Taking a Bandsaw to 1st Grade: Transforming Elementary School through Hands-on STEAM Education (Evaluation)

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Abstract

It is well recognized that the world needs interdisciplinary problem solvers and creative thinkers to address the problems of the future. Training in the fields of Science, Technology, Engineering, Art, and Math (STEAM) is crucial for understanding the complexity of the world around us and for identifying and tackling critical issues ranging from climate change to gender inequities. To that end, many programs have been launched all around the world to expose students to STEAM fields and to encourage them to pursue STEAM careers. One particularly effective approach is through hands-on learning and “making,” since children often have a natural affinity for tinkering and learn well through active involvement in meaningful activities [1]. Hands-on, project-based learning has been shown to get more students engaged with STEAM and help them learn key skills for the future [2]. However, most STEAM education programs target students in upper-middle or high school [3]. Bustamante et. al write, “Since engineering education has traditionally not been part of the general K–12 education experience (i.e., the beginning of primary school (age 5) through the end of secondary school (age 18)), early childhood educators have minimal background in engineering pedagogy, and engineering education has been largely absent from purposeful coverage in early childhood” [4]. If students are nurtured at earlier ages to love thinking critically, solving problems, and building, they may be more inclined to continue their education in STEAM fields. Exposing elementary school children to STEAM curriculum is key in instilling in them an early love of learning and problem-solving. This is often overlooked in our current educational system and should be addressed to help develop excellent future STEAM professionals.

This paper explores the idea of introducing hands-on learning to younger kids and discusses field experience of implementing project-based STEAM curriculum with elementary school students from age 6-12. It includes examples of curriculum, discusses case studies of specific student work, and analyzes engagement level with various projects with attention to the value of problem solving and real-world applications to classwork. This paper also includes observations on student skill-building, both in terms of technical skills and students’ communication, and data on student self-assessment of skills. The paper makes recommendations for future research and investigation and proposes methods for implementing similar coursework at other elementary schools.

Introduction

Numerous programs are currently underway to get K-12 students interested in Science, Technology, Engineering, Art, and Math (STEAM). Some of these efforts are regional and target local community schools while others are nationwide programs that try to reach a large audience. Programs such as First Robotics and First Lego League [5, 6] and those developed by
professional societies such as SME, ASME, IEEE, and SAE fall in the latter category [7, 8, 9, 10]. Many of these programs target students who are in high school and are at an age when they might already be thinking of career choices. There are programs targeting younger students, such as the University of Colorado at Boulder’s TeachEngineering curriculum [11], but these are comparatively fewer in number.

Many of the current efforts treat STEAM immersion as supplemental or an add-on to regular schooling, focusing primarily on afterschool programs and workshops. However, doing a single engineering design workshop is not enough to improve science learning; it is important to allow students to translate the learning and mindset from those workshops into supplemental tasks in math and science courses in order to solidify their knowledge [12]. In addition, a disproportionate amount of these workshops are robotics-based; students who are not that interested in robotics may not be seeking out other areas within STEAM that could be of interest to them and thus are not getting the early STEAM exposure [13]. Studies have shown that targeting children in middle school helps increase interest in STEAM and in helping them translate their understanding of math and science into engineering skills [14, 15]. However, there are fewer curricular efforts towards STEAM that are aimed at early childhood, and many early childhood educators choose to work with that age group if they are particularly intimidated by science and engineering [4]. This paper proposes introducing STEAM topics early in students’ education by integrating project-based design and engineering curriculum into elementary school, starting with students from age six.

There has recently been a push to include engineering design as part of core curriculum in K-12 and use it for college or career readiness [13, 16, 17, 18, 19]. Challenging children to engage with problem solving and teamwork at an earlier age helps build their critical thinking and interpersonal skills [20]. Nurturing children’s creativity is essential for future success, so introducing them to the design process at a younger age is helpful in helping them retain their creative spirit [21]. Our school focuses its curriculum towards these matters of student engagement, collaboration, and creative expression, and this paper reviews my implementation, methodology, and results from prioritizing these aspects of learning.

Our company, NuVu Studio, runs a full-time innovation school with a pedagogy based on the architectural studio model and geared around interdisciplinary, collaborative projects [22]. Instead of taking classes in discrete academic subjects, students take interdisciplinary studios where they focus on one topic for the full day for several weeks at a time. The company also has partner schools around the world where employees implement the curriculum at other existing schools. Typically, these are in middle and high schools where we teach in a makerspace during an elective class period. Sometimes we also partner with other teachers to co-teach classes such as Engineering or English where the creative curriculum helps supplement specific curricular goals. We are beginning to expand into elementary schools and are using a similar format,
focused more on having students explore a variety of interesting topics and nurturing a love of learning.

Our first partner elementary school was founded in 2018. In this school, there are no traditional classes and students are in a mixed-age environment instead of specific grade levels. Their mornings are dedicated to working on core skills including reading, writing, math, and typing in a self-directed environment. These core skills are primarily completed through online programs instead of by instruction from a teacher. This paper focuses on the afternoon curriculum, which is dedicated to our company’s STEAM projects in the makerspace. The school schedule is split into 3-6 week sessions where each session is dedicated to exploring a different topic. This school has a full makerspace including a band saw, drill press, 3D printers, and laser cutter. Students watch safety videos and are trained in safety practices [23]. Afterward, they are able to use any equipment as needed for their projects, with safety supervision as appropriate.

Figure 1: Students using the drill press and bandsaw

**Implementation**

This school’s learning design focuses on having a variety of 3-6 week long sessions throughout the year. The session topics span multiple areas of science, engineering, art, music, and performing arts. Each session is themed around broad topics such as plant science, music, painting murals, etc. and are described in detail in Table 1. They form a learning arc throughout the year that covers topics similar to what is taught in a traditional school curriculum while allowing students to dive deep into one topic at a time. The students range from ages 6-13 and are split into a 6-9 age group and a 9-13 age group. Table 1 lists several example sessions from the past year and includes examples of student projects from each session. A typical session follows the steps of the design process and can be mapped with the following structure:
1. Introduce the topic through “Frizzle Day” activity or trip related to the topic of the session as inspired by Ms. Frizzle on the show and book series *The Magic School Bus* [24]. Examples include searching for locally grown food at a grocery store, attending an exhibition on the science of sound, doing a mural tour of the city, etc.
2. Brainstorm and form teams based on common interests
3. Research topic
4. Sketch potential solutions/products
5. Prototype and sketch model solutions/products
6. Receive feedback from peers and experts
7. Pick an idea to move forward with
8. Additional research and prototyping/iterating
9. Create a Bill of Materials to determine what to buy, quantities, sizes, etc.
10. Construct final model
11. Host exhibition of learning in front of an audience of peers and an invited audience
12. Reflect on the session including personal progress and skills learned

Since the students are at different stages of core skills (Math, Reading, English, etc.), the open-ended aspect of the project parameters enables the students to learn much more individualized engineering skills. Students take the initiative to learn skills necessary to complete the projects they have designed. The instructors then help the students learn these skills and help manage safety during the process. However, the design process being followed is consistent across all ages despite the students being at various stages with their core skills. They typically work in teams and learn through the design process stages described above, guided by milestones created to help navigate the specific session topic.

Since the projects are open-ended, students are tasked with meeting frequent milestones (typically one week or less) instead of completing specific prescribed tasks. These milestones include goals such as sketching three ideas, having a first prototype, having a refined prototype, receiving feedback from peers and experts, and so on. Within these guidelines, students are given the task of self-managing their own team and individual projects as much as possible. They create calendars with personal deadlines to ensure they meet milestones. Setting milestones along the way and bringing in outside experts is useful in ensuring that consistent progress is being made throughout the time available. Students are focused on making steady progress towards achieving each milestone rather than struggling to break apart goals and tasks to reach one final due date at the end of the session. This has been successful in ensuring that students adhere to the design process while still maintaining a large amount of freedom to self-manage. This cycle is repeated for every thematic project so that the students learn and internalize the design process. During each cycle, based on their solution strategy, they identify specific needs for skills, such as the need to learn CAD or the need to learn to use the lathe. They are provided
instruction or help in acquiring these skills by the instructors. By balancing open-endedness and specificity of milestones, the students can stay focused while exploring their independent creative projects. Most of my students are able to consistently meet these milestones.

Table 1: Examples of Previous Sessions

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<tr>
<th>Session Topic and Skills Explored</th>
<th>Project Description</th>
<th>Example Projects</th>
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| **Experimental Playscapes:** *Architecture, User-centered design, Creativity, Mathematics, Fine motor skills, Digital rendering, Communication* | In this studio, the students will explore the concepts of play and fun and determine how objects and spaces can facilitate them! Students will begin with a skills week to learn different methods of construction including additive and subtractive manufacturing. Students will take what they’ve learned from that exercise into a longer project where they design playful structures and experiences for real clients and users! Students will create Photoshop renderings of their playscape in a real environment [25]. | ● Playscape on the theme of “teamwork and trust” that requires one person to lift another up to reach a second level to play on  
● Playscape on the theme of “imagination and creativity” that uses a series of trees for climbing around, in between, and into hidden nooks inside (see Figure 2). |
| **Entrepreneurship:** *Entrepreneurship, marketing, Digital sales, Math, Communication* | This studio is going to take students on an adventure to discover how they can turn their ideas into a business. Students will explore their own big ideas and abilities and will contemplate what it means to be a good person in business. Over the next 6 weeks, students will create products and launch their own business on Etsy [26]. | ● “Decorate it yourself” laser-cut animal-themed storage boxes (see Figure 3).  
● Cupcake scented candles in the shape of cupcakes (Thermoformed candle mold using a 3D printed model) |

Figure 2: Rendering of playscape, showing how it would look in the intended environment when built to full scale (including a person to demonstrate size)
| **Pen Pals 2.0:**  
*User-centered design, Cross-cultural engagement, Communication* | In this studio, students will collaborate with a school in Turkey. The students will share information about their food experiences with one another and brainstorm ways to improve those experiences. Teams from each school will work on an invention that changes an established cooking or eating experience, making it easier or more fun. The teams will then send design and instruction files to each other so that students at each school can try to recreate the designs from the other school.  
- A mixing bowl that transforms into a pan for mess-free baking (see Figure 4).  
- A utensil set where the handle can attach to a variety of utensils to save space |
| **Farming of the Future:**  
*Plant biology, Ethics, Engineering, Large scale construction, Communication* | Students will start this studio by learning the science of plants and our ecosystem. They will debate ethical issues related to food production and consumption and learn about tried and true methods and new innovations in farming. Then, they will create a growing system for the school, learn what it takes to grow and harvest successfully, and practice responsibility towards our earth and environment.  
- Vertical hydroponic garden with pumping system (see Figure 5)  
- Garden beds designed specifically for the plants grown in the school garden |

![Figure 3: DIY animal storage boxes packaged for shipping](image3)

![Figure 4: Mixing bowl to pan prototype](image4)

![Figure 5: Vertical hydroponic garden system](image5)
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<tr>
<th>Musical Inventions: Invention, Engineering, Design, Science of sound, Digital music composition, Communication</th>
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| How do we make music, and not just noise? How does a sound producing object invite the user to interact with it, and how do digital tools take those sounds to new heights?  
In this studio, students will explore high and low technology to invent their own unique music making machines. |
| ● A maraca in the heel of a shoe that makes noise when you walk  
● A music ensemble including a drum set made of unconventional materials such as an aluminum pan and a PVC pipe flute with a 3D printed mouthpiece (see Figure 6) |

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<th>Historical Innovations: History, Historical building techniques, Engineering, Design, Communication</th>
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<td>What if we could use modern tools to reimagine historical people, places, and events as if we were really there? What does the most cutting edge technological innovation look like for the scientists and engineers of that time? In this session, students will assume the role of an innovator from the Middle Ages and create a prototype of the invention using the techniques that were used during that time.</td>
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| ● Fireworks: mixed together chemicals to create gunpowder and added in metal salts for colors  
● Cannon: created a silicone mold and cast metal in it to make a replica (see Figure 7)  
● Chess: researched the original board and pieces and created a replica |

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<th>Augmented Reality Murals: Painting, Color theory, Sketching, Symbolism,</th>
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<td>How can you leave your mark on a space? During this session, students will all work in one group to create a permanent mural. Each layer of the mural will represent a different element of life in the school,</td>
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<td>● Mural background colors of purple, dark blue, and yellow to represent the emotions of trust, perseverance, and humor (See Figure 8)</td>
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Student engagement has increased dramatically through these hands-on methods. On the first day of school, the students all said their favorite thing about school was recess. By the end of the week, they wanted to come in early from recess to work on their projects. Student engagement persisted throughout the year and students were able to tackle more and more challenging projects. Their mindset shifted in terms of what they think they are capable of. Since there are more possibilities of what they can do in the educational environment, they set higher personal goals over time and worked harder to achieve them.

Throughout the year, however, I encountered several issues with student engagement and attitude. I attempted to address them by using the curriculum to inspire cultural shifts in student attitude. These issues included resistance to iteration and feedback, struggles with communication in front of an audience, and frustration with sketching to communicate ideas. Here, I discuss a few case studies of how I addressed these problems through the curriculum.

1. Exploration of Iteration

For the first few sessions, students were particularly resistant to feedback. They perceived it as an indication that they were not doing work “correctly” and struggled to understand the concept of iteration. I wanted to help my students become comfortable with giving and receiving constructive feedback and in embracing failure as a learning opportunity. To achieve this, I implemented an exercise called “Copy Copy.” We had each student investigate a different tool or object that we use in the makerspace and create different versions of it within strict time limits: sketches, cardboard prototypes, and a digital model. This forced them to create multiple
iterations at different levels of fidelity and allowed them to practice iteration on something that wasn’t their own creative idea. One student had been struggling both academically and with behavioral issues at the time that we began this project. At the beginning of the school year, he was a perfectionist. If he made a mistake while sketching, he would rip up his paper and throw it away immediately. During the Copy Copy exercise, he became very interested in creating replicas of a hole punch and was unbelievably engaged. He began by sketching the hole punch and was excited to show me all the drafts he made. Instead of throwing them away, he decided to turn them into a booklet and described to me all the mistakes he made at each stage and how he improved them in the following iteration. He was thrilled with his final sketch, not because it was perfect on the first try, but because he had done so many drafts in order to improve it. The cardboard prototype was supposed to be designed to move in a similar way to the initial object, but he went above and beyond in trying to figure out how to get it to punch holes in paper. He ended up attaching screws to the cardboard model that would puncture the paper. He then tested it on a piece of paper and compared the holes it created with the holes that the original hole punch created (see Figure 9). He loved experimenting in Tinkercad to try and replicate his object and created a very detailed model based on his observations of the hole punch, learning a lot of software skills along the way!

Figure 9: Working cardboard prototype of hole punch, paper comparing holes from hole punch and from cardboard prototype, TinkercAD model of hole punch [28].
II. Regular Opportunities for Presentation

Another issue I ran into was having students struggle with presenting their work. Several students were resistant to presenting without reading off of a written script. Communicating ideas to an audience is a crucial skill we emphasize, and we encourage our students to present without written notes so that they can communicate more naturally to the audience. At our first exhibition, even though students were prohibited from using written scripts, one student read from a script for the entire presentation. Throughout the year, the students presented their work at many stages during each session. Eventually, it became second nature to put together a presentation and practice it for the exhibition. At the end of the year, we held a communications workshop for other local children from the community. The same student who refused to present without a written script at the beginning of the year volunteered to give an impromptu pitch to the other children! Her pitch was cogent and served as an excellent example to the others. It was remarkable to see how far she had progressed by the end of the school year.

III. Using a Ritual for Skillbuilding

At the beginning of the year, my students were averse to sketching. Many complained that they were not good at drawing and not artistically inclined. I wanted to demonstrate to students that sketching is more than an art form: it is a communication tool. Quick sketches can help convey ideas much more effectively and efficiently than trying to describe them in words. To help them learn this, I ran a 5-minute sketching ritual each day with my students for an entire session. Each day, we’d pick an object and do a 5-second, 30-second, and 2-minute sketch of it (see Figure 10). It helped students realize that within 5 seconds they could draw the main lines of an object and be able to convey what it is. Within 30 seconds, they could add a significant amount of detail when they were focused on just drawing what they saw instead of thinking about whether or not they were good at drawing. After the first few days, we were able to add in additional student buy-in by having them choose the objects we drew. Each student chose a day when they would bring in an object that the entire class would draw. This again removed the focus from their fears about being poor artists and instead turned it into excitement about a shared experience that they were facilitating. By the end of the session, students were creating much more refined sketches and were able to use sketching to communicate. Students who previously refused to sketch ideas started instinctively turning to their sketchbooks when trying to communicate new concepts.
IV. Prototyping and Precision

During one session, one of the students wanted to create a model of a tiny house that had a table that slid in and out of the wall to save space. This was one of her first experiences using digital modeling software and a laser cutter, so she had a lot to learn in the process. She started making prototypes and learning that she had to make incredibly precise measurements in order to have the pieces fit together. She was often very frustrated throughout the process since the pieces weren’t lining up. However, by the end she was energized by the fact that she had made so many prototypes and iterations. She saw it as evidence of her hard work and proudly displayed all of them in a photograph together (see Figure 11).
V. Learning to Use New Machinery

During one session on Historical Innovations, one of my students wanted to make a mortar and pestle to grind coffee with. We decided to get a lathe for the school so that she could use it to create her project. She had no experience with woodworking and machine shop tools, but was eager to learn. She read the instructions to put the machine together and watched tutorials to learn how to use it. She learned skills like how to turn a piece of square stock into a cylinder and how to turn a bowl (see Figure 12). By the end of the session, she was proficient on the lathe and comfortable using it, and she’s looking forward to teaching others how to use it in the future!

VI. Girls as Leaders

One interesting observation is that the girls have set higher standards for themselves and exhibit strong leadership skills. We require all students to document their work daily, and at the end of each week we recognize all the students who have documented every day. The girls view this as a bare minimum requirement and are upset if they accidentally miss a day. On the other hand, many of the boys see it as a rough guideline and are happy if they receive recognition at the end of the week. The girls are more likely to view conflict and feedback as personal failures. The girls also accept responsibility for the group as a whole. There are four leaders in the school, all of whom are girls, who are each in charge of a separate group of the other students. They enforce cleaning duties, check off the goals of each student in their group, and provide feedback to their team. During group projects, the girls naturally fill the leadership roles. If the girls are absent on a particular day, the boys do not step up to a leadership role or accomplish much on their own, stating that it is because the girls aren’t present to lead the group or assign tasks.
**Student Assessments and Self-Efficacy Scores**

At the end of each session, students spend a whole day on reflection. This reflection includes providing feedback to their peers and analyzing their own experiences during the session. The students discuss personal reflections and complete a self-assessment of their learning during the session. The students fill out a survey which asks them to score their skill levels on specific skills that were used during the session such as “Brainstorming,” “Sketching,” “Prototyping,” and “2D-Design: Illustrator.” For each skill, they rate their level on a 3-point Likert scale with answer choices “Lacking,” “Developing,” or “Strong.” They also rate some of their experiences, such as “Teamwork,” “Paying Attention,” “Taking Feedback,” and “Giving Feedback.” For these ratings, they compare their experiences to their experiences during the previous session using a 3-point Likert scale with answer choices “Worse,” “Same,” or “Better.”

The following figures summarize some of the results of these surveys from two different project sessions described earlier in Table 1: “Experimental Playscapes” and “Farming of the Future.” These were two consecutive themes, “Experimental Playscapes” being the former and “Farming of the Future” the latter. The sample size for these surveys is 14 students; any student who filled out one survey but not the other was eliminated from the results to maintain consistency and to evaluate trends accurately. This study was limited by the number of students enrolled in the school and would benefit from conducting similar surveys with a larger sample size to better track student self-evaluation over time using the curriculum.

![Figure 13: Prototyping self-efficacy scores during two consecutive sessions.](image)

As shown in Figure 13, several students shifted their self-efficacy ratings for prototyping from “Developing” to “Strong” by the end of the second consecutive session where prototyping had been a key component. Many essential prototyping skills were introduced during the Experimental Playscapes session since the project focused on creating small architectural models. As a result, when the students had to create small prototypes of their large-scale
hydroponic structures during the Farming for the Future session, they already had experience with various prototyping techniques. The work during Farming for the Future built directly off of the scaffolding established during the Experimental Playscapes session, so the trends in Figure 13 are consistent with the intentions of the session.

![Figure 14: Teamwork self-efficacy scores during two consecutive sessions.](image)

As shown in Figure 14, the majority of students saw an improvement in their teamwork skills during the Experimental Playscapes session (as compared to the session before it). These improved skills were maintained or improved further during the Farming of the Future session. During the Experimental Playscapes session, students worked in groups of 2-3 based on their interests in different “areas of play” that were identified to frame the session. During the Farming of the Future session, students worked in larger groups of 4-6 on large-scale construction of garden beds and hydroponic systems. Despite the increase in team size during that session, they still indicated having positive experiences with teamwork, which may indicate growth in their teamwork skills as well. Throughout both sessions, students used conflict resolution and peer mediation techniques as needed to address disagreements amongst the teams.

**Recommendations for Implementation**

Several of the techniques we used have been incredibly successful in building engagement and letting students take control of their learning. These could be implemented in other makerspaces that aim to serve a similar age group.

One of the major successes of these methods has been in empowering students and then letting them get invested by giving them agency. Our makerspace is set up so they can do things on their own. Everything is designed to be within their reach, and they have the ability to organize the shop in a way that makes sense for them. They are given access to user-friendly entry level software that lowers the barrier to entry. For instance, they begin learning 3D modeling using
TinkerCAD so that they can 3D print right away [28]. More advanced students later move on to Fusion360 [29]. We use the Glowforge laser cutter which allows users to cut out and engrave drawings by scanning them in [30]. This lets them get started with laser cutting without having to learn software. Once they have a need for more precision, they learn to use Adobe Illustrator and have that interface with the laser cutter [31]. Students are free to use any combination of the tools at the shop while working on their projects and prototypes. Attention to accessibility in the shop helps expand students’ views of what is possible and promotes the conceptualization and testing of ideas. This environment makes failure feel like an integral and encouraged part of learning, which is key to student growth.

Turning skillbuilding into rituals has also been very successful in our learning environment. By having a daily sketching ritual, we turned sketching into a commonplace everyday activity instead of having it be a daunting display of artistic proficiency. We also had students sign up to get a chance to choose the objects being sketched. This created buy-in from the students and increased engagement dramatically. All of a sudden, sketching had an added element of show and tell which is a known and effective method of student engagement. This approach could be applied to other skills like brainstorming or cardboard prototyping. The creation of a ritual with the added element of student buy-in proved to be extremely beneficial for engagement and skillbuilding.

**Conclusion and Future Work**

**Key Takeaways**

It is clear that hands-on project-based education is teaching students vital skills. The students are incredibly engaged and eager to learn. Student engagement with the curriculum is critical to their growth, and it is very powerful to watch students voluntarily work on their projects during free time. Students that want to accomplish a goal or make a certain project are motivated to work harder and learn more readily. The students, even at this age, can perform what are often considered “adult” tasks when empowered to do so. They are able to safely use power tools like drills and machinery like a lathe and bandsaw. They are proficient in digital software and are able to sketch to communicate ideas and create refined prototypes. The students are learning skills in entrepreneurship, research, design, science, project management, and engineering before they enter middle school. Due to the project-based approach of addressing topics holistically, students are realizing first-hand that the real world cannot be compartmentalized into siloed subjects and are learning to be interdisciplinary thinkers. In addition, they learn many soft skills not emphasized in traditional school environments. They work in teams of various sizes, and they give and receive constructive feedback. They learn time management, big-picture thinking, problem solving, presenting work, and most importantly learn that failure is a crucial part of
learning. Students with this kind of education may even be ready for college level curriculum sooner.

Future Research

Often, students choose to stay in their comfort zone and need to be pushed further. The current pedagogy of the school relies on an entirely learner-driven environment, in which students often pursue what they already know. I would like to do further work in helping students push themselves out of their comfort zone while retaining the learner-driven environment.

It is remarkable that students at the elementary school age are capable of developing self-driven engagement with their education, and I want to quantify the difference in engagement compared to traditional elementary school curriculum. Currently, I only have access to self-efficacy data, but I would like to conduct additional assessments to evaluate whether or not the desired learning outcomes are being met. I also hypothesize that early nurturing in these STEAM fields may be crucial in recruiting and retaining a more diverse community in STEAM at the undergraduate and professional level, and I would like to conduct longitudinal studies to determine how access to this kind of curriculum impacts pursuing future careers in STEAM. Being able to quantify improvements in student skills and test ritual-based skill building methods would be very useful for other educators. Future research could also help measure the impact and effects of this type of curriculum.

Currently, open-ended projects are often not achievable in public school curricula due to the expense associated with makerspaces and difficulty adhering to pre-set curricular standards when students are simultaneously pursuing a wide range of projects. I am interested in exploring avenues to democratize this form of education to help more students from all backgrounds have access to these opportunities.
References


