Why Teach STEAM: A Review of the Literature

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**Introduction**

Today, being “tech savvy” is a key part of survival for the 21st century. STEM/STEAM in the early childhood classroom has been a new topic of interest in the educational field when trying to get our students ready for 21st century careers. It is likely that if we as educators do not implement the skills embedded in STEAM activities into our daily routines our students will not be ready for future century careers. The effectiveness of implementing STEAM into our daily classroom routines will make our students more proficient in those subject areas, will likely increase the number of women in the work-field areas of STEAM, will increase the overall numbers of Americans in STEAM related careers, and keep the U.S. competitive in the 21st century global economy. This paper will review the literature on the definition of STEAM and its importance in education, how STEAM is student centered and the benefits of student centered learning, how curriculum is integrated within STEAM, the ways in which STEAM prepares students for future careers and global competitiveness, and how teachers can implement and get others to implement STEAM education into their organizations.

**What is STEAM and Why is it Important?**

STEAM education is rapidly growing in the United States. STEAM stands for Science, Technology, Engineering, Art and Mathematics. Sometimes known as STEM, the Arts were added to the acronym as contributions to the arts has lead to cognitive gains and improved reasoning skills explains Taljaard (2016). Rather than teach the four disciplines as separate and discrete subjects, Hom (2014) suggests STEM integrates subjects into a cohesive learning paradigm based on real-world applications. According to Sneideman (2013) STEM is much more than an acronym. STEM is a philosophy. STEM is a way of thinking about how educators at all levels -including parents- should be helping students integrate knowledge across disciplines, encouraging them to think in a more connected and holistic way. STEAM and problem-based learning are based on the principle of learning by-doing, a powerful and memorable way to learn. They are also based on the premise that humans have an innate drive to solve problems according to Harper (2017).

According to a blog post from 2016, Curiosityville states that there is an exciting and powerful link between STEAM and early childhood. New research on brain development has shown that the brain is particularly receptive to learning math and logic between the ages of 1 and 4. STEAM skills are as important as learning letters, sounds, colors, shapes, and numbers for school readiness. The most important thing to remember about teaching STEM to early learners is that they are perfectly adapted to learn STEM concepts, and it is not difficult to teach STEM to young children. Children need to be presented opportunities to learn the same material in different settings and through different lenses. The traditional approach of teaching topics in isolation does not support the ways that children learn best. The secret is to tap into their natural and innate curiosity about the living world. By simply allowing them to investigate, by encouraging them to ask questions about the real world, you are engaging children in STEM (Sneideman, 2013).

In elementary schools STEM education focuses on the introductory level STEM courses, as well as awareness of STEM fields and occupations (Hom, 2014). This initial step provides standards-based structured inquiry-based and real world problem-based learning, connecting all four of the STEM subjects. The goal is to pique students’ interest into them wanting to pursue the courses, not because they have to. There is also an emphasis placed on bridging in-school and out-of-school STEM learning opportunities. According to Mason & Harris (2016) STEAM and early childhood approaches are complementary. STEAM in the early childhood classrooms are supported by many organizations that involve children and the subject areas STEAM addresses. The National Association of Science Teachers, for example, references the National Resource Center in a recent position statement on Early Childhood Science Education: “Current research indicates that the young children have the capacity for constructing conceptual learning and learning the practice of reasoning and inquiry”. Perhaps one reason it has taken a few years for STEAM to reach the early childhood level is that many adults, including educators, underestimate the skills, abilities, and potential of young children (Mason & Harris, 2016). We suggest that educators keep the prowess of these young children in mind as they plan early childhood STEAM lessons. In the blog post (2017) Gardner School noted schools and educators who incorporates STEAM education are shaping the everyday experiences for today’s children, preparing them to be excellent problem-solvers, creative collaborators, and thoughtful risk-takers.

At the college level, according to William (2010), there are major concerns as the United States is losing technology and engineering leadership as compared to other countries. With advances in technology, STEAM careers are growing exponentially. It is important for teachers to integrate these skills into their classrooms from a young age to college in order to prepare students for future careers.

**Student Centered Learning**

STEAM education is more than just integrating the curriculum. It is the teachers job to set up a supportive learning environment for students to guide learning, take ownership of work and to collaborate as a team to solve problems. The teachers provide students with some information and facilitate the students to find out more. In this way, students learn both content knowledge and the skills of learning, so that they might become self-directed learners. The ultimate goal is to cultivate real, in-depth learning, not just the application of superficially acquired information. Students should also be learning problem solving as a team, not alone. But teamwork does not mean groupthink! Students can learn how to work with others to engage with different points of view held by their fellow learners. When it comes to problem solving, students need evidence, but they also need the freedom to interpret the evidence differently and to discuss why they think as they do according to Shirley and Tee Ng (2017).

**Self Regulated Learning**

STEAM can set the foundation for students to be self-regulated learners. Genevieve (2015) says these skills are not intrinsic. They need to be explicitly taught and modeled to students. Teachers should teach self-regulating skills where students set personal goals motivated by their own growth and gradually releasing control of learning over to the student. Scaffolding and modeling these skills will result in student commitment. Students will be simultaneously handling the components, hearing the terms, and experiencing the content, so learning becomes authentic, engaging and meaningful (Harper, 2017). We are still trying to understand what practices best teach these self-regulation skills but we do know modeling and teaching these skills through STEAM activities helps students to see how to apply these skills (Genevieve, 2015).

**Play**

The research is quite clear that the best practice in early childhood education is to break away from passive instruction and allow for more play and investigation, and this kind of learning early in life builds skills and interests that serve children throughout their school years, and later in life. Lilian G. Katz, in *STEM in the Early Years*, lays out a case that the best practice for early education is to allow students to be active, engaged, and take initiative in their own learning. Long-term research also indicates that being allowed opportunities to take initiative in your own learning is not only good for STEM learning, but for overall long-term academic success (Sneideman, 2013).

**Curriculum Integration**

There is much overlap between STEAM activities and problem based learning as they each set out to solve a problem. STEAM is intentionally integrating the areas of Science, Technology, Engineering, the Arts and Mathematics to help solve the given problem by using in-depth thinking across disciplines (Shirley & Tee Ng, 2017) and removing boundaries between educational subjects (Taljaard,2016). Quigley and Herro (2016) suggest teaching these subjects in isolation, may narrow students approaches when attempting to solve problems.

**Science**

In the matter of goals and objectives related to science, young children are likely to gain greatly in all four basic learning goals: (1) knowledge/understanding, (2) skills, (3) dispositions, and (4) feelings. These kinds of learning goals give children opportunities to engage in in-depth investigations of phenomena around them worthy of their knowledge and understanding. We refer to these investigations as projects. Projects are based on the classical procedures of science in that they begin with a set of questions about the phenomena of interest, proceed to predictions of possible answers to the questions, followed by the gathering of data that can be expected to answer the questions as predicted (Katz, 2010). A recent survey by Julia Torquati and colleagues found that early childhood educators are least confident about teaching nature/science. And a survey conducted by Julie Ernst found that 92% of Minnesota childcare teachers spend the majority of their outdoor playtime in maintained or developed play spaces, and no teachers reported using natural areas for the majority of their outdoor playtime. Early science teaching is not a priority in most preschool classrooms, and most teachers are not taking children out to play and explore in natural settings. We need to work together to change the status quo for our nation’s children. If the leading thinkers on education believe that our hopes for a vibrant democracy hinge upon a foundation of STEM education, then we need to be encouraging best practices in STEM from the get-go. One of the best practices in teaching and learning is to make learning relevant, and there is nothing more relevant than being outside and exploring the world we live in. Let's not wait another day to take young children outside to start engaging them in STEM education (Sneideman, 2013).

**Technology**

The Nation's Report Card (2012) defines technology as any invention designed to make our lives easier. Today, many students have been exposed to or own some type of technological device. The new digital technologies have become an essential way to disseminate the knowledge gained from problem-solving projects. It is not only important for educators to explore the possibilities afforded by these new technologies, it is also important for educators to humbly accept that today's students, as digital natives, often have skills that exceed their own. So, as we teach our young people to solve problems, let's also appreciate what our students have to teach us about new technologies and be keen to learn from them when their digital knowledge surpasses ours (Shirley & Tee Ng, 2017). In a study done by the ECAR Study of Undergraduate Student and Information Technology, Brooks, Pomerantz and Reeves (2016) found when students used their devices they were engaged, communicated peer to peer and felt their devices were important to their academic success. The study also found minorities had greater confidence in technology while women’s confidence (compared to men) when it comes to technology was much lower. By teaching technology skills through STEAM activities, we are able to break down socio-economic barriers and boost technology confidence in all students. The technology used should be to enhance the learning, not to take away or distract from the overall goal of the learning.

**Engineering**

According to a report from the National Academy of Engineering and the Board on Science Education at the Center for Education, engineering is “a systematic and often iterative approach to designing objects, processes, and systems to meet human needs and wants.” Through that prism, the importance of engineering is simple: there will be times throughout anyone’s life where they will have to make things work. They might be concrete, like tools and materials, or they may be more abstract. In terms of problem solving, engineering might be the most valuable of the STEAM subjects. With the focus on STEM and STEAM, it’s thought that bringing engineering into a classroom requires a lot of models, electronic components, and complicated toys. In early childhood education, that’s not only unfeasible—it’s probably dangerous. Instead, look anywhere in the room where the students might need to solve a problem, then have them think through a system to solve that problem (instead of just having them try things until something works). That systematic way of thinking is engineering. In this way, engineering becomes a mindset (Specialty, 2017).

**Arts**

The A (arts) in STEAM was later added from the original idea of STEAM. The arts … Katz (2010) provides an instructive reminder of the way to implement art with STEM. “In our preschool and kindergarten practices we are not caught between formal academic lessons or cutting and pasting ‘refrigerator art’ activities.”  While these have their places, they are often over utilized to the detriment of structuring art in ways that allow students to display their understanding or creative interpretation of what they have observed or what they are thinking.

**Career Opportunities and Readiness**

The United States is becoming less competitive in STEM field as compared to other countries (Taljaard, 2016). In 2003 only 4% of US college graduates majored in engineering, compares to 13% of European students and 20% of students in Asia. Today, engineering professions are working with technology teachers it infuse engineering concepts into the K-12 education in hopes of closing this gap (William, 2010). According to Hill, Corbett, & Rose, (2010) science, technology, engineering, and mathematics (STEM) are widely regarded as critical to the national economy. Concern about America’s ability to be competitive in the global economy has led to a number of calls to action to strengthen these fields. Kuenzl (2008) explains that the concern is that the United States is not preparing a sufficient number of students, teachers, and practitioners in the areas of science, technology, engineering, and mathematics (STEM). A large majority of our secondary school students fail to reach proficiency in math and science, and many are taught by teachers lacking adequate subject matter knowledge. When compared to other nations, the math and science achievement of U.S. pupils and the rate of STEM degree attainment are inconsistent with a nation considered the world leader in scientific innovation. Early Childhood Development (2017) states when looking at the future job market and considering the types of roles our future workforce will need to fill, STEAM education is of extreme value. Hill, Corbett, & Rose, (2010) add that the workforce projections for 2018 by the U.S. Department of Labor show that nine of the 10 fastest-growing occupations that require at least a bachelor’s degree will require a significant amount of scientific or mathematical training. Students from historically disadvantaged groups such as African American and Hispanic students, both female and male, are less likely to have access to advanced courses in math and science in high school, which negatively affects their ability to enter and successfully complete STEM majors in college.

**Conclusion and Questions for Future Studies**

When looking at the research we find how this paper reviewed the literature on the definition of STEAM and its importance in education, how STEAM is student centered and the benefits of student centered learning, how curriculum is integrated within STEAM, the ways in which STEAM prepares students for future careers and global competitiveness, and how teachers can implement STEAM education into their organizations. Because of the factors stated above and its possibilities we need to start implementing STEAM into our early childhood classrooms. Our classrooms need to provide the environment that allows students to enjoy their learning and get excited to have choice, ownership, and voice while engaging in authentic learning. Sneideman (2013) explains that our knowledge of how people learn has grown substantially over the last few decades. We now understand that success in learning requires the learner to be at the center of the experience, making connections across disciplines and also across contextual settings. Children need to be presented opportunities to learn the same material in different settings and through different lenses. The traditional approach of teaching topics in isolation does not support the ways that children learn best. If we want to stay competitive in the global economy then we need to start focusing on STEAM activities by getting students attracted and interested in these subjects at an early age when curiosity is embedded in a child. Langdon, McKittrick, Beede, Khan,& Doms (2011) add, the greatest advancement in our society from medicine to mechanics have come from the minds of those interested in or studied in the areas of STEAM. Although still relatively small in number, the STEAM workforce has an outsized impact on a nation’s competitiveness, economic growth, and overall standard of living. STEAM jobs are the jobs of the future. They are essential for developing our technological innovation and global competitiveness. Sneideman (2013) feels that we need to work together to change the status quo for our nation’s children. If the leading thinkers on education believe that our hopes for a vibrant democracy hinge upon a foundation of STEM education, then we need to be encouraging best practices in STEAM from the get-go. One of the best practices in teaching and learning is to make learning relevant, and there is nothing more relevant than being outside and exploring the world we live in. Let’s not wait another day to take young children outside to start engaging them in STEAM education.

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