NARRATIVE INQUIRY AS SELF-STUDY: EXPLORING THE CONNECTION BETWEEN INTRINSIC MOTIVATION AND STEAM EDUCATION

By

YUNO BOUNDS

A CAPSTONE PROJECT PRESENTED TO THE COLLEGE OF THE ARTS OF THE

UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

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ABSTRACT OF CAPSTONE PROJECT PRESENTED TO THE COLLEGE OF THE ARTS OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS

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Yuno Bounds

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Chair: Tracey Hunter-Doniger
Committee Member: Patrick Grigsby
Major: Art Education

Abstract

This paper describes my self-exploration of the connection between intrinsic motivation and STEAM education (the integrated learning of science, technology, engineering, art, and math). The strong emphasis on STEM education has moved our focus away from art education; however, art could be the key to creating intrinsic motivation that enhances students' total academic learning. First, the literature review addresses multiple views of STEAM education, different types of motivation, and challenges to implementing STEAM learning in schools. Second, using experiences at a museum that integrates STEAM education, I explored how STEAM activities were related to intrinsic motivation. This project used narrative self-study as a methodology derived from self-study and narrative inquiry. Narrative inquiry reveals many layers of submerged emotions from stories. I used narrative inquiry to conduct a self-study in which I recount my experience from the learners' perspective and analyze my emotions objectively. To achieve my goal, I first collected my experiences at the museum and compiled them in an ISSUU journal. The journal comprises two sections for each scene: external events and inner thoughts. From the recorded narratives, I asked myself what triggered my feelings and how they connected to intrinsic motivation. After this exploration, four interesting findings surfaced regarding the environment, autonomy, divergent thinking, and synergistic extrinsic motivation. Finally, based on my findings, I created a STEAM suggestion brochure that can be integrated into after-school programs and other learning environments in the local community.

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How My STEAM Journey Began

My journey to STEAM education began with my struggle to find meaning as an art educator. As a lifelong art lover, all I wanted was for my students to enjoy themselves in art class. I wanted students to create in the way their intrinsic motivation drove them to. However, some students disliked art, and I hesitated to push them to do it. Then questions arose within me; if I hesitate to teach art to students who are not interested in it, what am I doing as an art educator?

I started asking myself why I became an art lover in the first place. Then, I noticed that I didn't become an art lover because of art classes. Even before I reached school age, I found fun in creativity through everyday experiences. I spent most of my childhood with my great-grandpa and did DIY projects every day. In the fall, we picked up wood and sticks to build chairs and a table. We calculated, designed, made blueprints, and created. In summer, we went to the beach to explore seashells and picked up beach glass to make art. The fun of creation and learning naturally permeated me. So I wondered, why don't we break the boundaries of art and other subjects and bring students' daily lives into learning? Art class does not necessarily have to teach only painting skills or sculpting techniques. If students are interested in something else, we can build creativity into their interests.

While I was researching students' intrinsic motivation, I came across the mission of the Cade Museum for Creativity & Invention. Part of the Cade Museum's mission statement reads, "Rather than teaching subjects in isolation, unconnected to daily life, we teach and inspire through inventions, creating an interlocking tapestry of experiences" (The Cade Museum, n.d.). The statement resonated with me. It offered a way to introduce a variety of subjects through children's curiosity. I found out that The Cade Museum offers interactive exhibits and programs using STEAM education, which sparks intrinsic learning. STEAM education connects science, technology, engineering, art, and math to create knowledge as a whole (Quigley & Herro, 2019). From that discovery, I gained a desire to explore STEAM education and its association with intrinsic learning further.

Statement of the Problem

Research affirms that STEAM education aids in improving students' overall academic performance (Cofield, 2017; Conradty et al., 2020; Henriksen, 2014; Needles, 2020). Integrating art can boost confidence for students lagging academically with STEM subjects, thus bolstering STEAM performance and beyond (Cofield, 2017). Confidence and self-efficacy are essential components of gaining intrinsic motivation. Benabou & Tirole (2001) state, "Confidence in his abilities and efficacy can help the individual undertake more ambitious goals and persist in the face of adversity" (p.2), and "higher self-confidence enhances the motivation to act" (p.2). While many educators agree that art education is an essential component of a well-rounded education, art education in American public schools is decreasing (Franklin, 2021). Cofield (2017) states that "the emphasis on STEM curriculum is encouraging a neglect of the arts, a field of study which might be exactly the compliment needed for successful STEM performance" (p.190). Art brings joy to STEM learning. Conradty et al. (2020) emphasize the vital need for the younger generation to achieve flexibility and joy in experimenting. Furthermore, a limited focus on art education can underserve students' design thinking and creative thinking and limit the potential of visual learners.

While the need for STEAM education is increasing, teachers in public schools are in a difficult situation. School teachers in the United States struggle with having limited time, space, funds, and administrative approval to learn and implement new strategies (Downey, Delamatre, & Jones, 2007). Cofield (2017) affirms, "Without the institutional support, it seems that it is a

Herculean task to educate oneself about the STEAM approach while managing a full-time job" (p. 339). Therefore, rather than add more responsibilities to public school teachers' roles, I chose to explore ways to incorporate STEAM education in local communities to encourage students' intrinsic motivation and help integrate the community into raising students.

Purpose of the Study

This study aims to explore the connection between intrinsic motivation and STEAM education and how STEAM can be integrated into the community to encourage students' learning. The community can act as a bridge between schools and students. Places and opportunities for students to connect their academic learning to real-life situations are essential. My goal is to utilize my findings to create a STEAM education suggestion guide for after-school programs that is adjustable for other nontraditional educational settings. I worked at an after-school program for more than eight years, and I believe there is space for STEAM education in these learning environments. Therefore, I sought to create an effective guide on how to plan and implement STEAM principles to help both teachers and students.

Research Questions

This study was conducted to find answers to these research questions.

1. How does a local Florida museum incorporate STEAM education for school-age children?
2. How does STEAM education relate to children's intrinsic motivation?
3. How can STEAM strategies be used in non-traditional educational settings in a community to help both educators and students?

Rationale and Significance of the Study

Art plays an essential role in STEAM education. In other words, art is a critical component in learning other subjects and vice versa. Although our society greatly emphasizes STEM education, we should not ignore art's role behind the scenes. Educators need to know that liberal arts are necessary for students' total academic growth and healthy thinking. Henriksen (2014) found that arts-based teaching leads to more motivated, engaged, and effective learning in STEM areas. Although STEAM education is essential to enhancing students' learning, developing an effective STEAM strategy is challenging. I believe that it is beneficial to learn from a facility that successfully implements STEAM education. This allows me to examine, analyze, and interpret STEAM strategies and how they can be used in other community settings to help both educators and students across the community.

Assumptions

This research is conducted on the belief that STEAM education enhances students' intrinsic motivation and that STEAM and intrinsic motivation are related. I assumed that the museum had methods of development for STEAM learning and identifiable success factors. I also believed that docents are trained to lead visitors' STEAM experiences to their full capacity. I assumed that non-traditional learning environments could contribute to motivating students' learning. Littleton (1993) states that an increasing number of museums, zoos, historic houses, and nature centers use their states' curriculum guides to help plan relevant school programs. Because of this, schoolteachers look to these facilities when planning field trips.

Limitations

Studies on STEAM education affirm that students in this century benefit from STEAM education. Although exploring ways to integrate STEAM education in public schools may be worthwhile, shifting the public school curriculum beyond the scope of this study. Instead, this research focuses on the STEAM strategies used in the Cade Museum and seeks possible ways to utilize them in after-school learning.

This self-study is based on my narratives and some reactions from my children; therefore, it does not rely on a large sample. Additionally, this narrative focuses on a specific museum that integrates STEAM strategies in its exhibits and curriculum; not all museums are structured in this way. Therefore, this study may not be generalizable to experiences in other museums.

Definition of Terms

The following terms are used throughout this paper:

STEM. STEM is recognized as a way to bridge the discrete disciplines of science, technology, engineering, and mathematics by using applications or processes from each to create knowledge as a whole (Morrison, as cited in Quigley & Herro, 2019, p.273).

STEAM. STEAM has an “A” for “art” added to STEM. It is an acronym for science, technology, engineering, art, and math. STEAM started gaining attention around 2012 in the United States, and the “A” represents the arts and liberal arts, such as humanities and social studies (Quigley & Herro, 2019). Instead of teaching subjects in isolation, STEAM education approaches problems from multifaceted perspectives and integrates art.

STEAM strategy. STEAM strategy is a plan of action to include STEAM in children’s daily lives. I use the word “strategy” instead of “curriculum” because I plan to include STEAM more naturally into children’s lives outside of traditional teaching.

Place-based education. Place-based education is designed to connect what students are taught in school to real-world challenges, opportunities, and connections. Learning experiences are designed to match real-life complexities and students are guided through an integrated, interdisciplinary, and frequently project-based approach in which all learners are accountable and challenged (Teton Science School, n.d.)

Intrinsic Motivation. It is the internal drive to do activities to satisfy one's internal rewards. It involves an interest in or enjoyment of the activity itself.

Autonomy. It refers to the capacity to control oneself and act spontaneously based on one's visions and decisions.

Divergent Thinking. It is a thought process to think there could be a range of different types of solutions to a problem (Heilman & Miles, 2020).

Synergistic Extrinsic Motivators. They are motivators from outside sources that work together with intrinsic motivations, such as peer encouragement (Jaquith, 2011).

Literature Review

This literature review supports the importance of art in STEAM education and the relationship between intrinsic motivation and STEAM and seeks how to build effective STEAM strategies in communities. Art and the humanities strengthen learning skills by enhancing students' intrinsic motivation and bringing positive feelings into the STEM field. "Individuals need to perceive themselves as capable of coping with unknown situations and problems instead of becoming stressed and experiencing anxiety" (Conradty et al., 2020, p.2). Our feelings and intricate emotions are the core of what makes us human, and they play essential roles in students' total academic growth and healthy thinking. Unfortunately, the strong emphasis on STEM in our society has resulted in a narrow arts education focus in schools. While STEAM education offers many benefits, challenges arise in shifting from STEM to STEAM learning. This literature review examines the benefits and challenges of STEAM education, the connection between motivation and STEAM, and practical ways STEAM education can be integrated into communities.

What is STEAM? Why add the A to STEM?

STEAM started gaining attention around 2012 in the United States. The "A" in STEAM represents the arts and liberal arts, such as the humanities and social studies (Quigley & Herro, 2019). STEM has been under the spotlight in the education field for quite some time; however, 21st-century society needs creativity to bring STEM capacities to their highest potential. STEM curricula are expected to benefit from integrating arts or creative aspects, which foster the discovery of creative solutions (Conradty et al., 2020). Art stems from creativity, expression, and emotions and is more than simply drawing and creating. Instead of teaching subjects in isolation, STEAM education approaches problems from multifaceted perspectives. Hunter-Doniger (2020) states, "With the addition of art to STEM subjects, creative problem solving and design thinking can take root" (p.1). Design thinking allows us to see things from different perspectives, such as considering the usability of a solution through the user's eyes.

Needles (2020) explains that the beginning of design thinking is like the scientific process, which involves observing and exploring the situation to develop understanding. However, design thinking explicitly involves empathy (Needles, 2020). This is where imagination, creativity, and humanities are needed. A designer imagines the user's world and thinks about why a certain design matters to them. Art is a human skill that is used to communicate with others on an emotional level. Steve Jobs, the co-founder of Apple Computers, once said, "Technology alone is not enough—it's technology married with liberal arts, married with the humanities, that yields us the results that make our heart sing" (Lehrer, 2011). The "A" in STEAM brings a critical component of what makes us human into the world of STEM.

Intrinsic Motivation

Art and humanity deal with intricate feelings and emotions. One of the essential feelings for positive learning is motivation. There are different types of motivation. Jaquith (2011) explains three different types of motivation: intrinsic motivation, extrinsic motivation, and synergistic extrinsic motivators. Intrinsic motivation comes from the inner self, and extrinsic motivation is motivation based on outside sources. Below are examples of intrinsic and extrinsic motivators.

Intrinsic motivators	Extrinsic motivators
• Interest • Involvement • Curiosity • Satisfaction • Positive challenges	• Expected evaluation • Contracted-for reward • External directives • Any of several similar sources (synergistic extrinsic motivators)

*List created from Amabile, as cited in Jaquith (2011, p.15).

Conradty et al. (2020) insist that interest is one of the most important intrinsic motivational factors for learning. Jaquith (2011) states that intrinsic motivation activates creativity and further claims that intrinsic motivations, such as students' interest and curiosity, are central to creative problem-finding and solving. As mentioned previously, creative problem-finding and solving are the core contributions art makes in STEAM education. This suggests that students' intrinsic motivation is innately related to the vital aspects of art in STEAM education, thus enhancing students' total academic success. When students are intrinsically motivated and their environments allow them to be self-directed, they challenge themselves to take risks and tackle problems that have no particular answers (Jaquith, 2011).

While intrinsic motivation drives students to challenge themselves, Jaquith (2011) warns that extrinsic motivation can hinder creativity. Extrinsic motivators may increase temporary, quick results, but learners may not continue to explore independently after achieving extrinsic rewards. However, synergistic extrinsic motivators could be used positively to help students' learning process. For example, Collins and Amabile (as cited in Jaquith, 2011) explain that synergistic extrinsic motivators, such as peer support or a desirable exhibition opportunity, integrate with intrinsic motivations to help students complete less exciting parts of the primary process.

Creative and Innovative Minds

To think outside the box, one needs an open mind, and to approach problems in new ways, imagination and creativity are required. Proponents of STEAM argue that art is an essential component of innovation. It provides engaging, different ways to view the world and connects math and science with real-world applications (Wynn & Harris, cited in Quigley & Herro, 2019). However, Owan and Nagaoka (2011) state that, for inventors, "Intrinsic motivation may stimulate creativity by supporting more challenging exploratory work while extrinsic rewards could suffocate creativity by drawing researchers' attention to more incremental approaches" (p.3). Conversely, extrinsic motivators do not enhance further exploration.

Intrinsic motivation and endless imagination drove inventors to explore further into uncharted areas. For example, Maria Sibylla Merian, a 17th-century scientific illustrator, and Dr. Cade, the inventor of Gatorade and the museum's namesake, both believed that the creative drive for innovative experiments comes from the power of imagination and the artistic mind (Nai & Meyer, 2016; The Cade Museum, n.d.). Additionally, Max Planck, the father of quantum theory, commented that pioneer scientists must have "a vivid intuitive imagination, for new ideas are not generated by deduction, but by artistically creative imagination" (Henriksen, 2014, p.1). Likewise, I believe that exposure to diverse fields and artistic views helps open one's mind and generate new questions about ordinary phenomena.

In his interview at the Kyoto STEAM International Art Competition, the scientist Kenjiro Ishi summarizes his experience by saying that it's merely a world under the microscope that scientists look at every day, but when artists make creations based on that view, many new "what-if" questions arise (Mori, 2021). Furthermore, Ishii continued, artists do unexpected things that scientists never think of doing. Their unexpected ideas give scientists further questions to explore and motivate them to engage in new experiments (Mori, 2021). If children were to have both artistic and scientific minds, their potential could become endless.

Taking Down the Subject Walls

One aim of using STEAM education is to use its approaches as bridges between subject areas. Henriksen (2014) says that breaking down the distinction between disciplines such as arts and music as creative and STEM subjects as more rigid or logical is needed to foster the future of innovative thinking. While many students excel in subjects they enjoy, some develop resistance to specific subjects. Many educators have heard students say, "I'm not an artist" or "I'm not into math." This self-labeling decreases students' intrinsic motivation to study further and, thus, hinders a student's potential in their less-preferred areas of study (Needles, 2020). Conradty et al. (2020) explain that STEM subjects are often regarded as stressful and sometimes produce anxiety; thus, they may generate feelings of discomfort. These negative emotions might prevent students from using their full potential and result in negative attitudes toward STEM subjects. Needles (2020) insist that many academic subjects address misconceptions, fears, and resistance, but the interdisciplinary nature of STEAM makes it a compelling means to address these challenges. The following are several theories on how students develop resistance to specific subjects.

First, students' resistance may come from learned helplessness. This is a behavior in which people believe a situation is unchangeable after repeatedly receiving negative stimuli (Peterson, Maier, & Seligman, 1996). In this case, receiving low scores on math or science tests or being over-criticized in art may lead students to conclude that they are not good enough, and they tend to give up on the subject. STEAM education can prevent this behavior by focusing on the process of learning instead of the outcome. Often, students' progress is recorded instead of graded in STEAM learning, and making mistakes is welcomed as an essential part of learning. Tully (2009) argues that success is in the doing, and failures should be celebrated and analyzed as part of the learning process. Furthermore, STEAM education can reduce students' fear of learning in their weaker subjects by showing them how interrelated different subjects are.

The second theory of learning resistance is the concept of a fixed mindset. A fixed mindset comes from a student's belief that it is just the nature of their intelligence that they are not good at something (Dweck, 2016). Some people may wonder why certain students believe they are naturally not good at something. Cofield (2017) addresses this by pointing out that people may have misinterpreted some discoveries of brain processes over time. One example is the well-known theory of hemisphere dominance. The left brain is associated with logical processes and verbal control; the right brain is aligned with visual and creative thinking. This theory may be misinterpreted as suggesting that people are either left-brained, logical, and scientific or right-brained, creative, and artistic. This may build a wall between these categories. However, Dr. Stanislas Dehaene revealed that while these two brain hemispheres do have different processes, they must work together for both sides to be effective (Cofield, 2017).

Therefore, if educators wish students to advance logically, it is best to stimulate both hemispheres. Dr. Braian Wandell (as cited in Cofield, 2017, p.195) presented data suggesting that studying various art forms was positively correlated with their reading and mathematics skills development rates. Students benefit most when logical and creative content is offered as an interdisciplinary mixture.

Challenges of STEAM Curriculum in Public Schools

Despite the importance of STEAM learning, there are obstacles to implementing effective STEAM education in public schools. Meeting standardized testing expectations is still emphasized in schools, reducing the time available for exploration both for teachers and students. Quigley and Herro (2019) claim that STEAM proponents are not in agreement about what constitutes STEAM, and there is a need to support effective STEAM teaching and implementation practice. Quigley and Herro (2019) also point out that many schools worldwide are shifting their focus to include STEAM education without understanding how to support teachers in this structure. For instance, Japan became a strongly academic-focused country after World War II. However, the pressures of achieving high scores on tests and being successful in school increased students' depression rates (Kawahata, Kiro, & Kikuchi, 2011). In 1972, to help students' mental health, the Japanese government decreased academic hours in public schools, and in 1998, they incorporated integrated learning into all public schools (Kawahata et al., 2011). Integrated learning shares the same concepts as STEAM learning, aiming to increase students' self-directed abilities, autonomy, creativity, and humanities skills through life-related instruction. However, against expectations, students' academic ability decreased alongside their effort toward learning. Kawahata et al. (2011) anticipated that without having standards or training for teachers on implementing integrated learning, both teachers and students were unable to understand the core goals of integrated learning (Kawahata et al., 2011). In response, the Minister of Education in Japan incorporated the teaching methods for integrated study as a requirement for teachers' certification in 2019. Research tells us that integrated learning, such as STEAM strategies, requires institutional support, resources, and educator training for instruction to be effective. In current school structures, many teachers struggle with a lack of funding, support, or time to develop arts-integrated lessons (Cofield, 2017). Incorporating STEAM learning in all schools may be an ultimate goal, but it currently faces many challenges.

STEAM Education in Museums and Communities

With rising interest in STEAM education, some museums have incorporated STEAM concepts into their curricula, including the Boston Children's Museum (Boston Children's Museum, 1970), the Museum of Arts and Sciences (MOAS, n.d.), and the Cade Museum for Creativity & Invention (Cade Museum, n.d.). If shifting the school system to adopt a STEAM curriculum is challenging, collaborating with local museums and other community settings offers a great way to connect students' learning. London (1994, p4.) writes that "community is the web of life that inextricably embraces, defines, and empowers children and adult-like." Therefore, community-wide contributions to raising students should help both students and teachers. Littleton (1993) affirms that when school curriculum is combined with museum reality, it yields powerful programs. Many museums are starting to use their state's curriculum guides to create school-relevant programs (Littleton, 1993). In this way, students learn fundamental academics in schools, and museums can offer fun STEAM activities that align with the state's curriculum and apply to real-life situations. London (1994) states, "Using the school as its base of operations, community-based art education forays out into the community for its motivation and its subject matter" (p.4). When students find their intrinsic motivation through museum STEAM activities, their learning attitude in schools may also improve.

STEAM Curriculum-Building

How can we build an effective STEAM curriculum? Creating STEAM curriculums is not a simple task; however, more communities and educators have begun embracing STEAM curricula as a more creative and appealing way to engage learners (Quigley & Herro, 2019). For example, Tulley (2009), the co-founder of the Tinkering School, argues that instead of raising another generation of children who are good at taking tests, we need to raise children who see the world's tough problems as puzzles and have the creative ability to solve them. Learner-centered approaches and inquiry-based learning are two ways to integrate creativity into problem-solving.

Learner-centered approaches help to promote children's self-directing abilities. The learner-centered approach is based on the belief that students should construct knowledge for themselves instead of teachers giving knowledge to learners (Delacruz, 2019). This is important because the learner-centered approach allows students to become problem-finders, problem-solvers, and good thinkers, by encouraging their curiosity and creativity to flourish. Jaquith (2011) states, "Autonomy empowers young artists in their creative inquiry. When children are permitted to self-direct their learning, control shifts from teacher to the learner" (p.17). This is important because it teaches learners to believe that their ideas matter and they are trusted to take ownership of their learning. Hunter-Doniger (2020) states, "To shape effective future leaders; we need to teach our students how to be autonomous and that their ideas matter" (p.41). Students with autonomy are motivated and can find joy in their learning. Learners solve problems and act as problem-finders when they identify challenges based on their interests (Jaquith, 2011). I believe that students' intrinsic motivation and autonomy are the keys to successful learning. The moment students feel that they want to learn more about a specific matter is the best time to engage them in an activity, and children get the most out of such activities. Learner-centered approaches can include inquiry-based learning (IBL) and project-based learning (PBL).

Needles (2020) explains that inquiry-based learning focuses on discovering the answer, and project-based learning explores the concept and creates to arrive at an answer. Needles (2020) explains, "The role of educator shifts: the traditional emphasis on facts and memorization is replaced with discussion and exploration. This type of learning can help foster curiosity while offering students the chance to take ownership of their learning" (p.10). Inquiry-based learning and project-based learning align well with STEAM education because they allow learners to explore different perspectives regarding their interests. Additionally, to increase creativity in learning, Needles (2020) suggests adding more limitations. Limited resources force learners to find more creative solutions (Needles, 2020). The limitation-based approach also helps in real-world situations when only specific resources are available to solve problems.

Research Method

This study applies a qualitative design. A qualitative research study uses words to describe details of the setting instead of numbers (Hancock & Algozzine, 2016). Within the umbrella of qualitative research, I decided to employ narrative self-study, a combination of self-study and narrative inquiry. Self-study is characterized by its focus on one's own practice and one's role in it; it entails looking more deeply to identify motivations, beliefs, and concerns around an aspect of practice (Hernández-Serrano, 2021). As an educator, I realized that STEAM education would be an excellent aid for enhancing students' learning, and I am motivated to explore effective STEAM strategies to enhance after-school learning. LaBoskey (2004) states that self-study should be self-initiated and have an aim for improvement. This study is self-initiated because it comes from my intrinsic interest in better understanding the effective use of STEAM strategies and exploring ways to integrate them into local community settings. Self-study also aims to enhance the quality of practice by opening up the results of the self-study to the public and contributing to others' knowledge (Vanassche & Keltchermans, 2015). My hope for this study is to become an excellent resource for those who intend to integrate STEAM education into learning and offer more intrinsic teaching methods to after-school students.

As my method for self-study, I decided to employ narrative inquiry. Narrative inquiry is the study of the ways humans understand the world (Connelly & Clandinin,1990), and it reveals many layers of submerged emotions from stories. The local museum's STEAM education inspired me to realize how motivating it is to learn through life experiences. "Narrative inquiry uses stories to understand social patterns" (Duquesne University, 2022, para. 1); "in identifying the tensions among and within stories, researchers analyze and interpret data in a rich way" (Clandinin & Murphy, as cited in Buffinton & Wilson, p.39). These methods aligned with my purpose to share my experiences at the museum in story form and interpret them. I recounted my experience from the learner's perspective and analyzed my emotions objectively. Then, I captured and made sense of my experience there, reflected on myself, analyzed, and defined my new findings.

Subjects and Research Site

As I have elected a self-study, I am the main research participant. The main subject in my study is STEAM strategies. My narrative story focuses on my experiences at a local museum located in downtown Gainesville, Florida. The hands-on, interactive exhibits focused on STEAM education for school-age children. The museum believes in creativity, and it seeks to inspire future inventors. Although my research subject is STEAM strategies; to gain a holistic view of approaches, my study includes casual conversations with staff members and my children's reactions.

Data Collection

For data collection, I recorded my memories of and experiences at the museum. I also collected brochures, photographs, and articles about the museum. Informal conversations with docents during my visits were noted in my journal. Although my narrative story focuses on my experiences at one location, the museum's exhibit changes every three to four months. Therefore, to capture several examples, the story includes my family's visits to the museum throughout 2021. It is a cumulative narrative of my five trips to the museum, including past visits. I also collected information from the museum's website and narratives about the museum gathered from different sources.

Data Analysis Procedures

I employed coding to seek convergence and corroboration of all of my findings and analyze them. Coding is used to systematically identify and categorize specific observable actions or characteristics that allow textual data to be searched through (Colorado State University, n.d.). First, to visualize whether activities were intrinsically motivated, I put color stickers on each story. Each sticker indicated different intrinsic motivators: interest, involvement, curiosity, satisfaction, positive challenges, or encouragement. Then, I converted the raw data into a chart. Next, I incorporated one of the methods suggested by Miles and Huberman (1994 as cited in Yin, 2003, p.111), "Making a matrix of categories and placing the evidence within such categories." I categorized the gathered narratives according to four aspects: (a) environment, (b) flow, (c) divergent thinking, and (d) synergistic extrinsic motivators. Finally, together with my findings, I used document analysis to develop my suggestions. Document analysis is a systematic procedure for reviewing or evaluating both printed and electronic documents (Bowen, 2009, p.27). I then placed the data into the categories to analyze the factors from each perspective. All accumulated information during the study was synthesized to identify aspects of effective STEAM strategies used in the museum for school-age children, and then I utilized the factors to create STEAM suggestion brochures for after-school programs.

Documentation

To visually document my collected narrative stories about the Cade Museum, I compiled my experiences into an ISSUU journal that is also available as a PDF on my website. To reveal my deeper thoughts on each event, I started by writing about the event looking outward, followed by my inner response while observing the event (see Appendix A). Along with my narrative stories, the journal includes photographs that go with each one. It can be found as an ISSUU journal at https://issuu.com/yuno.b/docs/steam_inner_response.pptx, and the PDF version can be found http://yuzu.site/?p=4529

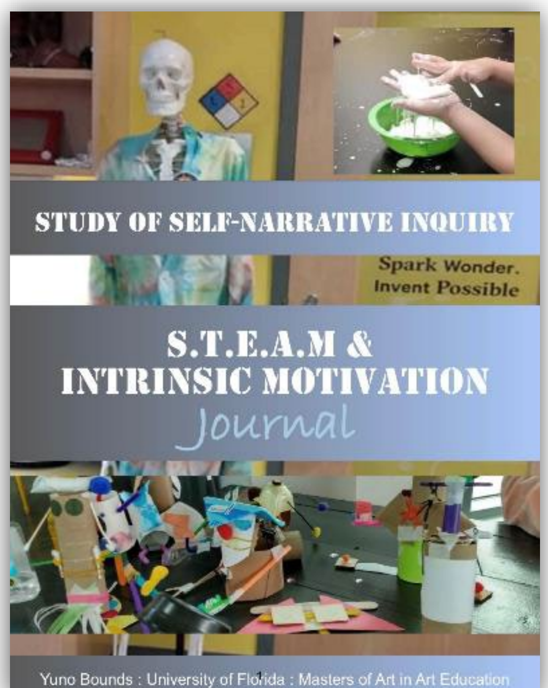


Figure 1. Journal book cover (ISSUU/PDF)

Findings

This study aimed to discover the role art plays in STEAM and how it connects to intrinsic motivation. While our society emphasizes a STEM curriculum, I saw the importance of arts that bring joy to learning. Knowledge is important, but the intrinsic desire to know more is essential for learning. First of all, to visualize whether the activities I observed were intrinsically motivated, I assigned colors to intrinsic motivators and put colored stickers on each scene in my journal. I used five intrinsic motivators mentioned in the literature: interest (yellow), involvement (green), curiosity (orange), satisfaction (blue), and positive challenges (red), and added encouragement (pink) as a synergistic extrinsic motivator. Interest is the most critical intrinsic motivational factor for learning (Conradty et al., 2020), and all 22 scenes in my journal featured interest. In total, 17 out of 22 scenes featured all six intrinsic motivators. I created the chart below to record the number of scenes in which each motivator appeared.

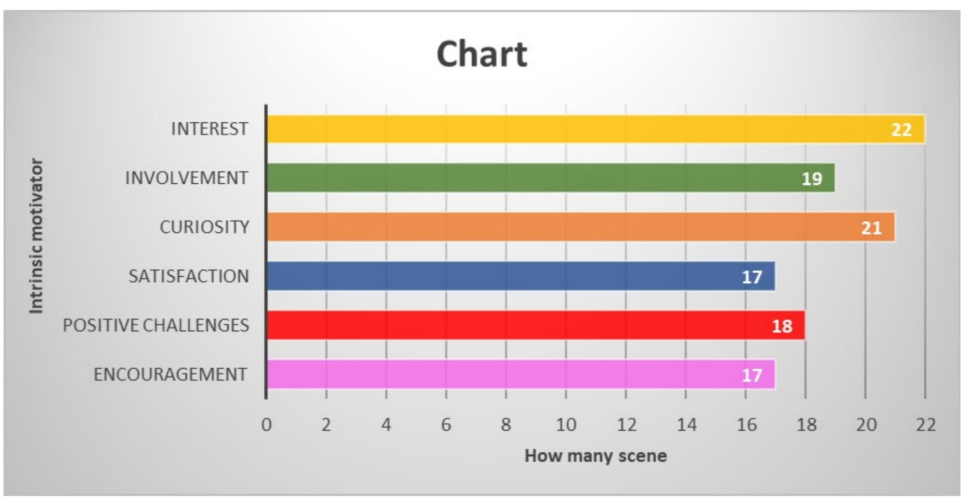


Figure 2. The number of scenes featuring each intrinsic motivator

After confirming that STEAM activities were intrinsically motivated, I went on to my core question: Why are they motivating? What are the connections between STEAM and intrinsic motivation? By breaking down my experience at the museum into pieces, investigating more deeply, and putting related pieces together, I was able to reveal answers to my question. Four of my essential findings related to intrinsic motivation were environment, autonomy, divergent thinking, and synergistic extrinsic motivators.

An Environment that Promotes Intrinsic Motivation

The first finding from the study was that the environment plays a significant role in stimulating intrinsic motivation. All scenes noted in my journal were immediately visually stimulating, and visitor activities were all hands-on. A docent explained that the beauty of this museum is that visitors get to touch and play with the living exhibition, unlike most museums with signs reading “please do not touch.” Learning the world through whole body senses and feeling the “wow” moment have been essential life components for me, and the Cade Museum made these moments possible. In the journal, I noted,

> When I entered the Cade Museum, I saw many children participating in hands-on activities, and I heard their surprised voices, and endless questions flying past such as, “How does this work?” “Wow, what is this?” “Why does it do that ?!” The main lobby, called the Rotunda, had 55-foot ceilings and was filled with children’s wonder and beautiful light from the skylight above (Scene 1: Entering the Museum, p.5).
>
> …The first thing I noticed in the Rotunda was numerous polygons and shapes that could be constructed into 3D forms. A sign that read “The Ways We Play: Building Blocks” explained that toys and games that let you think and build could turn the play into an invention. The sign stated: “Like the cardboard pieces in PolyCade, the Cade Museum’s architecture is based on an ancient mathematical pattern called a Fibonacci sequence.” This made me look up at the ceiling of the museum. I felt that this activity was well-thought-out. While visitors play and build with shapes, they are educated about the museum’s architectural design and the mathematical sequence behind it. They connected the activity to real-life learning and explained how it could be used and integrated into our lives. I felt that helping children understand how math is used in our daily lives is a great way to teach them that math is more than doing drills at school (Scene 3: Polygons, p.8).

Figure 3. Rotunda and PolyCades

As soon as I entered the museum, I felt vibrant creative energy. With the open space full of activities and light shining down from the beautiful skylight, the atmosphere instantly attracted me. Then, the activity with PolyCades and the connection to the building intrinsically motivated me to study the building more. I learned that the Cade Museum's design stemmed from a metaphor for the human brain because the brain is where experiences are reformulated to create new ideas that, in turn, influence others (GWWO architects, n.d.). As the design discussion continued, the designers were intrigued by the Fibonacci sequence and the Golden Spiral and their occurrence in nature and science. Then, these concepts were intertwined into the form and story of the Cade Museum. The rotunda was designed as the main hall to bring all of the museum experiences together (GWWO architects, n.d.).

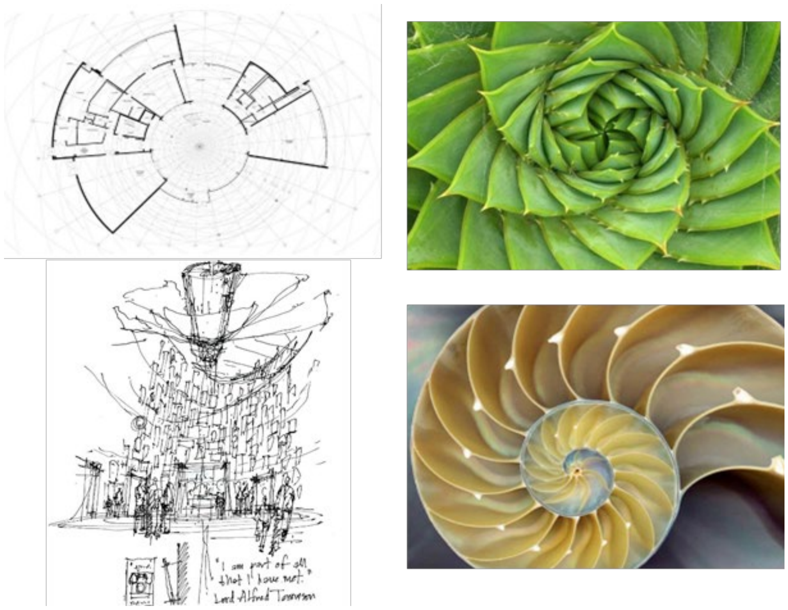


Figure 4. Fibonacci sequence and the floor plan (GWWO architects, n.d.)

The attractiveness of the building was derived from a sequence that occurred in nature and science. Furthermore, the designers' passion for drawing on creative ideas was reflected in the design process. An environment that holds passion and meaning inspires us. The Reggio Emilia approach shares a similar vision, referring to the environment as an educator (Strong-Wilson & Ellis, 2007). The environment is much more than just how it looks; the important aspect is how it feels from children's perspectives. For example, educators might place furniture, toys, or materials in unexpected ways to spark discussion (Strong-Wilson & Ellis, 2007). The Cade Museum placed many activities in the way to spark motivation to learn more. For example, in the journal, I noted,

> The museum's bathroom walls were decorated with the history of toilet-related inventions. When I went to wash my hands, I noticed that the mirrors were decorated with the history of soap inventions and an explanation of how soap works. The museum also has a website for home activities that use soap. On the day I was there, the museum had invited a guest speaker who invented toilet steps, and my children were able to talk to

> the inventor and try his invention. It was an innovative idea to use the bathroom as part of the exhibit. I have never seen an exhibit extend into the bathroom, but if we aim to connect children's learning to real life, it seems only natural to use the bathroom as a place to learn about toilet-related inventions. I loved that they informed me how soap works while I was washing my hands—it was a great time to learn about the chemistry of soap. I was also impressed that they offered home activities related to soap that children could do at home; this will encourage visitors to bring fun learning into their own homes (Scene 3: Toilet & Guest Speaker, p.31-32).

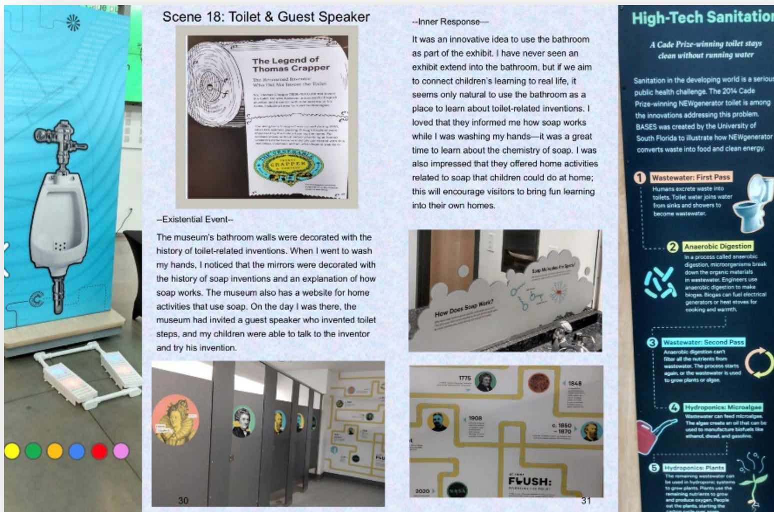


Figure 5. Exhibit in the bathroom, spread from the accompanying capstone journal

The exhibit in the bathroom was unexpected, and it caught my attention right away. Since I was in the bathroom, learning about toilet history, invention, and how soap works came naturally. To stimulate the intrinsic motivation of learning, being in the right place at the right moment was an effective way to make the learning experience memorable. Moreover, having a guest speaker who invented the toilet steps made the experience more engaging; it was inspiring to be able to talk to the inventor. The environment plays a prominent role in how children perceive and use space to create meaning (Strong-Wilson & Ellis, 2007). STEAM education turns an ordinary environment into an intrinsically motivating and meaningful environment that sparks a new discussion.

Free Area and Time for Incubation

The free area was another environment and activity that stimulated visitors' intrinsic motivation. Children need to have a safe space where they are trusted to do what their inner drive inspires them to do. Csikszentmihalyi (2007) states, "If too few opportunities for curiosity are available if too many obstacles are placed in the way of risk and exploration, the motivation to engage in creative behavior is easily extinguished" (p.11). Children's natural art abilities unfold when adults provide materials and a good environment. Adult intervention can hinder the unfolding of younger children's innate creative abilities (Zimmerman & Zimmerman, 2000). While many activities had some instructions at the Cade Museum, some areas were designed for complete free play. In the journal, I noted,

> The museum had free areas with thread and fabric activities, blocks, and engineering. I got to feel different kinds of fabrics, weave threads through holes on the wall to create a picture, and make patterns with square fabrics. My children were especially interested in the blocks and engineering. My son stacked wooden blocks straight up and soon found out that they were not stable. He started to intersect blocks to make the stack more durable. My daughter and some other children worked on a building together, creating a house. A docent told me that children became little inventors when left alone in a free area with all these materials…Children can always find ways to use the simplest of materials. When adults decide on specific times and activities for children, we may be limiting their creativity and potential (Scene 17: Free Area – Blocks and Engineering, p.29).

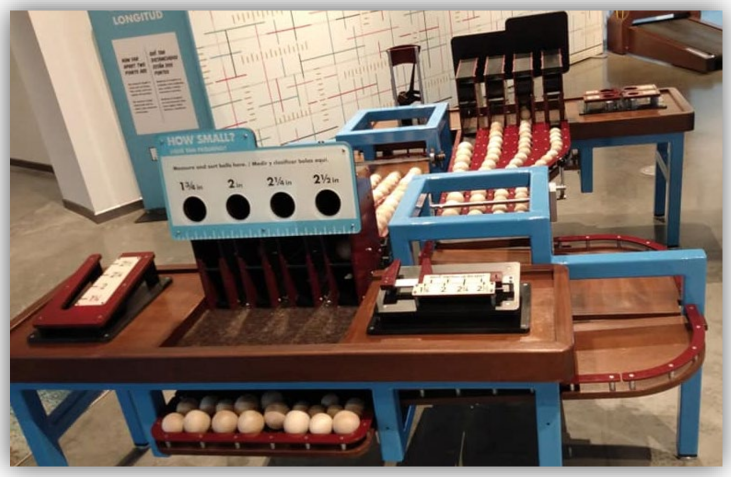
Strong-Wilson and Ellis (2007) mention that "from a child's point of view, an environment is what the child can make of it. Children will often find uses for objects and spaces that adults do not anticipate or intend" (p.43). By providing an environment that provokes further discussion and curiosity, educators expect the unexpected (Strong-Wilson & Ellis, 2007). Therefore, instead of giving step-by-step instruction, educators can promote children's learning by creating an ideal environment for them to explore, learn, and create freely. STEAM invites opportunities and materials from various sources, and thus, children can easily find activities that are intrinsically motivating to them.

I also noticed that time in a free area sometimes works as incubation time to process our thoughts while relaxing. Simply stacking blocks or doodling on paper can deemphasize the current focus and bring us to a relaxed state of mind. Looking at history, many inventors came up with creative ideas in relaxing moments. For example, Einstein came up with most of his theories late at night when it was tranquil. Archimedes, who described the concept of buoyancy, was taking a bath when the concept arose (Heilman & Miles, 2020). Also, Tulley (2009), the founder of the Tinkering School, found that when children face difficult setbacks or complexities on their projects, a behavior of "decoration" emerges. Tulley (2009) explains that decorating an unfinished project is a kind of conceptual incubation. From these interludes come deep insights and amazing new approaches to solving the problems that had frustrated the creator just moments before (Tully, 2009). STEAM involves sophisticated ideas that overlap many subjects; providing a free area where children can relax and refresh their minds helps them to conceptualize their thoughts.

STEAM Increases Autonomy

STEAM activities focus on children's interests, increasing their autonomy. Jaquith (2011) stated that learners who have educational autonomy and are in control of their own learning solve problems through intrinsic motivation. The moment children feel they want to know more about a specific matter, it is the best time to engage them in the activity and children get the most out of it. Referring to my journal book, I noted,

> … My five-year-old son tried the activity of putting balls into the right-sized holes—only the correct-sized ball would fit into the correct hole to roll down the trails. My son put balls into the holes randomly, and the balls kept coming back. He tried for a while, and he did not want to leave the activity, so I moved on to the weighing activity, which challenged visitors to match the weight of pumpkins with other objects. When I returned to my son, he was still throwing the balls in the holes, but now he knew precisely which ball was 1¾ inch, 2 inches, 2¼ inch, and 2½ inch… I felt like these activities made numbers more tangible, as my son could experience them through hands-on interaction. In the end, I was surprised that my son was able to tell me the size of each ball by just looking at and touching them (Scene 12: Measurement Rules, p.22).



(*Figure 6.* The ball activity in the Measurement Rules exhibit)

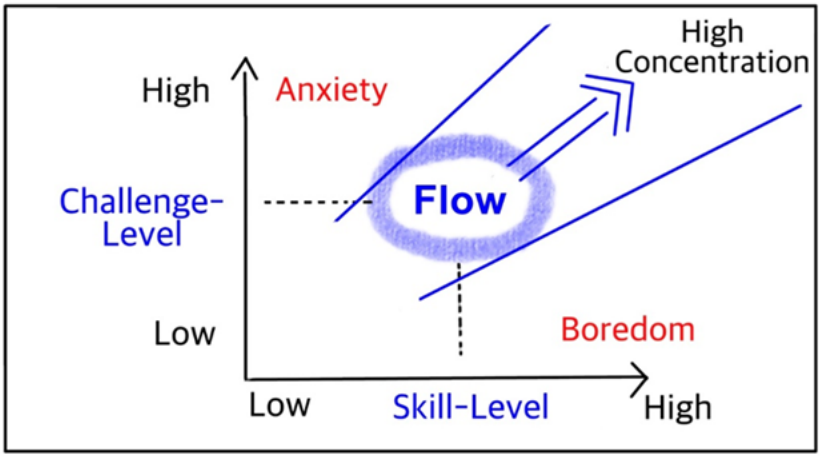
The average attention span of 5 years old is 10 to 15 minutes (Normal Attention Span, n.d.). However, he spontaneously stayed in the activity for more than 20 minutes. In the beginning, he could not recognize the size of the balls. He usually gets upset when he can not understand how things work, but incorporating the fun part of the balls rolling down the trails intrinsically motivated him to keep trying. In the end, he could instantly distinguish the slight size difference of each ball. This activity shows that STEAM brings fun into learning and enhances children's autonomy.

The Flow

Autonomy often invites children into the *flow*. Flow is the name of a phenomenon, the feeling of being in one's zone. STEAM enhances autonomy by providing intrinsically motivating activities from various fields, thus increasing the chance of flow. Csikszentmihalyi (1990) explains that flow is a state in which people are so involved in an activity that nothing else seems to matter; the experience is so enjoyable that people will continue to do it for the sake of doing it. Flow occurs due to intrinsic motivation to do things that make us genuinely happy. Bedar & Al-Shboul (2020) states that "Intrinsic motivations reflect the human's tendency to learn and understand and refers to doing something that is pleasant" (p.49). In the flow, the person is highly concentrated, and people find happiness in a heightened state of concentration (Csikszentmihalyi, 1990). Referring to my journal book, I noted,

> …I sat by the kinetic sand table and just played with the sand. The texture of the kinetic sand was different from regular sand—it tended to hold its shape without having to add any water. The texture of the kinetic sand felt unusual and weird, yet I couldn't stop touching it. It was interesting to see the sand keep its shape for a while before slowly diminishing its form. I wondered what ingredients gave this sand its funny, satisfying texture. Was it water and a little glue that kept the sand together? Perhaps some cornstarch mixed in? While my children wandered, I tried to see how tall and skinny of a mountain I could make without letting it fall. Then my children came back to me with their finished projects. I realized that I wasn't sure how long I had been playing with the kinetic sand. I knew it was not hours, but it was long enough for my children to finish their small projects… (Scene 7: Free Area - Kinetic Sand, p.12).

I lost track of time playing in the Kinetic sand. The kinetic sand was different than the sand I used to play with as a child. Then I was eager to see how tall and the skinny mountain I could make before it diminished. I unconsciously challenged my skill with the new medium. The next time I noticed, I was in a state of flow. There is no specific way to get into the flow; however, Csikszentmihalyi (1990) explains when our skills are challenged in a balanced way, we end up being in the flow state. For example, when things are too challenging, we may develop anxiety. However, the challenge is too easy for our current skills; we may get bored. There needs to be a good balance of challenge and skill for flow to begin. I recreated the chart based on Csikszentmihalyi (1990)'s concept of flow. (See Figure 7).



(*Figure 7.* The chart was created based on the concept *flow* by Csikszentmihalyi, 1990.)

Once we get in the flow state, we concentrate, get better, and increase our challenge. Challenge and skill go up coherently, and learning intensifies. The trigger to the flow states varies in each person, and children must be intrinsically motivated and autonomous to do the activity. By experiencing flow, children feel pure joy and come to understand that learning is fun. STEAM provides activities from various sources that stimulate the curiosity of each child with different interests, thus enhancing their autonomy.

Divergent Thinking

The most important finding from this study was that STEAM promotes divergent thinking. Dr. Kenneth, the author of *Creativity and the Brain,* claims that while there are many definitions of creativity, he identifies creativity as divergent thinking. "Creativity is finding unity in what appears to be diversity" (Heilman & Miles, 2020, 2:25). Heilman and Miles (2020) explain that convergent thinking is when there are right answers and we stick to the right answer to solve a problem, and divergent thinking is when there could be a range of different types of solutions to a problem. The Cade Museum provided unordinary STEAM activities that changed my views. They showed me that different outcomes from one concept are possible. Referring to my journal, I noted,

> The game with pumpkins was full of surprises. For example, it would never have occurred to me that vegetables could be used as controllers. My first thought was, how does this even work? Then, after a docent explained that our bodies and the vegetables work together to create ionic circuits, I was amazed that they had used this knowledge to come up with the idea to turn pumpkins into gaming controllers—such a creative and fun way to engage children in activity and inspire numerous questions (Scene 11: All About Games, p.22).

My ordinary idea of gaming controllers was challenged. If I were told to design a gaming controller, I would probably create a controller made of plastics, as many other controller developers do. Heilman and Miles (2020) explain that the first step in the creative process is disengagement, meaning disengaging from current knowledge or beliefs about what we think is necessary. Then, divergent thinking follows, allowing us to think of other possibilities and alternatives. This real-pumpkin controller broke my usual belief about plastic controllers and showed me that there are other alternatives to make controllers. It also stimulated my curiosity about how it worked. The museum surprised me even further when I visited it on a different day. Referring to my journal, I noted,

> This time the Fab Lab had an electric drawing activity that used fabric squares. Fabric squares decorated with conductive ink were connected to a device that used two conductors to complete an electrical circuit and control a computer… In my mind, fabric was something that would not conduct electricity—I had never thought about it any further. This activity showed me that many things become possible with new ideas. In this case, weaving conductive thread into fabric turns the fabric into an electric conductor (Scene 16: Fab Lab – Computer Drawing, p.28).

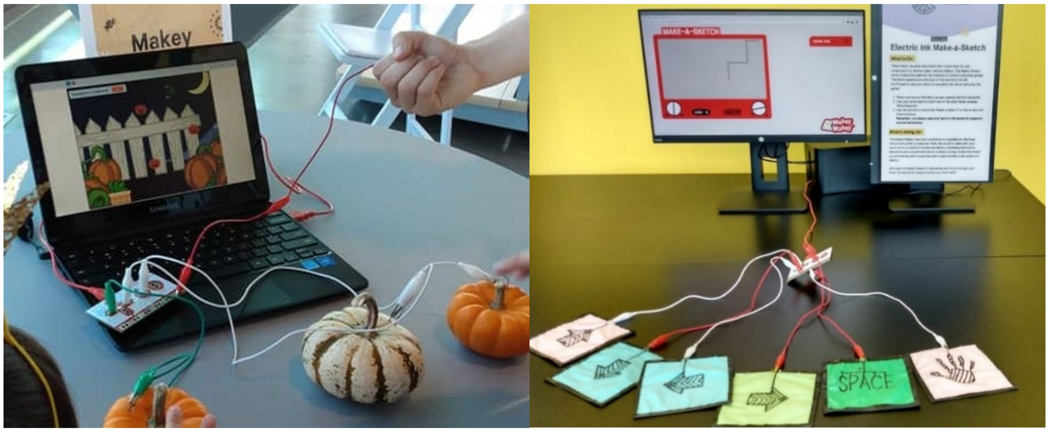


Figure 8. Pumpkin controllers and e-textile controllers

Pumpkins as controllers was a creative idea, but it made sense because I had some knowledge that vegetables could conduct electricity. The second time, the controller was made of fabrics. This did not make sense because fabric usually does not conduct electricity. Once again, I had to disengage from my usual thinking and look for other possibilities for this exhibit to make sense. STEAM activities question ordinary phenomena and if there are any other ways to make situations work, which encourages divergent thinking. Heilman and Miles (2020) also state that curiosity and risk-taking are important in creativity and divergent thinking. People take risks to explore more when they are curious and intrinsically motivated. Heilman and Miles (2020) found that a place deep in the brain called the ventral striatum is a reward system that animals feel gratification from when it is stimulated. The excitability of that system turns out to be very important for drive and motivation. In history, many artists, composers, and scientists were financially destitute, but they wanted to create because it gave them great joy (Heilman & Miles, 2020). A kindergartener uses all of her paints and glues to experiment, even though there is a risk of not having enough paints to finish her homework. When children find their own questions intrinsically motivating, they take risks to explore more.

Edison’s Pile of Junk was another activity that encouraged divergent thinking. Thomas Edison’s booth started with his quote, “To invent, you need a good imagination and a pile of Junk.” Referring to my journal, I noted,

> … A docent in the booth handed my children and me a bag, a card, and some tools. Inside the bag, there were random items such as a piece of Styrofoam, some plastic, a popsicle stick, a pipe cleaner, a toilet-paper tube, etc. The card had instructions to make a bug. A docent explained that “Edison invented amazing things from a pile of junk. Try to make what it says on the card using the junk you have.” My children’s eyes sparkled as they opened their bags to see their junk. They eagerly started brainstorming how to make the bug, bragging about what they had in their bags, sharing their ideas, talking to others, giving opinions, and exchanging items… docent in this booth told me that children often surprise her with their unexpected creations or ways of using the materials that they would not have considered (Scene 16: Edison’s Pile of Junk, p.10).

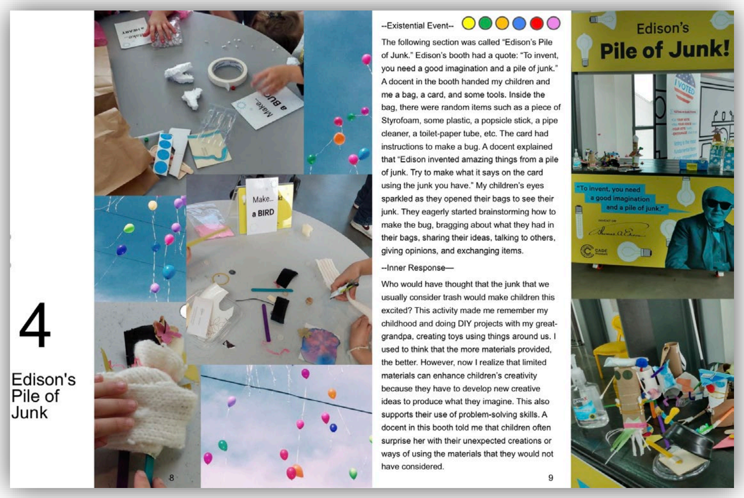


Figure 9. Edison’s Pile of Junk, spread from the accompanying capstone journal

I was amazed that the junk that we usually consider trash made children so excited. I used to think that providing more materials was better; however, I now realize that it is the other way around. Limited materials promote children’s divergent thinking and creativity because they must develop new, creative ideas to fulfill the roles of the parts they lack. For example, my daughter had to make a bird, but she did not have feathers. She then had to be creative and come up with alternative ideas for making feathers with the limited materials she had. In addition, this experience connects to real-life problem-solving skills by developing flexibility and adaptability.

For more opportunities to expose children to diverse activities, the museum changes its theme and activities every four months. All activities are related to the theme so that children can explore the theme more deeply through numerous activities. Heilman and Miles (2020) suggest that it is important to be stimulated as often as possible and to do as many new and novel things as you possibly can while growing up. Every time my children and I went to the museum, we had new experiences. Usually, visiting a museum once satisfies me; however, this museum made me want to visit repeatedly, and I was excited about what would be there the next time. STEAM provides learning opportunities from different perspectives, and being exposed to various stimuli and broad knowledge, children learn to question ordinary phenomena and connect different pieces to create their own ideas.

Extrinsic Motivators and Synergistic Extrinsic Motivators

While intrinsic motivators had an essential effect on STEAM learning, I did not see an effect in learning from extrinsic motivators. However, I found that synergistic extrinsic motivators play a vital role in healthy learning. Starting from extrinsic motivators, I noted in my journal,

> We were offered the chance to do two scavenger hunts that took place throughout the museum. The first one was a question scavenger hunt with the goal of answering all of the questions in the brochure. We had to actively find the answers throughout the museum. There was a prize for this hunt if we answered them all. The other hunt was to find paper crickets that were hidden throughout the museum. My children did not finish the question scavenger hunt, but they spotted all of the paper crickets…Interestingly, even though a prize was involved, my children were not interested in answering the questions in the brochure. They were more interested in doing the hands-on activities and exploring. They were, however, excited to look for the paper crickets, and they found them all. I noticed that other families were similar, with the parents rather than the

> children looking for the answers. The children were more interested in doing things that were intrinsically fun for them rather than trying to earn prizes (Scene 13: Scavenger Hunt, p.24).

We also visited the museum on different days and were offered scavenger hunts with prizes; however, my children were not interested in them. My children usually like prizes; however, they were so interested in the activities and having fun that they did not care for the prizes. This reminded me that it is important to focus on making activities intrinsically fun for children instead of providing extrinsic motivators such as prizes.

While I did not see an effect from purely extrinsic motivators, docents acted as synergistic extrinsic motivators that helped visitors engage with activities. Synergistic extrinsic motivators are motivators from outside a person that work together with intrinsic motivations, such as encouragement (Jaquith, 2011). In almost every activity area, except for the free play area, docents were present to engage children in the activity. The museum refers to docents as educators as they are not ordinary docents who explain the backgrounds of artifacts. In the museum's docent training packet, they explain the vision of docents' roles,

> The Cade Museum is not primarily a museum of things or artifacts, but a museum of ideas. Docents at the Cade Museum guide visitors in an experience designed to help them develop an inventive mindset by connecting them to the stories and ideas behind inventors, entrepreneurs and visionaries, both current and historical. Our vision is to help all visitors begin to see themselves as people uniquely endowed with a creative mind (The Cade Museum Docent Handbook, 2018).

Docents acted as facilitators to enhance visitors' learning. Every time we came to a new activity, wondering how it worked, a docent quickly approached us with enthusiasm. Sometimes they were dressed in a lab coat, and sometimes, they were dressed as a witch, the Cat in the Hat, or other costumes. Referring to my journal, I noted,

> A printing press and 3D printers in the Fab Lab demonstrated the evolution of technology. A boy in front of me was looking at an old printing press and a docent approached him, asking if he wanted to see how it worked. I decided to stay and find out

> how the machine worked as well. The docent asked the boy's name, showed him how the press worked, and printed a newspaper. The boy received the printed newspaper and exclaimed when he saw that his name was in the newspaper. The docent smiled as the boy's eyes brightened (Scene 8: Fab Lab – Printing Press, p.15).
>
> On one side of the Fab Lab there were 3D printing machines. A family was doodling on a 3D design computer, and a docent suggested that they could make the design into a key chain. The docent explained some design techniques to the family, and some other visitors, including me, gathered to listen as well. Soon everyone started asking detailed questions about how to change specific colors or dimensions to visualize what they imagined (Scene 9: Fab Lab – 3D design, p.17).

A docent made the visitor's day memorable while he learned about the printing press. Also, when a docent approached the family to show some design techniques, the doodling changed to a spontaneous group 3D-design lesson. While we could choose to participate in any activity we wanted to, docents were synergistic extrinsic motivators, encouraging us to try new things and connecting fun and learning. I and my children were there, simply having fun; simultaneously, we learned so much from each activity.

Additionally, synergistic extrinsic motivators played an essential role in teamwork. The Cade Museum offered several collaborative events, such as Fossil Fun, JA BizTown, and Operation Full STEAM. Fossil Fun was a collaboration between local museums and libraries that even utilized virtual learning. Referring to my journal book, I noted,

> The Cade Museum, the Florida Museum and the Alachua County Library District collaborated to present the fossil fun exhibit. The Alachua Library provided a "Take & Make Fossil Box" that allowed children to dig into a hands-on prehistoric activity. I picked up one of the fossil boxes and my children enjoyed digging for the fossils. Then we joined the live virtual programs that the museums hosted to uncover the mysteries of Florida's prehistoric past and learn how fossils are formed. The fossil boxes also included passes to the Florida Museum of Natural History and the Cade Museum. After we learned about fossils, we visited each of the museums, which had exhibitions that elaborated the coherent theme of fossils and dinosaurs. This opportunity provided a full month of fun learning for my children and me (Scene 20: Collaborative Fossil Fun, p.35).

This collaborative event cultivated our intrinsic motivation with a fun fossil digging box and scaffolded our learning with live virtual programs. The opportunity to learn together online was a fun moment. The opportunity to go to two museums was a great synergistic extrinsic motivator to see fossils and dinosaurs. Since we knew many people had joined this collaborative event and museums were involved, we were excited to share new knowledge with people at the museums. Collaboration was a great synergistic extrinsic motivator that kept us learning further.

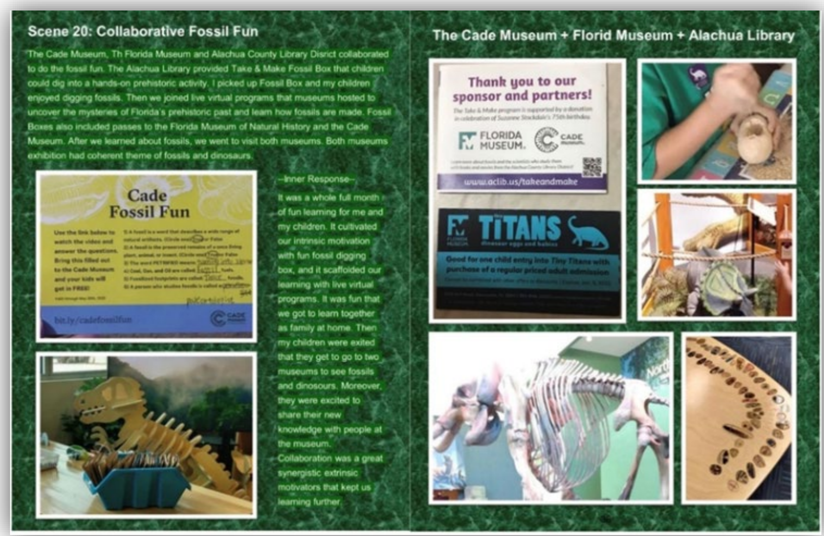


Figure 10. Fossil Fun, spread from the accompanying capstone journal

Heilman and Miles (2020) point out that nature and nurture are both important for brain development, and those two things must go together. For example, if babies were fed, they start to grow as part of the nature of their development. However, nurture is also necessary for healthy mental and brain development (Heilman & Miles, 2020). As an extreme example, if a children are raised inside a room with nothing in it except foods, they will not have enough stimulation for brain growth (Heilman & Miles, 2020). Therefore, it is essential that children have an environment that stimulates their curiosity and enhances their learning. At the same time, educators, family, and community members should become synergistic extrinsic motivators who give children support, care, encouragement, and opportunities to set their own goals and make meaning themselves. Having a purpose of engaging helps children to be motivated and become self-directed learners. The nature of STEAM education, with various interrelated subjects, makes it even more vital that educators have strong communication skills to encourage and understand one another. When children feel cared for, important, and like their learning matters, it helps their total growth.

Summary of Findings

From my findings, I see positive relationships between intrinsic motivation and STEAM education. Intrinsic motivators from Jaquith's (2011) article, interest, involvement, curiosity, satisfaction, and positive challenges, were fostered throughout the STEAM activities at the Cade Museum. After I did the coding to categorize each scene, four interesting findings related to intrinsic motivation surfaced.

First, the environment is an important factor in stimulating intrinsic motivation. An environment that sparks curiosity and mesmerizing moments drive us to learn further. An unordinary setting or unusual ways to set up materials stimulate children's wonder and inspire new discussions. Also, providing areas where children can freely do activities and get into their own worlds helps them relax; this also works to provide incubation time for them to smoothly process their thoughts. The second finding was that STEAM and intrinsic motivation enhance autonomy, and being autonomous often brings children to a state of flow. When in flow, children are immersed in their activities and highly concentrated, giving them pure joy. Finding joy and feeling that learning is fun is the core of what is essential in STEAM education. Third, STEAM education's natural integration of a variety of subjects enhances divergent thinking. Being exposed to various stimuli and pieces of information teaches children to question ordinary phenomena and connect different pieces to create their own ideas. Lastly, while my study focused on intrinsic motivators, synergistic extrinsic motivators appear to have an important role in children's learning. Encouragement from peers, family, and community members was external, but it kept children motivated.

Discussion and Conclusions

Motivation is key to promoting learning. Intrinsic motivation naturally resides in all of us; however, it does not always happen automatically. Intrinsic motivation can easily be diminished when children are not in a suitable environment (Heilman & Miles, 2020). For children to be intrinsically motivated, they need an environment that sparks their curiosity. When we think of a learning environment, many of us think of desks, books, and chairs in a quiet place. However, learning is not only about adults lecturing to convey knowledge to children. Learning can occur spontaneously when children are offered environments that interest them. STEAM education naturally entails an environment that stimulates children's curiosity from various sources. Once children are intrinsically motivated, it increases their autonomy and the chance of experiencing flow. Flow gives children pure joy in learning, and their learning intensifies. Another important element is that synergistic extrinsic motivators, such as encouragement, become important to maintain intrinsic motivation. Many children face obstacles and difficult situations once learning becomes intense, and we, as educators, need to be the best supporters for them. Children need to feel that they are trusted and important. We all live in societal groups, and positive relations with others become a significant source of intrinsic motivation.

This research showed that STEAM and integrated learning positively affect children's ability to develop divergent thinking to find their answers. Art can bring fun to education, tuning complex academic subjects into joyful experiences—art and creativity in STEAM act as threads to weave different parts of knowledge into a one-of-a-kind tapestry.

Significance and Implications

After finding that STEAM education positively relates to intrinsic motivation and enhances children's learning, I suggest that we provide more opportunities for STEAM learning in our communities. As mentioned in the statement of the problem earlier in this paper, art education hours are declining in schools. However, art plays a vital role in integrated learning by stimulating intrinsic motivation and increasing total learning. Therefore, art-integrated learning such as STEAM should be embraced. While shifting whole school systems towards integrated learning is challenging, afterschool programs can provide STEAM education and connect children's school subjects to real-life learning. Afterschool programs are not required to teach academic subjects; thus, they can be the place for hands-on projects that bring fun into learning. If afterschool programs provide intrinsically motivating, fun STEAM activities, children will gain autonomy and become self-directed learners. Once children learn to be self-directed, it helps them spontaneously focus in school. Children can also learn divergent thinking in afterschool programs, which children can utilize to overcome their weak academic subjects in school by seeking alternative ways to solve problems. When afterschool programs and other local communities provide intrinsically motivating environments and activities, children will find their fun and own meaning in learning. Moreover, if schools collaborate with afterschool programs and the local community, the whole community becomes synergistic extrinsic motivators to engage in collaborative events, and children feel cared for and important.

Recommendations

As an extension of this study and my findings, I created a divergent thinking exercise(Appendix B), a STEAM education steps called *tapestry* (Appendix C), and a brochure to incorporate STEAM learning in after-school programs. I worked in after-school programs for over eight years, and they are an excellent context to function as a hub to connect STEAM learning, local schools, and the community. The brochure can be found as an ISSUU book at https://issuu.com/yuno.b/docs/steam_brochure.pptx

PDF version can be found at: http://yuzu.site/?p=4529 (See Figure 1).

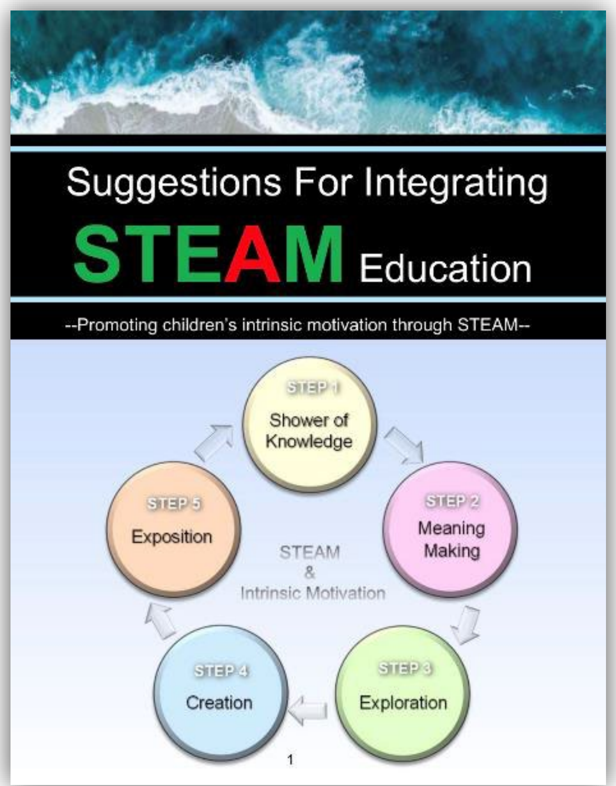


Figure 11. STEAM suggestion brochure cover (ISSUU/PDF)

Conclusion

This study showed me how much I could learn from narrative experiences. By collecting memorable experiences and writing them down in narrative form, I was able to recount events with submerged emotions and analyze them objectively. This study revealed how art and creativity play a role in STEAM and intrinsic motivation; additionally, it explored how STEAM helps children's total learning. It changed my perspective on art education. I was once in a deep tunnel looking for ways to teach art to children who dislike art. As an art educator, I have always felt that I was expected to teach drawing, sculpture, or design, which might be explained as traditional art. Now I have realized that art does not have to be only about traditional art; there are many other possible ways of art education. Creativity can be integrated into other subjects to raise one another, which is the power of art behind STEAM learning. Future projects will focus on learning the positive relation between STEAM education and intrinsic motivation, finding ways to integrate them into afterschool programs, and whether STEAM education can be embraced in public schools. My goal in an art teaching carrier is for children to find a love of learning in any field, enjoy themselves, and become lifelong learners.

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Appendices

Appendix A

Self-Narrative Inquiry Journal (Text-Only)

This is my narratives (text only) compiled in a journal. Notes recording the existential events, followed by my inner responses.

Scene One: Entering the Museum

When I entered the Cade Museum, I saw many children participating in hands-on activities, and I heard their surprised voices and endless questions flying past such as, "How does this work?" "Wow, what is this?" "Why does it do that ?!" The main lobby, called the rotunda, had 55-foot ceilings and was filled with children's wonder and beautiful light from the skylight above.

--Inner Response--

When I first entered, it felt different from other museums I had been to. In other museums, I usually feel serenity and dignity. The atmosphere tends to change drastically from the outside world; the space feels almost like a holy place where I have to be quiet and well-mannered. However, this time was different. On entering the Cade Museum, I encountered a lively atmosphere filled with abundant curiosity. Hearing children's surprised voices and curious questions reminded me that learning about the world through all of my senses and experiencing "wow" moments have been essential life components for me.

Scene Two: Rotunda (Main Lobby)

There were a few different sections in the rotunda (the main lobby), and each section provided hands-on activities with a docent/educator overseeing the activity. The museum calls its docents educators, and a number of docents/educators were positioned throughout the museum to answer questions or assist with activities. One docent explained to me that the beauty of this museum is that visitors get to touch and play with the living exhibition, unlike most museums that have signs warning visitors to "please do not touch."

--Inner Response--

As an afterschool program teacher, I often took my students on field trips. Taking them to a museum tended to be a more challenging trip because the teachers constantly had to remind students to be quiet, walk quietly, and not touch anything. At the time, I thought that going to a museum was a good thing. However, thinking back and trying to imagine the students' perspectives, I am uncertain that the experience was so beneficial when they were constantly told to be quiet and not touch anything during the trip.

Scene Three: Polygons

The first thing I noticed in the rotunda was numerous polygons and shapes that could be constructed into 3D forms. A sign that read "The Ways We Play: Building Blocks" explained that toys and games that let you think and build can turn play into an invention. The sign stated:

"Like the cardboard pieces in PolyCade, the Cade Museum's architecture is based on an ancient mathematical pattern called a Fibonacci sequence."

--Inner Response--

This made me look up at the ceiling of the museum. I felt that this activity was well-thought out. While visitors play and build with shapes, they are educated about the museum's architectural design and the mathematical sequence behind it. They connected the activity to real-life learning and explained how it could be used and integrated into our lives. I felt that helping children understand how math is used in our daily lives is a great way to teach them that math is more than doing drills at school.

Scene Four: Edison's Pile of Junk

The following section was called "Edison's Pile of Junk." Edison's booth had a quote: "To invent, you need a good imagination and a pile of junk." A docent in the booth handed my children and me a bag, a card, and some tools. Inside the bag, there were random items such as a piece of Styrofoam, some plastic, a popsicle stick, a pipe cleaner, a toilet-paper tube, etc. The card had instructions to make a bug. A docent explained that "Edison invented amazing things from a pile of junk. Try to make what it says on the card using the junk you have." My children's eyes sparkled as they opened their bags to see their junk. They eagerly started brainstorming how to make the bug, bragging about what they had in their bags, sharing their ideas, talking to others, giving opinions, and exchanging items.

--Inner Response--

Who would have thought that the junk that we usually consider trash would make children this excited? This activity made me remember my childhood and doing DIY projects with my great-grandpa, creating toys using things around us. I used to think that the more materials provided, the better. However, now I realize that limited materials can enhance children's creativity because they have to develop new creative ideas to produce what they imagine. This also supports their use of problem-solving skills. A docent in this booth told me that children often surprise her with their unexpected creations or ways of using the materials that they would not have considered.

Scene Five: Creativity Lab – Making a Rainbow in a Tube

When I entered the Creativity Lab, I saw that many children were engaged in hands-on experiments. There was lots of laughter and "wows." There were different activities to choose from, including creating rainbows in test tubes, drawing with droppers, making glowing slime, and playing with kinetic sands. The whole room was decorated with a variety of scientific themes. While my children made slime, I joined the station making rainbows in tubes.

--Inner Response--

I genuinely love hearing children's excited voices. Listening to someone having fun makes me curious about what they are doing and makes me want to join in. I liked the set-up of the activities; as soon as I entered, I could see each activity booth, each looking exciting to try. Even though the room was decorated in scientific themes, the activities were mess-friendly; the environment felt like a mix of scientific knowledge with the messy, fun part of art. For example, making a rainbow tube was fun and challenging. I had to be very careful to keep each color in place, and I had to try a few different angles and different speeds to see what worked best. After some experimenting, I was pleased to finally have a nice rainbow. My children also tried the rainbow tubes after I did, and I felt that the results showed each of our individual characteristics.

Scene Six: Creativity Lab – Drawing with Droppers

In the drawing with droppers section of the Creativity Lab, my children and I were encouraged to draw on a coffee filter with washable markers. After we finished drawing, a docent gave us a dropper of liquid to put droplets on the drawing. When the droplets hit the drawings on the coffee filters, the colors spread. Some of the colors mixed together in unexpected ways, creating soft colors and dyeing the whole coffee filter. Once the coffee filters were dry, we had the option to take them home as is, or we could make something out of the dyed coffee filter. Using the coffee filter and a pipe cleaner, I made a butterfly out of mine. One of my children made a flower, while the other kept theirs as is.

--Inner Response--

It was amazing to watch the water spread slowly and create a gentle mix of colors as it permeated through the washable marker dye. The drawings and colors on the filter mixed in unexpected ways. It was interesting to try a different way to utilize washable features and coffee filters. When I used the dropper to put droplets on the filter, I felt like I was experimenting to see what the outcome would be on each part of the coffee filter. I also loved that we had an option to enjoy the dyed coffee filter as is or to create something new out of it. When my children asked me if we could do the activity at home, many questions, such as would it also work with permanent markers, came to mind. I speculated about what would happen if we used dry-erase makers or natural colors extracted from plants? Would they react any differently when we dropped water on them? How about the paper? Could I use something other than a coffee filter? More exploration ideas popped endlessly into my mind. I realized that we are too used to drawing on paper with crayons or markers explicitly made for drawing. When offered an unusual way to draw and create, I wondered more about what else we could do.

Scene Seven: Free Area, Kinetic Sand

While many sections of the Creative Lab offered activities with explanations, a few of the areas were dedicated to completely free play. I decided to take a break while my children explored other activities in the same room. I sat by the kinetic sand table and just played with the sand. The texture of the kinetic sand was different from regular sand—it tended to hold its shape without having to add any water.

--Inner Response--

The texture of the kinetic sand felt unusual and weird, yet I couldn't stop touching it. It was interesting to see the sand keep its shape for a while before slowly diminishing its form. I wondered what ingredients gave this sand its funny, satisfying texture. Was it water and a little glue that kept the sand together? Perhaps some cornstarch mixed in? While my children wandered, I tried to see how tall and skinny of a mountain I could make without letting it fall. Then my children came back to me with their finished projects. I realized that I wasn't sure how long I had been playing with the kinetic sand. I knew it was not hours, but it was long enough for my children to finish their small projects at other stations in the room. I felt that I may have been in a state of *flow*, which is the phenomenon or feeling of being in one's "zone." When one is in flow, they are fully immersed in an activity, highly concentrated, and their skills are challenged. Csikszentmihalyi (1990) explained this further, stating that people find happiness in a heightened state of concentration.

Scene Eight: Fab Lab – Printing Press

A printing press and 3D printers in the Fab Lab demonstrated the evolution of technology. A boy in front of me was looking at an old printing press and a docent approached him, asking if he wanted to see how it worked. I decided to stay and find out how the machine worked as well. The docent asked the boy's name, showed him how the press worked, and printed a newspaper. The boy received the printed newspaper and exclaimed when he saw that his name was in the newspaper. The docent smiled as the boy's eyes brightened.

--Inner Response--

It was a wonderful surprise for the little boy, and it made me and the others who were watching smile. Having one's name in the newspaper does not happen very often, and I believe it made him feel very special. We are surrounded by printed materials like books, newspapers, and flyers in our daily lives, but we rarely think about how these things are printed. I believe the boy will never forget about the printing press. Sometimes small engagements such as these can change a child's life, maybe even leading to their future career. Among the many gifts I have received throughout my life, I most vividly remember the ones that someone made for me. For example, I have received a backpack that my grandmother sewed my name onto, a tote bag upon which my friend drew my favorite things, a picture collage made by my mom, and furniture that my great-grandpa made for me. When someone does something especially for you, it is memorable for a lifetime.

Scene Nine: Fab Lab – 3D Design

On one side of the Fab Lab there were 3D printing machines. A family was doodling on a 3D design computer, and a docent suggested that they could make the design into a key chain. The docent explained some design techniques to the family, and some other visitors, including me, gathered to listen as well. Soon everyone started asking detailed questions about how to change specific colors or dimensions to visualize what they imagined.

--Inner Response--

At first the family was just doodling on the computer, but when the docent approached the family to show them some design techniques, the doodling became spontaneous 3D-design learning. The family and the other visitors came up with many questions that allowed the docent to teach us about 3D design in more detail. I had never done a 3D design before, and seeing others learning from scratch and watching the design come to life motivated me to try it. Others must have been inspired in the same way because people began lining up to try it. All we needed was a little kickstart and a little bit of knowledge to try something new. I liked how they juxtaposed the ancient printing press against the leading-edge 3D printing machines to show how printing technology has evolved.

Scene Ten: Dr. Cade's Invention Booth

After walking through the other activities, I reached Dr. Cade's invention booth. The introduction at this station began by stating that and inventor's mind contains limitless curiosity. Dr. Cade's passion extended past the fields of science and math—he loved art, poetry, writing, music, mechanics, and athletics. It went on to state that exposure to diverse fields, especially art, enables us to think like an inventor and see connections that others may miss. Dr. Cade's booth showed how Gatorade was invented: it started with a conversation between a security guard and doctors about a problem with coffee. This casual conversation provided a spark of creativity, and teamwork provided the solution. The museum also recreated Dr. Cade's lab for the exhibit.

--Inner Response--

I believe that exposure to diverse fields is the best way to open our minds. Things I see in a certain way might look very different from other perspectives. Dr. Cade's room made me realize that science and art are closely related, and curiosity and experiments lead people to new inventions. Artists often experiment with different mediums and art forms to find their way; this becomes their expression invention. I liked the idea of having a lab in the museum—it will be fun to have a lab in the art facility.

Scene Eleven: All About Games

The first room on the second floor was all about games. The theme for this exhibit was *Toys and Games: The Way We Play*. There was an old-fashioned arcade game, an activity for creating pixel pictures, a game with controllers made of real pumpkins, and puzzles. I looked at the arcade game, and the character in the game was Dr. Cade. A docent explained that they had created this arcade game, from designing the character to programming the game, downstairs in the 3D-design area. Next to the arcade game was the station for creating pixel pictures. This activity was analog: I had to put small square pieces together to create a picture. After that, I tried the game with pumpkin controllers. I had to put my hands on the pumpkins to complete the circuit to use the mouse and play the game. I was there near Halloween, and I noticed that the docents were dressed up in unique costumes.

--Inner Response--

This room was amazing. The big old-fashioned arcade game at the entrance grabbed my attention first. It brought me back to my childhood. When I looked into the screen, I noticed an unfamiliar character. When I realized that the character was actually Dr. Cade, the inventor whom the museum is named after, it brought a big smile to my face. What a fun way to introduce his story and go through this quest together. It made me wonder how he could have become a character in the game. I was surprised to hear that the museum staff, educators, and developers had worked together to create everything from scratch for the Fab Lab. People from different professions contributed their skills to create a one-of-a-kind exhibit. It sounded like so much fun, and I wished I could have been part of the team. I love art and design, but being able to experience the programming and see the images come to life must have been rewarding. I was so inspired, in fact, that I looked up internship opportunities and filled out a volunteer application when I got home.

Doing the pixel-picture activity made me feel closer to the character design job. Designing a game character sounds like a job that would require special skills, but if I was able to put small squares together to form a picture, I should be able to combine pixels into an image on a digital platform. This activity also showed me that I could practice pixel drawing without a computer. It will be great to introduce this idea to students who do not have a computer at home but are interested in learning digital imaging.

The game with pumpkins was full of surprises. For example, it would never have occurred to me that vegetables could be used as controllers. My first thought was, how does this even work? Then, after a docent explained that our bodies and the vegetables work together to create ionic circuits, I was amazed that they had used this knowledge to come up with idea to turn pumpkins into gaming controllers—such a creative and fun way to engage children in activity and inspire numerous questions.

Scene Twelve: Measurement Rules

One room was dedicated to measurement rules. It explored the meaning of size, height, length, weight, volume, and more through hands-on activities. An educator explained that this is a moving exhibition and that the Children's Museum in Pittsburgh created this interactive exhibit. My five-year-old son tried the activity of putting balls into the right-sized holes—only the correct-sized ball would fit into the correct hole to roll down the trails. My son put balls into the holes randomly, and the balls kept coming back. He tried for a while, and he did not want to leave the activity, so I moved on to the weighing activity, which challenged visitors to match the weight of pumpkins with other objects. When I returned to my son, he was still throwing the balls in the holes, but now he knew precisely which ball was 1¾ inch, 2 inches, 2¼ inch, and 2½ inch.

--Inner Response--

Collaborating with other museums is a great way to share each museum's unique activities and exhibits. I tend to have a hard time with numbers, and I felt like these activities made numbers more tangible, as I could experience them through hands-on interaction. In the end, I was surprised that my son was able to tell me the size of each ball by just looking at and touching them.

Scene Thirteen: Scavenger Hunt

We were offered the chance to do two scavenger hunts that took place throughout the museum. The first one was a question scavenger hunt with the goal of answering all of the questions in the brochure. We had to actively find the answers throughout the museum. There was a prize for this hunt if we answered them all. The other hunt was to find paper crickets that were hidden throughout the museum. My children did not finish the question scavenger hunt, but they spotted all of the paper crickets.

--Inner Response--

This was a fun way to engage people in actively exploring the museum. I enjoyed finding the answers as I moved through the museum. Interestingly, even though a prize was involved, my children were not interested in answering the questions in the brochure. They were more interested in doing the hands-on activities and exploring. They were, however, excited to look for the paper crickets, and they found them all. I noticed that other families were similar, with the parents rather than the children looking for the answers. The children were more interested in doing things that were intrinsically fun for them rather than trying to earn prizes.

Scene Fourteen: Exhibit Change

The museum changes its theme and activities every four months. A docent told me that educators, scientists, and developers work together to develop the creative activities. Therefore, I went back to the museum when they introduced a new theme. This new theme was *Tech Tapestry,* and the exhibit name was *Fabric Frontiers – Textiles and Technology*. Besides a few permanent exhibits, the museum was filled with new and different activities. For example, the activity in the Creative Lab was to make thread from wool using spindles.

--Inner Response--

I had heard that the museum changes its exhibits a few times a year, but I was surprised by how much they actually changed. After the exhibit change, it felt like I had come to a different museum; it was a completely new experience. I like how they have a theme for each exhibit and all of the activities are related to the theme so that children can explore it more deeply through the numerous activities. My children never get bored of going to the museum—they always have a new experience. One visit to a museum usually satisfies me, but this museum makes me want to visit repeatedly; I'm excited about what will be there next time I visit.

Scene Fifteen: Fab Lab – Stack a Screen Print

This activity mimicked the silkscreen print process without using real ink or silkscreen. I chose a piece of clothing to which I could add a design, then I laid a transparent design sheet and stacked more layers on top to create a multi-colored design. I was able to change the layers around to see if the colors looked better in different orders and rearrange the layers to create a design I liked.

--Inner Response--

This is a great way to introduce silk screen printing to early-elementary-aged children. Screen printing may be challenging for younger children, but this activity demonstrated the concept of screen printing and how it works. If this activity was used in the classroom, children could also draw their designs on a transparent design sheet with opaque colors. I have thought of screen printing for older students, but this activity made me realize that we can develop ideas to make more complex things more accessible to younger children. Doing this activity in the classroom would also give educators the opportunity to determine whether the children are interested in screen printing before buying the materials to do it in class. This activity could also help explain silkscreen printing to adults who are visual or kinesthetic learners.

Scene Sixteen: Fab Lab – Computer Drawing

This time the Fab Lab had an electric drawing activity that used fabric squares. Fabric squares decorated with conductive ink were connected to a device that used two conductors to complete an electrical circuit and control a computer. The sign at the activity explained that when we place our hands on the fabric and draw electronically, our body acts as a conductor to complete the electrical circuit. The fabric, which is called E-textiles, contains electrics. Manufacturers can add electronics to these fabrics using conductive thread.

--Inner Response--

This activity both inspired me and stimulated my curiosity. In my mind, fabric was something that would not conduct electricity—I had never thought about it any further. This activity showed me that many things become possible with new ideas. In this case, weaving conductive thread into fabric turns the fabric into an electric conductor. Using my body as a conductor and watching the electric ink create a drawing on the PC made me imagine the electricity going through my body even though I could not feel a thing. Being able to imagine something we cannot see or feel was a valuable, unique experience that I want my students to experience.

Scene Seventeen: Free Area – Blocks and Engineering

The museum had new free areas with threat and fabric activities, blocks, and engineering. I got to feel different kinds of fabrics, weave thread through holes on the wall to create a picture, and make patterns with square fabrics. My children were especially interested in the blocks and engineering. My son stacked wooden blocks straight up and soon found out that they were not stable. He started to intersect blocks to make the stack more durable. My daughter and some other children worked on a building together, creating a house. A docent told me that children became little inventors when left alone in a free area with all these materials.

--Inner Response--

I agree with the docent that children become little inventors when they are given a variety of materials and time to explore. Children can always find ways to use the simplest of materials. When adults decide on specific times and activities for children, we may be limiting their creativity and potential. I grew up spending time with my great-grandpa, and he let me do what I liked all day long. He always supported me in the things I tried, so I was never afraid to try new things. I still appreciate the freedom and loving care he gave me.

Scene Eighteen: Bathroom and Guest Speaker

The museum's bathroom walls were decorated with the history of toilet-related inventions. When I went to wash my hands, I noticed that the mirrors were decorated with the history of soap inventions and an explanation of how soap works. The museum also has a website for home activities that use soap. On the day I was there, the museum had invited a guest speaker who invented toilet steps, and my children were able to talk to the inventor and try his invention.

--Inner Response--

It was an innovative idea to use the bathroom as part of the exhibit. I have never seen an exhibit extend into the bathroom, but if we aim to connect children's learning to real life, it seems only natural to use the bathroom as a place to learn about toilet-related inventions. I loved that they informed me how soap works while I was washing my hands—it was a great time to learn about the chemistry of soap. I was also impressed that they offered home activities related to soap that children could do at home; this will encourage visitors to bring fun learning into their own homes.

Scene Nineteen: JA BizTown

This time, the upstairs was dedicated to JA BizTown. The museum had partnered with Junior Achievement's JA BizTown program, which combines in-class learning with a day-long visit to a simulated town. This learning experience allows elementary school students to operate banks, manage restaurants, write checks, and more (JA Biztown, n.d.). I noticed that the stores in the pretend town were stores that we have locally, which made it feel more realistic. In addition, I learned that the museum collaborates with local public schools to bring every fifth grade class in the local county to experience this exhibit.

--Inner Response--

Partnering with other organizations is a great way to involve the community in a learning space. I was amazed to learn that all fifth grade classes from the local public schools get to experience JA BizTown. It is vital to connect with local schools so that children can tie their school learning to real-life scenarios outside of school. If we teach children academics to enrich their lives, we should also offer them places and opportunities in which they can utilize their knowledge.

Scene Twenty: Collaborative Fossil Fun

The Cade Museum, the Florida Museum and the Alachua County Library District collaborated to present the fossil fun exhibit. The Alachua Library provided a "Take & Make Fossil Box" that allowed children to dig into a hands-on prehistoric activity. I picked up one of the fossil boxes and my children enjoyed digging for the fossils. Then we joined the live virtual programs that the museums hosted to uncover the mysteries of Florida's prehistoric past and learn how fossils are formed. The fossil boxes also included passes to the Florida Museum of Natural History and the Cade Museum. After we learned about fossils, we visited each of the museums, which had exhibitions that elaborated the coherent theme of fossils and dinosaurs.

--Inner Response--

This opportunity provided a full month of fun learning for my children and me. It cultivated our intrinsic motivation with the fun fossil digging box, and it scaffolded our learning with live virtual programs. It was fun to learn together as a family at home. My children were excited to go to two different museums to see fossils and dinosaurs. They were also excited to share their new knowledge with the people at the museums. The collaboration between the museums offered a great synergistic extrinsic motivator that kept us learning.

Scene Twenty-One: Decoration Spinning Things. Inspirations

In this display, the museum's wall was decorated with quotes from inventors from various backgrounds. One sign explaining curiosity said, "Curiosity is a happy state of mind because it embraces the fact that you *don't* already know everything. It brings lifelong adventure."

--Inner Response--

The wall decoration was full of inspiration. I used to think that scientists and doctors were highly focused, but I learned that many had various interests. By walking around and reading the signs, I felt empowered that we all have the potential to become who we want to be.

Scene Twenty-Two: Operation Full STEAM

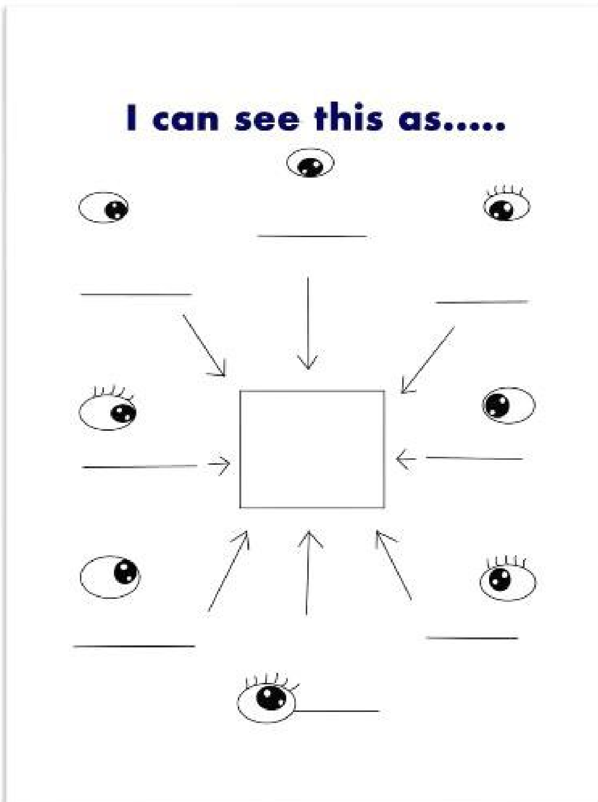
I learned that the Cade Museum offers a program called Operation Full STEAM. The program started in 2018 to help schools with historically low scores in STEAM subjects. The students visit the Cade Museum and participate in hands-on activities that reinforce classroom learning throughout the school year. For example, with crayons, aluminum foil, and a little heat, second graders learn to differentiate magma from lava and how the rock cycle works; handling slime, meanwhile, teaches students about solids, liquids, and gases (Johnson, 2021).

--Inner Response--

Operation Full STEAM was not part of the exhibit, but I learned about this program on the museum's website. I felt that this is exactly the meaning of STEAM education: reinforcing classroom learning with fun hands-on activities that touch on many subject areas. Collaborating with local schools allows students to visit the museum as part of their classroom learning so that all children can experience the fun of the museum, not only those students whose families visit the museum outside of school hours.

Appendix B

Divergent Thinking Exercise



1. Ask students to bring in an item that was going to be thrown away.

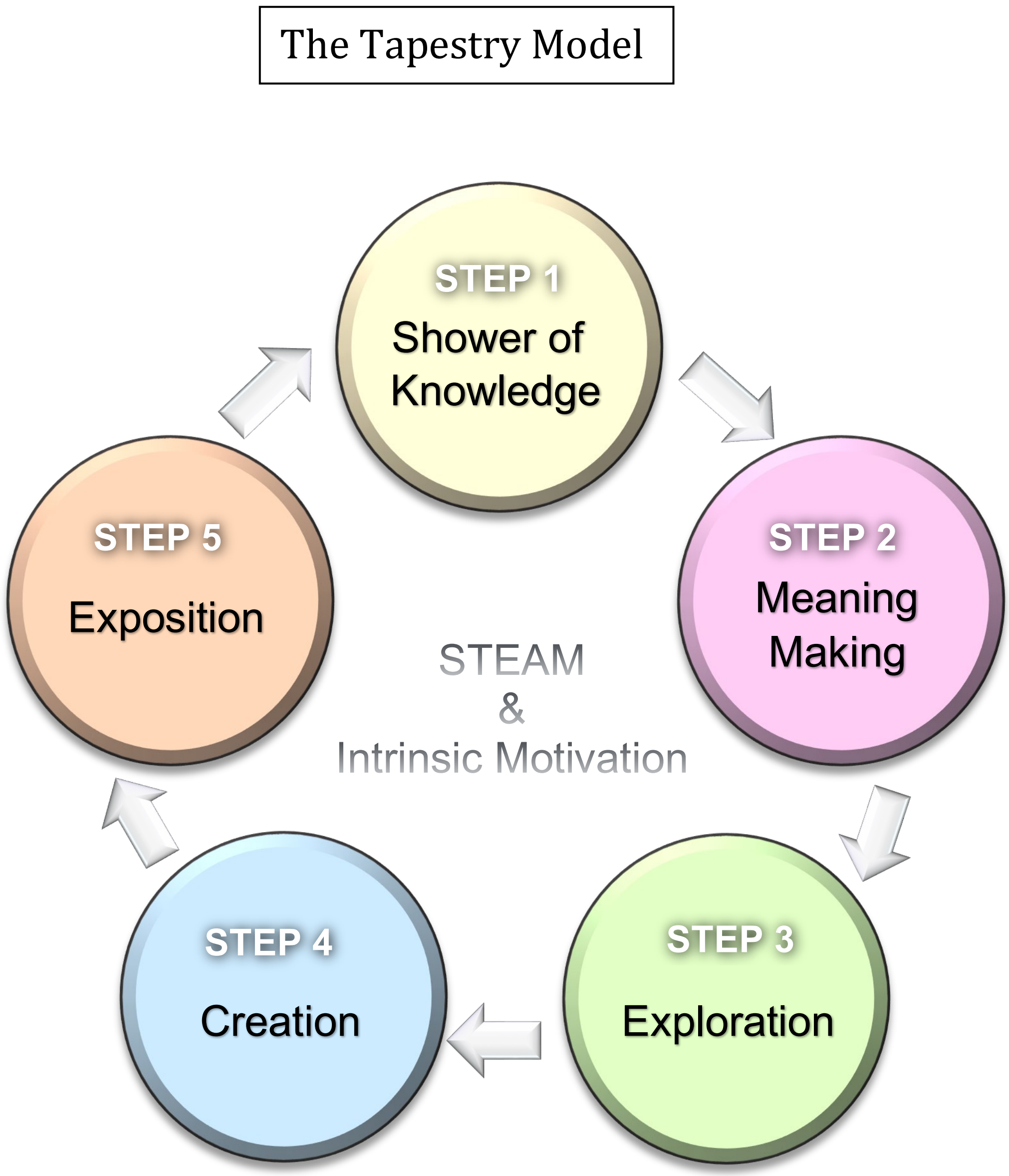
2. Divide students into small groups and have them place the “trash” items they brought on the table. Pass out a few “I can see this as” worksheets to each group and have them fill one out for each item at their table.

3. One-by-one, each group will show their items to other groups and share their responses. For example: “Our group saw this item as (1) trash, (2) a cereal box, (3) thick paper, (4) a cartoon on a box, (5) colorful cardboard, and (6) a cat house,” and so on.

4. Discuss with the students by asking questions such as: “What did others think of the item you brought in today that you thought was trash?” “Why did you get different answers?” “What is the purpose of this material, and what else could it be used for?” “What potential does this material have?” “What is trash and what are materials?”

Appendix C

The Tapestry (STEAM education steps)



(Inspired by the Tinkering School unit)

The Tapestry Model (about 12 weeks)				
1: Shower of Knowledge	**2: Meaning Making**	**3: Exploration**	**4: Creation**	**5: Exposition**
- Pick a big idea. - Based on the big idea, expose children to broad knowledge, skills, experiences, and stimulation. - Bring in experts from each STEAM area that relates to the topic. - Take trips to relevant sites or institutions.	- What is the problem/question each student wants to solve/answer? - Why do you think this specific topic is important? What's your passion? - Educators act as facilitators to help children find meaning in the topic they picked.	- Let children explore their interests more deeply. - Look at the matter from different STEAM perspectives. - Use divergent thinking.	- Learn how to express ideas, hopes, and dreams in a way that will engage someone else and convince them that the idea is worth doing. - Connect knowledge about what children learned. - Use any form of expression: build, create, write, visualize, and more.	- Open the school to the public for exhibition. - Share ideas with the public. - Answer questions from viewers. - Children reflect and examine their own motivation and understanding of the topic. - Record results in a portfolio.
- Preparation **- Inspiration and motivation**	**- Find their own interest and meaning (intrinsic motivation)** **- Become self-directed learners**	**- Divergent thinking** **- Curiosity-driven exploration** **- Learner-centered**	**- Creative expression** **- Invention** **- Language arts skills**	**- Sense of accomplishment** **- Synergistic extrinsic motivators** **- Self-analysis**

List of Figures with Figure Captions

Author Biography

Yuno Bounds holds a Bachelor of Arts in Liberal and Fine Arts from the Kyoto University of the Arts in Japan. This research was conducted as part of her Master of Arts in Art Education from the University of Florida.

Yuno Bounds is an artist, art educator, and nature lover. Yuno grew up on Okinawa Island, the southernmost prefecture in Japan. Growing up on a subtropical island naturally led her to develop a love for the ocean and nature. She spent most of her childhood with her great-grandfather doing DIY projects that used materials around them. Inspired by nature and DIY and drawing, she became an art lover.

In high school, Yuno met an art teacher who used student-centered learning, which showed her that art is more than drawing and creating. Yuno matriculated into the Kyoto University of the Arts and learned that art is essential not only in her life but in everyone's.

Yuno worked as an education technician in the Children, Youth, and Teen program on American military bases located in Okinawa, Japan, for a total of 8 years. Yuno was fortunate to work with children from a variety of backgrounds. She acknowledges that the experience made her more open-minded and made her realize that accepting diversity and differences is essential to building great relationships with others. While Yuno's job was to contribute to whole-child education, she specifically focused on art-infused projects.

During her master's study, Yuno developed a strong interest in STEAM education. She believes that STEAM education is a great way to support children's intrinsic motivation and learning through life experiences. Now, Yuno seeks to explore ways to foster students' intrinsic motivation through STEAM education and develop effective STEAM curriculums.