EDUCATION COMMISSION OF THE STATES

ARTS EDUCATION PARTNERSHIP

POLICY BRIEF

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Preparing Students for Learning, Work and Life Through STEAM Education

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Technology and the need for new skills are shifting the workforce — requiring workers to be more creative and demanding culturally competent and innovative thinkers who are prepared to solve new global problems. Advocates for STEAM education — the intersection of science, technology, engineering, arts and math — believe it builds the habits of mind for life and work in the 21st century.

In late 2018, the Arts Education Partnership launched new work investigating policies and practices in STEAM education. To date, the work has produced a landscape analysis of state polices that include STEAM education, including those related to access, funding and coordination of state leadership. This work revealed that states are just beginning to include the arts in STEM policies and that more questions than answers exist.

To address these questions, AEP and Education Commission of the States convened 14 leaders to look beyond current state policy and explore new opportunities in STEAM. Conversations at this Thinkers Meeting focused on the perspectives of researchers, policymakers and practitioners. Collectively, the group considered questions to guide future practice, research and policy work:

What unique value do **the arts bring to STEM** and **STEM to the arts**?

What is the **workforce rationale** for **STEAM skills**?

What are the **policy opportunities** to **support arts learning in STEM**?

This report highlights the Thinkers Meeting participants' conversations and insights.

Defining STEAM Education

For this report, STEAM education is defined as an approach to teaching in which students demonstrate critical thinking and creative problem-solving at the intersection of science, technology, engineering, arts and math.

Participants noted that enhancing the experience of the learner is central to a definition of STEAM education. Students leverage the five content areas to build new understanding and solve problems that are authentic to their lives. The unique value of STEAM education is in the transdisciplinary thinking that occurs when creative and analytical thought occur simultaneously. Analytical thinking (most often associated with the STEM subjects) and creative expression (most often associated with the arts) combine to foster innovation.

What Does High-Quality STEAM Education Look Like?

Participants responded that quality STEAM education focuses on cognition, which they described as the process of learning through new experiences and perspectives. The arts and STEM are both important to supporting this process, as they expose students to a broad range of thoughts, concepts and sensory experiences when implemented together.

STEAM instruction should be grounded in clear learning standards and integrate multiple disciplines in ways that preserve their individual integrity. The resulting approach is both flexible and aligned with academic standards, allowing teachers to guide student exploration, inquiry and creativity, while ensuring that students meet established learning objectives.

Participants also discussed authenticity as an element of quality. For STEAM learning to be authentic, students must identify the problems they explore. In addition, those problems should be relevant to students' lives, and they must occur at the natural intersections between the arts and the STEM fields. For example, **Nevada**'s STEAM Committee identifies spatial awareness as one example of an authentic intersection of the arts and sciences; spatial ability is both an arts-based skill (3D modeling) and a math and science skill (space imagination).

How do STEM and STEAM Education Differ?

STEM education is commonly understood as 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 education includes art and design in STEM to develop a more comprehensive education model. Despite these common understandings, participants acknowledged that both STEM and STEAM education are defined in many different ways by different groups.

Participants regarded STEAM and STEM education as two distinct pathways, but noted that policymakers, practitioners and researchers continue to ask whether STEAM should replace STEM or only enhance it. For more than two decades, state and federal policymakers have informally included the arts in STEM education, but states like **Nevada** and **Ohio** have recently implemented policies that create a distinction between STEM and STEAM practices. Federal lawmakers underscore this distinction by

maintaining separate congressional caucuses for STEM education, STEAM and the arts.

Participants saw an opportunity to preserve the distinctions between STEM and STEAM education through research. Researchers have designed and implemented multiple studies to gather data and evidence specific to STEM programming. While STEAM education is not a new practice — the National Science Foundation, National Endowment for the Arts and U.S. Department of Education have funded STEAM projects for over a decade — researchers have not studied its impact as extensively as STEM learning. Participants saw this disparity in available evidence as an opportunity for rigorous research and data collection specific to STEAM learning. They noted that by specifically examining the impacts of STEAM education, the research community could help policymakers and practitioners understand the benefits that the arts bring to STEM education and better ground STEAM policies and practices in evidence.

After considering the distinctions between STEM and STEAM in policy and research, participants discussed the unique value of STEAM learning in practice. They noted that the arts can introduce new competencies and skills, including active learning, social and emotional and interpersonal skills, divergent thinking and cultural competency. These skills have unique applications to school, work and life. While STEM education can also foster these habits of mind, participants argued that the arts provide an opportunity to further enhance learning and development in meaningful and intentional ways.

ACTIVE LEARNING

Participants said that artists have opportunities to simultaneously learn new information, practice skills and incorporate feedback. For example, musicians learn music by singing, taking feedback from listeners and adapting their technique accordingly. Dancers do the same through movement. By incorporating arts into STEM education, educators can increase opportunities for students to practice active learning, especially in schools with fewer resources to support experimentation in science courses.

SOCIAL AND EMOTIONAL LEARNING

Existing research demonstrates the impact of the arts on students' social and emotional development, including gains in motivation, perseverance, engagement, empathy and emotional regulation. Students learn to adjust their actions in relation to others' actions — enhancing their self-efficacy and social perceptiveness. Participants discussed the arts' unique ability to help students understand new perspectives and engage in social and emotional skill building. They stated that this focus can support a growing trend to enrich STEM education with social and emotional learning strategies.

DIVERGENT THINKING

Participants stated that integrating the creative process found in the arts into STEM instruction can enable students to practice divergent thinking. They defined divergent thinking as a way of solving problems that generates innovative and creative ideas by exploring a variety of possible solutions. High-quality STEAM education creates a safe place for student inquiry and risk taking, allowing students to enhance their problem-solving skills by engaging in multiple disciplines.

CULTURAL COMPETENCY

Participants mentioned that globalization demands a workforce that can work together across cultural lines, requiring an openness to different ways of thinking. As the country becomes more diverse and the world more

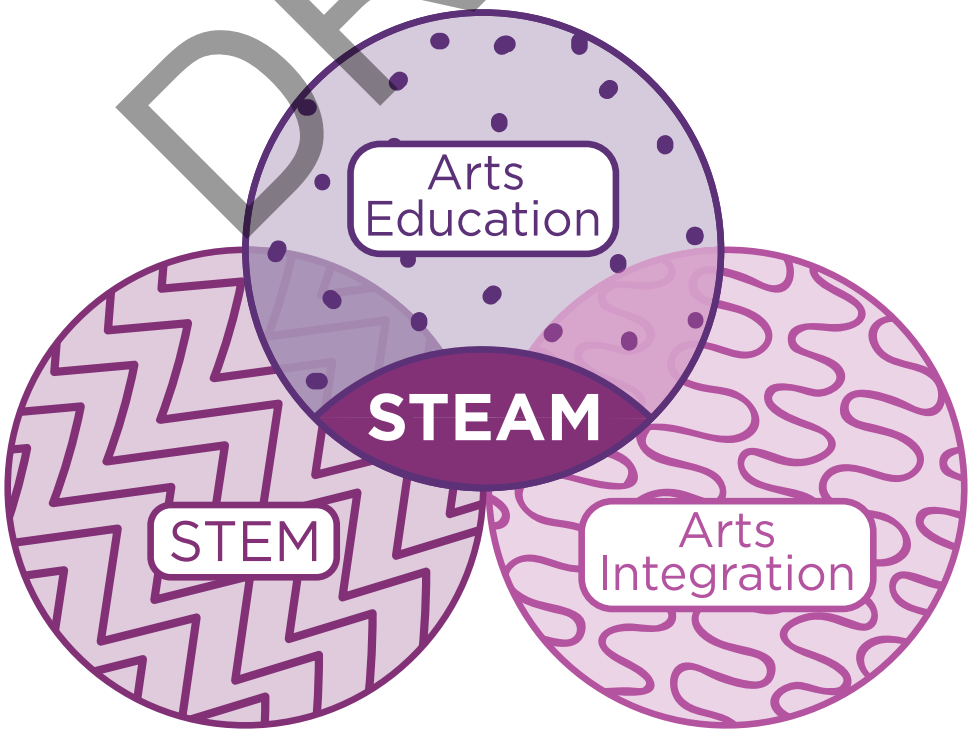
interconnected, the arts provide a unique framework for students to develop necessary cultural competencies. For example, experiencing artwork from other cultures can teach awareness and understanding.

How Is STEAM Different From Arts Integration?

The John F. Kennedy Center for the Performing Arts defines arts integration as "an approach to teaching in which students construct and demonstrate understanding through an art form. Students engage in a creative process which connects an art form and another subject area and meets evolving objectives in both."

Participants were careful to distinguish STEAM education from arts integration. STEAM education features many approaches to teaching, including arts integration as one approach. Other approaches include problem- or project-based learning and student inquiry and experimentation. Participants identified different goals as a key distinction between STEAM instruction and arts integration. When done well, the outcome of arts integration is a deeper understanding in both the arts and at least one other subject area. STEAM education embraces this, but also focuses on the processes of learning and problem-solving. While students develop deeper understanding of content, they are simultaneously practicing skills that transfer across subject areas and investigating complex problems.

Ultimately, STEAM instruction shares attributes of arts education, arts integration and STEM education. Participants suggested that STEAM learning occurs at the intersection of all three instructional practices.



STEAM Skills and Abilities: The Workforce Rationale

Researchers project that, by 2030, emerging technologies will reset expectations for the workforce and 85% of the jobs that today's K-12 learners will be doing have not yet been created. The broad, transferable skills and abilities required for career success — such as communication, problem-solving and collaboration — are projected to continue to be in high demand from employers.

STEAM education is one approach states have taken to advance skill development and achievement in fast growing occupations in the arts and STEM fields. Participants offered a rationale for STEAM learning that addresses both skills and careers: STEAM education ensures that students on any career pathway have the skills and abilities necessary for success, while inspiring and preparing students for STEAM jobs — including those in arts, sciences, design, technology and engineering.

What Skills and Abilities Does STEAM Foster?

Participants described STEAM education as uniquely situated to equip students with abilities sought by high-wage, high-growth and high-demand jobs.

- **DEFINING PROBLEMS:** Students use scientific and creative processes to make observations, ask questions and define problems. Participants stated that the arts can improve observational skills, providing students with additional tools to identify and describe problems. Creativity and self-expression in the arts further enhance students' abilities to synthesize and communicate observations about the world around them in ways that are easily understood.
- **GENERATING IDEAS:** Creativity is a high-demand skill for occupations across the arts, STEM and service fields. Participants argued that artists are better prepared to think creatively, and that innovation is a unique value that the arts bring to STEM learning. Divergent thinking practiced in STEAM education involves thinking in multiple directions, seeking innovation and investigating new ideas. The arts promote fluent thinking — an essential element of problem-solving — and generate a variety of new, creative and unconventional solutions.
- **TRANSFORMING AND SYNTHESIZING:** Participants noted that STEAM education teaches the processes of modifying, adapting and combining disparate ideas. The intersection of the arts and STEM learning encourages students to think about content and concepts from different points of view, using critical thinking skills to identify strengths and weaknesses of alternative solutions or approaches to problems.

What Careers Does STEAM Support?

Participants said that STEAM education prepares students for high-paying careers in STEM and the arts, as the arts can both enhance STEM careers and provide additional, viable career pathways. The Bureau of Labor Statistics reported that median wages for creative occupations were higher than the overall median wage, and that 93 out of 100 STEM occupations had wages above the national average. Research from the Georgetown Center on Education and the Workforce projected arts and STEM occupations to be two of the fastest growing occupations from 2010 to 2020.

STEAM jobs tend to require that employees hold a postsecondary degree more than other jobs. The Georgetown report shows that 91% of jobs in the arts and 94% of jobs in STEM require a bachelor's degree. Participants discussed the implications for this shift through the lens of racial equity, as racial and ethnic disparities in postsecondary attainment perpetuate inequitable opportunities in the workforce. More students will need a postsecondary degree to secure a higher-wage position, and STEAM education provides students with additional access to engage in STEM and arts careers.

EXAMPLES OF STEAM JOBS

While participants observed that the skills and abilities practiced in STEAM learning are transferrable across all occupations, they identified the following jobs as examples of careers directly related to STEAM. While these occupations do not represent the breadth of career options, they include:

- Animation.
- Architecture.
- Conservation.
- Design (web, product, graphics).
- Engineering.
- Health Care.
- Math.
- Nursing.
- Sound Engineering.
- Technology.
- Urban Planning.
- Video Game Development.

EXAMPLE

Sound Engineer

Sound engineers work on the technical aspects of sound and music production by manipulating and reproducing the mechanics of sound. By controlling such technology as microphones, sound boards and speaker systems, they combine concepts of math, physics, engineering and musicianship to produce the best quality sound for spaces and audiences. Advance CTE includes audio systems technicians as a sample career within the Arts, A/V Technology and Communications Career Cluster adopted by several states.

EXAMPLE

Technology

Participants discussed Apple as an example of a company that has capitalized on STEAM skill sets in building new technologies. Apple is one of the biggest job creators in the United States, employing 2 million people in all 50 states across thousands of professional fields. Apple employs designers, scientists, hardware and software engineers, and marketing professionals who use STEAM skills; and the value of the arts is evident in Apple products and services.

Barriers and Gaps

Participants identified five common barriers that prevent states and districts from implementing and sustaining high-quality STEAM programs:

LACK OF A SHARED DEFINITION

One of the most significant barriers participants identified was a lack of a shared definition and understanding of what STEAM education is, how it can be used effectively, how it differs from STEM and arts education, and the unique value that the arts bring to STEM learning. Without a universal definition of STEAM education that has utility across sectors, the field lacks a foundation for quality standards in STEAM education.

LACK OF EFFECTIVE TEACHER PREPARATION AND PROFESSIONAL DEVELOPMENT

Participants noted that teachers may experience challenges with STEM or arts subjects when implementing a STEAM curriculum. They saw this as particularly relevant for elementary general education teachers, who often lack deep preparation in arts or STEM subjects. Currently, arts-integrated instructional practices are not widely included in teacher preparation programs, and participants noted that states and districts may struggle to include new content in professional development plans.

CURRICULAR RESTRAINTS

Participants pointed to lack of clarity on how the National Core Arts Standards, Next Generation Science Standards and Common Core Mathematics Standards should be integrated or assessed in STEAM learning. There is also not a common assessment tool based on both process and content standards across subject areas. Lack of an adequate assessment tool for STEAM education may encourage schools to limit instructional time for STEAM specific courses in favor of tested subject areas.

CAPACITY RESTRAINTS

Participants said that schools are faced with capacity constraints related to time, scheduling and funding. Whether a school implements a specific STEAM class or integrates STEAM learning into other subject areas, limited time during the school day can become a barrier. Effective STEAM education also requires collaboration and planning across subject areas and grade levels. Participants noted that STEAM skills are hard to acquire with just one experience and require ongoing exposure. Many schools lack time during the school day for teachers to collaboratively plan instruction with teachers outside of their content area and grade level. Collaborative planning ensures that lessons are well integrated and scaffolded over time.

LACK OF RIGOROUS RESEARCH AND DATA ON STEAM EDUCATION

Much less rigorous, peer-reviewed academic research exists on STEAM education than on arts or STEM education, particularly through the lens of racial equity. Current classifications of occupations in workforce research do not explicitly consider the intersection of the arts and STEM education in careers, requiring researchers to make judgments about which occupations qualify as STEAM occupations or require STEAM skills. Participants noted that without rigorous research and accurate data, decision-makers at all levels may not support the rationale for STEAM education.

What State Leaders Can Do

Participants discussed opportunities for state and local policymakers to overcome these barriers:

DEVELOP A VISION. State leaders can prevent inconsistent and inequitable implementation of STEAM programs by establishing a statewide vision for, and shared definitions of, STEAM education. As demonstrated in **Georgia** and **South Carolina**, state leadership can design tools outlining consistent guidance that schools can refer to when building STEAM programs.

SUPPORT TEACHERS AND HIGH-QUALITY INSTRUCTION. Participants suggested that state and district leaders can examine the use of time and resources to implement targeted professional development for teachers in and beyond the arts. Decision-makers can also examine licensure requirements for teachers, requiring teacher preparation programs to include elements of arts-integrated instruction rooted in a vision for STEAM education.

BUILD CONNECTIONS. Forging connections between STEAM subjects and other related policy areas — such as STEM, workforce development, career and technical education, social and emotional learning, and teacher licensure and recruitment — enables policymakers to build multipronged strategies. For example, **Ohio** enables districts to use career and technical education funds for STEAM programs — which it defines as a type of STEM education — providing additional opportunities for schools.

BUILD CAPACITY. Leaders can build the capacity of schools and educators by developing a consistent framework for assessment and adjusting schedules to allow for planning across departments and grade levels. **Nevada** established a STEAM subcommittee to the STEM Advisory Council to operate as a working group to support professional development, increase access to high-quality STEAM education throughout the state and target goals set forth by the **Nevada** Governor's Office of Science, Innovation and Technology. This entity published a definition and vision for STEAM learning, as well as guiding principles for the integration of learning standards, assessment and the future of STEAM education. The subcommittee includes representatives from the state department of education, the state arts agency, higher education staff, performing and visual arts organizations, science museums, school districts and funders.

COLLECT DATA AND PROMOTE RESEARCH. States can include STEAM data in systems for statewide data collection and reporting. Data can shed light on access and inform program evaluation. Leaders can dedicate staff and resources for data collection, designate funds for research and develop research agendas.

CLARIFY AND INCREASE FUNDING PATHWAYS. To overcome barriers of uncertainty around the allowable uses of Every Student Succeeds Act (ESSA) funds, state leaders can develop aligned pathways across school, district, state and federal leadership regarding the use of funds — similar to **California** Alliance for Arts Education's guidance on the Title I Initiative. This specific pathway overcomes barriers to entry across the state for implementing proven, effective programming. **Pennsylvania** included STEAM education in its ESSA Consolidated State Plan as a priority area for the use of Title IV 21st Century Community Learning Center funds. Beyond ESSA funds, state leaders can articulate how career and technical education, STEM or formula funding can be used for STEAM activities.

Final Thoughts

STEAM Thinkers Meeting participants found that, in an increasingly diverse and technologically advanced world, STEAM education prepares students with the skill sets required for success. Local, state and federal policymakers recognize the value of STEAM learning and have begun to incorporate the arts into STEM policies, but more research is needed to support these efforts. Opportunities remain for decision-makers at all levels to articulate a shared definition of STEAM education and implement policies to address common barriers. Considered individually, STEM education and the arts can address many of these challenges, but participants concluded that a well-rounded STEAM education is worth well more than the sum of its parts.

Thinkers Meeting Participants

Education Commission of the States Thinkers Meetings convene national education leaders to identify best practices that states can adopt to improve education. This report does not present a consensus among all participants in the meeting. Rather, it offers an overview of the meeting's major themes.

MODERATORS

- **Mary Dell'Erba**, Senior Project Manager, Arts Education Partnership
- **Brian Sponsler**, Vice President, Policy, Education Commission of the States

PARTICIPANTS

- **Marvin Carr**, Senior Advisor, STEM and Community Relations, Institute of Museum and Library Services
- **Patti Curtis**, Robert Noyce/Ellen Lettvin Informal STEM Education Fellow, STEM Next Foundation
- **Jennifer Edelen**, Director, Wolf Trap Institute for Early Learning Through the Arts, Wolf Trap Foundation for the Performing Arts
- **Annie Hsiao**, Deputy Assistant Secretary for Policy and Programs, Office of Elementary and Secondary Education, U.S. Department of Education
- **Ayanna Hudson**, Director of Arts Education, National Endowment for the Arts
- **Joyce Huser**, President, State Education Agency Directors of Arts Education; Fine Arts Education Consultant, Kansas Department of Education
- **Brian Mitchell**, Director, Governor's Office of Science, Innovation and Technology, State of Nevada
- **Lucinda Presley**, Chair/Executive Director, Innovation Collaborative
- **Nicole Smith**, Research Professor and Chief Economist, Georgetown University Center on Education and the Workforce
- **Louis Soares**, Chief Learning and Innovation Officer, American Council on Education

EDUCATION COMMISSION OF THE STATES STAFF

- **Jane Best**, Former Director, Arts Education Partnership
- **Erika Hawthorne**, Engagement Specialist, Arts Education Partnership

About the Author

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As a senior project manager for the Arts Education Partnership, Mary oversees project work plans and supports the development of AEP deliverables. Prior to joining Education Commission of the States, she worked for the Arts Education in Maryland Schools Alliance, where she served in a variety of capacities in programming, administration and policy. With over 20 years of dance training, Mary is passionate about the arts and education. Contact Mary at mdellerba@ecs.org or **202.844.6283**.

About AEP

AEP at Education Commission of the States is a national coalition of more than 100 education, arts, cultural, government, business and philanthropic organizations that was created in 1995 by the National Endowment for the Arts and the U.S. Department of Education.

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