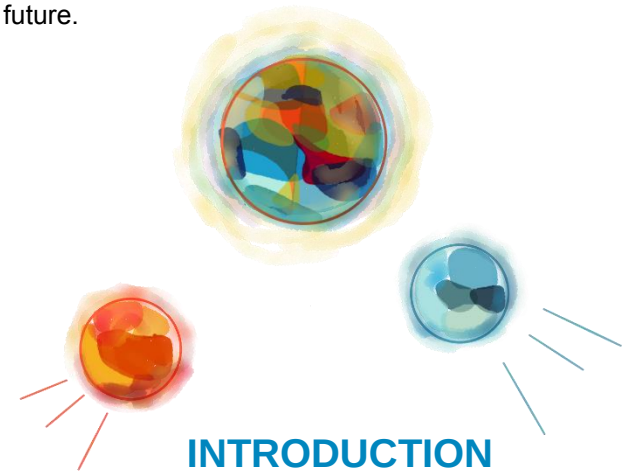
STEAM

A Working Definition & Guiding Principles: Enriching Nevada's Future

The STEAM Committee is a civic advisory working group consisting of STEAM professionals and community advocates, committed to supporting arts integration across all disciplines of study. A permanent sub-committee of the Nevada STEM Advisory Council, we are supporting professional development programs for PreK-college educators, increasing access to high quality STEAM opportunities for students throughout the state, and targeting stated goals put forth by the Nevada Office of Science, Innovation, and Technology. The following position paper reflects our collective belief in the power of arts integration to leverage STEM education and prepare students most effectively for the new economies of Nevada's future.



INTRODUCTION

S.T.E.M. (science, technology, engineering, and math) education represents the current and increasingly exciting chapter in educational reform taking place here in Nevada. STEM places an emphasis on project-based approaches, while concurrently modernizing workforce development initiatives. With STEM, the priority is clear and forward thinking: academic preparedness for 21st century workforce development can be achieved through the teaching and instruction of STEM[1].

This approach for PreK-college education is already resulting in exciting and worthwhile opportunities for Nevada's students, as well as for industry, by building intellectual capital in Nevada's future workforce. Therefore, *The STEAM Committee supports continued investment in STEM and further recommends widespread integration of the arts throughout PreK-college education.*

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Creativity and divergent thinking are the fuel of innovation. STEAM is about highlighting the qualities of arts education that produce exceptional creativity and inspired innovation; future leaders that shape our workforce and help diversify Nevada's economy in significant and sustainable ways. STEAM does not reflect efforts to highlight the importance of arts education as compared to STEM, but in addition to STEM. Arts education, for its part in Nevada's progress, is understood as complimentary and fundamentally different from STEM.

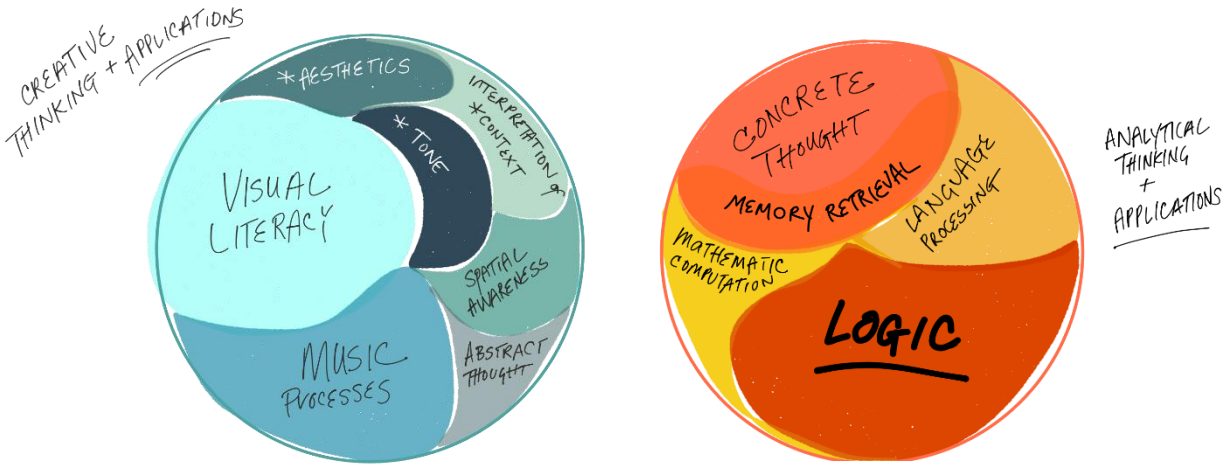
The past two decades of research in education demonstrates clearly the critical and unique role arts education plays in engaging, retaining, and enriching the whole child throughout every stage of her/his PreK-college development[2]. The arts are also one of the strongest educational cornerstones available for building successful cultures in schools[3]. And across the nation, education in the arts and humanities are increasingly understood as critical to workforce development in STEM fields[4].

Aside from advocacy and professional development, the STEAM Committee is playing an integral role in two STEAM-related educational reforms with the potential to impact students over the long arch of their educational development, through arts instruction and arts integration: 1) the newly revised Nevada Academic Content Standards for Fine Arts, and 2) the recent passage of Senate Bill SB 241. These two opportunities provide Nevada students with PreK-12 instruction based on some of the strongest core content standards (for both art and science) in the nation, as well as the opportunity to earn a seal of academic achievement, beyond a standard high school diploma, in STEM and/or STEAM. The adoption of the STEAM Certificate Program places Nevada at the forefront of states attempting to cement their support for and dedication to this type of interdisciplinary learning, as Nevada is one of only six states in the country offering a STEAM- based credential for high school students[6].

Given the growth and trajectory of STEAM education, we believe that STEAM is a viable and necessary part of Nevada's future. As such, it is necessary to provide Nevada with a working definition of STEAM and a framework for establishing guiding principles. This includes expectations for scope, structure, and assessment, as well as identifying the statewide leaders in STEAM education in order to provide ongoing resources for encouraging best practices.

STEAM: A Working Definition

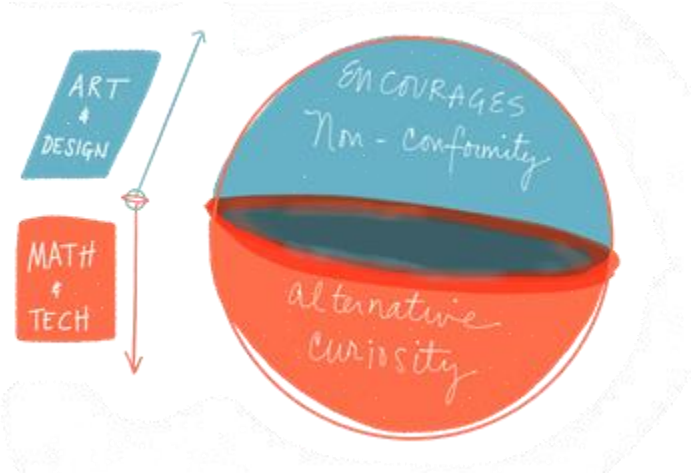
Complimentary to STEM education, STEAM is an interdisciplinary approach to teaching and learning that integrates authentic and implicit instruction in Fine Arts beyond the design process. STEAM effectively leverages both concrete and abstract thinking in meaningful and engaging ways. That the *creative* and *analytical* are so commonly thought of as occupying separate and competing spheres of thought, the meaning and purpose behind STEAM becomes clear when we imagine these two spheres interacting with one another to create new chemistry - new attitudes. STEAM is the nexus of both creative and analytical processes, designed to produce new ways of approaching problems and creating solutions in a real-world context.



Guiding Principles

The true key to any successful STEAM lesson is authenticity; finding the natural and obvious intersections of fine art and design within science, math and engineering, and then layering relevant technology and cultural considerations over the experience, to enhance and develop the student's understanding of new knowledge.

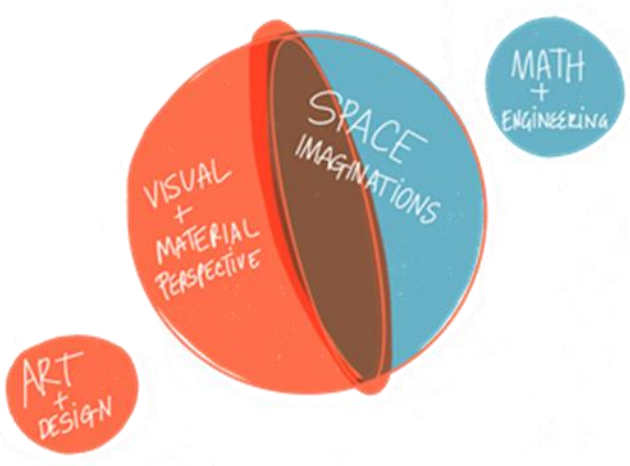
Effective STEAM instruction applies a growth mindset for both teaching and learning, one that recognizes new research in cognitive development and the construction of knowledge. STEAM education implicitly includes instruction of art and design, but it also makes space for skill-sets increasingly associated with creativity and innovation - across disciplines. In a STEAM context, a math and an art teacher can both recognize the inverse value of specific skills and find ways to develop them in students. *Space imagination*, for example, is a math skill[7]. Spatial ability is also an arts-based skill (3D modeling, linear perspective). Spatial awareness is therefore one example of an authentic intersection of art and math and can serve as a guiding principle of a STEAM lesson[8].



Time, practice, application, and research of STEAM will ultimately inform and tease out which specific aptitudes are most synergistic for students to learn from, develop, and apply. In the meantime, **conscious consideration of that which is mutually beneficial to holistic learning (creatively and analytically) is the core guiding principle of STEAM today.**

A STEAM based lesson or activity must provide opportunities for analytical thinking and application, including but not limited to – problem solving, concrete thought, language processing and speech, logic, mathematical computation and memory retrieval. It must also provide opportunities for creative thinking and applications including – visual literacy, music processes, story-telling, abstract thought, spatial awareness, interpretation of context, tone, and meaning as well as experiments in the application of the elements and principles of design. Across the arc of a student's learning experience, this multi-modal approach to integration should be present in every stage of a learning activity, including a demonstration of mastery that allows for multiple expressions of understanding. This makes STEAM education fundamentally holistic; it requires whole brain thinking and provides opportunities to express multiple intelligences and modes of learning.

Statistical analysis and research shows that this type of holistic approach to inclusion and integration of the arts in STEM subjects has a relevant impact on diverse groups of learners traditionally underrepresented in STEM fields[9]. By broadening our approach to how we engage students with STEM content, through the integration of the arts, we inherently broaden the types of students we can meaningfully connect with across content areas and learning styles.



STRUCTURE & SCOPE

The structure of a STEAM based classroom lesson often relies on creating art as the student's final product. There are fitting examples of lessons where students bead jewelry that codes for segments of a genomic sequence or a message in Morse Code. Students might also create a painting using sound vibrations, dramatize the activity of a molecule, choreograph the rotation of the earth, or explore the art and science of photography.

With the introduction of the Nevada Academic Content Standards for Fine Arts, based on the National Core Art Standards, we now have the ability to leverage fine arts instruction beyond the art creation phase and to explore connecting to and responding to art as a process of interdisciplinary learning. This allows us to introduce art into the classroom as a process of engagement and inquiry. Students can respond to, ask questions about, discuss, debate, and explore fine art as part of their larger understanding of the world, while simultaneously leveraging social awareness and 21st Century social skills like collaboration and critical thinking. As artists create in response to the social, cultural and global constructs they live in, the ability of students to deconstruct and respond to those messages becomes increasing valuable. Generally treated as soft skills, social skills and social awareness, both of which can be authentically integrated through the fine arts, are increasingly in demand in from the giants driving our global technology and economic growth[4].

"The leading edge of evidence presentation is in science. The leading edge of beauty is in high art."

-EDWARD TUFTE

All too often, we rely solely on the process of design in a lesson to supply the Arts portion of a STEAM based classroom experience. The shift from STEM to STEAM necessitates a major shift in the way we understand design-based thinking. For at least the last decade, we have been teaching students an engineering-based design process whereby design is an ordered and concise path with a clear starting point and an emphasis on the cyclical nature of testing and improving a final product.

This traditional approach to design is not only illogical in the practice of the arts, it ignores the important design-based thinking aspects of confusion and uncertainty. By shifting students towards an arts-based method of design thinking (and away from an engineering design process) we create room for curiosity, creativity, mess, divergent thinking, and most importantly, failure - all of which are required skills and aptitudes for innovative thinking. If we are leveraging design as the arts in a STEAM program, it needs to be done within the scope of design-based thinking and according to the structure of the elements and principles of design.

Practically speaking, when planning and implementing STEAM lessons, there is a tendency to try and pull applications and ideas from each of the STEAM fields. This is unnecessary and often leads to forced or incoherent experiences for students. On the other end of the spectrum, there is a tendency to try and simplify STEAM education into single activities, such as a painting based on a season or a poster about a science experiment. While this can be useful or suitable within the context of a larger lesson, this does not constitute a STEAM lesson in and of itself.

The 'A' in STEAM cannot be thrown in as an afterthought, or even a well-designed final project to a STEM based lesson. This approach misses the valuable opportunities that STEAM education intrinsically provides: multi-modal, in-depth exploration, based on diverse learning styles, and aptitudes for creative and analytical thought and applications. As we move towards treating arts instruction with the same respect and attention as our STEM content, we better allow for a standards-driven, student expressions of creativity and innovation, making STEAM an essential approach to forward thinking holistic education.

STEAM education, much like STEM, is most applicable with project-based learning (PBL) as it fundamentally allows for deeper exploration and multiple applications of learning. STEAM education, as project-based learning, may seem daunting to assess in a standards driven educational model, given its hands-on, inquiry-based approach. But arts integration can account for this most effectively by shifting our focus from product to process. Our goal should not be to change STEM education (or PBL) to fit into format of standardized testing, but to change our understanding and broaden our concept of what valuable assessment looks like.

ASSESSMENT

The most valuable part of any STEAM activity is the experience and journey, which need not be lost in the abstract. If a STEAM lesson or activity is administered properly, the result will be evident in the material artifacts of blended knowledge, just as any high-quality STEM project will be. Evidence of STEAM learning outcomes however, should be based first on process-oriented experiences across the learning arc and secondly on relevant, authentic products. The goal of production is to reinforce exploration and creativity: an openness to new experiences and knowledge of artistic practices, not necessarily mastery of specific workforce development skills, all while maintaining room for failure as part of a successful student experience. **The richness and range of this type of integrated learning necessitates a narrow focus for any STEAM lesson on a minimal number of coherent and relevant standards; ideally one fine art standard and one STEM content standard.**

Communication and collaboration (teamwork), relying on frequent application of artistic practice and processes (rehearsing, creating, ideating, designing, critiquing, reflecting, documenting, etc.), to keep students engaged with their personal and academic experience, are therefore required for any lesson to be successful. Teachers across disciplines are encouraged to collaborate as part of their STEAM pedagogy[10] and apply shared engagement opportunities with their students as a best practice as well[11].

In fact, STEAM learning flourishes in communities where subject matter experts collaborate and partner on interdisciplinary learning for their students. The expectation is not that our Art Teachers focus on STEM content or our Science Teachers use Art Standards, but that students have access to both in cohesive and authentic experiences. Taking this approach will ensure that the requirements and metrics in place, designed to evaluate student growth and understanding across a given lesson, helps students explore their personal goals within a given project, as well as the academic standards of the larger lesson.

Even more specifically, feedback and assessment should be on-going throughout any STEAM project or activity. Consistent and relevant feedback between students, their peers, and collaborative teams of educators allows the focus to stay on the experience, not the result. Of course, summative assessments should be based on how student work reflects the ability to apply standards-based knowledge from the overall experience, highlighting the ways in which the work illustrates and reflects mastery of specific standards. However, summative assessments necessarily need to provide flexibility for non-uniform, interdisciplinary, divergent thinking; successful projects and massive failures alike. If the ultimate goal is creativity and innovation, we must shift our assessment practices to reward those types of risks, regardless of the outcome.

Finally, because of the exciting and often alluring nature of the work produced by this type of learning, we recommend that the outcome of STEAM curricula and projects be shared with a larger audience, beyond the classroom. Making a point to share student work reinforces the STEAM culture within one's school and community. It further requires the practice of 21st century workforce development skills in concrete ways, beyond the lesson and/or project itself. Most importantly, **STEAM provides students the gift of expanding their reach and impact on the world, in ways that highlight their own unique creative capacities - the best quality of the Fine Arts.**

THE FUTURE

The objective of STEAM Education in Nevada is to continue to elevate the learning experience for teachers and students across the state to better support our future citizenry and economic growth. STEAM is gaining traction across the nation as a way to implicitly leverage the fine arts in a students well-rounded education while simultaneously pushing STEM fields to the forefront of our future growth and achievement**.** The Arts and STEM should no longer occupy competing spheres of importance in the educational landscape: we can have both, and we will be better for it.

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As STEAM grows and takes root in diverse classroom environments, it will continue to evolve. Already there are vocal cries for the inclusion of other disciplines, creating new acronyms to reflect a focus on reading, humanities and social studies. We are not specifically advocating for these transitions. However, the interdisciplinary and whole brained approach of STEAM inherently creates opportunities for teachers to integrate across the disciplines as authentic opportunities arise. We should approach STEAM more as an opportunity to create interdisciplinary fine arts integration practices in our learning environments and less as a dictate about which content areas matter the most. They all matter, and they all have a place in creating well rounded students. Our hope is that as we build a common language and understanding of the nature of STEAM education, we can build a common practice; providing increasing resources, examples and training across the state of Nevada.

A draft of this paper was shared and distributed at the first NV STEAM Conference, hosted by Nevada Museum of Art and DRI Science Alive, on Saturday, February 24, 2018, with the explicit intention of soliciting community feedback from PreK-12 educators. Their feedback, along with the feedback of students, other STEAM professionals, and the wider community, was incorporated into subsequent drafts of this document. This paper continues to evolve to reflect community feedback until such time as the STEAM Committee presents and recommends a final framework to the NV STEM Advisory Council - Spring 2018. For more information and/or to become involved in the STEAM Committee and the Nevada STEM Council, please contact Brian Mitchell, Director of the Office of Science, Innovation and Technology, blmitchell@gov.nv.gov.

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Resources for Best Practices

Nevada Organizations Currently Providing STEAM Education & Professional Development for PreK-College Educators:

Nevada Museum of Art, Reno: http://www.nevadaart.org

Science Alive, Desert Research Institute, Las Vegas & Reno: https://sciencealive.dri.edu

Smith Center, Las Vegas: https://www.thesmithcenter.com

The Discovery - Terry Lee Wells Nevada Discovery Museum, Reno: https://nvdm.org

Children's Discovery Museum, Las Vegas: https://www.discoverykidslv.org

Online Classroom Resources / Curricula / Case Studies

Exploratorium at Pier 15: www.exploratorium.edu

Edutopia: https:www.edutopia.org

Institutes of Play: www.instituteofplay.org

The STEAM Committee Founding Members

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