

Research and Policy Implications of STEAM Education for Young Students

Matt Weyer and Mary Dell'Erba

Over the past several years, policymakers have turned to [STEM education](#) (science, technology, engineering and math) to improve the economic outlook of their state and to meet the evolving requirements necessary to modernize the workforce. Policymakers continue to turn to STEM education to improve the economic outlooks of their states and to meet the evolving requirements of a competitive workforce. But with a stronger focus on the secondary grades, opportunities to build strong foundations in STEM skills early on have not occurred systematically. Subsequent achievement demonstrates this: student science achievement recently decreased [for fourth graders](#), and the math and science achievement of 15-year-olds is below the international average. The [National Science Foundation](#) also points to disparities in K-12 student performance in STEM education as an impediment to the country's overall economic success and global competitiveness. Examining the teaching and learning of STEM in the early grades may inform solutions to increase student achievement. The National Academies of Sciences, Engineering and Medicine have recently elevated this issue, developing a [consensus study report](#) on the benefits of science and engineering in pre-K through fifth grade, with a specific focus on children who have been historically marginalized.

In addition to attention from policymakers and researchers, more systematic approaches can strengthen foundations to ensure students are developing the necessary skills. This includes student-

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For a list of the research reviewed, see the references section at the end of this report. It is important to note that research provided minimal examination of STEAM programming's impacts on education outcomes for young children directly. Most research looked at the impacts of arts integration (e.g., dance, music, visual arts) and not an interdisciplinary STEAM approach. Lack of a shared or clear definition, and the fact that STEAM is a nascent field, may be reasons for the dearth of research. Exploring this new frontier may help set parameters for policy, practice and research.

centered learning and developing children’s curiosity, engagement and critical thinking skills. In 2019, Education Commission of the States held a Thinkers Meeting focused on pre-K and elementary STEM. Emerging from this effort is a suite of resources to support young students, including [state-level actions](#) and ways to support [teachers](#) and [leaders](#).

STEM and STEAM

There are two distinctions to note about STEAM education. First, it embraces arts integration, which generally connects an art form or discipline with subject areas outside of the arts. Second, STEAM approaches allow for enhanced problem- or project-based learning and student inquiry and experimentation. Both STEAM and arts integration hold potential for pre-K and elementary grades. [Research](#) shows that participation in arts-integrated learning improves students’ physical, cognitive, and social and emotional skills. This includes [reading ability](#), [writing fluency](#) and [problem-solving](#) to name a few. The interconnectivity between disciplines (i.e., not teaching any one discipline in isolation) is also important. In 2018, the Arts Education Partnership hosted a Thinkers Meeting convening 14 leaders in STEAM to [explore new opportunities](#) to more clearly define STEAM and explore new opportunities for STEAM in state policy. Part of that discussion focused on clarifying the distinctions between STEM and STEAM.

- STEM is an approach to learning where science, technology, engineering and math are applied to real-world problems that connect school and community, and promote student achievement and preparation for global competitiveness.
- STEAM includes art and design in STEM to develop a more comprehensive education model.

Participants identified several ways STEAM can uniquely build competencies and skills: by promoting active learning, social and emotional learning, divergent thinking and cultural competency.

Despite pockets of innovation around the country, gaps in STEM access and achievement largely fall on [gendered, racial and ethnic](#) lines – creating inequitable outcomes; some starting [as early as](#) first grade and continuing through 12th grade and graduate programs in colleges and universities. Why does this matter? Diverse perspectives enrich, rather than perpetuate, perspectives and [unconscious biases](#) of those who are currently overrepresented in STEM fields. The inclusion of the arts may provide [a means to embed](#) new forms of capacity, expertise and perspective.

In collaboration with the Arts Education Partnership, Education Commission of the States is turning its attention to STEAM education (adding the “A” for arts), which can promote a more comprehensive approach and provide state policymakers with more policy levers. Several states have already begun implementing STEAM education and are [making progress](#). Yet more can be done to capitalize on the early years to build strong foundational skills. To explore the positive impacts of STEAM education for young learners in pre-K through fifth grade, this Policy Brief highlights four trends from arts integration and STEAM research over the past 20 years. It includes examples, along with implications for each trend, and closes with considerations for state policymakers.

Trends and Impacts From P-3 STEAM Research

Four high-level trends emerged from the research: impacts on academic achievement and cognitive functioning; impacts on social and emotional learning; leveraging developmentally appropriate practices to enhance instruction and outcomes; and supporting teacher professional development and effective arts integration.

Impacts on Academic Achievement and Cognitive Functioning

Based on research, arts integration in the P-5 grades has proven benefits for student performance in [several content areas](#) and skills, including engineering, literacy and reading, numeracy and math, writing, vocabulary development, as well as the arts (dance, music, theatre and visual arts).

- In [a study](#) of a STEM/arts professional development program, researchers found a significant positive impact for pre-K and kindergarten students in standardized math scores.

- [A review](#) of a theatre infusion project, controlling for gender and socioeconomic background, demonstrated that participating fourth and fifth graders were 42% more likely to score proficiently in language arts than nonparticipants.
- Additional research reveals that early arts participation is linked to improved outcomes in [eighth grade science and writing](#).

Arts integration appears to have a positive impact on cognitive functioning and several related subskills. Studies demonstrated positive effects on creativity, engagement, executive functioning, innovation, interest, language, spatial thinking, and auditory and sensorimotor skills. Researchers also documented improvements in [critical thinking skills](#).

- Spatial thinking skills (awareness of space, representation of space, and the reasoning involved in interpreting spatial information and making decisions) are essential for STEM [learning](#) and [achievement](#). Researchers have also noted [gender](#) and [socioeconomic](#) gaps in these skills that emerge early in life. Incorporating spatial thinking in classrooms holds significant promise in [pre-K](#) and [elementary grades](#).

What Does This Mean for Policy?

Research points to several academic and cognitive functioning benefits that arts education can impart. An important consideration is that when STEAM is carried out through an interdisciplinary approach, it can produce outcomes across content areas, not just those implicit in the acronym. This signals a need for more broad discussions of STEAM as a block of instruction rather than subjects taught in isolation. To [provide the conditions](#) for this type of flexibility, **Michigan** allows districts or schools to apply for [seat time waivers](#) that exempt innovative education programs from instructional time requirements, providing teachers and administrators with enhanced flexibility to implement interdisciplinary instructional approaches.

Impacts on Social and Emotional Learning

Students who participated in integrated arts education experienced improvements in social and emotional learning as well as positive emotions, self-regulation, engagement, self-confidence, self-efficacy, and communication and social skills.

- [Research](#) demonstrates that pre-K children who participated in an arts-integrated program showed enhanced positive emotions, such as happiness,

interest and pride in dance, music and visual arts classes, based on teacher observations when compared with peers in traditional pre-K classes. This included greater observed positive and negative emotion regulation.

- Head Start students who participated in a creative dance and movement program [demonstrated gains](#) in social competence and reductions in problem behaviors. An additional study found that [participation in music programming](#) led to improved benefits in cooperation, interaction and independence measures.

What Does This Mean for Policy?

Building STEAM skills early on sets a strong foundation that helps students more effectively collaborate, regulate emotions, and engage in tasks and projects. **Maryland's** [early learning standards](#) (through eight years of age) embed fine arts, health, science and social foundations within more traditional standards, such as language, literacy and math. Additionally, researchers across various studies mentioned the social and emotional impacts on [school readiness](#) and [transitions into kindergarten](#) as fundamentally important.

Leveraging Developmentally Appropriate Practices to Enhance Instruction and Outcomes

Young students [learn best](#) through play, experience and active engagement with materials and their classmates, encouraged and facilitated by educators. Several studies examined the impacts of hands-on, play-based and authentic engagement with STEAM subjects and found positive impacts for students. This suggests that arts and STEM education could be mutually reinforcing from a play-based perspective. These studies noted the importance of developing students' autonomy, curiosity and inquiry through project-based and [student-centered learning](#).

- In [a study](#) of classrooms that supported collective STEM-related play, outcomes included preschoolers' use of engineering and scientific thinking. It also noted enhanced outcomes for female students, who have traditionally been excluded from STEM education.
- Integrating dance, dramatic inquiry, artistic design and physical education into STEAM curricula for pre-K through third grade classrooms led to [improved understanding](#) of engineering and technology.

What Does This Mean for Policy?

Student-centered learning is personalized, [competency based](#), student driven and connected to real world experiences. This approach may hold the key to implementing developmentally appropriate early STEAM education, especially in the context of [education recovery](#) during and after the COVID-19 pandemic. **New Hampshire** developed [minimum standards](#) rooted in [competency-based education](#) and its [state model competencies](#) that can encourage implementation of student-centered learning practices.

Supporting Teacher Professional Development and Effective Arts Integration

High-quality STEAM education for young students cannot happen without effective educators who understand child development and the components necessary for implementing STEAM education: effective pedagogy, learner and teacher empowerment, intentionality, and growth and innovation. In addition to the lack of a clear definition of STEAM, there is a lack of [models](#) or supports for STEAM teaching practices.

Recently, instruction [in the early grades](#) has been dominated by language, literacy and math skill development. Layered on top of this is evidence that pre-K and elementary teachers may [lack background knowledge](#) in STEM disciplines and may bring certain anxieties or apprehension to the undertaking of these subjects in their classrooms — especially in [math](#). According to 2019 National Assessment of Educational Progress in science, 24% of fourth grade teachers said they spend [less than two hours](#) per week teaching science. Further, [only 31%](#) of elementary teachers felt well-prepared to teach science.

Limited research also points to in-service and pre-service teachers' interest in STEAM education, but that [several barriers](#) to implementation exist. Professional development can be a first step.

- In a study of [professional development](#) for pre-K teachers, research demonstrated an improvement in teachers' self-efficacy and confidence in planning and implementing STEAM content, although ongoing support was reiterated to address reluctance for implementation.
- Changes in pedagogy, changes in attitudes, fidelity to program, teacher background and collaboration concerning arts integration [were all identified](#) as positively contributing to student outcomes.

What Does This Mean for Policy?

During an era where the teacher workforce is stretched remarkably thin, layering on additional expectations may seem counterproductive. But when viewed as a strategy for pandemic recovery, providing high-quality professional development and coaching supports can help educators become more comfortable with STEAM education and can help young students develop strong foundations for potentially rapid acceleration. In **Nevada**, [the STEAM Subcommittee](#), a permanent subcommittee of the Nevada STEM Advisory Council, supports professional development for pre-K through college educators, among other goals. State leaders can tap into [various funding streams](#) to support training and placement of [teaching artists](#) in schools, including grants to state education and arts agencies. Teaching artists can support schools and educators by providing high-quality professional development and coaching or by helping to co-create and co-implement lessons.

Policy Considerations

The positive outcomes are clear: STEAM education can become a significant piece of pre-K and elementary education, one that is engaging and aligned with developmentally appropriate practice and content standards. Here are six policy considerations for state leaders thinking of leveraging STEAM education.

Map out your state's landscape. Consider whether your state has any existing infrastructure that could support creating or enhancing P-5 STEAM education. States including **Idaho, Iowa** and **Washington** have [state-level structures](#) to support capacity-building, coordination and implementation.

Identify barriers and opportunities. Examine logistical restraints that may pose as barriers to (or opportunities for) effective STEAM education implementation. These include [instructional time](#) requirements (beyond [recommendations](#)) for STEAM. Standards may also be used to ensure developmentally appropriate practice.

Support teachers. Ensure pre-K and elementary teachers receive high-quality professional development in interdisciplinary STEAM education, which research links to increased implementation and improved student outcomes. This could be coupled with both training on student-centered learning, and instruction on creating authentic and meaningful lessons.

Use a targeted approach that centers on equity. Targeting STEAM curriculum and teacher professional development in low-performing districts and schools that have traditionally been marginalized can help maximize resources. This can be done through technical assistance from the state education agency or a request for proposals process that prioritizes equity and racial justice in the development and implementation of a pilot program.

Consider a formative assessment framework. Incentivize the state education agency to create a framework for evaluating learning environments, curriculum and instruction that centers developmentally appropriate practice. An accountability framework may also serve to elevate the importance of early STEAM education — currently, [science achievement](#) is generally not measured until the end of elementary school.

Partner with the community. Use teaching artist rosters and other arts and business organizations in the community to form partnerships, focusing on integrating professionals into classroom environments and providing enrichment opportunities. Teaching Artists Guild maintains [a national map](#). [After-school opportunities](#) can also be considered.

Early STEAM Education in States' ESSER Plans

To address [interrupted instruction](#) stemming from the COVID-19 pandemic, several states are [leveraging STEAM education](#) for young students.

- To accelerate learning, state leaders in **Georgia** have [prioritized](#) a focus on the fundamentals, which includes supporting cross-disciplinary collaboration and providing opportunity grants to schools to fund access to specific topics and grades, specifically highlighting K-5 and STEAM.
- **New Jersey** officials will be [coordinating](#) Elementary and Secondary School Emergency Relief (ESSER)-supported activities with funds under the Every Student Succeeds Act (Title IV, Part A) to explore student-centered learning acceleration activities in STEM and the arts and to help to ensure instructional emphasis on an interdisciplinary approach.
- The **Ohio** Department of Education will continue to prioritize and expand personalized learning for students, as well as summer learning, afterschool and enrichment programs including STEM/STEAM education.

Final Thoughts

The COVID-19 pandemic has put a tremendous strain on students, families, teachers and administrators, and has further contributed to declining achievement scores across grades, subjects and demographic groups. This can be especially true for young students, and those from racially minoritized groups and low-income families, as the pandemic has further squeezed already strained and underperforming systems. As state leaders look to recover from the pandemic and rebuild their education systems to become more comprehensive, equitable, resilient and productive, STEAM education in the pre-K through elementary grades is well positioned to leverage young children's natural curiosity and engagement to create strong foundations. As STEM jobs are expected to [increase by 11%](#) from 2020 to 2030 (outpacing the total across all occupations by roughly 8%), improving P-5 STEAM education outcomes can serve as a pipeline to help guarantee our country's economic prosperity and global competitiveness for years to come.

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Acknowledgment

Education Commission of the States would like to thank Klaudia Neufeld for her contribution to this Policy Brief. Klaudia is a Ph.D. candidate in Educational Leadership and Policy Studies at the University of Denver, and a Social-Emotional Learning Specialist for the Adams 12 School District in Colorado.

