music, social sciences, and language arts, arguing that these fields provide the 'who and why' (human context) for the 'what and how' of STEM.
- Rhode Island School of Design (RISD): Starting around 2010, John Maeda, then-president of RISD, became a leading champion of the movement. He advocated for placing art and design at the center of the national innovation agenda, arguing that design thinking is essential for tech breakthroughs.

Examples of STEAM fields include architecture, product design, animation, and game development).
More about STEAM:

- Focus: Combines technical skills with creative ideas, including visual arts, design, music, drama, and humanities.
- Goal: Encouraging 'out-of-the-box' thinking, collaboration, and communication.
- Approach: Emphasizes the *process* and human-centered design (e.g., building a robot while also considering its aesthetic, ethical implications, and human interface).



Source: Institute for Arts Integration and STEAM

Example of Core STEAM Program Offerings

- Robotics & Coding: Students build and program robots (using tools like LEGO or Dash & Dot) and learn languages like Scratch to create games and animations.
- Engineering Challenges: Hands-on projects such as building bridges, towers, and aerodynamic gliders to understand forces like tension and lift.
- Science Experiments: Interactive labs covering chemistry (e.g., 'Elephant Toothpaste'), biology (DNA models), and physics (balloon-powered cars).
- Arts & Design: Programs often include 3D printing, digital media, culinary arts, and light-up circuit-based crafts to foster creative thinking.
- Digital Arts: Coding games, animation, or photography.
- Science: Exploring biology, chemistry, and physics through experiments." [4]

Source: www.pexels.com

BENEFITS OF STEAM EDUCATION

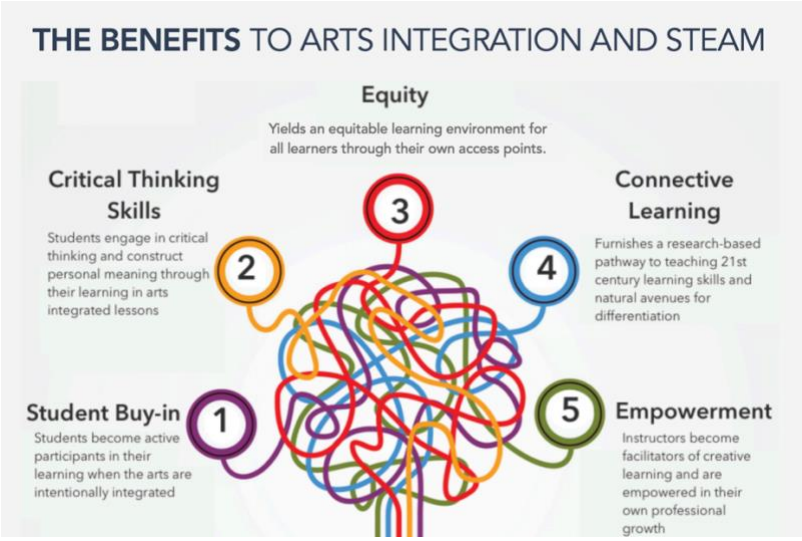
There are many benefits that come when young people engage in STEAM activities. According to Resilient Educator, "There's been a big push for incorporating **lessons and activities that use STEAM**: science, technology, engineering, art, and math. But how exactly do these multilayered projects help students? Here are some of the specific ways in which students can benefit from STEAM in the classroom.

- **Exposes Students to The Creative Process:** When students engage in activities that combine different elements of STEAM, they experience guided inquiry in which they must ask thoughtful questions, discover answers, apply what they learn, and problem-solve creatively. Students learning how to make a wire sculpture that lights up must ask questions about how it works, try out different wiring techniques to get the sculpture to light up, think about the meaning behind their artistic creation, and experience the creative process, going from a design on paper to a tangible, functional object. Offers meaningful collaboration

- **Encourages girls to explore STEM fields:** Since girls and women are underrepresented in the fields of science, technology, engineering, and math, developing STEAM projects helps girls become familiar with these fields at an early age. Early exposure can increase their chances of exploring these fields further as they get older, and high-quality STEAM projects will still benefit boys as well so that all students are able to acquire these 21st-century skills. It also shows youth a different way to value the arts.

- **Offer Meaningful Collaboration**: Many STEAM projects involve teamwork and thoughtful dialogue in which students exchange ideas and discuss ways to problem-solve. Through these activities, students learn how to divide up responsibilities, compromise, listen to and encourage each other. Some students might approach STEAM with excitement or curiosity, while others might be more timid or apprehensive.

  Strategically placing students together in groups can create powerful teams in which students learn how to help each other and figure out how to use their different strengths and skill sets. If students are learning how to create 3D art depicting sea animals, one student might be knowledgeable about aquatic animals, another might be familiar with optical illusions or excited about constructing 3D glasses. Together, their knowledge, enthusiasm, and skillsets can be utilized to help successfully complete the project as a team.



Source: The Institute for Arts Integration and STEAM

- **Increases critical thinking:** STEAM projects require students to systematically think through problems, applying the information they learn along the way about technology and engineering to figure out the best solutions. Cross-curricular projects also engage different parts of students' brains so that they are seeing the project through different lenses, focusing on details while also learning to step back and look at the bigger picture.

- **Provides a unique way to problem-solve:** American students don't tend to do as well as students from other countries when it comes to international assessments that measure math, science, and problem-solving skills. STEAM projects give students a chance to problem-solve in unique ways because they're forced to use a variety of methods to solve problems that pop up during these types of activities. By experiencing trial and error, learning how to take risks, and

figuring out how to really "think outside the box", students get away from the commonly used approach of applying a known method or formula to solve a set of problems in a step-by-step way. With STEAM, they must solve in more creative, non-linear ways.

- **Gives All Students Hands-On Learning Experiences:** While some students grow up in homes in which they are taught how to build and fix things, and are given many manipulatives to do so, others aren't exposed to these important learning opportunities. STEAM projects give students a chance to engage in hands-on, experiential learning. Students are often using different materials and tools in order to discover how something works, how to build it, and how to fix it. This levels the playing field so that all students acquire these crucial skills, regardless of their gender, socioeconomic status, or race." [5]

- **Inquiry Based**: According to the Institute for Arts Integration and STEAM, "Any good STEAM lesson is grounded in inquiry, problem-solving and process-based learning. In fact, this is one of the distinguishing characteristics between Arts Integration and STEAM. So when viewing STEAM in the classroom, you want to pay close attention to the essential question and the process surrounding its exploration. What problems are being investigated and solved? How are both contents being used to explore the problems? Why is the process important to the question posed? These are all important components to a STEAM classroom or lesson.

- **21st Century Skills**: The 4Cs of 21st century skills – Collaboration, Creativity, Critical Thinking and Communication – aren't going anywhere. They are a critical component to student success in a rapidly changing workforce and society. Luckily, these are easily woven into any quality STEAM lesson. This is where the active engagement really starts to shine with student groups, creating original solutions and compositions and exploring questions from multiple perspectives." [6]

STEM vs. STEAM

Let's take a closer look at the similarities and differences between STEM vs. STEAM.

"**The Similarities**	**The Differences**
STEM and STEAM are both standards-based educational approaches to a rigorous, integrated math and science curriculum.	STEAM is an access point for inquiry, dialogue, and critical thinking.
Both push students to engage in inquiry-based thinking and problem-solving through process-based learning.	STEM focuses on real-world learning through investigations, problem-solving, and evidence-based explanations.
Both address multiple content areas, including literacy and social sciences.	STEAM has a process-driven focus and requires the use of soft skills in addition to academic knowledge.
	STEM focuses on developing deep content knowledge and higher-level thinking through hands-on experiences." [7]

Situations Where Each Is Favored

- "Policy and industry narratives that prioritize workforce-ready technical skills often highlight STEM.
- Advocates for holistic, human-centered education and 21st-century competencies often argue for STEAM.
- Some authors frame the debate as less 'either/or' and more about designing integrated pathways that use both models strategically.

Limitations of a STEM-Only Approach

- Focuses on technical skills may overlook creativity and design.
- Real-world problems often require both analytical and creative thinking.
- Some students may feel disconnected from purely technical subjects.

Case Examples of STEM and STEAM Activities

- A STEM-focused unit: A typical middle or high school STEM project (e.g., designing and testing a bridge, building a robot) emphasizing engineering design, math, and data analysis. Specific learning outcomes may include content mastery, problem-solving steps, and technical communication.
- A STEAM-focused unit: A comparable project with integrated arts, for example designing an interactive exhibit or city model that combines engineering, environmental science, and visual design. Outcomes may include collaborative decision-making, aesthetic choices, storytelling, and audience engagement." [8]

What Is the Difference Between STEM and STEAM?

"When looking at STEM vs. STEAM, the difference lies in the way they approach scientific concepts. STEM focuses explicitly on the hard scientific, technological, engineering or mathematical skills to drive progress or create a new concept. In STEAM curricula, per The Conversation, students leverage both hard and soft skills to solve problems.

For example, STEAM encourages collaboration to understand a STEM concept. By integrating concepts and practices of the arts, STEAM uses tools such as data visualization or fine art imagery to deepen one's understanding of science, math and technology. This kind of out-of-the-box thinking is what leads STEAM professionals to create new products using 3D printers or distill complicated data sets into easy-to-understand formats, such as infographics." [9]

What the Research Says

According to the Institute for Art Integration and STEAM, "Recent research shows that STEAM is a promising approach to positively impacting student achievement and teacher efficacy. In a 2016 study, researchers investigated the impact of STEAM lessons on physical science learning in grades 3 to 5 in high poverty elementary schools in an urban district. Findings indicated that students who received just nine hours of STEAM instruction made improvements in their science achievement (Brouillette, L., & Graham, N. J.).

Another study from 2014 shows the connecting STEAM and literacy can positively impact cognitive development, in our cycles of teaching and increase literacy and math skills, and help students reflect meaningfully on their work and that of their peers (Cunnington, Marisol, Andrea Kantrowitz, Susanne Harnett, and Aline Hill-Ries.).

This is further supported by a study on the relationship between theater arts and student literacy and mathematics achievement from 2014. 'Results showed that students whose language arts curricula were infused with theater arts often outperformed their control group counterparts, who received no arts integration, in both math and language arts' (Inoa, R., Weltsek, G., & Tabone, C.).

And in an international study published in the Journal of Educational Change, researchers found that secondary teachers' reflections 'revealed inter-, trans- and cross-disciplinary learning shaped by teacher collaboration, dialogue and classroom organization that fosters critical and creative thinking.' (Anne Harris and Leon R. de Bruin)." [10]

Source: California Afterschool Network

STEAM AND AFTERSCHOOL

Afterschool programs are appropriately situated to engage youth in STEAM activities. According to the Afterschool Alliance the benefits of Afterschool STEAM include:

- "increased engagement: makes learning fun through interactive projects and fun themes.
- career readiness: introduces students to future-driven fields early.
- academic improvement: reinforces school-day learning in math and science."

Key Components of High-Quality STEAM Programs

Not all STEAM activities in programs are high quality. Below are some quality indicators:

- "Hands-on Learning: Activities focus on experiments, building, and creation rather than passive learning.
- Skill Development: Emphasis on 21st-century skills like problem-solving, collaboration, and logical thinking.
- Interactive Technology: Use of tools like robotics kits, coding software, and 3D design software.
- Integration of Arts: Using art to encourage creative thinking within technical subjects (e.g., design thinking, digital art)." [11]

Source: Resilient Educator

CURIOSITY

STEM and STEAM activities are perfect for young people because it taps into their innate curiosity and desire to learn how the world works. Below we have reposted a blog by CuriOdyssey entitled, *CuriOdyssey and Curiosity, Engines of Discovery*.

> ***"Curiosity is one of the main ways children learn about the world. When kids ask "why?" or "how does this work?", they're not just being playful—they're actively building understanding, problem-solving skills, and creativity."*** – Chat GPT

"'Curiosity is the desire to learn, to understand new things and to know how they work. We can teach a new generation to observe patterns in our world and in science, technology, engineering and math by taking advantage of their natural tendency to be curious, thereby enhancing the likelihood of new discoveries and inventions,' says CuriOdyssey Executive Director Rachel Meyer. 'We need people who are curious and who feel free to tinker and explore without fear of failure. When curious people fail, they analyze their failure to understand it so they can do better the next time.'

> ***"I have no special talents. I am only passionately curious."—*** Albert Einstein

Curiosity is at the very root of the scientific process. After observation the first step is to ask, 'Why?' Supporting kids' natural curiosity at an early age about what makes the world work is the best way to excite their interest in STEM. Whether kids aspire to become scientists or artists, science fluency, like being fluent in a language, will make them better at it. If we do not spark curiosity, future generations will not understand the benefits of being science-fluent.

Curiosity is the mark of an active, open, observant mind and helps us see learning as fun, fueling imagination, creativity and innovation. It prepares the brain for learning and makes subsequent learning more rewarding. Research also shows that curiosity is just as important as intelligence in determining how well students do in school.

We know that kids' curiosity leads to cognitive growth and a new understanding of the world around them, so we feed their quest for knowledge with a unique collection of hands-on experiences and opportunities that prompt questions and exploration. What does an owl eat? How does gravity work?

What are the patterns found in nature? What causes chaotic motion? How does light change colors? Why does a snake shed its skin?" [12]

MORE ABOUT…

Founded in 1953 as a junior museum in San Mateo, CA, the museum was rebranded in 2011 as CuriOdyssey, catalyzing growth in audiences, educational programs and exhibits. During the past ten years, CuriOdyssey's annual average attendance grew from just under 70,000 to approximately 200,000 annually, and the exhibit collection has more than doubled to 48 works. Educational programs (including public school field trips and free programming for underserved schools and groups) now serve thousands of children annually. CuriOdyssey developed one of the most sought-after science camp programs for young children in the community.

RESOURCES TO LEARN MORE ABOUT STEM AND STEAM

In addition to the resources listed in the End Notes, we have listed additional resources below.

- Expanded Learning STEM Quality Elements
- A Guide to Developing STEM in Expanded Learning Programs
- Assessment and Planning Tool for STEM in Expanded Learning Programs
- Building Local Systems of Programmatic Support for STEM Learning
- Collaborate to Innovate
- The Benefits of Teaching STEAM Lessons
- STEM/STEAM Teacher: Education, Salary, and Outlook
- Professional Development Resources for STEM Teachers
- STEM and STEAM Books For Teachers, Teens, and Kids
- The Art of Inquiry in STEAM Education
- Online STEM and STEAM Projects for Teachers & Students
- The Evolution of STEM and STEAM in the U.S.
- How to Add Engineering to the Arts
- STEAM Careers for the 21st Century
- 40 STEAM Apps and Websites
- Free Arts Integration and STEAM Lessons
- How to Create a STEAM Classroom Library
- Preparing Students for a STEAM-Powered Workplace
- Your Guide to STEAM Design Challenges
- 15 Ways to Integrated Math and Art in Elementary Classrooms
- Global STEM Alliance- STEM Education Framework
- EDMO- STEM vs STEAM: What's the difference?
- STE(A)M Truck- The History and Importance of STEAM Education
- National Inventors Hall of Fame- The STEM vs STEAM Debate
- Kaley Lacqua- What is STEM Education?

APPENDIX 1-3

The following appendices offer interviews with experts from the field, which include:

- Voices from the Field: Sally Baker from The Institute for Arts Integration and STEAM
- Voices from the Field: Dr. Carol Tang on STEM and STEAM
- Voices from the Field: Dr. Rebecca Hawley, Executive Director of San Francisco STEAM Academy.

APPENDIX 1
Voices from the Field: Sally Baker from The Institute for Arts Integration and STEAM

Source: www.pexels.com

> ***"STEAM Education is an approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking."*** – The Institute for Arts Integration and STEAM

The "A" was added to STEM (science, technology, engineering and mathematics) and stands for Arts Integration. We interviewed Sally Baker, CEO of **The Institute for Arts Integration and STEAM** to learn more. Below are some of her responses to our questions.

Q: Do you think that the movement from STEM to STEAM was a positive one for afterschool providers?

A: *Absolutely, and here is why: Though closely related, STEM and STEAM approach learning in meaningfully different ways. Both are rooted in problem solving, encourage students to learn through hands-on exploration, and emphasize the interdisciplinary application of knowledge. The distinction, of course, lies in the addition of the "A," which places the arts as an intentional and purposeful part of the problem-solving process rather than a separate subject. That addition changes everything.*

The arts invite personal interpretation and expression in a way that pure STEM does not. When students are given creative agency alongside scientific and mathematical thinking, something shifts. STEAM opens

up entirely new access points for students who might not see themselves in traditional STEM pathways, and it gives teachers new and powerful ways to reach learners who think, create, and communicate differently.

For afterschool providers specifically, this shift is especially significant. Afterschool spaces have always had the freedom to prioritize engagement, joy, and exploration in ways that the traditional school day sometimes cannot. STEAM fits that environment naturally. It creates room for creative innovation and the kind of culturally responsive problem solving that resonates with students beyond the classroom walls.

The move from STEM to STEAM was not simply the addition of an arts class. It was an invitation to reimagine what learning can look like when creativity is treated as essential rather than supplemental. For afterschool providers, that invitation is one worth accepting wholeheartedly.

Source: www.pexels.com

Q: What value or advantages did this shift create?
A: *The advantages of shifting from STEM to STEAM are multifaceted, and so are the challenges. Both are worth understanding honestly.*

On the advantage side, STEAM appeals to a broader and more diverse set of learners. Not every student finds their entry point through science and math. When the arts serve as a launching pad into learning, it creates greater equity in who gets to participate and who sees themselves as a capable problem solver. It also acknowledges something that is simply true: complex problems require collaboration across diverse ways of thinking, and the arts represent one of the most powerful of those ways.

STEAM solutions also tend to have a deeper human impact. The arts are rooted in storytelling, and people are moved and changed through stories in ways that data alone rarely achieves. Consider a water pollution project. A STEM solution might produce a brilliant device that senses and captures pollutants in a local waterway. A STEAM solution might build that same device and pair it with a time-lapsed documentary that tells the story of the water's transformation. The science is equally rigorous, but the

story makes people care. It draws in funding, builds community awareness, and connects the issue to the lives of people who might otherwise never have engaged with it.

The honest challenge of STEAM, however, is that it is harder to implement well. For decades, the arts have been treated as supplementary to learning rather than essential to it. As a result, most teachers were never trained in the arts or in arts integration, and effective STEAM educators need to either be willing to bridge those disciplines themselves or know how to reach out to partner teachers, teaching artists, and outside organizations with complementary expertise.
For afterschool providers, finding staff who are equipped and confident to do this work with real intention can be a genuine challenge. But when it happens, and when it is done well, the results are some of the most powerful learning experiences young people can have.

Q: In your observation of youth programs, what do you think they most often get wrong in the design of STEAM activities?
A: *This is an easy one: Most programs miss the fundamental point of what STEAM actually is, and it is not entirely their fault. The term has become so widely used that it has lost much of its meaning. Programming a robot is not STEAM. That is computer science. Conducting a hands-on science experiment is not STEAM. That is hands-on science. Drawing what you have learned in math class is not STEAM. That is drawing.*

STEAM is a problem-solving process. It is what happens when students use science, technology, engineering, the arts, and mathematics together to address a real problem: imagining a range of possible solutions, testing them, analyzing data to make improvements, and ultimately presenting their findings to an authentic audience who has a genuine stake in the outcome. That last part matters more than most programs realize. Authentic audience changes everything about how students engage with and invest in their work.

This does not mean every STEAM experience needs to be a lengthy, elaborate project. But unless students are using those integrated disciplines in service of solving a problem, the activity is not truly STEAM, regardless of what it is called.

I want to be clear that there is nothing wrong with coding robots, conducting experiments, or drawing mathematical concepts. Those are valuable learning experiences in their own right. The problem arises when we call them STEAM and believe we have done the work of integration. We have not. And in doing so, we miss the extraordinary power that genuine STEAM experiences have to develop creative, collaborative, and innovative thinkers who are equipped to tackle the complex challenges their communities and their world will ask of them.

Q: In your observation of youth programs, what do you think they most often get right in the design of STEAM activities?
A: *More than they might realize, actually. Most youth programs have a genuine and intuitive understanding that STEAM should feel different from traditional classroom learning. They know it should be student-driven, hands-on, and engaging, and that instinct is exactly right. When young people are tinkering, building, sculpting, planting, and making something they can call their own, something important is happening, even if the formal framework around it is still developing.*

Getting all of the pieces moving together in the right direction is genuinely hard work. But a room full of students who are using both their hands and their minds to explore, collaborate, create, and solve is already on the right track. That energy and engagement is not a small thing. It is actually the foundation that everything else gets built on, and it is something that many more formal educational settings struggle to create at all. Afterschool programs often underestimate how much that culture of curiosity and making is worth.

Q: Advocates for STEAM claim that activities are more accessible for girls and kids of color. Do you agree?

A: *Yes, and the research supports it, but with an important caveat: STEAM is only more accessible when it is implemented with genuine intention.*

The data on representation in STEM fields is sobering. Women make up only about 28 percent of the STEM workforce, and students of color remain significantly underrepresented in STEM pathways at every level of education. The barriers are not rooted in capability. They are rooted in access, messaging, and whose ways of thinking and knowing have historically been valued in these spaces.

Research tells us that girls begin to internalize the message that they are less naturally gifted in math and science as early as age six, well before they have had a meaningful chance to explore either field. For students of color, the compounding messages about who belongs in STEM fields begin early and persist throughout their education.

This is precisely where the arts become so powerful. The arts are rooted in personal interpretation, cultural expression, and multiple ways of knowing. When students are invited to bring their own stories, perspectives, and creative instincts into the problem-solving process, the playing field shifts. A student who has never seen herself in a science textbook may find her entry point through filmmaking, visual art, or music. A student whose cultural background is rarely reflected in traditional curriculum may find that STEAM gives him a way to address problems that matter deeply to his community.

Arts integration research, consistently shows that integrated learning increases engagement and achievement among underrepresented groups, including girls, students of color, and students from lower income backgrounds. That is not a coincidence. It is evidence that broadening what learning looks like broadens who gets to succeed at it.

So yes, I agree wholeheartedly that STEAM should offer more opportunities for girls and students of color. They are just as capable, just as innovative, and just as deserving of a learning experience that reflects their full potential. The goal of STEAM, done well, is not just to diversify who enters these fields. It is to fundamentally reimagine what those fields can look like when everyone has a seat at the table.

Q: STEAM seems to favor collaboration and having young people work on teams. How is this reflected in the adult world of science being conducted?

A: *The short answer is that virtually every meaningful scientific discovery of our time has been a collaborative one. STEAM is not teaching students a soft skill. It is preparing them for the actual way that consequential work gets done in the world.*

It is worth making an important distinction here between working in groups and working in teams, because they are not the same thing. In a group, tasks are divided, completed separately, and combined at the end to produce a final product. The individuals contribute their pieces, but the thinking largely stays separate. A team functions very differently. In a true team, the sum is greater than its parts. People

listen to one another, challenge each other's assumptions, bring their unique knowledge and experience to bear on a shared problem, and arrive at solutions that no single member of the team could have reached alone. That is not just a feel-good idea; it is how modern science actually operates.

Even scientists who spend most of their time working independently in a laboratory rarely work in true isolation. They consult colleagues, present their findings at conferences, publish research that others read and respond to, and participate in a living community of inquiry around their area of study. Every individual contribution pushes the entire field forward. Science is, at its core, a deeply social and collaborative enterprise.

When STEAM asks young people to work in teams to solve real problems, it is not simply a classroom management strategy. It is an authentic reflection of how discovery actually happens, and an investment in developing the kinds of thinkers who know how to listen, build on the ideas of others, and create something together that none of them could have created alone.

MORE ABOUT…


Sally Baker

Sally Baker is the CEO of The Institute for Arts Integration and STEAM and she has over 25 years of experience in arts education, arts integration, and STEAM instruction. Half of her career has been spent in arts organizations across the country and the other half in public schools and universities. Previous to this job, which she started in January 2026, she served as the STEAM Program Specialist for the Georgia Department of Education, coaching and advising Georgia schools through the STEAM certification process. Sally believes strongly in the transformative power of integrated learning and have seen STEAM programs solve many of education's "unsolvable" challenges.

THE INSTITUTE FOR ARTS INTEGRATION AND STEAM

The Institute for Arts Integration and STEAM is the world's largest online professional development provider for teachers and leaders using arts-integrated approaches. Founded in 2013 by Susan Riley, a former music educator and administrator, the Institute now serves over 800,000 educators globally each year through its online workshops, resources, courses, conferences and certification.


Source: Resilient Educator

APPENDIX 2
Voices from the Field: Dr. Carol Tang on STEM and STEAM

Source: www.pexels.com

Carol Tang, Ph.D, is an expert on science in afterschool and she is also the Senior Vice President for Learning and Public Engagement at the American Museum of Natural History in New York City. We interviewed Carol regarding STEM and STEAM in afterschool and her responses are below.

Q: Do you think that the movement from STEM to STEAM was a positive one for afterschool providers? What value or advantages did this shift create?
A: *The move to broaden the concept of STEM to include arts was really important for afterschool providers and educators in informal organizations. For example, the federal government's Institute of Museum and Library Services began to fund STEM initiatives in history museums, art museums, and cultural museums beyond science centers, zoos/aquariums, and natural history museums. I think that this helped everyone take STEM out of a silo where it may have seemed inaccessible.*

But what worried me was that STEM and STEAM became acronyms that felt like a checklist of required elements. And I don't think it should be a strict recipe—my hope is that these concepts are just ways to engage the natural curiosity and foster mastery in young people. I always hope that afterschool providers are inspired by the fact that there are math and science teaching moments everywhere—even during sports, snack time, playground games—and not just during homework help time. When I was the Director of the Coalition for Science Afterschool, we decided to use "science" rather than STEM simply because we were hoping to demystify and personalize the concept and we felt that any acronym made it feel prescribed rather than inclusive.

Q: In your observation of youth programs, what do you think they most often get wrong in the design of STEAM activities?
A: *As always, my personal opinion is that when afterschool experiences prioritize school standards and academic outcomes, we are not doing what we do best for young people. I think when youth programs*

do not feel confident about leading STEAM activities or where they put cognitive goals first, they rely on activities where there is a clear "answer" or where the result is predictable. This is understandable because no practitioner wants to have an activity that is doesn't fit into the available time slot, are hard to set up/clean up, and where participants don't get the answers to the questions they raise. This is true for both science AND art projects so it's not unique to STEAM.

So the best STEAM projects might be the ones where youth are exploring their own interests and they may not get the expected results. Or they may want to work at their own pace or in groups or individually. And maybe most importantly, the best projects might be ones where there are more questions at the end than there are easy answers.

We may have to accept in art, science, and STEAM projects that participants may not be satisfied with their results, that they think they "failed," or they are not finished at the end of the day. So I don't think it's easy to design high-quality STEAM activities but if one accepts these outcomes as still leading to a growth mindset (so important for STEM!) and that it fosters intrinsic curiosity, that allows us to re-define what "high-quality" means.

Q: In your observation of youth programs, what do you think they most often get right in the design of STEAM activities?
A: *What I've enjoyed the most in observing afterschool professionals implementing STEAM is that the providers themselves learn to appreciate what science can be. So many of us had bad experiences at some time with math or science in school ourselves and we bring that fear and frustration unintentionally to our work. So I absolutely love it when the adults in a program realize that STEAM can be fun and engaging and relevant, not just for youth, but for themselves personally.*

I know it sounds cliche but having once you realize how much chemistry there is in baking cookies or how much math is used to knit a beanie (and so many engineering examples all around us!), I think we can all relate to STEM a bit more. So I think the best part of STEAM is how much it engages educators with a growth mindset about science and math. Once STEAM becomes a habit or part of our everyday practice, it doesn't feel like a chore to incorporate it into our afterschool programming.

Q: Advocates for STEAM claim that activities are more accessible for girls and kids of color. Do you agree?
A: *So many studies show that using STEAM approaches or any other integrated and applied approaches to STEM is much more effective for reaching young people who aren't already interested in science. In fact, this is documented in our national science standards, NGSS, where a whole appendix is dedicated to this topic. I think it's not just the addition of arts which brings in kids who claim they are "bad at math," but it's the fact that young people can see that STEM can be relevant to their own lives and mental well-being.*

In this sense, I think STEM and STEAM is afterschool is so critically important. Learning in out-of-school settings can be more meaningful than learning it in a classroom because afterschool is more aligned to the "real world." You can succeed in STEAM without rote answers and where failures can be more "educational" than predicted results.

This more accurately reflects what scientific research really is. Scientists will say that what excites them most is what we DON'T know about the world around us! In school, we learn about what we already

discovered. In afterschool and in science, we experience and discover new things about the world and about ourselves.

Source: www.pexels.com

Q: STEAM seems to favor collaboration and having young people work on teams. How is this reflected in the adult world of science being conducted?

A: *One stereotype of a scientist is a "mad scientist" who works alone in the dark bringing evil to the world! In fact, most science today is done collaboratively either in person or virtually. These days, we are often collaborating with someone who may live thousands of miles away and we connect through virtual meetings, texts, shared documents. So having STEAM activities that are collaborative and project-based is more similar to what professional scientists and engineers do.*

Another similarity is that on many professional work settings, teams are composed of people with different skills and talents. Collectively, they can look at challenges and solutions from different perspectives. Some folks may be computer modelers while others are in the field observing wildlife and yet others are performing chemical extractions in a laboratory. That also can mirror what happens in out-of-school time projects where youth have to discover what they are good at, how those skills complement each other and how they have to learn new skills and vocabulary to finish a project.

And lastly, what makes afterschool STEAM projects more similar to real world science research is that no one knows what the final product will be or even that it would be a successful result. In school, kids know that the activities probably have an "answer" and there is pressure to get a good grade on that project. In afterschool and in real life, there is no guarantee of a successful completion—but the discovery, growth, resilience, persistence and the collaboration itself can be a reward and should be celebrated and enjoyed.

MORE ABOUT…


Carol Tang, Ph.D.

Carol Tang, Ph.D. is the Senior Vice President for Learning and Public Engagement at the American Museum of Natural History. Carol joined the Museum in 2024 and oversees the Exhibitions, Education, Science Visualization & Public Engagement, Research & Evaluation, and Global Business Development departments. She previously served as executive director of the Children's Creativity Museum (CCM) in San Francisco, California. Under her decade- long leadership, CCM increased attendance, underwent strategic planning during the COVID-19 pandemic, and greatly expanded its community partnerships and service—earning recognition for advancing diversity, equity, accessibility, and inclusion from the American Alliance of Museums in 2023. Before leading CCM, Tang was the Senior Science Educator at the California Academy of Sciences (Cal Academy) and directed early childhood, youth, lifelong learning, and educator professional development offerings; she then oversaw the development of natural history exhibitions, planetarium and aquarium design, and public art installations when Cal Academy reopened in a new building in 2008. She has also directed the Coalition for Science After School, a national STEM education organization, and was a Program Officer leading Out-of-School Time grantmaking strategy at the S.D. Bechtel, Jr. Foundation.

American Museum of Natural History

The **American Museum of Natural History** in New York City is one of the world's preeminent scientific and cultural institutions. Since its founding in 1869, the Museum has advanced its global mission to discover, interpret, and disseminate information about human cultures, the natural world, and the universe through a wide-ranging program of scientific research, education, and exhibition.

APPENDIX 3
Voices from the Field: Dr. Rebecca Hawley, Executive Director of San Francisco STEAM Academy

Source: www.pexels.com

There's been a big push for incorporating lessons and activities that use STEAM: science, technology, engineering, art, and math. There are schools and afterschool programs that are dedicated to STEAM frameworks and also many that are working to incorporate individual STEAM activities. Below we offer an interview with Dr. Rebecca Hawley, Executive Director of San Francisco STEAM Academy.

Q: What is STEAM?
A: *STEAM stands for Science, Technology, Engineering, Arts, and Mathematics. It is an interdisciplinary approach to learning that integrates these subjects through hands-on, real-world projects. Rather than teaching subjects in isolation, STEAM encourages students to ask questions, design solutions, build, test ideas, and think creatively.*

Q: Why is STEAM Important?
A: *STEAM prepares students for the future by developing critical thinking, creative problem solving, collaboration, communication, innovation, and resilience. It increases engagement by making learning fun, meaningful, and connected to real-world challenges.*

Q: What Does It Mean to Be a STEAM School?
A: *A STEAM School integrates science, technology, engineering, arts, and mathematics across the curriculum while maintaining strong foundational academics. At SF STEAM Academy, we combine innovation with research-based curriculum.*

Curriculum at SF STEAM Academy:
- *Mathematics: Bridges in Mathematics (The Math Learning Center)*
- *Language Arts & Social Studies: Arts & Letters*
- *Science: Mystery Science*

• Social-Emotional Learning: Conscious Discipline and Wayfinder
These programs provide academic rigor, while our STEAM framework brings learning to life through projects, inquiry, and design challenges, using a whole-child approach and universal design for learning.

Guiding Principles & Frameworks:
• Project-Based Learning (PBL)
• Engineering Design Process
• Inquiry-Based Instruction
• Universal Design for Learning (UDL)
• Whole-child development through Conscious Discipline

What We Look for in a STEAM Teacher:
• Strong knowledge of child development and different learning styles
• Ability to teach foundational academics using a project-based and transdisciplinary approach to teaching and learning
• Skill in facilitating inquiry and hands-on learning
• Collaborative and reflective practice
• Commitment to equity and inclusive classrooms
• Alignment with positive classroom management practices

Source: www.pexels.com

Q: Is STEAM Used in All Subjects?
A: *Yes. STEAM thinking strengthens our core curriculum. Students apply mathematical reasoning in real-world design challenges, integrate literacy with research and presentation, conduct scientific investigations, use the arts, and build collaboration and emotional regulation skills throughout the day.*

Q: Do You Offer Dedicated STEAM Experiences?
A: *Yes. In addition to integrated classroom instruction, students participate in STEAM lab experiences, engineering and robotics projects, maker challenges, and technology integration opportunities during the school day and through our after-school and camp programs.*

Q: Is STEAM Appropriate for Afterschool Programs?
A: *Absolutely. STEAM enrichment in after-school settings—such as robotics, coding, LEGO engineering, and design labs, backyard sciences, gardening, and arts activities —provides extended time for exploration, creativity, and collaborative innovation.*

MORE ABOUT…


Dr. Rebecca Hawley

Dr. Rebecca Hawley is an accomplished leader in Education, Early Intervention, Special Education, and Family Support Services with 25 years of experience across the Bay Area, nationally, and internationally. Her career centers on advancing equitable, developmentally informed, and individualized access to education and related services for children and adolescents ages 2–21.

As an expert in child development, Dr. Hawley integrates research-based developmental frameworks with practical, school-based application, ensuring that instructional decisions, intervention plans, and service delivery models are grounded in evidence and tailored to the whole child. Her work spans early childhood programs, elementary and middle school settings, and specialized environments serving neurodiverse learners, multilingual students, and students facing mental health challenges.

Dr. Hawley provides direct support, strategic leadership, and programmatic oversight to non-profit organizations, state and federal agencies, and independent schools. She is highly regarded for her ability to build and strengthen multidisciplinary teams, coach and mentor teachers, and develop systems that support instructional excellence, inclusive learning environments, and culturally responsive practice. Her mentorship emphasizes reflective teaching, collaborative problem-solving, and data-informed decision-making to improve student outcomes and elevate teacher confidence.

SF S.T.E.A.M. Academy

San Francisco STEAM Academy is an innovative elementary school that nurtures children's intrinsic motivation, creativity, and real-world problem-solving skills.

Their research-backed, student-centered approach embraces hands-on, interdisciplinary learning: core academics enriched with arts, movement, and life skills such as cooking, gardening, and crafting. Authentic, real-world problem-solving fosters confidence and creativity. A connected, thriving learning community where children feel valued and inspired. Education should be transformative—a launchpad for every child's future possibilities.

At SF S.T.E.A.M. Academy, learning is active, engaging, and meaningful, equipping students to think analytically, innovate boldly, and thrive in an ever-changing world. They nurture the next generation of problem-solvers, creative thinkers, and compassionate leaders.

END NOTES

[1] Google AI, What is the definition of STEM?
[2] Dottie Rose, *A Brief History of STEM*
[3] The Institute for Arts Integration and STEAM, *What is STEAM Education?*
[4] Google AI, What is the history of STEAM?
[5] Resilient Educator, *The Benefits of Teaching STEAM Lessons*
[6] The Institute for Arts Integration and STEAM, *STEAM in the Classroom Look-For List*
[7] K12, *STEM vs. STEAM: Understanding the Key Differences*
[8] Google AI, What is the difference between STEM and STEAM?
[9] University of Central Florida, *Comparing STEM vs. STEAM: Why the Arts Make a Difference*
[10] The Institute for Arts Integration and STEAM, *What is STEAM Education?*
[11] Google AI, What are some key components of high-quality STEAM programs?
[12] CuriOdyssey, *CuriOdyssey and Curiosity, Engines of Discovery*

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