‘STILL I’LL RISE’:
EXPLORING GIRLS’ PARTICIPATION DURING LITERACY-RICH STEM EXPERIENCES

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This dissertation is dedicated to my father, James Albert Stockton, who passed away on January 2, 2021. He encouraged me to obtain a doctoral degree, believing I could achieve this goal even when I doubted myself. His love and unwavering support allowed me to push through even though he joined the ancestors before I completed this program.

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Abstract

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True equity and justice in our society will be achieved when we reach a day where no structures: systemic, racial, gender, ethnic, financial, or any other factor will impede people from pursuing and achieving their goals and reaching their full potential. To get on that path, the work starts now.

This dissertation examines how girls participate during literacy-rich STEM experiences in a girls-only summer camp versus a mixed-gender camp. Using a qualitative collective case study design situated in critical sociocultural perspectives, participants' participation was analyzed through the lenses of cognition, emotion, and behavior. Data sources included video data of students participating in literacy-rich STEM activities such as using resources to design and plant a garden or to hypothesize and calculate the impact of an invasive species. When coding cognition, observable higher order thinking behaviors were categorized as either analysis, application, or evaluation. Emotional responses were classified as positive (for example, expressing joy), or negative (for example, expressing frustration). Behavior data were categorized as either interactional or irrelevant to the activity. Furthermore, the data were examined to determine whether the added literacy was needed to complete the STEM task in an authentic way.

Additionally, this study explored how integrating literacy into STEM benefits diverse learners from groups who are under-represented in STEM professions, such as girls. Analysis

showed that how girls' participation changes when STEM activities are literacy-rich is multi-faceted and depends on the facilitator's ability, ample wait time, and exposure to the material more than once.

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Chapter 1: Introduction

The second stanza of “Still I Rise” written by Maya Angelou (1978) says,

“Does my sassiness upset you?
Why are you beset with gloom?
‘Cause I walk like I've got oil wells
Pumping in my living room.”

“Still I Rise,” one of Maya Angelou’s (1978) most well-known poems focuses on the ability to be resilient, rise above, and achieve goals despite the challenges and barriers in the way. Although one can assert this Angelou poem centers the struggles of Black women, the poem still holds value and truth for females of any age or racial background.

Children, regardless of gender, should be able to pursue any path that speaks to them. Unfortunately, many times, female children are not engaged seriously at school in the same way as male children. The female confidence might be attributed to being sassy or even arrogance. When girls have many encounters like this over time, it can impact their confidence. Sieghart (2022) sees this lack of confidence as an *authority gap*. She shared:

> I’ve talked to women from Africa, Latin America, Asia and the Middle East, as well as from Europe and America, and they all say that they have experience of being taken less seriously than men. We notice that we interrupt them more, challenge their expertise more and listen to them less … It makes women fume, it dents their confidence and holds them back (p.6).

When girls are questioned about being able to do a task or having the knowledge to accomplish a task, it might make them believe that some subject areas, such as science, technology, engineering, and math (STEM), are not for them or more suited for boys. Furthermore, “elementary and secondary classes in STEM often create dynamics that encourage male dominance and female submissiveness" (Kuchynka et al., 2022, p. 266). Why would girls pursue a STEM career if their knowledge gained in those areas is questioned and they are placed in situations to default to a male lead? Reshma Saujani (2015), founder of Girls Who Code, said, "We tell our girls to go slow and focus on reading and writing … I'll speak to a classroom full of girls and I'll say, 'How many of you have ever said you hate math?' Every hand raised. We would never allow them to say 'I hate to read. I hate to write.'" It seems like girls must have permission or encouragement to like math or science because societal structures make it comfortable for girls to dislike STEM and share that stance when asked.

Through my research, I explored how educators can leverage literacy-rich experiences and the arts when it comes to girls participating in STEM. In particular, I explore how integrating literacy into STEM benefits diverse learners from groups who are under-represented in STEM professions, specifically girls. The National Research Council (2014) explained that integrated STEM instruction typically uses project-based learning or problem-based learning to solve multi-layered problems through academic skills in various content areas (pp 51-52).

Background

STEM, which represents the disciplines of science, technology, engineering and math, has become a big push in the K-12 setting. Indiana is no exception. The Indiana Department of Education (IDOE, 2022) has developed a process where Indiana schools can be certified as a STEM school. The IDOE STEM Schools Certification process began in 2014 and over 100 Indiana schools have earned the certification.

There are reasons departments of education, district leaders, and school leaders are elevating the importance of STEM. The U.S. Department of Labor collects data for occupational employment and wage. When it comes to STEM, the department tracks data on 100 STEM jobs such as "computer and mathematical, architecture and engineering, life and physical science and postsecondary teaching occupations related to these areas” (U.S. Bureau of Labor Statistics, 2021). In the Employment Projection 2021-2031 report released in September 2022, the Bureau of Labor Statistics (BLS) predicts that due to increasing demand for technical expertise, an increase of STEM jobs such as information technology (IT) and cybersecurity will be needed. Technical expertise jobs are expected to have the third-largest employment increase. Also, the BLS predicts there will be an average employment growth of 15.4% in the fields of computer and mathematical jobs from now through 2031. There are three jobs in those sectors that are considered to be fast growing: data scientists, information security analysts, and statisticians. STEM careers are not only growing in demand, but they also pay a high wage. According to 2021 BLS data, on average, the annual salary for data scientists is $100,910, information security analysts is $102,600, and statisticians is $95, 570. According to the 2020 United States Census, the median family income was $67,521 (US Census Bureau, 2021). This means many STEM jobs allow one person in a family to earn more income than many two-earner income families. Regardless of each person’s vision of the American dream for himself or herself, most of the dreams include the ability to at least take care of oneself.

Demand for these high paying jobs is a strong reason to push for STEM integration. However, it is important to find ways to make STEM careers accessible to all, especially underrepresented groups. Literacy-into-STEM integration is one pathway to reach those goals.

Literacy-Into-STEM Integration

Literacy-into-STEM integration is part of a larger movement called STEAM, that is, STEM plus arts. The arts not only encompass creative arts like music and art, but also include literature, writing, and history. For my research, I narrowed my focus to creative arts and literacy-rich experiences that involve a cross-curricular aspect with STEM.

Literacy-Rich Experiences

Literacy-rich environments are essential for students to achieve academic success. The Technical Training Assistance Center (2018, p.2), funded by the Florida Department of Education, defines literacy-rich as “an environment that supports all four domains of language: reading, writing, speaking and listening.” During my research study, I observed several instances where literacy-rich experiences and creative arts work in tandem with STEM. For example, students listened to a lecture about the benefits of indigo dye for fabric arts and were able to engage the speaker with follow up questions which used the literacy domains of listening and speaking. Students then learned the science behind how indigo was made. Last, they were able to dye cloth and make their own artistic design using indigo. This particular activity meshed STEM, literacy-rich experiences, and art together.

These environments cannot be restricted to only reading. Understanding the benefits of literacy-rich environments outside of English/language arts instruction is important as is exploring them within other settings, such as STEM environments.

Although STEM is more deeply explored in the middle and high school settings, it is crucial to understand the value of STEM in the elementary setting. The secondary setting may be too late to build children’s STEM confidence and participation, especially for underrepresented groups like girls. “Children form theories about the world long before they can understand if those theories are true. To combat those self-limiting beliefs, teachers must provide numerous meaningful learning experiences to deepen students’ understanding” (National Science Resources Center of the National Academy of Sciences and the Smithsonian, 1997, p.30).

Purpose

Through my research, I seek to explore how literacy-rich STEM experiences and creative arts during a week-long, multi-age, STEM camp for 3rd, 4th, and 5th graders impacts girls’ participation during STEM activities. I will compare girls' engagement with STEM across a girls-only version and a co-ed version of the camp. I also will explore how the impact of literacy-rich experiences influences their participation while doing STEM content.

Significance of the Study

At some point in the future, there may come a time when gender is no longer a measure which can be used to predict the fields a person may pursue as a career. Many factors contribute to why there are fewer females in STEM careers.

> Psychologists have studied the impact of implicit attitudes and stereotypes; feminist theorists have examined the role of masculine influences embedded in our culture; advertising experts have looked at the role of gender in marketing of STEM products; media experts have examined how boys and girls are portrayed in popular culture; and educators have looked at curriculum content and social dynamics in school. All of these factors taken together—along with recent accounts of sexual harassment in tech fields, workplace discrimination, and pay inequity—have contributed to a society that simply does not support women who pursue STEM careers the same way it supports men. (Sullivan, 2019, pp. xvi-xvii)

This suggests there needs to be a strengthening of environments where girls want to participate in STEM and engage in STEM learning.

My Histories with STEM

This research topic is important to me due to several personal experiences. During the course of my career, I have served as a middle and high school English teacher, an elementary and high school literacy coach, an elementary English as a new language teacher, an elementary librarian, and a middle school academic dean, where I supervised, coached and evaluated all middle school English teachers, middle school social studies teachers, and K-8 elective/special areas teachers. Currently, I am an education consultant who helps school administrators and teachers provide a quality education where I specifically focus on areas such as literacy, multilingual learners, cultural responsiveness, and school environment. Across the roles I held earlier in my career and my work today, literacy is the key element that ties all of these roles together. I believe all students can use literacy as a tool to access knowledge in any academic discipline.

Except for my first year in the classroom and some of my current education consulting work, I have worked in the city where I live. This midwestern city is also where I attended school K-12. It was vital for me to teach in the city where I had been taught and to teach students who are racially identified as Black as I am. In most of the schools where I have served, the majority of students were students of color, and a large percentage of those students of color were Black. I wanted to be the type of teacher who pushed students to achieve their greatest potential, just as I had been pushed as a kid.

In school, I did well academically but did not always have the confidence to shine. One day, my high school math teacher asked me to come to the board and explain a math problem the rest of the class could not understand. Typically, my male classmates would volunteer, so I was nervous about being called, especially since I had not volunteered to share. After I explained and worked the problem out on the board, he had me write my initials. It was important to him that I was publicly recognized. When I wrote "SSS," he gave me a new nickname that has stuck with me to this day "S Cubed." I felt empowered and had the most confidence I had ever had in math. When I reflectively look back at this experience, this should not have been the case. I earned high academic marks in math for years, but I still became nervous to demonstrate knowledge that I knew I had.

Years later, I worked in a math and science academy during my second and third years in the classroom. Although I taught 6th and 7th grade English and 9th grade creative writing, I was expected to weave STEM into my curriculum. Additionally, I was one of the sponsors of the school's science Olympiad club. Within our team, we were in groups and some students participated in individual challenges. When my principal approached me about being a sponsor, although I was confident in math and science, I was not teaching either of those subjects and wondered if I was the best woman for the job. I quickly learned that I was.

My group was tasked with using several literacy domains for our competition. My students practiced for weeks on a challenge that split our team in half: one half had to communicate a creation to the other half of the team through writing, while the other half had to build the creation. Throughout this process, the students had to utilize complex science skills while using written skills to communicate. I had to teach students how to comprehend and analyze a scientific concept and then communicate the concept to others. This allowed students to gain a deeper understanding of the science skills while simultaneously strengthening their writing skills. By the end of the activity, my students used the four literacy domains of reading, writing, speaking, and listening. They also had to bring those domains together and comprehend how to execute the task. Their hard work paid off. My group earned third place during the science Olympiad competition at Purdue University. Being the adult facilitator of this team allowed me to see how STEM and literacy could work in tandem to build skills in both areas simultaneously.

Although I have never been a science teacher, working in a math and science academy increased my desire to continue to weave STEM concepts into my curriculum even when I no longer worked there. Literacy skills are needed in every single class. When I integrated STEM and other subject areas into my secondary English classroom, it provided students with the tools to better attack the content area when they were in the other subject area classes.

Not only did my research explore the importance of literacy-rich STEM experiences, but it also acknowledges the importance of cross-curricular work with literacy and encourages non-literacy educators to explore ways to leverage literacy-rich experiences in their content areas, especially in the STEM content areas.

Research Questions

It is not only important to understand the benefits of exposing girls to literary-rich STEM experiences, but it is also important to understand the potential barriers and roadblocks young females may face when attempting to fully engage in STEM learning. In theory, girls are sitting in the same classes as their male counterparts and are receiving the same instruction. In reality, being in a mixed gender environment and receiving the same instruction does not guarantee that girls will (a) desire to participate (Wang and Frye, 2019), (b) have the confidence to participate (Sieghart, 2022; Ma et al., 2022), and (c) avoid deferring to male peers' lead in the classroom environment (Kuchynka et al., 2022).

To further understand the impact of literacy-rich STEM experiences and creative arts for girls in a girls-only STEM camp versus a mixed gender STEM camp, there are three main concepts I will explore:

1. How does cross-curricular work that infuses literacy and creative arts into STEM activity influence girls' interactions and participation?
2. How does girls' participation vary across literacy-infused STEM activities? Which activities invite more participation? What STEM identities do girls take up in these activities?
3. How does girls' participation vary across girls-only and mixed gender groups?

Local Context

My research study took place in a non-traditional learning environment, specifically a camp on a 28-acre farm located in a mid-size urban city. State data for the city where this camp is located shows that, in 2022, 45.4% of female students in grades 3-8 passed the English/language portion of the state's annual standardized test compared to only 37.2% of males. Girls' higher achievement in literacy opens an opportunity to study whether this strength could be used to bolster their STEM knowledge and participation. When it comes to math for the same grade bands, only 37.2% girls passed the assessment compared to 41.5% of boys. Additionally, in science, which is taken only by fourth and sixth grade students, only 37.0% of girls passed in comparison to 40.2% of boys (Indiana Department of Education, 2022).

The camp STEM World (pseudonym) operates STEM programming on the farm throughout the year, with STEM camps happening during the summer, including a camp only for girls. The day camps in past years ran for one week, Monday-Friday, from 9 a.m. to 2 p.m. The camp days and hours were shifted prior to my study to better meet parents' needs. The camp shifted to one week, Monday-Thursday, from 9 a.m. to 4 p.m.

STEM World had three week-long STEM camps for the public. (The other camps were closed to school districts who have a partnership with the organization.) Two weeks were mixed gender and one week was girls-only. I observed and collected data during all three weeks.

The three public camps provided learning opportunities for students to learn and explore STEM. During the camp, the girls had numerous opportunities to participate in hands-on activities, such as makerspaces, that they may not have had access to in the traditional school setting. In their article, authors Gravel et al. (2017) assert that literacy can be a framework for makers to represent text across disciplines by using various modes and that identifying, organizing, and integrating information is a way students can obtain knowledge for making. This connects practices between standards that can take place due to STEM literacies (pp. 925-926). The implication for educators is to use literacy intentionally in STEM curriculum construction.

Time is limited when teaching children. Unlike secondary educators who typically focus on one subject area, elementary educators plan lessons for multiple subject areas, but in isolation. They might need support with cross-curricular lesson planning. Educators learning how to maximize instructional minutes through cross-curriculum learning activities with STEM and literacy can provide an opportunity for students to learn efficiently and on a deeper level, especially girls.

Mills asserts "there is a shared recognition that reading and writing practices using words-on-paper-based text formats are necessary, but not sufficient, for communicating across the multiple platforms of meaning making in society" (2016, p 25). In other words, Mills reminds us when it comes to the four language domains, there are various ways those domains can be displayed and integrated inside the traditional classroom or in a learning space.

Theoretical Framework: Critical Sociocultural Perspectives on STEM

To analyze the data I have collected to answer my research questions, I will situate this research in critical sociocultural perspectives on literacy and STEM.

Identity

Critical perspectives explore ways individuals can be empowered to break out of boxes placed upon them by race, class, or gender (Fay, 1987, as cited in Creswell and Poth, 2017). When it comes to STEM, critical theory addresses the constraints, real or imagined, that keeps systems and societal beliefs and structures going in the same way despite efforts to change the system or to address a problem like getting more girls involved in STEM and increasing the number of girls entering and remaining in STEM careers.

Earlier in this chapter, I explained that data from the state where I conducted my research shows that girls have stronger achievement in literacy. If the literature and media girls are being inundated with positions them as not as capable as boys, those messages could become ingrained in their psyche and push them to not engage in STEM as they could. “In observations of more than one hundred classrooms, Sadker et al. (2009) found that male students are more than often heard and female students are more often stifled” (69). To truly understand the benefits for girls in a girls-only STEM camp versus girls in a mixed gender STEM camp, issues like this must be explored.

Kimberlé Williams Crenshaw, a leading scholar of critical race theory, coined the term intersectionality which is the concept that we live inside multiple identities (1989). I am both a woman and Black. Each of those identities play a role in the lens through which I see the world and how I operate in the word. Even though my research is focused on girls, the girls in my study came from three racial backgrounds: Black, Latino, and White. There are not cries for more White people to join STEM. Although the White girls fall into an underrepresented group for their gender, they do not fall into an underrepresented group based on their race. Then, when we look at our Latino and Black girls, we know that both girls and people of color are underrepresented in STEM. Patricia Collins, in her book *Black Feminist Thought* said, “The need for such thought (Black feminist thought) arises because African-American women as a group remain oppressed within a U.S. context characterized by injustice (2002, p.12). Collins wrote an entire book about the importance of understanding how females who are also racially Black operate in the world which should cause us to pause and think about how these multiple identities impact young girls. We must acknowledge that some girls live in two or more identities that are not sufficiently represented in STEM, and each of those identities should be considered when looking at increasing the number of girls who consider a STEM career.

Situating my research in critical perspectives allows me to extend my thinking beyond what is on the surface. Mansfield et al. (2014) explain that the STEM crisis, when it comes to increasing underrepresented groups such as people of color and girls, focuses too much on external sources as the magic cure all. Instead, they suggest there are STEM experts within school walls. The policies and education grants on both the federal and state government level are a distraction to the real levers of change that need to be pulled. Through my research, I will highlight how girls can be empowered to participate and engage more in STEM in a girls-only setting versus a mixed gender setting and the levers of change needed which might differ from the narratives that have the largest attention.

Multiliteracies

Families shape who their children are through their values, culture, and background, so it is important to also understand and consider sociocultural approaches to learning and knowing before taking a deeper dive into the sociocultural aspect of multiliteracies and how it intersects with STEM and STEAM.

When it comes to expanding literacy to encompass STEM, it is important to note the multiliteracies framework from the New London Group (1996), a group of ten people from various backgrounds with a common interest in literacy. In *A Pedagogy of Multiliteracies*, they argued that what was typically included under the umbrella of literacy should be expanded. Multiliteracies "accounts for the multiplicity of communication channels, media, and modes" (Mills, 2016, p. 19) that should be considered when thinking about literacy.

Community is key. Student ownership of learning is one part of the equation. Understanding who students are and their backgrounds is another part of the equation. As a Black woman, I can remember the classroom and spaces where I felt seen and felt welcomed versus the spaces that seemed to only tolerate my presence. The spaces where I felt welcome acknowledged that my lived experiences had value and were critical to my learning.

When it comes to the cultural nature of knowledge, it is important to embrace the diverse experiences students have and bring with them to the classroom or learning space. Case (1996, p. 81) explained that educators must have an authentic praxis in the learning environment and find ways to introduce and integrate students into it. In particular, from the lens of sociohistoric theory, students must have access to culturally appropriate curricula (Case, 1996, p.81). When it comes to STEM, this includes aspects of student communities in the activities. If the instructors do not live in the students' communities or do not know much about the students' culture, they must be willing to do some work to learn to about the students to make the connections in an authentic way.

Let us consider a group of students who are learning about the ecosystem of honeybees. They need to understand how the impact of honeybees doing what they do shows up in their community and where they can look to see this impact. Having students look at data about the cost of honey in their neighborhoods and paralleling that with honeybee activity can help students see why environmentalists would encourage students to plant flowers to provide food for honeybees. When students can make real connections to their lives and their communities, they are motivated to engage, and engagement can lead to better internalization of the content. Lee reminds us that "cognitive, social, physical, and biological dimensions of both individuals and contexts interact in important ways" (Lee, 2008, p. 275). Being aware of those actions and leveraging them ultimately helps students from diverse backgrounds grow a sense of belonging and feel more included in their learning communities.

The learning community is not only a place to learn, but it is also a community to join. At my research site, students are frequently referred to as scientists or engineers. They even have the opportunity to work with scientists who visit the site. Sfard (1998, p. 6) states "while the learners are newcomers and potential reformers of the practice, the teachers are the preservers of its continuity. From a lone entrepreneur, the learner turns into an integral part of a team." Being called scientists or engineers matters because the organization believes exposure to STEM will lead to more students pursuing a STEM degree and STEM profession. Additionally, since they are targeting girls and students of color who are underrepresented in STEM careers, the organization feels it is crucial for these students to see themselves in these roles and as part of the community.

It is also helpful for younger students to see older students engaged in STEAM or STEM. The National Academies of Sciences, Engineering, and Medicine (2018, p.26) reminds us that Vygotsky, Luria, and Leontiey asserted that students grow cognitively through joint activities mediated by adults or more advanced children. This aligns with the strategy of having older student mentors supporting younger students as they are learning. The teacher who acts as mediator is more than the facilitator. The teacher is collaborating with students, young and older, to help them internalize and engage in academic content, often in a setting that has a bit more freedom than the traditional classroom setting.

As the students start seeing themselves as scientists, engineers, mathematicians, or technology specialists, they need to be able to connect this academic work to people who work in these roles in their own communities. This connection sets the groundwork for students engaging in multiliteracies within STEAM. Learning is not an independent activity. It occurs in interaction between students and text as well as the interactions between students who have read the same text or experienced the same literacy opportunities. This study aims also to understand the best dynamics and interactions between literacy and STEM to maximize students learning STEM content as well as engage their literacy skills at the same time. Just as STEM has four components, there are multiple components to literacy: reading, writing, speaking, and listening. Each literacy component can help students access each part of STEM in various ways.

As alluded to earlier, this paper will highlight literacy-into-STEM integration while focusing the analysis on how patriarchal structures, societal norms, and social interactions impact underrepresented groups like girls when it comes to STEM. This multi-pronged approach acknowledges the layers that must be addressed in order to increase the pipeline of girls' participation in STEM and later as women in STEM careers. Additionally, it drives home the point that systemic changes and the way we think about impacting this issue must be considered.

I would be remiss if I did not acknowledge that my identity resides in two underrepresented groups in STEM. Racially, I am considered Black, and I am a cis-gendered female. Although my personal labels drive my interest in this research, my theoretical underpinning guides my data analysis and my research conclusions.

Chapter 2: Literature Review

Literacy is not only limited to reading class in the elementary setting or English/language arts in the secondary setting. It permeates all courses in schools. However, the intentionality of literacy-rich experiences is more prevalent and more of a focus in reading and English/language arts classes. This literature review will highlight how intentionally addressing and leveraging the four literacy domains of reading, writing, speaking, and listening can impact students, especially girls' learning and participation in STEM. This literature review examines research on literacy-into-STEM integration (also known as STEAM), the benefits of STEAM for girls' learning and participation, and the benefits to girls in a girls-only environment versus a co-ed environment.

STEM and Arts Integration

STEAM is more than cross-curricular work of having a STEM element and an arts element in a lesson. It is more about how these elements can work in tandem to produce an observable change. The ideal aspiration would be to produce an observable change that crosses more than one of the STEAM content areas. Despite being focused on learning in the STEM fields, Halverson and Sawyer (2022) argue that "the arts are central to our understanding of learning and knowing and therefore of crucial importance" (p.1). Often, the arts can be seen as fluff, and too many times, arts programs like music, art, or dance are the first to be cut when school leaders need to get their expenses within the range of the budget (Hambek, 2016). Instead, the arts, which also includes areas like literature or theater, should be seen as an area that is just as necessary as science, technology, engineering, and math (Chen, 2022).

The term STEAM made its way to the national spotlight in part due to the Rhode Island School of Design (RISD). The organization's advocacy work eventually led to the creation of the Congressional STEAM Caucus in 2013 (Allina, 2018, p. 77). A driver of the initiative was the rationale that a focus on the integration of arts and STEM would benefit the economy and allow students to compete in the global setting. There was an understanding that when it came to careers no component of STEM works without the intersection of other domains within STEM or outside of STEM like the various components of the arts.

Moreover, literacy and creative arts do not live in a vacuum. How they function in society is rooted in how we value and use the disciplines. Halverson and Sawyer believe we should expand our thinking and our research to move beyond simply using the arts to improve STEM. They challenged that researchers should consider that “engaging in arts practice leads to deep learning that has benefits far beyond the specific discipline” and “learning through the arts refers to what is learned that is general knowledge that extends beyond the techniques being mastered.” They posit the arts can be the medium in which students engage in learning another content area and techniques used in the arts can be applied to different content areas” (2022, p. 5).

In New York, six Title I elementary schools participated in a research study. Three schools implemented an integrated math, English, and arts curriculum. Students who were instructed through the interdisciplinary curriculum were compared to students who were taught subjects separately. The researchers found that the interdisciplinary curriculum “improved treatment students’ visual arts skills, literacy, and math achievement” (Cunnington et al., 2014, p.13).

STEAM education should not be seen as using the arts to teach STEM. In the example above, when the curriculum was integrated, it was a win for all the content areas. When one thinks of the arts, creativity is an attribute that may come to mind. If STEAM is seen as only bringing the skill of creativity to STEM, the mark has been missed. Sochacka et al. (2016) argued that creativity is already part of STEM, and the arts would be better used to help students learning engineering with a problem-based learning approach (p.19). They also contended that STEAM education can help students develop their STEM identity.

Additionally, in a review of the literature about STEAM education and early childhood, researchers found that an emphasis on STEAM helped ensure that subject areas like science were not left behind while reading and math were being prioritized. With younger students, there is a heightened focus on teaching students how to read and making sure they have essential math skills to function in society. This may mean that science or social studies instruction is tossed to the side. The researchers asserted that science aligns with young children's naturally inquisitive nature (Wahyuningsih et al., 2020, pp.37-38). Using time that should go to engaging students in all the content areas in order to instead give a double dose of reading and math denies students the opportunity to be exposed to areas like science, technology, and engineering at an early age. That exposure is needed to give students as many opportunities to explore these areas so they will see these areas as a skill they can do (Froschauer, 2016).

Voicu et al. (2022) explored STEAM professionals' beliefs about early access to STEAM. They conducted a survey involving STEAM professionals and parents to compare beliefs about STEAM education across six countries. In their findings, overall, STEAM professionals believed that introducing students to STEAM in the preschool years or elementary years can provide students with a holistic education approach (p.14). Moreover, when it came to increasing underrepresented groups in STEAM, the STEAM professionals believed that parents played a critical role in children's beliefs, especially when it came to girls. The professionals asserted that parents needed to be educated about the benefits of STEAM to make an impact on the actions of their children (Voicu et al., 2022, p.12). The study implications suggest that STEAM education should involve a partnership between teachers, students, and parents. Even if schools introduce STEAM at an early age, the benefits of STEAM for students, especially girls or students of color, need to be reinforced at home. If the values of STEAM at school contradicts the values girls or students of color are receiving at home, this could influence how they see STEAM. Furthermore, it could shape their beliefs about whether they are STEM people or have the ability to develop the skills to pursue a STEM career.

Since my research data was collected in a summer camp and not a traditional classroom or a school, it was important to review examples of research that looked at similar out-of-school STEM opportunities. Nelson and colleagues examined *Checkout STEM* kits and play-based experiences. “Checkout STEM is a program [that supplies kits that families can check out from school] that works to support the development of STEM and literacy skills through learning events that are engaging and responsive. Each kit includes two carefully chosen children’s books, developmentally appropriate play materials, and a research-based activity guide focused on a STEM topic such as coding” (Nelson et al., 2019, p. 12). These kits allowed literacy and STEM to take place outside of the traditional classroom and promoted various ways to explore literacy as well as engage in STEM. The researchers found that because Checkout STEM kits were take home kits, it engaged both children and parents in STEM and literacy integration. Even if the parents did not explicitly state that STEM and literacy is important, the fact that the parents checked out the kit and worked through the kits with their children showed their children through these actions that STEM and literacy are important and they can go together. Although beyond the scope of my own study, the organization where I conducted my research started making similar family STEM kits during the pandemic to keep families engaged in STEM while school buildings were closed, and this practice has continued even when schools resumed in-person. Educators should keep the home and school relationship at the forefront of their minds.

Multiliteracies and STEAM

Soules and colleagues explored multiple ways to develop literacy within science teaching. In 2012–2013, they examined how a faculty team collaborated on crafting multiple goals designed to re-examine science pedagogy in light of the national focus on literacy, “embedding reading strategies, information literacy concepts, writing-to-learn, and writing-to-communicate activities in key science courses” (2014, p. 122). As RISD stated earlier in this chapter, the national dialogue about what should be important or a focus in education was a consideration when charting the path on this course.

The groupings Soules et al. used do not include all of the literacy domains of reading, writing, speaking, and listening. They focused on: reading strategies, writing-to-learn, writing-to-communicate, and information literacy (Soules et al., 2014, p. 124). Science was the domain where literacies were used to engage students in learning. The researchers applied these literacies to different types of sciences such as physics, chemistry, and biology and then they identified different activities that would be applicable to each science course. For example, reading notebooks were suggested for the aforementioned science courses. What differed was if the notebook was required or merely a suggestion. For physics, it was required, for chemistry, it was extra credit, but for biology it was optional. Narrowing in on chemistry and biology gives the greatest connection to student choice and autonomy when using multiliteracies. Having the literacy be optional allows the instructor to focus on the needs of the students and the knowledge and background or sociocultural aspect the students bring with them into the classroom.

Kennedy and Wexler focused on another aspect of STEM, technology. Their focus was the secondary level. One STEM issue Kennedy and Wexler highlighted was “coursework often contains content that has no obvious real-world meaning to adolescents and is frequently abstract and laden with multistep operations” (2013, p. 28). The sociocultural framework is rooted in multiple discourses. These discourses are based on the experiences students have. If students cannot make a connection, it can be difficult for them to learn the content. Even if teachers understand this, they may take the easy way out. Kennedy and Wexler stated, “Too often, teachers select multimedia-based materials “off the rack” (e.g., from www.YouTube.com or other online sources, such as the Khan Academy; www.khanacademy.org) because they are usually free and seemingly efficient” (2013, p. 21). A free multiliteracy may not be the best option for students, especially when little thought is put into the usage. Free does not always mean the resource is of quality or rooted in research-based practices.

Zollman pointed out the problems with how STEM literacy is currently defined, and he states, “first, constructing a definition of STEM literacy by adding the four separately defined literacy strands of science, technology, engineering, and mathematics together dilutes the essence of each. Second, such a compilation listing neglects the synergy of the four strands. Third, it does not realize the personal needs of the individual. We want to have STEM literacy to further learning for economic, societal, and personal needs” (Zollman, 2012, p. 15). This view aligns with the New Literacies Studies which has “worked against a universalist view of literacy; that is, the notion that literacy is an ideologically benign set of context-free skills that can be taught without regarding children’s background experiences” (Mills, 2016, p.25). The individual experiences students bring are part of their learning. When the lessons, strategies, and skills are tightly confined, it limits the possibilities and academic output of students.

Expanding those limitations can be a laborious task. In Yamika Nation, Indigenous elders aimed to revitalize Ichishkíin Sɨ́nwit. Currently there are no monolingual speakers of the language (Worth Jansen, 2010, p. 8). The elders knew it was not enough to have an Ichishkíin language class; the language had to be embedded as part of the curriculum. This led to the Ichishkíin mathematics project case study.

This study took place with the belief that Indigenous traditional ecological knowledge, also known as TEK, will help improve Indigenous methods in STEM fields and remove barriers for Indigenous inclusion in STEM (Ruef et al., 2020, p. 430). One of the overall purposes of Ruef et al. was to show that "Indigenous students and collaborators that they and their cultural knowledges have a place within STEM education" and to invite "newcomers to experience and know valuable Indigenous TEK contributions (2020, p. 431).

This process had its benefits. It forced the scholars to not only consider translating words into another language to build the mathematics curriculum, but it also forced them to consider items in the target culture that could be used to bring the mathematical concepts to life. Additionally, the scholars had to situate the curriculum in a way that ensured they met the needs of the Indigenous students but also ensured students learned the mathematics standards they need to know to be successful in the world.

When it comes to the sociocultural literacies, the child's lived experiences are key. González et al. (2005, p. ix-x) research explored using students' life experiences and knowledge they learned outside of school as a bridge to the learning in school. They called this funds of knowledge. Students' culture, heritage, and background matters. As stated above, the researchers used the Indigenous students' background and culture as part of the math curriculum, bridging home and school. Students' backgrounds should be woven into instruction. Standardized instruction might get the job done, but at what cost? As Soules et al. (2014) states, "To be successful, students must be able to read, research, and write effectively" (p.122). These literacies are also fundamental to learning core scientific concepts and to the development of the knowledge, skills, and practices necessary to apply those concepts to new situations and complex problems.

Guyotte et al. (2014) see the push from STEM to STEAM as an opportunity to look at society with a critical lens and engage in social practice. They believe the arts engages students in the practice of doing because of its hands-on nature which aligns with STEM since it can have many hands-on components. Through the act of doing, students can gain knowledge, deepen their understanding, and collaborate and engage with others. They believe STEAM education is "an experience rich in doing" (Guyotte et al., 2014, p.19). Using their own experiences is a way students can improve their literacy while valuing who they are with the ultimate goal of the skills being transferable.

STEAM and Girls

STEAM Benefits for Girls

Children who are girls should feel valued and face no barriers to participating and engaging in STEM knowledge. Dr. Myra Sadker, an education researcher who spent much of her career championing girls and bringing attention to gender bias in schools, once said "If the cure for cancer was in the mind of a girl, we might never discover it" (Johnson & Ginsberg, 2015, p. vi). Bias and stereotypes can keep girls from seeing subjects like math and science as subject areas they can master. Pushing them beyond the stereotypes that portray girls as not being good at math will be beneficial to society and to the girls themselves.

What is important to discuss is what needs to happen to increase girls' participation and learning in STEM. Panetta and Williams (2018) suggest that girls do not need to be more like boys to be successful in STEM. Instead, parents should build upon girls' interests and connect it to STEM (p.16). STEM permeates many facets of our lives and is more than learning how to code or build a robot. If a girl loves baking, chemistry is involved. If a girl loves the outdoors, this could be an opportunity to engage her in biology. Girls do not need to shift who they are to develop a STEM identity.

When should students be introduced to STEM concepts? Sullivan (2019) believes the earlier, the better. She argues that young children are “natural scientists” who ask why and question what is happening in the world. When it comes to girls, Sullivan stated that “Programmable robotics kits are an example of a digital tool that has been shown to increase girls’ level of interest in being an engineer when they grow up.” These early childhood robotics initiatives are beneficial for both males and females because it leads to both genders seeing robotics as gender-neutral activity (Sullivan, 2019, p.9). Girls need opportunities to build their confidence and STEM identity and to not be overcome by negative stereotypes.

Unfortunately, some leaders in society continue to circulate negative narratives about women in STEM careers. In 2015 during a speech at the World Conference of Science Journalists, Nobel prize winning biochemist Tim Hunt said, "Let me tell you about my trouble with girls. Three things happen when they are in the lab. You fall in love with them, they fall in love with you, and when you criticize them, they cry" (Chappell, 2015). Not only is it important to focus on girls and the bias they may have about STEM, but it is also just as important to break those biases and stereotypes.

As it is commonly said, “Better late than never.” Even though research has shown early intervention is important, intervention can still be helpful at a later stage. Wajngurt and Sloan (2019) decided to evaluate the impact of a STEAM course at the community college level versus a traditional STEM course. The aim of the study was to learn if participating in a STEAM course pushed students to enroll in more STEM courses in the future. Their research showed that twice as many students who took the traditional STEM course enrolled in another STEM class compared to the students who took the STEAM course. However, their findings also showed that "when comparing percentages at follow up by gender, more female students (10%) from the STEAM course pursued STEM at follow-up than male students (6.7%), while more male students (17.9%) from the traditional STEM course pursued another STEM course than female students (14.3%)" (Wajngurt and Sloan, 2019, p.22). Even though more students pursued STEM overall when taking the traditional STEM course, the STEAM course recruited more females to actually enroll in a STEM class in comparison to their male counterparts.

STEAM and Intersectionality with Race and Gender

Ireland et al. conducted a review on Black females and STEM. From their review of the literature, they concluded (2018, p.247) that Black girls in STEM would benefit from teachers who use culturally relevant pedagogy in the classroom. However, they asserted that it was important to refrain from the narrative about how being both Black and female is a negative, but instead challenged readers to remember there is no one Black female identity and that we should consider "factors such as power, privilege, and institutional barriers" (Ireland et al., 2018, p.245). The barriers to girls engaging in STEM are nuanced and multiple considerations should be taken when thinking about this issue.

STEAM in a Girls-Only Environment Vs. Mixed Gender

With the projected need of STEM careers in the future, it is important to increase the numbers of students from all genders, socio-economic status, and racial backgrounds in pursuing a STEM career. Knowing that societal norms may influence girls to not see themselves as capable in STEM or even as a STEM person, it is important to review the research on how girls engage in STEM in a girls-only environment and a mixed gender environment.

Wang and Frye (2019) collected data on a free two-week girls-only camp called GEMS, Girls in Engineering, Math, and Science. This STEAM camp aimed to address the female gender gap in STEM careers. They found that the cooperative nature of the camp as well as the camp being girls-only helped the girls become more open to STEM topics (Wang and Frye, 2019, p.10). The dynamics within mixed gender groups can be different than in single gender groups, but in this study, girls found the girls-only space one where they could consider STEM more.

Liao et al. (2016) argued that 21st century learning includes creativity and problem solving and integrating the arts into STEM would help students from underrepresented groups in STEM achieve that goal. Specifically, they studied how art educators could build STEM skills through digital media arts. Through a digital artmaking camp girls told stories and created animations using technology and ingenuity. They also learned how to code games. By the end of the program the "percentage of students who indicated they plan to take more technology courses in the future increased by 16%" (Liao, et al., 2016, p.34). Parents will sometimes see their children have a disdain for a food item during dinner, but once they try it, they find out they like it. For these girls, the exposure helps them see this avenue as a possibility.

Although there is research that shows the benefits of girls-only environments for girls' STEM engagement and learning, there is also research that shows benefits for girls in both settings. Ma et al. (2022) conducted a study that included 91 sixth graders. Sixth grade was part of the elementary grade school, not middle school. Instead of having girls in one class and boys in another class, the students were grouped in three ways across two classrooms: boys-only, girls-only, and mixed gender. They found that "the mixed-gender groups stimulated more interaction behaviors and higher order thinking than the same-gender groups, and students tended to be more expressive of their emotions (both positive and negative) during the learning process" (Ma et al., 2022, p.9). However, in the girls-only group, students exhibited fewer behaviors that took away from learning and participation. The boys tended to have more behaviors that interrupted participation and learning, and in the co-ed setting boys became upset when criticized by girls and when boys exhibited aggressive behavior, it negatively impacted the girls. Although this research showed that both boys and girls engaged more in STEM when in mixed-gender settings, it was clear that there are behaviors of male students that could negatively impact girls' experiences.

However, the reality is that many of the experiences students have will include male and female students. The Inspira STEAM project had an aim of increasing girls' confidence in STEAM. Students were separated by gender during sessions; however, students had opportunities to come together as a collective. They stated, "The Inspira STEAM project separates to integrate differences that individuals need to understand in order to comprehend the role of gender bias in the real world. Improvement is more viable from the awareness of reality" (Guenaga Gómez & Fernández Álvarez, 2020, p.227). Even with research showing the benefits of STEAM for girls, it is just as important to remember that girls need to be able to take those skills back into society, a mixed gender society.

The school day is limited. Even knowing what the research says does not guarantee a change in the school schedule. When arts-into-STEM integration happens in the school setting collaboration is key. From the building leader's perspective, that means getting schedules to align so all the teachers who are collaborating can meet, discuss, and plan together. Sometimes the schedule does not work. Other times the looming fear of consequences that may come from students not scoring collectively well on a state standardized assessment might drive the school leader's focus away from integrating arts and STEM. This is why I was interested in learning how other settings might stand in the gap and provide what schools may not be able to provide.

In chapter three, I will explain how I used collective case study design to explore the benefits to girls' engagement in a literacy-rich STEM environment that includes other areas such as the arts.

Chapter 3: Methodology

In chapter three, I will explain how I used collective case study design to answer my research questions and why this methodology is best suited to help me answer those questions. I will also detail my role in the research, the context of the research, the data collection and analysis process, and my expected findings.

Statement of Purpose & Research Questions

My identity as a woman, my experiences as a young girl, and my experiences with girls throughout my career as a K-12 educator piqued my interest in which settings and which instructional strategies could be used to increase girls' participation in STEM. In particular, through my research, I aim to understand how literacy-rich STEM experiences and creative arts during a week-long, multi-age, STEM camp for 3rd, 4th, and 5th graders impacts girls' participation and learning of STEM topics.

To learn more about girls' participation and learning when exposed to and engaged in literacy-rich STEM experiences and creative arts integration-into-STEM experiences, I identified the following research questions:

1. How does cross-curricular work that infuses literacy and creative arts into STEM activity influence girls' interactions and participation?
2. How does girls' participation vary across literacy-infused STEM activities? Which activities invite more participation? What STEM identities do girls take up in these activities?
3. How does girls' participation vary across girls-only and mixed gender groups?

Method

The research design I selected for my study was case study. Privitera & Ahlgrim-Delzell define a case study as a "qualitative analysis of an individual group, organization, or event used to illustrate a phenomenon, explore a new hypothesis, or compare the observations of many cases" (2018, p.320). Because I will be drawing conclusions from more than one case, the type of case study used in my research is collective case study.

Although my research was collected at one location, I will be comparing and contrasting three individual cases. Those cases are three week-long STEM camps. Each week of camp is considered an individual case.

My research centers on girls' participation. It was important to understand how participation shows up in various settings which is why two cases involve a co-ed setting and one involves a girls-only setting. My research is situated in the critical sociocultural perspectives theoretical framework. As mentioned in chapter one, this framework centers on co-constructing knowledge. Through the week-long camps, students engage in work, many times, collectively. Timotheou and Ioannou (2021) found during their research that "STEAM Making contexts can give students the opportunity to work in groups to create a new product. Interdisciplinary projects that make use of making, tinkering, coding and play (herein refer to as Making) can enhance the metacognitive, cognitive and socio-communicative dimensions of collective creativity" (p. 136).

Case study research design requires the researcher to collect various sets of data to create the clearest picture possible before conclusions are drawn. To ensure I had a good pulse on what really happened during these weeks of camps, I attended camp every single day. In addition to attending camp, I videorecorded all activities, collected students' journals, asked students and staff questions, reviewed the curriculum, wrote fieldnotes, and collected informational survey data from the staff and parents of the campers.

The focus of my study is general inquiry which is when a researcher seeks to synthesize data such as interviews, artifacts, and observations to add to the body of knowledge on a particular defined area. Since I did not introduce a new instrument to test and since I am not trying to develop a new theory, I knew general inquiry was the proper path to take to for my study.

Researcher Role

During camp, I arrived before the day began to set up my equipment so I would not disrupt the instructor or the students. During data collection, I moved between the etic and emic role. In the etic role, the researcher is solely observing and does not engage with participants, but in the emic role, the researcher does engage with participants. As a K-12 educator for over 15 years, I was aware that my presence could impact the data if I was too involved with participants. I limited my participation with participants to open-ended questions such as "Tell me more about what you are doing?" Although my main focus was being an observer only, at times, it was necessary to shift into the observer-participant role to ask clarifying questions or to hear more from students.

Also, as a researcher, I had to hold up a mirror to analyze my purposes and beliefs. Peshkin stated it was important to "consciously attend to the orientations that will shape what I see and what I make of what I see" (1988, p. 21). Although I have the same race as some of my study's participants and the same gender of some of my participants, it was crucial to keep at the forefront of my mind that I must check my biases and think about the why behind the conclusions I draw. Eve Tuck also gives researchers thoughts for consideration. "What will be the outcomes and effects of this research in and on our communities? Are we certain that the benefits will outweigh the costs? What questions might we ask ourselves before we allow researcher entry?" (Tuck, 2009, p. 410). The last actions I want to take are actions that dilute or harm my research study. I do not want the privilege I have as a Black female researcher to cause me to not take the task of conducting research in an ethical, methodical, and organized way; it would infer with my goal of adding to the literacy-rich STEM experiences body of knowledge.

Study Setting & Context

My research was conducted at STEM World (pseudonym). STEM World operates on a 28-acre farm within the boundaries of a mid-size urban city. STEM World offers STEM professional development for teachers, STEM day camps, STEM summer camps, STEM field trips, a STEM leadership program for secondary students, and free activities parents can do with their children at home through their YouTube channel.

The focus on my study is the STEM summer camps. STEM World has some camps closed to the public, so I observed the elementary camps that were open to the public which consisted of three different weeks of camp. During each week, the campers are divided into three groups by grade bands: K-1, 2-3, and 4-5. Occasionally a few third graders who had fourth or fifth grade siblings were in the 4-5 group.

The formal lessons would take place at a recreational shelter at the camp. Each grade band had its own shelter. Campers had a basket for their belongings, there were picnic tables to sit at and a whiteboard easel for the instructor to use. This is the priority location where students wrote in their reflection journals. Learning happened at the shelter and at other places on the property.

Study Participants

The study participants included parents, STEM World staff, and campers. All participants completed an informed consent or assent before entering the study. Each week of camp went from 9 a.m. to 4 p.m. from Monday through Thursday. Each camper's parent completed a survey to provide demographic information about their child(ren) who participated in the study and information about parents' hopes for sending their children and if their children had attended previously. Staff were also asked demographic questions and asked to share their length of time with the organization.

During weeks one and two, twelve students participated in the study. During week three, eleven students participated in the study. However, this did not give me 35 student participants. I only had 31 students. One girl attended all three weeks. Another girl attended during the first and third camp. The third multiple week attender attended during both weeks two and three.

The first week of camp centered around the topic of innovation. The camp was mixed gender. Out of the twelve students, four were girls and eight were boys. Nine students were Caucasian, two were Black, and one was Latino. During the second week, the focus was on plants. All participants were girls since this was a girls-only week. Nine students were Caucasian, two were Black, and one was Latino. During the last week, the focus was on the Earth, and there were six girls and five boys. Nine students were Caucasian, one was Black, and one was Latino.

It is also important to note that the students had just completed an upper elementary grade prior to summer break and camp beginning. Upper elementary includes third, fourth, and fifth grade for the purposes of this study. Grades K-2 tend to be thought of as learn to read versus grades 3-5 where the focus is read to learn. To be able to have as many types of literacy-rich experiences as possible, I chose to study students who should be beyond the learning to read stage. During week one there were three third graders, three fourth graders, and six fifth graders. During week two there were six third graders, four fourth graders, and two fifth graders. During week three, there were eight fourth graders and three fifth graders.

Data Sources

I collected various pieces of data to answer my research questions. I worked with the organization's director to inform participants about the study. When families signed up to enroll their children in summer camp, they were told about the study and provided with an option to receive more information about participating in the study. If the family checked yes on the form to learn more, I followed up by email and sent the informed consent.

Camper Participant Questions

The families of the campers answered the following questions.

1. Are you a new or returning family for STEM World?
2. Do you believe participating in STEM World will help your child academically? If so, how? If not, why do you think that is?
3. Do you believe participating in STEM World will help your child's literacy skills?

Parents also provided the race and gender of both their child(ren) and themselves. They provided their highest education level and selected which income range they were in. Also, parents shared the grade their children completed before summer camp began.

Staff Participant Questions

I also attended a STEM World staff meeting to provide an overview of my study. Staff members who chose to participate in the study signed the informed consent. STEM World staff members were asked the following questions:

1. Are you a new or returning staff member for The STEM World?
2. What activities have you led that involved reading? What do you believe students learned?

3. What activities have you led that involved writing? What do you believe students learned?
4. Did students have an opportunity to share orally? If so, what did they share?
5. What new vocabulary words do you believe students learned?
6. Do you believe participating in The STEM World activities has helped students academically? If so, how? If not, why do you think that is?

I also collected demographic information as well which included their race, age, and gender.

All non-student adult staff members participated in the study. The organization also has interns. Some of these interns are adult high school or college students. Only one intern opted into the study and one STEM mentor, a high school student, opted into the study.

Video Data and Informal Interviews

Because there were multiple camper groups at the camp, it was important that I knew who was in or out of the study by using a wrist band system. I videotaped students and the staff facilitators while activities were being conducted. Students who consented to the study had one color wrist band and students who did not consent wore another color wrist band. Because this camp took place during the summer with the temperature in the high 80s to 90s, I had no worries about students wearing long sleeves and hiding the wrist band. Every morning before camp started, I distributed the wrist bands and reminded students they all had to wear them for the entire day.

In addition to videotaping all activities, I also informally interviewed students while they were completing activities to learn more about what they are doing. I collected students' reflection journals at the end of each session; students completed reflection journals as a normal part of STEM World's programming and this activity was not added for the purposes of this study.

To minimize risk to my participants, I secured data in my IU drive, and pseudonyms were used in place of participants' names. Students were reminded that the work they completed would not be used for a grade or shared with their schools. Staff and students were reminded that their responses are confidential, and they could opt out at any time. Staff were also reminded that participating in the study would not have an impact on their employment.

Data Collection and Camp Organization

STEM World facilitated six camps during summer 2021. Each camp was a week long. I observed only half of the camps. Three of the camps were only for school districts that had a partnership with the organization. My research took place with the three camps that were open to any student in the city. Each camp had two lead staff members. Those staff members managed the camp and jumped in to facilitate parts of the lesson as needed. Each camp was broken into three grade band groups. Group one included students entering K or 1st grade in the upcoming school year. Group two included students entering 2nd and 3rd in the upcoming school year. Group three included students entering 4th and 5th grade in the upcoming school year. This is the starting placement. Some students were shifted up a grade band due to one grade band having too many campers or because siblings were in another grade band to keep siblings together. My research focused on group three each week. Most students in group three were entering grades 4 and 5 in the upcoming school year, but for reasons I mentioned above, there were some third graders.

Each grade band had one facilitator. Each facilitator was assisted by two college interns, three to five high school interns, and three to four middle school STEM Future Leaders (SFLs). Additionally, each group had an on-call substitute group instructor.

Each week of camp had a predictable daily schedule.

9:00 - 9:15	Drop off time
9:15 - 9:40	Connection and belonging activities
9:40 - 9:45	Break
9:45 - 10:40	Lesson 1
10:40 - 10:50	Break and snack
10:55 - 11:45	Lesson 2
11:45 - 12:00	Break
12:00 - 1:00	Lunch and free play
1:00 - 1:10	Clean up
1:10 - 1:15	Transition
1:15 - 2:15	Choice time 1
2:15 - 3:15	Choice time 2
3:15 - 3:35	Reflection (discussion and journal) and belonging activities
3:35 - 3:45	Clean up
3:45 - 4:00	Pick up time

The literacy-rich and/or creative arts infused lessons I focused on in this study are the ones that took place before lunch which were labeled lesson one and lesson two. The first half of the day was more structured where all students were offered the opportunity to participate in the lesson. During the second half of the day, students were presented with opportunities, and they engaged with the activity of their choice.

For each camp, I have included a chart of the lessons available for each day.

Camp 1 - Creative Innovators (mixed gender)

	Day 1 – What's an innovator?	Day 2 - Innovative design	Day 3 - Innovative artists	Day 4 - Innovative engineers
Lesson 1	Ephemeral art	Duct tape creations	Print making	Rosie Revere - Build a flying machine
Lesson 2	Rigamajig	Snap circuits	Chihuly sculpture	Build a fort

Camp 2 - Plant Wizards (girls-only)

	Day 1 – Plant structures and needs	Day 2 – Garden plants	Day 3 – Water and plants	Day 4 – Forest plants
Lesson 1	Specimen bracelet hike	Plants we use and eat	Water surface tension	Forest plants
Lesson 2	Green invaders	Square foot gardening	Mapping the Creek	Life in leaf litter

Camp 3 - Earth's Superheroes (mixed gender)

	Day 1 – Earth system's overview - Geosphere	Day 2 – Earth system's overview - Biosphere	Day 3 – Earth system's overview - Hydrosphere	Day 4 – Earth system's overview - Atmosphere
Lesson 1	Earth systems	Green invaders	Salt water vs fresh water	Air pollution catcher
Lesson 2	Soil science	Plate tectonics	Macro invertebrate count	Cotton ball clouds

The majority of my data came from videotaped observations and reflection journals. The camp day was divided into two halves, before lunch and after lunch. I let the video camera roll uninterrupted before and after lunch. The video was paused during transitions such as walking to another location on the farm. This gave me a total of eight videos for each camp with a grand total of 24 videos for the entire study. Additionally, there were 31 students in the study. However, some participants participated in more than one week camp. That is why I have four days of journal entries from 35, not 31 participants.

Each day began with a lesson at the shelters. Then students completed another lesson which included various activities to solidify their knowledge. These activities were hands on and sometimes also involved a brief video of less than ten minutes to reinforce a skill. The second half of the day involved an activity from an outside professional such as a person who makes indigo dye or a carpenter. Students would learn from them and complete an activity. There was a choice in these activities. Students also went to various places on the property to continue learning like the creek, beehive, imagination station, or trails.

Data Analysis Procedures

Analyzing Lesson Plans for Literacy-Rich STEM Activities

I analyzed the lessons for STEM and literacy integration. I examined the books in each lesson and discussed to what degree they were integrated into the STEM component of the activity. I examined lessons for literacy-rich activities that included the four domains of literacy: reading, writing, speaking and listening (Technical Training Assistance Center, 2018, p.2). I then compared the least literacy-rich lessons and most literacy-rich lessons across camps and examined the videos for those lessons to understand factors that influenced girls' participation.

Analyzing Girls' Participation in Literacy-Rich STEM Activities

I next analyzed children's responses to each lesson's instruction and how the campers participated in two literacy-rich lessons during each week of each camp. For each selected lesson, I examined the number of instances of talk by girls and identified influencing factors. I also examined the quality of girls' participation by examining the roles that girls took up within the activity (e.g., leading or following). I transcribed children's interactions during the lessons and coded the lessons to understand girls' participation. Similar to Ma et al. (2022), I used a modified coding system based on Fredricks et al. (2004) system. To code my data, I chose to use a version of Ma et al.'s coding system which focuses on organizing participants' participation through the lens of cognition, emotion, and behavior. For cognition, I counted observable high-order thinking behaviors of analysis, application, and evaluation. Emotional responses were categorized as positive, such as joy and happiness, and negative, such as anger or frustration. Next, behavior was categorized by interaction behavior, such as discussion participation, listening, and hand raising, and irrelevant behavior such as destructive behavior or irrelevant actions or discourse. Last, I compared the data in the all-girls group to the co-ed group to determine if the gender make up of the group impacted girls' participation during STEM activities.

Chapter 4: Literacy-Rich STEM Activities and Summer Camp Context

In chapter four, I focus on the activities campers participated in during each week at camp daily, during lesson one and lesson two. I also identify the literacy practices in each lesson and discuss to what degree they were integrated into the STEM component of the activity.

The Summer Camp

The Camp Setting

A reservoir runs right through the back of the property. One section of the reservoir is referred to as the creek. Students had learning experiences on the shores of the creek and in the creek. The back of the property is densely filled with trees. This allows for some animals to reside on the property and provides opportunities for students to walk trails and take nature hikes. Directly in front of the dense trees is either grass or alfalfa. The alfalfa is grown and sold for profit. The profit helps with property maintenance cost. This wide-open space allows children to run or sit down for learning opportunities.

The learning garden is an area where children plant various plants such as fruits, vegetables, and herbs. They help with watering and harvesting. Campers are also taught about the plants and get to eat the harvest once it is ready. In this space, students learn various harvest meals they can make at home. The learning garden shed provides all of the tools that students need to upkeep the garden and to learn about the garden.

Next to the learning garden is the imagination station. This is a free choice area. The instructors rotate various activities for students to choose from each time they go to this area of the farm.

Next to the imagination station is the barn. The barn is divided into two big rooms. The front room is an office space for staff. The back space has a STEM library. Within the STEM library are books on various STEM topics written for a range of ages. There is a projector for teachers to show videos or a PowerPoint presentation. This is where the iPad carts are located.

Exiting the barn from the back room takes campers out to the beehive. In partnership with a local beekeeper, students can learn about bees. At this time, the honey is not sold for profit. Students are able to taste honey or take honey butter home. They also learn about bee death and why some bees do not survive.

An apple orchard was recently planted through a donation of trees. The apple orchard was originally put next to the firepit. Now, the orchard has been relocated near the barn. The firepit serves as a gathering place for everyone. Students can meet here to discuss lessons. Parents hangout here to socialize after dropping off their children for activities.

Goals of the Camp

This setting was an appropriate choice for my study because STEM World has a goal of increasing STEM learning access to underrepresented groups such as students of color and girls. Due to that goal, the organization offers girls-only camps and workshops. The founder and director of the organization was a former teacher as well as the lead content director. Two lead instructors, who also alternate in supervising the camp, are current teachers who have had input into the curriculum. These instructors felt it was important to embed literacy and the arts into the STEM curriculum. This setting provided an opportunity to learn how cross-curricular work that infuses literacy and creative arts into STEM activity impact literacy learning and how these activities impact the participation of girls in this setting.

Organization of the Camp

Each of the three weeks of camp I observed had a theme. Camp one’s theme was creative innovators. Camp two’s theme was plant wizards, and camp three’s theme was Earth’s superheroes. In addition to the weekly theme, each day had a focus area that related to the overarching weekly theme.

Each day of camp was divided into two halves, the half before lunch and the half after lunch. Before lunch, each day, students had two lessons that all students were encouraged to participate in. After lunch, students were presented with two or more activities, and they chose the activity they wanted to participate in. For the purpose of this study, I chose to focus on activities that occurred before lunch.

Before lunch, each student was present for two lessons. There were two activities each day for a total of eight activities for each week of the four-day camp. However, there were only 23 unique activities, not 24, because one activity during week two was later repeated during week three.

Focal Activities

For each camp, I chose two activities that integrated literacy and STEM concepts. For camp one, I chose rigamajig and snap circuits. Rigamajig is an activity where students receive a kit of parts such as boards, bolts, nuts, etc. and then have to create a prototype with one or more people that does an action. Students must write a plan, orally negotiate the plan, and work collaboratively to use STEM skills to build an object. For snap circuits, students work in pairs with a snap circuits kit. They must read the directions in the manual to build a complete circuit. The manual provides 70 ways to build a circuit to complete a task such as turning on a light bulb or singing “Happy Birthday.”

For camp two, I chose green invaders and square foot gardening. The green invaders activity is a modified version of tag. The tagger is a student who is an invasive species who is trying to tag other students who are native species to take over. The literacy component and STEM application comes after the game when students take the knowledge they learned about invasive species and how responders can make a difference in protecting native species by thinking of ways to protect local native species. During square foot gardening, students listen to a story about the inventor of square foot gardening, who happens to be an engineer, and learn how to plan a square foot garden. Students have to read plant packets and discuss the best course of action to plan the garden.

For camp three, I chose green invaders again. Since week two is girls-only and week three is mixed gender, it is important to explore how girls engaged in the activity in each setting. The second activity for week three was salt water vs. fresh water. The hydrosphere was the focus sphere of the day. Students learned about the limited resource of freshwater, they compared and contrasted fresh water and salt water, and learn why salt water was denser.

Since I found value in all of the lessons, I included the lessons that were not a focus of this study in the appendix section.

For each lesson I included below, I included the lesson plan components: recommended time, academic standards, STEM connection, literature used, materials, and directions the facilitators were given to follow. At the end of the lesson, I added a chart which pulled out the dominant instances where students engaged in STEM, creative arts, or literacy. I also added my analysis of about how well the STEM and literacy learning integrate/merge in the activity which explains why the literacy is needed to understand or carry out the STEM portion.

Camp 1 - Creative Innovators

Camp one's focus was innovators and innovation. In STEM fields, professionals can be tasked with finding a solution instead of following a previously-created plan. The creative innovator week centers on the idea of innovators being needed to find solutions to problems that exist or to create an item or a solution that adds values to the community. The value add could be art or the creation of a tool to benefit the community members. Innovation can happen through science, technology, and engineering. Math is woven through all three to ensure the innovation works, especially when it comes to measuring or calculating the tools and amount of supplies needed. The engineering design process is a focus area of this week.

Day 1 - What's an innovator?

Featured Lesson: Rigamajig

Grades: 4-5

Time: 30 - 45 minutes

Standards:

- 3-5.E.3 (Next Generation Science Standards) Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Objective: Exploring a kit of parts without directions, named items, etc. to determine what to do and how to use it.

STEM Career Connection: An engineer is a person who designs and builds complex products, machines, systems, or structures. Anything that is built must first be engineered, or planned out. Engineers want to know how and why things work. They have scientific training that they use to make practical things.

Literature Connections: *The Most Magnificent Thing* by Ashley Spires; *Be A Maker* by Katey Howes and Elizabet Vuković

Materials: Rigamajig Basic Builder Kit

Procedures:

1. Unpack Rigamajig and investigate all of the different parts together before any play.
2. Begin by looking at all the parts as a group and ask children to describe what they see,

where have they seen these kinds of shapes in real life, etc.?

3. As a whole group on large chart paper, ask children to name the shapes that they see. For example, the wing nut could be labeled as a "butterfly."
4. Develop a common language as a class.
5. Name them and draw them on large chart paper as a group. This can later be used as the classes' reference page, which can be taken out when the toy comes out for a lesson or free play.
6. The initial discussion can also go in the direction of creative and more abstract ideas as well.
7. Followed by the unpacking, the teacher and students establish the ground rules for positive cooperative play.
8. Brainstorm ideas of using the materials safely. Refer to other building materials that they may have used in the classroom in the past. Talk about what works while using those materials and what may also work with Rigamajig. Talk about basic rules of cooperation and sharing.
    a. How do we ask for something that we need?
    b. How do we ask for a turn and say, "I'm using this right now, but you can use it when I'm done."
    c. How do we listen to another person's idea or suggestion respectfully?
    d. How do we suggest other pieces or other configurations of pieces to one another if the one we first wanted wasn't available?
9. Observe with an interested and supportive attitude and, as needed, encourage problem-solving thinking, creativity, collaboration, discussion, and questions.

10. Reflection:

a. What makes a good collaborator?

b. Tell us about a problem you encountered and how you solved it.

c. In their science journal, create drawings and descriptions or photographs and descriptions of work

d. Share and present work with each other, include discussions of how and why construction decisions were made.

Table 4.1 STEM, Arts, and Literacy Goals Integration in Rigamajig Lesson

STEM	● develop a prototype ● use feedback to improve a prototype
Creative Arts	● arrange rigamajig shapes into a useable prototype ● draw prototype and include prototype notes in journal
Literacy	● speak to peers to negotiate ideas and next types in creating a prototype ● write descriptions of prototypes in journal
Literature Connections Text	● persevere when building a new item - *The Most Magnificent Thing* by Ashley Spires ● use creativity when building a new item - *Be A Maker* by Katey Howes and Elizabet Vuković

Analysis of the Rigamajig Activity

The STEM career connection for this task was the job of an engineer. Engineers do not work in isolation. They must collaborate. The goal of this lesson was to get students to build a prototype on their own, using trial and error. Specifically, the science standard called for students to conduct an investigation to improve a protype or model.

In this activity, students did not have the opportunity to improve an existing model. Instead, they were tasked with making their own model with a group. Much of the talking and discussion involved students determining whose idea to use. This activity could have been more productive and mirrored more real-world experiences if students started the work in groups. Then, they could have built upon each other's knowledge to draw a prototype before constructing it.

Day 2 - Innovative Design

Featured Lesson - Snap Circuits

Grades: 4-5

Time: 45 minutes

Standards:

- 4.PS.4 (Indiana Science Standards) Describe and investigate the different ways in which energy can be generated and/or converted from one form of energy to another form of energy.

Objective: Participants will learn basic engineering, electronics and circuitry concepts by using building components with snaps to assemble electronic circuits on a simple "rows-and-columns" base grid.

STEM Career Connection: An electronics technician is an electrical professional who assembles and installs electrical components of devices and structures. Electronics technicians can install electrical wiring and equipment in buildings for commercial or residential purposes, maintain electronic systems by performing inspections and repairs and design electrical systems for use in devices or buildings. An electronics technician might specialize in a particular area, such as lighting, transport, computers or machinery.

Literature Connections: *Bright Dreams: The Brilliant Inventions of Nikola Tesla* by Tracy Dockray; *The Boy Who Thought Outside the Box: The Story of Video Game Inventor Ralph Baer* by Marcie Wessels; *Oscar and the Bird: A Book about Electricity* by Geoff Waring

Materials: Snap Circuits Jr. (we have 18 sets); Energy Balls

Procedures:

1. Ask participants what they know about electronics.
    a. How do we use electronics for work? fun?
2. Talk about how we use electronics in our daily lives.
3. Use the Energy Ball to demonstrate how electricity travels through a closed circuit but not through an open one. You can start with just your hand connecting the circuit. Then add more people to the loop to see how it continues to travel through the loop as long as it's closed.
4. Draw a diagram of an electric circuit, showing one that is closed and one that is open. Children can draw and label the same in their journals.
5. Tell participants that we will be using a kit called Snap Circuits. This kit makes learning electronics a snap!
6. Show the participants a Snap Circuits Jr. set. See what they notice about the pieces. Make predictions and ask questions.
7. Then, with a partner, participants will follow the directions in the booklet in the set to create different circuits. Start with assembling the battery pack, making sure all groups have the batteries inserted correctly. Then have all groups do activity 1 in the Snap Circuits instruction manual, as this is a fairly simple switch circuit that will help everyone

understand how the materials work. Then, they can explore other activities, with the manual or experiment with their own creations.

Table 4.2 STEM, Arts, and Literacy Goals Integration in Snap Circuits

STEM	● understand the difference between closed and open circuit ● understand how electricity travels ● complete a circuit
Creative Arts	● create a circuit different from the instructions
Literacy	● read circuit instructions ● comprehend circuit instructions ● discuss ways to create a unique circuit
Literature Connection Texts	● learn about Nikola Tesla's early years working with electricity - *Bright Dreams: The Brilliant Inventions of Nikola Tesla* by Tracy Dockray ● learn about Ralph Baer, the father of video games - *The Boy Who Thought Outside the Box: The Story of Video Game Inventor Ralph Baer* by Marcie Wessels ● learn how electricity is made - *Oscar and the Bird: A Book about Electricity* by Geoff Waring

Analysis of the Snap Circuits Activity

The STEM career connection for this task is electronic technician. The facilitator gives students information about closed and open circuits. When students understand the difference between open and closed circuits, then they create a circuit following directions in the snap circuits kit. Additionally, the lesson plan encourages the facilitator to allow students to create their own circuits. The lesson focuses on the academic science standard of investigating the ways energy can be generated or converted.

The facilitator walks students through completing the first circuit activity. Next, they work in pairs and choose their own snap circuits activities from the book. To successfully complete this task, students must read the instructions and talk to each other about how to implement them, especially if their partner misinterprets the instructions. However, there is not much guidance on what it looks like to collaborate to build an item such as a circuit. Also, although there is a literacy connection, via trade books, included in the lesson plan, there are not literacy standards listed, nor is it clear what literacy skills will be used and how.

Camp 2 - Plant Wizards

Camp two's focus is on plant life. During this girls-only week, students will learn about the structure and functions of plants and maintaining various ecological environments where plants grow. When it comes to STEM, this week has a heavy emphasis on science and math. Girls tap into science via plant structures and learning about the environment where plants thrive best. Math skills are used to collect and analyze data regarding invasive species and the creek water.

Day 1 - Plant Structures and Needs

Featured Lesson- Green Invaders

Grades: 4-5

Time: 45 minutes

Standards:

- 4.ESS.4 (Next Generation Science Standards) Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans.
- 4.LS.2 (Next Generation Science Standards) Use evidence to support the explanation that a change in the environment may result in a plant or animal will to survive and reproduce, move to a new location, or die.

- 4.LS.3 (Next Generation Science Standards) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction in a different ecosystem.
- 5.ESS.3(Next Generation Science Standards) Investigate ways individual communities within the United States protect the Earth's resources and environment.
- 5.LS.2 (Next Generation Science Standards) Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

Objectives: Participants observe how quickly an invasive species can replace native species.

STEM Career Connection: An Invasion Ecologist is a scientist who studies the establishment, spread, and impact of invasive and nonnative species. An ecologist is a scientist who studies the relationship between living things and their environment.

Literature Connections: *Plant Invaders (Smithsonian Readers)* by Vickie An; *Nature Out of Balance: How Invasive Species Are Changing the Planet (Orca Footprints, 19)*, by Merrie-Ellen Wilcox; *Aliens from Earth: When Animals and Plants Invade Other Ecosystems* by Mary Batten

Materials: Pictures of invasive species, Strips of blue cloth (to indicate Native Species), Strips of yellow cloth (to indicate Responder), A large, flat playing field, Cones for boundaries of the playing field, Timer, Data Table and pen

Procedures:

8. Introduction: What are native species?
    a. A native plant is a specific kind, or species, of plant that has been growing in a particular area for many, many years (since before the Europeans settled in North America).

b. Some examples of native species in Indiana are: American cranberry, Black chokeberry, Buttonbush, Grey dogwood, Redbud, Columbine. https://indianawildlife.org/education/native-plants-finder/

9. Introduction: What are invasive species?
    a. Show Invasive Species pamphlet and discuss what an invasive species is. (a species that is not native to an area)
    b. An example from the farm is Lesser Celandine.
    c. Garlic Mustard is an invasive species that was completely removed from the farm.
10. Why are invasive species a problem?
    a. Due to a lack of natural predators, invasive populations grow quickly and outcompete native species for resources, disrupting food webs and even endangering some species.
    b. Some invaders threaten human health. For instance, introduced mosquitoes can carry diseases such as the West Nile and Zika viruses.
    c. Invasive species cost the U.S. about $120 billion annually between the damage they cause and control efforts.
11. What can we do?
    a. Discuss ideas on what we can do to help (i.e. - remove invasive species, plant more native plants, etc)

Game:

Procedure: Explain to students how the game will work and ask them to hypothesize and compare/contrast how the outcome might be different after each round.

Write their hypothesis on the board, if possible. There will be four rounds total (see chart below). This activity functions as a tag-based game.

Roles: At the beginning of each round, students are assigned a role. Each role has a different set of parameters.

Native Species – The person playing the Native species needs to run away from the Invasive species, and if he/ she is tagged he/she will become an Invasive species. If he/she is tagged, he/she has to stand still (freeze) for 10 seconds. If the Responder touches him/her within the 10 seconds (he/she slowly counts out loud to the number 10), then he/she goes back to being a Native species. If he/she is not "freed" by a Responder within that time period, then he/she removes his/her blue flag and permanently remains an Invasive species.

Invasive Species – The Invasive species will try to tag players who are Native species.

Responder – The Responder's role is to help Native species by detecting, reporting, and removing Invasive species. In the game, the responder does this by untagging players who have been tagged by Invaders. The Responder(s) will wear the yellow cloth and will try to tag Native species that have been tagged and are counting to the number

Timekeeper – The teacher can keep track of time, and record data on the chart after each round.

*Students are not allowed to block each other

Playing the Game:

Round 1 – Long Exposure to Invasives

Assigning of roles

# of Responders: 0

# of Invasive Species: 2–3

# of Native Species: total remaining students

Procedure

Time for 45 seconds

Wrap-up

- Ask about the length of time needed for the Invasive species to overcome the Native species.
- Ask students what could be done to inhibit the spread of the Invasive species
- Expected outcome: Due to the long exposure time, all Native species are impacted by Invasive species.

Round 2 – Short Exposure to Invasives

Assigning of roles

# of Responders: 0

# of Invasive Species: 2–3

# of Native Species: total remaining students

Procedure

Time for 15 seconds

Have students hypothesize: the impact of a shorter amount of time compared to Round 1.

Wrap-up

- Take a count of remaining Native species. Ask about the amount of time needed for the Invasive species to overcome the Native species.
- Expected outcome is that there will be more Native Species remaining compared to the first round, because the amount of time allowed for Invasive species to spread is shorter.
- Ask students to hypothesize how the next round will change when doubling the number of Invasive species.

Round 3 – Higher Propagule Pressure (double the number of Invasives)

Assigning of roles

# of Responders: 0

# of Invasive Species:4-6

# of Native Species: total remaining students

Procedure

Time for 15 seconds

Have students hypothesize or guess the impact of doubling the number of Invasive species.

Wrap-up

- Ask students if their hypothesis was correct.
- Ask students to hypothesize how the next round will change when adding a Responder.

Round 4 – Responder to the Rescue

Assigning of roles

# of Responders: 2

# of Invasive Species:4-6

# of Native Species: total remaining students

Procedure

Time for 15 seconds

Wrap-up

- Take a count of remaining Native species
- Ask students to compare the four rounds and explain the impact that the introduction of Responders had on the spread of the invasive species.
- Expected Outcome: There should be a higher number of Native species present due to the Responder role.
- Explain to students how to become a real life Responder by learning how to identify invasive species and knowing how to report them properly.

Discussion/Debrief questions: Once the game is played, the main ideas should be revisited.

1. What were the Invasive species doing? How would that actually happen in real life? *The Invasive species were reducing the biodiversity of the Native species through competition, predation, or by removing/changing the habitat. The ecosystem went from predominantly native to entirely invasive organisms.*
2. Why was it so easy to convert Native species to Invasive species in the first round? *Because there was nothing to stop the invasive species: When we start taking notice and*

become proactive against the Invasive species, we can have a dramatic effect on stopping or slowing the spread.

3. How is the amount of time an Invasive species has to invade related to the impact it has on the environment? *The longer the species is present, the greater impact it has*.
4. What impact did the Responder have? The Responder reduced the impact of the Invasive species by reporting and controlling it.
    a. Why was it more difficult to overcome Native plants?
    b. What would change if there were more Responders?

        There was a difference in the effectiveness of the Invasive species when Responders were added. If there were more responders, Invasive species would have a more difficult time becoming established.
5. How important is it that we get more people to become Responders in real life?
    a. How could you become a Responder in real life?
    b. How can we get more Responders in real life?
        i. Very important. Invasive species damage our ecosystem, our economy, and even human health. If there were more Responders in real life, Invasive species wouldn't be so effective at negatively impacting our environment. To become a responder in real life, you can research what are the high-priority species for early detection in your area, then learn how to identify and report that species.

Table 4.3 STEM, Arts, and Literacy Goals Integration in Green Invaders - Girls-Only Camp

STEM	● understand what an invasive species and native plants are ● learn about the invasive ecologist career ● learn how to make a scientific hypothesis

	• learn to track data out in the field
Creative Arts	• n/a
Literacy	• synthesize information and explain how to be a responder • write down hypotheses in a science journal
Literature Connection Texts	• learn how to stop a growing invasive species - *Plant Invaders (Smithsonian Readers)* by Vickie An • learn about invasive species around the world and why humans are the most invasive species - *Nature Out of Balance: How Invasive Species Are Changing the Planet (Orca Footprints, 19)* by Merrie-Ellen Wilcox • learn about specific invasive species cases around the world and the impact on the ecosystem - *Aliens from Earth: When Animals and Plants Invade Other Ecosystems* by Mary Batten

Analysis of Green Invaders Activity

The STEM career connection for this task is an invasion ecologist. The science standards covered focus on developing solutions to reduce human impact on the natural environment and learning ways people in the United States protect the environment. Students participated in activities that require them to listen for information about invasive species. They review a pamphlet about invasive species and then synthesize the information to discuss and write down a hypothesis about what they believe would occur while participating in the invader game. Students use math skills to capture data from the invasive species game. They also use critical thinking skills such as analysis to make an environmental plan just as an ecologist would do in the field with colleagues.

Day 2 - Garden Plants

Featured Lesson - Square Foot Gardening

Grades: 4-5

Time: 30-60 minutes

Standards:

- 4.LS.2 (Next Generation Science Standards) Use evidence to support the explanation that a change in the environment may result in a plant or animal will to survive and reproduce, move to a new location, or die.
- 4.LS.3 (Next Generation Science Standards) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction in a different ecosystems.
- 4.M.1 (Indiana Academic Math Standards) Measure length to the nearest quarter-inch, eighth-inch, and millimeter.
- 4.M.4 (Indiana Academic Math Standards) Apply the area and perimeter formulas for rectangles to solve real-world problems and other mathematical problems. Recognize area as additive and find the area of complex shapes composed of rectangles by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts; apply this technique to solve real-world problems and other mathematical problems.
- 5.LS.2 (Next Generation Science Standards) Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

Objectives: Participants will consider why people plant gardens and compare and contrast different gardens at the farm; participants will identify the needs of plants and how each need met in gardens at the farm; participants will observe plants identifying different plant parts and the function of each part; participants will classify garden plants/produce; participants will explore and work in the gardens at the farm, planting, watering, weeding, and/or harvesting as appropriate.

STEM Career Connection: A horticulturist is an expert in garden creation and management. A horticulturist works and conducts research in the science and skill of growing flowers, fruits, vegetables or ornamental plants. Plant breeding is an important part of horticulture.

Literature Links: *Right This Very Minute: A table-to-farm book about food and farming* by Lisl H. Detlefsen, *Tops and Bottoms* by Janet Stevens, *From Seed to Plant* by Gail Gibbons, *How a Seed Grows* (Let's-Read-and-Find-Out Science 1 Series) by Helene J. Jordan, *Square Foot Gardening with Kids* by Mel Bartholomew

Materials:

- copies of SCUMPS scientific observation sheet, clip boards, pencils, rulers

Procedures:

Introduction:

1. At the farm we grow a variety of different plants in our crop fields, gardens, and orchard.
2. Today we are going to investigate our gardens and some of the different plants we grow in our gardens *and do some work in the gardens (depending on time of year)*.
3. Why do people plant gardens? (to grow food to eat, because they like they way the plants look, to help bees and butterflies, etc.)
4. At the farm, we have gardens to help kids learn more about where food comes from and how plants grow.
5. We have to be sure to provide a space for our garden plants that give them access to everything they need to grow and stay healthy. What do plants need to grow? (soil, water, sunlight, air, correct temperature)

6. Record this information on chart paper (other parts will be filled in later):

PLANTS

HAVE	NEED	GIVE
roots	water	oxygen
seeds	air	fruit/vegetables
leaves	sun	flowers/pollen
stems	soil	shelter
flowers		building materials
fruit/vegetables		material for textiles

7. Thinking about plants, what are some different parts plants have? (roots, stem, leaves, flowers, fruit/vegetable, seeds) Add information to chart.
8. We like to grow a variety of different plants in our gardens. We think it's fun to be able to harvest and sample lots of different kinds of fruits and vegetables. What is the difference between fruits and vegetables, scientifically thinking? (fruits contain seeds and vegetables are other parts of the plant that we eat)
9. Generate a list of some fruits and some vegetables.
10. As we work with plants and in our gardens, look for how the needs of plants are being met and where you see different plant parts.
11. Go to the pollinator garden. While at the pollinator garden:
    a. Learn the names of three plants that attract butterflies.
    b. What attracts butterflies to native plants? Label these plant parts on the flower drawing or sticker above.
    c. Write the name of the food or energy source the plant provides for butterflies.
    d. Cover your eyes and be very quiet and listen to the sounds in the butterfly garden for 2 minutes at a minimum. Tell what sounds you hear.

Plant Observation:

1. Scientists learn about the world around them by making observations.
2. Today, we will work as scientists to make observations of a plant.
3. Let's look at one type of plant from our garden. Each participant will choose one specific plant to observe using the SCUMPS (size, color, use, materials, parts, shape) observation sheet to record their observations.
    a. What color?
    b. How long or tall?
    c. What plant parts can be seen?
    d. What is texture?
    e. Is there an odor?
    f. What type of plant is it or will it grow into?
4. Have participants share observations and identifications.
5. Ask: What are the benefits of plants to humans and other animals?

Square-Foot Garden Planning & Planting (if an additional activity is needed)

- When we have some space in our square foot gardens that need to be planted, we make a plan for what we are going to plant.
- Sometimes we can prepare seed sheets that help us plant more efficiently and for us to have ready when we have space in the garden.
- Pass out Square Foot Gardening Plant Spacing Cheat Sheets and have participants find plants they are planting on list. Identify how many seedlings/seeds/bulbs can be planted in one square foot.

  As a large or in small groups, plan out square foot garden based on plants and space.

- Paper Towels - Pass out paper towel to each student or pair of students. Students draw on paper towel the plan for seeds/plants that will be planted in that section of the garden. Towels can be arranged on the floor to plan out the entire garden. Seeds can be directly glued onto paper towel and entire towel planted.
- Using Garden Grids - Pass out garden grids and dry erase markers. Have students plot what will be planted in each section and how many seeds/plants can go in each square. Can be done on large paper or dry erase board as differentiation.
    a. Go outside and divide the garden into squares (if needed) and plant seedlings/seeds/bulbs according to square foot gardening plan.
    b. Make observations about plant needs and plant parts while at gardens.
    c. Back inside, discuss observations and why plants are important.
    d. Help students identify nonliving and other living things needed by plants to grow and stay healthy.

Reflection:

- What are some parts of plants?
- What do plants need to grow and stay healthy?
- Why are plants important? What are some of their uses?
- Why do people plant gardens?
- If you could plant your own garden, what plant would you put in it? Why?

Table 4.4 STEM, Arts, and Literacy Goals Integration in Square Foot Gardening

STEM	• explore the job of a horticulturist • identify plant needs • identify plant parts • participate in square foot gardening • make observations about various gardens

Creative Arts	• determine the design for the square foot garden
Literacy	• read directions on plant seeds and plant bulb packets • write observations on the SCUMPS observation form • discuss and compare and contrast findings on the various gardens
Literature Connection Texts	• learn about agriculture and how food goes from the farm to the table - *Right This Very Minute: A table-to-farm book about food and farming* by Lisl H. Detlefsen • learn that we eat the tops or the bottoms of certain harvest - *Tops and Bottoms* by Janet Stevens • learn the stages of plant life starting from the seed stage - *From Seed to Plant* by Gail Gibbons • learn the steps to get a seed to grow into a plant - *How a Seed Grows* (Let's-Read-and-Find-Out Science 1 Series) by Helene J. Jordan • learn how to use gridded boxes to make a square foot garden - *Square Foot Gardening with Kids* by Mel Bartholomew

Analysis of Square Foot Gardening Activity

The STEM career connection for this day is a horticulturist. Science standards for the lesson focus on understanding plant anatomy and what plants need to grow and thrive. The math standards cover measuring length to the nearest quarter-inch, eighth-inch, and millimeter and using the perimeter formula.

Students participate in activities to show them the importance of observation in the role of a horticulturist. Students learn capturing observations is important. Since it would be hard to remember all of the discoveries that are observed, students write down their observations in their science journals. They also listen to books about gardening. Using the knowledge they are exposed to and their observations, they help plant seeds in the garden. This task also requires authentic reading when students had to read seed packets to determine how to sow the seeds. They also engaged in speaking when they had to negotiate what approach to take for the square foot garden and how the plants should be ordered in the garden based on information on the seed packets.

Camp 3 - Earth Superheroes

Camp three's focus is on four of Earth's spheres: geosphere, biosphere, hydrosphere, and atmosphere. Each day focuses on one of the spheres. The superheroes' theme centers on the belief that scientists, technologists, engineers, and mathematicians are heroes because they use their knowledge in their respective fields to solve problems. This week is more of a survey course where students are able to dabble a bit in each area of STEM as it relates to the spheres previously mentioned.

Day 2 - Earth System's Overview - Biosphere

Featured Lesson- Green Invaders (Biosphere Version)

Note: This activity was also used during camp two. After the activity details below, I have included a paragraph explaining how this activity fits into camp three versus camp two.

Grades: 4-5

Time: 45 minutes

Standards:

- 4.ESS.4 (Next Generation Science Standards) Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans.
- 4.LS.2 (Next Generation Science Standards) Use evidence to support the explanation that a change in the environment may result in a plant or animal will survive and reproduce, move to a new location, or die.

- 4.LS.3 (Next Generation Science Standards) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction in a different ecosystem.
- 5.ESS.3(Next Generation Science Standards) Investigate ways individual communities within the United States protect the Earth's resources and environment.
- 5.LS.2 (Next Generation Science Standards - From Molecules to Organisms) Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

Objectives: Participants observe how quickly an invasive species can replace native species.

STEM Career Connection: An Invasion Ecologist is a scientist who studies the establishment, spread, and impact of invasive and nonnative species. An ecologist is a scientist who studies the relationship between living things and their environment.

Literature Connections: *Plant Invaders (Smithsonian Readers)* by Vickie An; *Nature Out of Balance: How Invasive Species Are Changing the Planet (Orca Footprints, 19)*, by Merrie-Ellen Wilcox; *Aliens from Earth: When Animals and Plants Invade Other Ecosystems* by Mary Batten

Materials: Pictures of invasive species, Strips of blue cloth (to indicate Native Species), Strips of yellow cloth (to indicate Responder), A large, flat playing field, Cones for boundaries of the playing field, Timer, Data Table and pen

Procedures:

1. Introduction: What are native species?

a. A native plant is a specific kind, or species, of plant that has been growing in a particular area for many, many years (since before the Europeans settled in North America).

b. Some examples of native species in Indiana are: American cranberry, Black chokeberry, Buttonbush, Grey dogwood, Redbud, Columbine. https://indianawildlife.org/education/native-plants-finder/

2. Introduction: What are invasive species?

    a. Show Invasive Species pamphlet and discuss what an invasive species is. (a species that is not native to an area)

    b. An example from the farm is Lesser Celandine.

    c. Garlic Mustard is an invasive species that was completely removed from the farm.

3. Why are invasive species a problem?

    a. Due to a lack of natural predators, invasive populations grow quickly and outcompete native species for resources, disrupting food webs and even endangering some species.

    b. Some invaders threaten human health. For instance, introduced mosquitoes can carry diseases such as the West Nile and Zika viruses.

    c. Invasive species cost the U.S. about $120 billion annually between the damage they cause and control efforts.

4. What can we do?

    a. Discuss ideas on what we can do to help (i.e. - remove invasive species, plant more native plants, etc.)

Game:

Procedure: Explain to students how the game will work and ask them to hypothesize and compare/contrast how the outcome might be different after each round. Write their hypothesis on the board, if possible. There will be four rounds total (see chart below). This activity functions as a tag-based game.

Roles: At the beginning of each round, students are assigned a role. Each role has a different set of parameters.

Native Species – The person playing the Native species needs to run away from the Invasive species, and if he/ she is tagged he/she will become an Invasive species. If he/she is tagged, he/she has to stand still (freeze) for 10 seconds. If the Responder touches him/her within the 10 seconds (he/she slowly counts out loud to the number 10), then he/she goes back to being a Native species. If he/she is not "freed" by a Responder within that time period, then he/she removes his/her blue flag and permanently remains an Invasive species.

Invasive Species – The Invasive species will try to tag players who are Native species.

Responder – The Responder's role is to help Native species by detecting, reporting, and removing Invasive species. In the game, the responder does this by untagging players who have been tagged by Invaders. The Responder(s) will wear the yellow cloth and will try to tag Native species that have been tagged and are counting to the number

Timekeeper – The teacher can keep track of time, and record data on the chart after each round.

*Students are not allowed to block each other

Playing the Game:

Round 1 – Long Exposure to Invasives

Assigning of roles

# of Responders: 0

# of Invasive Species: 2–3

# of Native Species: total remaining students

Procedure

Time for 45 seconds

Wrap-up

- Ask about the length of time needed for the Invasive species to overcome the Native species.
- Ask students what could be done to inhibit the spread of the Invasive species
- Expected outcome: Due to the long exposure time, all Native species are impacted by Invasive species.

Round 2 – Short Exposure to Invasives

Assigning of roles

# of Responders: 0

# of Invasive Species: 2–3

# of Native Species: total remaining students

Procedure

Time for 15 seconds

Have students hypothesize: the impact of a shorter amount of time compared to Round 1.

Wrap-up

- Take a count of remaining Native species. Ask about the amount of time needed for the Invasive species to overcome the Native species.
- Expected outcome is that there will be more Native Species remaining compared to the first round, because the amount of time allowed for Invasive species to spread is shorter.
- Ask students to hypothesize how the next round will change when doubling the number of Invasive species.

Round 3 – Higher Propagule Pressure (double the number of Invasives)

Assigning of roles

# of Responders: 0

# of Invasive Species:4-6

# of Native Species: total remaining students

Procedure

Time for 15 seconds

Have students hypothesize or guess the impact of doubling the number of Invasive species.

Wrap-up

- Ask students if their hypothesis was correct.

- Ask students to hypothesize how the next round will change when adding a Responder.

Round 4 – Responder to the Rescue

Assigning of roles

# of Responders: 2

# of Invasive Species:4-6

# of Native Species: total remaining students

Procedure

Time for 15 seconds

Wrap-up

- Take a count of remaining Native species
- Ask students to compare the four rounds and explain the impact that the introduction of Responders had on the spread of the invasive species.
- Expected Outcome: There should be a higher number of Native species present due to the Responder role.
- Explain to students how to become a real life Responder by learning how to identify invasive species and knowing how to report them properly.

Discussion/Debrief questions: Once the game is played, the main ideas should be revisited.

5. What were the Invasive species doing? How would that actually happen in real life? *The Invasive species were reducing the biodiversity of the Native species through competition, predation, or by removing/changing the habitat. The ecosystem went from predominantly native to entirely invasive organisms.*

6. Why was it so easy to convert Native species to Invasive species in the first round? *Because there was nothing to stop the invasive species: When we start taking notice and become proactive against the Invasive species, we can have a dramatic effect on stopping or slowing the spread.*
7. How is the amount of time an Invasive species has to invade related to the impact it has on the environment? *The longer the species is present, the greater impact it has*.
8. What impact did the Responder have? The Responder reduced the impact of the Invasive species by reporting and controlling it.
    c. Why was it more difficult to overcome Native plants?
    d. What would change if there were more Responders?

    There was a difference in the effectiveness of the Invasive species when Responders were added. If there were more responders, Invasive species would have a more difficult time becoming established.

5. How important is it that we get more people to become Responders in real life?
    c. How could you become a Responder in real life?
    d. How can we get more Responders in real life?
        ii. Very important. Invasive species damage our ecosystem, our economy, and even human health. If there were more Responders in real life, Invasive species wouldn't be so effective at negatively impacting our environment. To become a responder in real life, you can research what are the high-priority species for early detection in your area, then learn how to identify and report that species.

Table 4.5 STEM, Arts, and Literacy Goals Integration in Green Invaders - Mixed Gender

STEM	• understand what an invasive species and native plants are • learn about the invasive ecologist career • learn how to make a scientific hypothesis • learn to track data out in the field
Creative Arts	• n/a
Literacy	• synthesize information and explain how to be a responder • write down hypotheses in science journal
Literature Connection Texts	• learn how to stop a growing invasive species - *Plant Invaders (Smithsonian Readers)* by Vickie An • learn about invasive species around the world and why humans are the most invasive species - *Nature Out of Balance: How Invasive Species Are Changing the Planet (Orca Footprints, 19)* by Merrie-Ellen Wilcox • learn about specific invasive species cases around the world and the impact on the ecosystem - *Aliens from Earth: When Animals and Plants Invade Other Ecosystems* by Mary Batten

Analysis of Green Invaders (Biosphere Version)

The STEM career connection for this task is an invasion ecologist. The science standards covered focus on developing solutions to reduce human impact on the natural environment and learning ways people in the United States protect the environment, specifically the biosphere. As the week progresses, students learn about how all the spheres work in tandem which emphasizes why it is important to not have any sphere have an issue such as an invasive species. Students participate in an activity that requires them to listen for information about invasive species. They review a pamphlet about invasive species and then synthesize the information to discuss and write down a hypothesis about what they believe would occur while participating in the invader game. Students use math skills to capture data from the invasive species game. They also use critical thinking skills such as analysis to make an environmental plan just as an ecologist would do in the field with colleagues.

Day 3 - Earth system's overview - Hydrosphere

Featured Lesson - Salt Water vs. Fresh Water

Grades: 4-5

Time: 45 minutes

Standards:

- **4.ESS.4** Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans.
- **5.PS.1** Describe and measure the volume and mass of a sample of a given material.
- **5.PS.2** Demonstrate that regardless of how parts of an object are assembled the mass of the whole object is identical to the sum of the mass of the parts; however, the volume can differ from the sum of the volumes. (Law of Conservation of Mass)

Objectives: Participants will describe the differences between freshwater and saltwater, understand that freshwater is a limited resource, test both types of water to increase their understanding of density and buoyancy, and collect data to discuss their findings (can print table below, or have students make their own).

STEM Career Tie In: Hydrologists are scientists who study water and the water cycle. Hydrologists gather and evaluate meteorological data to predict a drought; collect and analyze water and mud samples to determine levels of pollutants in a water system; help create environmentally responsible water usage regulations for communities along a major river.

Literature Connections: *Does It Sink or Float?* by Susan Hughes; *All the Water in the World* by George Ella Lyon

Materials: water, salt, measuring cups, food coloring, digital scales, small items to test buoyancy (Lego, toy boat, rock, styrofoam, stick, etc.), 1 egg per 2-3 participants (smaller the better)

Procedures

1. Watch the video: The Basics of Freshwater
    a. Discuss the amount of freshwater in the world (3%).
    b. Tell students that 97% of the water in the world is saltwater.
    c. What are the differences between freshwater and saltwater? Record ideas on white board.
2. Tell participants that they will create a water sample of saltwater using precise measurements.
    a. Each group of 2-3 participants will measure 1 cup of water into 2 containers.
    b. Add 1 tablespoon of salt into one container and stir.
    c. Observe. Notice similarities and differences between saltwater and freshwater.
    d. Each group will get the following table to gather information.

Describe	Freshwater	Saltwater
Texture (smooth, rough, slippery)		
Transparency (can you see through it)		
Color		
Smell		

    e. Discuss findings.
3. What is density?
    a. Ask participants to share background knowledge.
    b. Watch video to learn about density: What is Density?

c. Discuss vocabulary: mass, volume, density, weight, gravity

4. Participants will predict if the 2 containers of water weigh the same. Make predictions.
    a. Give each group a digital scale. Measure the weight of each container. Record results.
    b. Participants should notice that saltwater weighs more than freshwater. Saltwater is denser than freshwater.
5. Participants will see if an egg floats in freshwater or saltwater.
    a. Predict - will the egg float in saltwater or freshwater?
    b. Demonstrate - Facilitator places an egg in fresh water *(The egg will sink in the fresh water because it has greater density than the water. The egg will float in the salt water because when salt is added to water its density becomes greater than that of the egg.)*
    c. Question - Will the egg float in saltwater?
        i. Test - each group will continue to add salt one teaspoon at a time until the egg floats.
        ii. How many teaspoons of salt did you need to add?
    d. Reflection:
        i. What did you observe?
        ii. Why did the egg float in saltwater?

Describe	Freshwater	Saltwater
Texture (smooth, rough, slippery)		

Transparency (can you see through it)		
Color		
Smell		

Table 4.6 STEM, Arts, and Literacy Goals Integration in Salt Water Vs. Fresh Water

STEM	• compare and contrast fresh water and salt water • review terms: mass, volume, density, weight, and gravity • conduct egg floating experiment
Creative Arts	• N/A
Literacy	• complete egg floating experiment graphic organizer • listen to *Does It Sink or Float?* • write reflections in a science journal
Literature Connection Texts	• learn about matter and characteristics that make items sink or float - *Does It Sink or Float?* by Susan Hughes • learn about the water cycle through a text written in lyrical verse - *All the Water in the World* by George Ella Lyon

Analysis of Salt Water vs. Fresh Water Activity

The STEM career connection for this day is a hydrologist. Science academic standards covered focus on solutions to reduce the human impact on the environment and understand the law of conservation mass. For math, students use the mass and volume formulas.

The hydrosphere is the sphere of focus. Students watch and listen to a video about the hydrosphere, and they listen to and discuss books about the hydrosphere. Then, they are tasked with conducting buoyancy experiments and have an authentic writing & math task when they track data for what happened each time. Then they discuss their findings, make a new hypothesis, and try the experiment again, documenting the process in writing.

Summary

A literacy-rich activity is an activity that supports the four domains of literacy: reading, writing, speaking and listening (Technical Training Assistance Center, 2018, p.2). There was little evidence of embedded literacy integration with STEM in the lesson plans overall. The two lessons that had the most integration were snap circuits and square foot gardening. Also, the lesson plans given to the facilitators had no literacy standards identified. In chapters five and six, I will take a closer look at the six lessons I described in chapter four.

In chapter five, I will also take a closer look at what actually happened during the lessons of focus in comparison to how they were planned. I will also zoom in on the green invaders' activity, in particular, because this activity was completed during the girls-only week and during the mixed gender week.

Chapter 5: Girls' Participation During Camp Activities

In chapter four, I highlighted two activities from each of the three weeks of camps. This highlight included analyzing the elements of the lesson plan and how the literacy domains of reading, writing, speaking, and listening are integrated with STEM. Those activities are included in the table below.

Table 5.1 STEM Camp Focus Lessons

WEEK	CAMP	LESSON 1	LESSON 2
Week 1–Mixed Gender	Creative Innovators	Rigamajig	Snap Circuits
Week 2–Girls Only	Plant Wizards	Green Invaders	Square Foot Gardening
Week 3–Mixed Gender	Earth's Superheroes	Green Invaders–Biosphere	Salt Water vs. Fresh Water

In this chapter, I analyze how children actually participated in the activities. For camp one, creative innovators, I focus on how girls and boys participated in the rigamajig and snap circuits activities. For the girls-only camp two, plant wizards, I analyze how girls participated in the green invaders and square-foot gardening. For camp three, Earth's superheroes, I analyze how girls and boys participated in the green invaders' activity and also the salt water vs. fresh water activity. Since camp two is girls-only, and camp three is mixed-gender, I also compare how girls participated in the green invaders' activity during the girls-only and the mixed-gender camp. Table 5.2 shows an overview of the participation in the six activities.

Table 5.2 STEM Camp Focus Lessons Participation

WEEK	CAMP	LESSON 1	LESSON 2
Week 1–Mixed Gender	Creative Innovators	Rigamajig Girls - 88 Boys - 209	Snap Circuits Girls - 151 Boys - 193
Week 2–Girls Only	Plant Wizards	Green Invaders Girls - 45	Square Foot Gardening Girls - 94
Week 3–Mixed Gender	Earth's Superheroes	Green Invaders Girls - 32 Boys - 44	Salt Water vs. Fresh Water Girls - 33 Boys - 42

- The lessons that had the strongest literacy and STEM integration were also the lessons where girls participated the most. The activities that elicited the most participation from the girls were snap circuits and square foot gardening.
- The activities that elicited the most participation from the boys were rigamajig and snap circuits.
- Both girls and boys participated the least during the two focus activities during week three, which were green invaders and salt water vs. fresh water.

I have categorized the activities under two umbrellas, those that had limited STEM and literacy integration and those that have a good balance, I explain what actually took place for each lesson plan and the themes that I found related to the quality of their engagement (higher-level thinking, enjoyment, or frustration; interactional or irrelevant to the activity) in their responses to the activities.

Lessons with Limited Literacy and STEM Integration

I identified four lessons that had limited literacy and STEM integration. Those activities were: rigamajig, green invaders (both mixed gender and girls-only week), and salt water vs. fresh water.

Limited Integration - Participation in Creative Innovators Mixed Gender Camp

During camp one, 12 students participated. Out of the twelve students, four were girls and eight were boys. There were five White girls and four White boys, two Black boys, and one Latino boy. One White girl attended all three weeks of camp. Another White girl attended camp one and camp three. The rest of the children attended for just one week.

Children's Response to Rigamajig–Mixed Gender

Some activities and lessons took place at the shelter the group was located at; however, rigamajig was at a station behind the barn. After the facilitator defined what an innovator was and read excerpts from *The Most Magnificent Thing* by Ashley Spires and *Be a Maker* by Katey Howes and Elizabet Vuković, students walked across the farm to the back of the barn. Once they arrived, the teacher said, "Remember what we learned about an innovator from the book we read? An innovator is someone who creates something." She then asked the students to sit down. Then, the instructor held up each of the pieces and had students brainstorm what each piece could be. The brainstorming session was whole group, and the teacher called on students to share ideas. As students were sharing, she instructed them to take notes about what their campmates said and how they might incorporate it into a design they would later create. After taking notes in their science journal for five minutes, they were instructed to share their notes with their neighbors. Two students chose not to share with a neighbor.

After students shared their ideas for five minutes, the students were divided into two groups. The instructors counted off the students and did not choose groups in advance of this activity. Each group had to choose which idea to execute. The instructor explained that students should ask for a shape and not take shapes or tools from others without asking.

Group A had four boys (three White and one Black) and two White girls. Group B had one Black boy, one White boy, one Latino boy, and three White girls. A girl from Group A asked if they could break into pairs within the group to make multiple items. The instructor agreed but noted that depending on the items there may not be enough pieces to build multiple items.

Students spent most of their time determining how to divide into smaller groups. And as the instructor predicted, there were not enough pieces for more than two groups. Students began building, but only two prototypes were completed, a wagon and a fan. Time was also a factor. Once time was up, students had to stop and return to the shelter since there was another group that was coming to the space after their time was up.

As shown in the charts below, the students had lots of interactive dialogue. Not all dialogue showed higher level thinking; however, sharing background information and their ideas orally with each other allowed them to co-construct knowledge to put into use when they attempted to build an item.

Table 5.3 Total of Observed Participation – Rigamajig

Category	Sub-category	Female	Male
cognition	analysis	9	21
	application	3	14
	evaluation	5	9
emotion	positive	2	2
	negative	1	1
behavior	interaction	50	160
	irrelevant	0	2

Table 5.4 Examples of Observed Participation – Rigamajig

Category	Sub-category	Female	Male
cognition	analysis	G1: "It looks like a wheel." G2: "It looks like a tire." G3: "It looks like my mom's fake smile." G4: "It looks like a scythe."	B1: "That piece looks like a screw." B2: "It looks like a key." B3: "It looks like a banana."
	application	G3: "How about two and two partners to make more than one thing?"	B5: "I'm going to make a fan that we will have to spin on our own." B2: "I'm going to use the hook to pick up something." B4: "We can make a wagon. We need seven long pieces and two short pieces." B2 "Let's make a wagon." B1: "I want to make a fan."
	evaluation	G1: "That should spin." G2: "It's not working right."	B2: "It worked" B4: "Do you think a hook would work better?"
emotion	positive	G2: "Yea!" G3: "Woo hoo!"	"That will work."
	negative	G1: "Move!"	B4: "Dang it."
behavior	interaction	G2: "How many boards?" (to a male groupmate)	"We have the part over here." "Basically, we are going to help them (points to three peers) make a wagon"

			(to group A) "I'm going to make a fan." "I have the four wheels." B4: "I need a curve."
	irrelevant	N/A	B2: "Gotcha" (student killed a bug) B5: "That's not true." (referencing a movie)

For this first table, I will explain why a few of these examples are categorized in the manner they are in my coding scheme.

For cognition-analysis, a girl said, "It looks like a wheel." and another girl said, "It looks like a scythe." Students were asked to make connections between objects they encountered in other places and apply that knowledge to the parts that were included in the rigamajig kit. They had to analyze the pieces and then make a connection.

For cognition-application, students applied their written designs as they built a prototype. The prototype had to perform a task or be used to complete a task. A boy said, "I want to make a fan." This was said after he concluded that he could put some of the pieces together to spin like a fan which would complete the task of cooling people off when they are hot.

For cognition-evaluation, children evaluated how their prototype was working. For example, a girl said, "That should spin," in reference to making a fan. Her evaluation was about some of the parts not being put together correctly for the prototype to perform as planned.

Emotion was categorized as positive or negative. Positive emotions tended to be celebratory based on reaching success, such as when a girl yelled, "woo hoo" after the fan prototype finally worked. Negative emotions took away from the learning process and tended to occur after frustration had built up, such as when a girl yelled “move” to a boy who was playing around and not contributing to the work.

Last, the behavior was categorized as interactional or irrelevant. Interactional behaviors involved students conversing to share and build upon each others’ knowledge to complete the task. At one point, a boy said, “I need a curve.” He was trying to figure out how to best connect a few other pieces and determined a curved shape would be the best piece to achieve that goal. Irrelevant behaviors were ones that had nothing to do with the activity at hand, such as when two students were debating a plot point in the Netflix show *Stranger Things*, and one of the students said, “That’s not true.”

Analysis of Children’s Response to Rigamajig–Mixed Gender

Amount of Participation. I identified 88 instances of girls participating and 209 instances of boys participating. Boys’ participation was more than double the amount of the girls’ participation.

Control of Design. Because students were told they had to pick one idea to build for the prototype, each group had to negotiate which prototype was chosen. Initially, the students were broken into two groups randomly by the facilitator. Below is an excerpt from group one’s conversation. Pseudonyms are used for the children’s names.

Ann: I have an idea. Can we make a–

Tom: We can make a fan. (points to pieces) Those could be blades.

Ann: Thinking about all the stuff we could use–

Ben: We could make a fan.

Abe: I found out how to make a wagon.

Facilitator: A wagon?

Abe: Yeah, a wagon.

Facilitator: (walks over to the other group)

Bob: We are gonna need seven long pieces, two more long pieces, and some nuts and bolts.

Nia: (closes science journal and doesn't share idea) okay.

Initially, there were two groups, and both chose a prototype designed by a boy. Then, some boys wanted to break the groups into smaller groups. Each group was divided in half. When there were four groups, all prototype designs chosen were still the male ones. Ben, who led the division of group one, got to make a fan.

Amount of Talk. The boys, whose designs were chosen, talked more because they explained what the prototype was supposed to do and how they thought it should be constructed using the rigamajig pieces. For example, Nia, who was mentioned as closing her book earlier, stayed silent and followed the directions given to her during the rest of the activity.

Roles. This led to the other group members falling into a follower role. In an authentic work setting, there is typically a lead for a project, so it is normal to have group members follow the lead. However, none of the leaders were girls. The female facilitator did not provide guidance on how to determine which model to use. For example, the wagon idea did not work. It fell apart after it was constructed, and unfortunately, time to troubleshoot was not available since this occurred right before it was time to leave the barn area and return to the shelter. If another design, possibly by a girl, was chosen, maybe there would have been a successful prototype built for that group.

The rigamajig lesson had the potential of mirroring an authentic STEM experience; however, the facilitator did not have a process for narrowing the students' ideas in each group where it still allowed all students to contribute meaningfully to the building of the prototype.

Limited Integration - Participation in Plant Wizards Girls-Only Camp

During camp two, 12 students participated in the study. All participants were girls since this was a girls-only week. There were nine White girls, two Black girls (who were sisters), and one Latina. One White girl attended all three weeks of camp, and one Black girl attended Camp Two and Camp Three.

Children's Response to Green Invaders–Girls Only

The green invaders activity is an activity to teach students about invasive species, their impact on native species, and actions students can take to limit the spread of invasive species.

During the lesson before green invaders, the girls learned about poison ivy and made a plant specimen bracelet. The girls went on a hike to collect items from nature for the bracelet. During this hike, the facilitator briefly talked about invasive species and how they invade spaces and can potentially take over those spaces. Once this lesson began, the facilitator started by referencing what she mentioned on the hike during the previous lesson.

Then, the facilitator provided a local example of honeysuckle. She explained that it was brought to the state based on its beauty, but the plant spreads quickly and kills other plants changing the ecosystem in the state. During this time, the girls listened. They were not engaged in conversation yet.

The facilitator then had a STEM intern, a high school student, explain how the green invaders activity would go. He referred to it as invader tag and stated it was his favorite activity of the entire week. He went on to explain that the game had four rounds. Each round was two minutes long. During round one, all the girls were native species. They wore blue bandanas on their arms. The STEM intern was an invasive species. If he tagged them, they became an invasive species, but they couldn't tag anyone else. During round two, the rules were the same, except there were two STEM interns who were invasive species. Round three was like round two, except one of the girls was a responder. After a student was tagged by an invasive species STEM intern, the student had to count aloud to ten, if the responder tagged them before the time was up, the student would stay a native plant. Round four was like round three, except there were two girl students as responders.

After each round, students returned to the shelter to collect data and reflect about what happened after each round. One of the STEM interns added the data to the chart, which has been included below. After round one, data was collected on the board, and there was a brief reflection before the game resumed. After round two, they skipped the debrief and only wrote down the data. However, after rounds three and four, in addition to adding data to the chart, students were also asked to draw conclusions about the impact of the responder role and what that means for humans and their responsibilities when it comes to non-native species taking over and killing native species. These debriefs were led by the high school STEM Future Leader and not the facilitator.

Table 5.5 Green Invaders Invasive & Native Species Data

	Round 1	Round 2	Round 3	Round 4
Number of Invasive Species	1	2	2	2
Number of Responders	0	1	1	2
Number of Native Species -	12	12	11	10

Start				
Number of Native Species - End	2	12	11	9
Percentage of Native Species Remaining	17%	100%	100%	90%

Table 5.6 Totals of Observed Participation – Green Invaders

Category	Sub-category	Female
cognition	analysis	0
	application	1
	evaluation	0
emotion	positive	12
	negative	2
behavior	interaction	25
	irrelevant	5

Table 5.7 Examples of Observed Participation – Green Invaders

Category	Sub-category	Female
cognition	analysis	n/a
	application	G1: "We were too slow."
	evaluation	n/a
emotion	positive	G1: "Yea." G2: "Oh yeah." G3: "OMG."
	negative	G2: "Dang it." G4: "Stop."

behavior	interaction	G3: "We should go this way."
	irrelevant	G5: "I'm so tired." G6: "I love yellow bandanas."

Analysis of Children's Response to Green Invaders–Girls Only

The majority of the activity involved the girls participating in the four rounds of the game. Once the facilitator explained what invasive species were at the beginning of the lesson, the rest of the lesson was facilitated by three high school students who served as the STEM interns.

Amount of Participation. I identified 45 instances of girls participating. While students were running around in the game, they were not participating in the ways identified in my coding scheme. This participation data was from before and after each round.

Control of Design. In the past, STEM World had a few invasive species on its property, such as honeysuckle. Students from past camps helped pull and clear out invasive species in addition to the knowledge they learned while at STEM World. Since, at the time of this camp, there were no invasive species present. This game was the main way for the girls to understand this concept. Below is an excerpt from one debrief. Pseudonyms are used for the children's names.

Round 1 Debrief

STEM Future Leader (SFL): So we started with 12 native species and ended with 2. Why do you think that is?

Beth: Because we weren't fast.

Jen: We didn't run fast enough; we were too slow.

SFL: Because there was no one to help you when–there was nobody to help you if got you tagged. Right?

Several girls: (in unison) Yeah.

SFL: Alright, so now one person is gonna be a responder. Who wants to be a responder?

Round 2

There was no debrief.

Round 3

SFL: (After realizing that there was still only one invasive species at the end of the round) Wow. That's a good example of how us removing the honeysuckle and all the other invasive species really helps out the other native plants.

Jen: Can I be a responder?

Wilma: Can I be a responder?

SFL: For this last round, we are going to have two invasive species. (Five girls raise their hands and move in front of the SFL in hopes that he will pick them)

Round 4

SFL: So even with two invasive species, the responders could still help.

Ann: Did it help?

Facilitator: They want to play another round.

Millie: It's my turn to be an invasive species.

The interns' facilitation got the girls engaged and excited about the game. After each round, the girls jumped up and down and raised their hands to be picked as the responder or an invasive species. The excitement was tied to the action of playing tag, not necessarily the academic content this activity was used to teach.

The SFLs did not provide much wait time during the debriefs. Since these debriefs were led by the high school students and not the facilitator, the debriefs lacked depth.

The most interesting evidence of participation was during the last debrief when a girl questioned how effective responders were when she said, “Did it help?” However, this comment was ignored, and the focus turned to the girls jumping up and down and requesting a fifth round.

Amount of Talk. Because the bulk of this activity was focused on the girls playing the game, there was not a lot of opportunity to observe participation. However, if the SFL had more training on how to better facilitate a conversation or if the facilitator facilitated the debrief after each round, I believe there could have been a higher quality of participation.

Roles. Regardless of whether a group is single-gendered or mixed-gendered, leaders rise to the top. One girl consistently volunteered for roles during the game. Additionally, she provided strategies for how the other girls should participate. At one point, she said, “We need to tire them (SFLs) out.”

The invasive species was mostly led by the older children. The older children managed the activity well; however, their strength was not in conversation facilitation. Had the girls been given wait time to answer, they could have had the opportunity to engage in some meaningful conversation and practice applying the knowledge they learned about invasive species before the activity began.

Limited Integration - Participation in Earth’s Superheroes–Mixed Gender Camp

During camp three, 11 students participated in the study. There were four white girls and five white boys, one Black girl, and one Latino male. One white girl attended all three weeks of camp. Another white girl attended camp one and camp three, and one Black girl attended camp two and camp three.

Children's Response to Green Invaders–Mixed Gender

This activity was also used during the girls-only week. Students participated to learn more about invasive species.

The facilitator explained what native species and invasive species were. Then, she read *Nature Out of Balance: How Invasive Species are Changing the Planet*. Students were not asked questions while the book was read. Then, she drew the chart on the whiteboard as the facilitator did during the previous all-girls week. This facilitator changed the chart and had students copy the modified chart. Students did not have to copy the chart during the girls-only week. Below, I have included the chart and an image from a female student's science journal.

Another difference between this week and the previous week is that the facilitator changed the length of the rounds. The girls did each round for two minutes. This week, the facilitator, who was different from the facilitator from the previous week, decided the first round would be 45 seconds, and all subsequent rounds would only be 15 seconds.

Instead of having students come back to the shelter after each round to debrief, the debrief took place at the end after all rounds were completed. The debrief was confusing to students because the facilitator subtracted wrong several times. Some students did not want to correct their charts and disengaged from the debriefing activity.

Table 5.10 Green Invaders Invasive & Native Species Data – Mixed Gender

	Round 1	Round 2	Round 3	Round 4
Length of Round	45 sec	15 sec	15 sec	15 sec
Number of Invasive Species	3	3	6	3
Number of Native Species - Start	13	13	10	11

Number of Responders	0	0	0	2
Number of Invasive Species - End	11	6	10	6
Number of Native Species - End	5	10	6	10

Image 5.2 Science Journal - Female Student

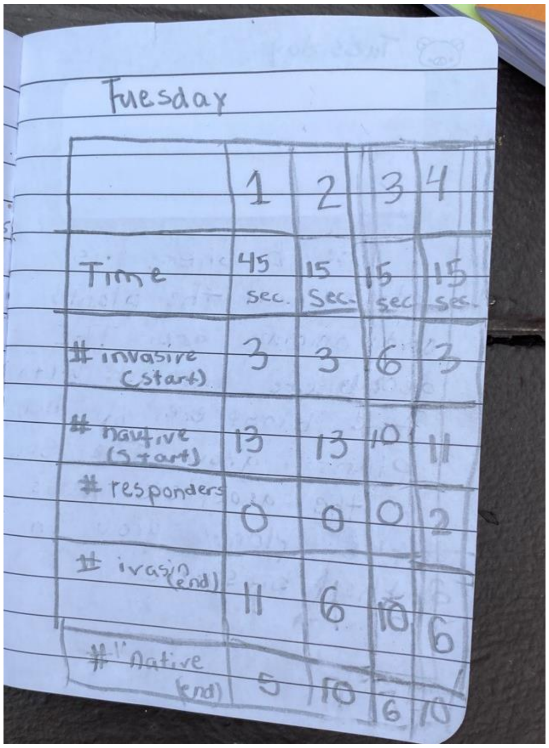


Table 5.11 Total of Observed Participation – Green Invaders – Mixed Gender

Category	Sub-category	Female	Male
cognition	analysis	7	0
	application	1	0
	evaluation	2	0
emotion	positive	1	1

	negative	1	5
behavior	interaction	16	27
	irrelevant	4	11

Table 5.12 Examples of Observed Participation – Green Invaders – Mixed Gender

Category	Sub-category	Female	Male
cognition	analysis	G1: "They can hurt our ecosystem." G2: "They harm the habitats they move into."	B3: "The invasive species were there for a lot of time."
	application	G1: "They can hurt our ecosystem."	n/a
	evaluation	G6: "Is this right?" (The facilitator's math to determine how many native species were left was wrong. This student questioned the facilitator's math calculations)	n/a
emotion	positive	G2: "This is so easy."	B4: "Yes."
	negative	G5: "You got wiped out." (student was making fun of a girl who fell during the game)	B2: "I don't want to do this anymore."
behavior	interaction	G3: "I want to be a responder."	B1: "Go like this" (student was opening and closing scissors and was trying to get another student to do it too)
	irrelevant	G4: "It's raining."	B3: "What animal?"

Analysis of Children's Response to Green Invaders–Mixed Gender

Two girls who participated in this camp also participated in the girls-only camp where this activity took place. The majority of questions asked by the facilitator were answered by these two girls. It seemed that participating in the previous week empowered them with the confidence to provide answers in a mixed-gender setting.

This activity was more intense during the mixed-gender group in comparison to the girls-only group. Half of the boys and one girl became really competitive during this game. When these competitive students were invasive species, they wanted to eliminate as many native species as possible. When there were native species, the students were focused on a responder tagging them to convert them back to a native species.

The facilitator noted that in years past, students picked garlic mustard, an invasive species, on the farm. The facilitator during the girls-only week used a different example, honeysuckle. Since there were currently no invasive species, students played this game instead, so some of the literacy discussions were not authentic since they were based on what occurred during this modified game of tag.

Amount of Participation. I identified 32 instances of girls' participation and 44 instances of boys' participation. This activity was used during the girls-only week, where there were 45 instances of girls participating, 13 more than the mixed-gender group. This facilitator, who was different from the girls-only week, spent more time sharing information, including reading *Nature Out of Balance: How Invasive Species are Changing the Planet*. The data coded in the chart was mostly collected during the frontloading of information before the game and after all of the rounds were over.

Unlike the high school facilitators from the previous week, the adult facilitator for this week wrote down the data in a notebook after each round. She used her notes to write the data on the whiteboard, which students copied into their science journals. Also, there was some data that fit the criteria of the coding scheme during the game that was included.

Control of Design. In the past, STEM World had a few invasive species on its property, such as garlic mustard. The prior week's facilitator mentioned honeysuckle. Two girls, one Black, and one White participated in the girls-only week and had already participated in this activity. Right before round one began, these girls got three boys and one girl (this girl attended week one in addition to week three) and made a huddle to strategize.

Since, at the time of this camp, there were no invasive species present, this game was the main way for the students to understand this concept. Below is an excerpt from the debrief that took place after all the rounds of the game. Pseudonyms are used for the children's names.

> Facilitator: So we did for 45 seconds for this one. Go ahead and put that on your table. So the number of invasive species to start with was three; we had three people to begin with. Our number of native species, to start with, was the rest of you, which was 13. The number of responders that we did that first round was zero. In the end, the number of invasive species that we had was—
>
> Martie: Three.
>
> Facilitator: Seven, and we had six native species at the end. Whoops! Eight and five. I wrote down the wrong ones.
>
> Cindy: How many?
>
> Facilitator: Eight invasive and five native. Alright. Our second round–our second round was a short exposure to invasives, so the invasive species is here, but it's only for a small amount of time comparatively, so we only did 15 seconds. We did 15 seconds in that second round. The number of invasive species we started with was three. The number of native species was 13. The number of responders was still zero. In the end, we had four invasive species, and we had nine native species.

Tessa: There is a problem.

Facilitator: Ugh! That's not right. Sorry, this was written in a different way. Hold on.

Cindy: (shakes head and puts her head down on top of her science journal, which is on the picnic table)

Facilitator: In the end, there were six native–invasive species and seven native.

Cindy: (to girl at her table) Just scribble it out and write next to it.

Facilitator: So we doubled the number of invasive species that we had, and we did six invasive species to begin with, which means we had ten native species to start with.

Tessa: Uh?

Facilitator: In the end–(she stops, looks at her notebook, back at the whiteboard, and back to the book again and places her hand on her hip.)

Cindy: How many responders?

Facilitator: We had zero responders again, and in the end, we had seven native species and, in the end, then we had–

Tessa: Six.

Facilitator: Six

Cindy: Ms. F, I can't see it (motions for the facilitator to move back; student appears puzzled by the data on the board.)

Facilitator: Oh, that can't be right. No that can't–hold on. Guys, I'm real sorry. This is my problem. It is because this number doesn't add into who I start with. That's the problem. (She realizes that she had been adding in the SFL in the total on rounds where they were asked to be invasive species. Therefore, they wouldn't be part of the native species count because they were external to the number of students in the game. The facilitator updates chart which matches image 5.2)

Roles. In the excerpt included above, there were no boys included as they did not vocally participate in ways according to the coding scheme during that part of the debrief. The two girls who participated in the week prior took a leadership and teacher role in noticing the errors with the facilitator's mathematical calculations.

The downfall of this activity versus when it took place during the previous week was the facilitator's struggle with the data collection. However, this activity showed a benefit to the girls who had participated during the prior week. They became leaders during week three of camp based on experiencing this activity during the prior week.

Children's Response to Salt Water vs. Fresh Water–Mixed Gender

The same students who participated in the green invader's lesson–mixed gender also participated in this lesson. This lesson focused on the hydrosphere and students understanding the differences between freshwater and saltwater.

When the lesson began, the facilitator reminded students that they learned about the geosphere on Monday and the biosphere on Tuesday, based on that, she had them brainstorm and share what they believe might be part of the hydrosphere. Male and female students equally provided answers for the brainstorming.

After the brainstorming, students listened to the facilitator read the book *Air and Water*. After the book concluded, the facilitator radioed a person in the barn to see if students could come to the barn to watch a video about the hydrosphere. There were no questions asked about what was read. Instead, after receiving confirmation that the students could come, she told them to start walking to the barn.

Once in the barn, the students watched a short video, T*he Basics of Freshwater: Crash Course Kids*. After watching the video, the facilitator had students walk back to the shelter. They did not discuss or debrief the content in the video.

After students returned to the shelter, materials were distributed for the salt water vs fresh water activity. The students were divided into four groups. Each group had a container of fresh water. Then students were asked to copy the chart below into their science journals. Next, they weighed the fresh water. As a group, they agreed on the descriptions for the fresh water. To make the salt water they analyzed, they added salt to the fresh water. Each group was given a different kind of salt: Himalayan salt, sea salt, table salt, or iodized salt. It was not explained why it was necessary to have each table use a different salt. After descriptions were added about the salt water, students weighed the water again. Students realized the water was denser when it had salt.

Table 5.13 Fresh Water vs. Salt Water Investigation

	Fresh Water	Salt Walter
Texture	smooth	little grainy
Transparency	transparent	less transparent
Color	clear	white, gray, pink
Smell	fresh, metallic	salty

After learning that salt water is denser, students went back to the barn to watch a video about density. After the video, a lead facilitator for the organization that manages activities at the barn debriefed the video. She used the bottle to show students a visualization of 97% salt water and 3% fresh water. She also noted that 2% of fresh water is not accessible due to being frozen.

After returning to the shelter, students were informed that if an object is denser than the water, it would sink. Then students were asked to hypothesize if an egg would float in salt water and if it would float in fresh water. Next, the facilitator put an egg in fresh water, and it sank.

Next students were instructed to place the egg in the salt water they made earlier in the day. All eggs sank. Then she told the students they could make it float, but they would have to figure out how much salt would need to be added.

Table 5.14 Total of Observed Participation – Salt Water vs. Fresh Water – Mixed Gender

Category	Sub-category	Female	Male
cognition	analysis	4	3
	application	4	4
	evaluation	1	1
emotion	positive	1	0
	negative	0	1
behavior	interaction	20	30
	irrelevant	3	3

Table 5.15 Examples of Observed Participation – Salt Water vs. Fresh Water – Mixed Gender

Category	Sub-category	Female	Male
cognition	analysis	G4: "It feels kind of gross."	B2: "Would 3% be fresh water?"
	application		B5: "It would impact animals too." (Students hypothesize the impact of water scarcity)
	evaluation	G5: "We need more." (Student realized the egg was close to floating in the salt water and suggested adding a little more salt)	B6: "It would get more dense."

emotion	positive	G2: “Ooh!”	
	negative		B3: I’m always watching you.” (This student repeated this phrase at random to antagonize another student)
behavior	interaction	G1: “Jellyfish are part of the hydrosphere.”	B1: “A tsunami?”
	irrelevant	G3: “Pink, yellow, or blue?” (Student was inquiring what another student’s favorite color was)	B4: “Marvel (movies) isn’t even scary.”

Analysis of Children’s Response to Salt Water vs. Fresh Water–Mixed Gender

This activity involved two trips to the barn. All students watched both videos; however, they were only invited into a conversation about the video during the second trip to the barn. When it came to the participation of girls in this activity, there was no significant difference between them and their male counterparts. The facilitator seemed to struggle with explaining the information which appeared to influence the participation of all learners.

Amount of Participation. I identified 33 instances of girls' participation and 42 instances of boys. The participation is similar to the last activity, which had 32 for girls and 44 for boys. Unlike the last activity where girls dominated certain parts, the participation was spread out across the various activities for salt water vs fresh water.

Control of Design. The career focus for this week was hydrologist. The activities that were part of this lesson were included to help students understand the different components of a hydrologist’s job.

Below is an excerpt from the debrief with students after they watched a video about density. The facilitator in this debrief was different from the main facilitator. This facilitator is one who works with all camp groups when they come to the barn. Pseudonyms are used for the children's names.

Tim: What did you put in the cups?

Facilitator: It is just water and food coloring.

Cindy: It is just representing. (She is helping the boy understand that this a model to help with understanding water)

Facilitator: Yeah. It is just to give you a visual. Because a lot of people think, oh there's tons of water. I could just dump this on the gravel or the cement–especially now, we have been having a drought. Which means we haven't been getting a lot of what?

Multiple students male & female: water, rain

Facilitator: Rain. Right. That's where we get a lot of our fresh water from the lakes and the creek, and stuff like that because, if we don't have a lot of water, it not only affects us but what else does it affect?

Tim: Animals.

Tessa: Plants.

Facilitator: So if our plants aren't growing, what do they give off?

Tim: Food, oxygen.

Facilitator: Right, oxygen and they provide us with a lot. If we don't have this, this also affects us by not having a lot of water.

Roles. In the excerpt included above, a female student interjected to help a male student understand what the model was and its purpose. The students were caught up too much in details that did not matter and missed the purpose of the model. Female and male students worked well together during the activity. The groups had an even distribution of both girls and boys taking charge.

The facilitator was the same for this activity and the green invader activity earlier in the week. When the students went to the barn, the facilitator that showed the video was better at explaining concepts to students. Had the main facilitator been able to communicate and implement the lesson better, I believe students would have been able to engage more.

Lessons with Promising Literacy and STEM Integration

I identified two lessons that had the most promising literacy and STEM integration and looked closely at girls' participation. These activities were snap circuits and square foot gardening.

Promising Integration and Participation in Creative Innovators Mixed Gender Camp

As stated earlier, 12 students participated during this lesson. Out of the twelve students, four were girls and eight were boys. There were five White girls and four White boys, two Black boys, and one Latino boy. One White girl attended all three weeks of camp.

Children's Response to Snap Circuits Lesson–Mixed Gender

Although it is possible that students do not attend every day of camp, for camp one, the same students that participated during rigamajig participated during the snap circuits lesson. For the snap circuits lesson, students were tasked with working in pairs to build a closed circuit in order to complete a task such as turning on a light.

The lesson began with the instructor asking, "How many of you have used snap circuits before?" Four hands went up in the air. Four students (three White boys and one Black boy) stated they had used them before.

Next, the instructor began reading from a book. She did not tell the students which book it was, nor did she start from the beginning of the book. The book she read was *Bright Dreams:*

The Brilliant Inventions of Nikola Tesla by Tracy Dockray. She talked to students about what a circuit was. After reading two pages, she showed a diagram of a circuit. Then, she read about the difference between an open and closed circuit. She then reviewed the difference with students. She asked, "If you have an open circuit, will electricity work?" In unison, the students said no. Then she asked, "If you have a closed circuit, will electricity work?" In unison, the students said yes.

Next, she connected the concept to a light switch. She told students when they turn off a switch, the light goes off because the circuit is now open. Students were informed that if any circuit was disconnected, then the circuit was open, and the electricity would not work.

After that, she gave students snap circuits kits. Students were instructed to work in pairs and to do project one with their kit. They were told to read the directions and work with their partner to build the closed circuit to make the bulb light up. Instead of allowing students to follow the instructions, the instructor decided to narrate the instruction and make sure each student was doing each step correctly.

After students showed her they could successfully complete project one, they were told they could do any of the other 70 activities in the book. The lesson plan stated students build circuits using the book and also be encouraged to build circuits on their own. The instructor made the activity focus on the tasks within the manual. However, after the teacher walked them through the first project, the majority of students abandoned the directions and instead put pieces together to see what would happen. The abandonment seemed due to the frustration of comprehending the directions in the manual.

Whether students used the manual or created a circuit on their own, they had to figure out how to approach the task. Some pairs divided the work by having one person read the directions and explain them. Then, the other partner implemented the directions. In some pairs, both students read the instructions, and both added the circuit pieces to the board. Girls were more likely to be the reader when only one student read. Additionally, one White girl began floating from table to table, reading directions and explaining what to do.

Table 5.16 Examples of Observed Participation – Snap Circuits

Category	Sub-category	Female	Male
cognition	analysis	4	9
	application	18	27
	evaluation	19	18
emotion	positive	20	13
	negative	4	13
behavior	interaction	78	94
	irrelevant	8	19

Table 5.17 Totals of Observed Participation – Snap Circuits

Category	Sub-category	Female	Male
cognition	analysis	G1: “Where are the instructions?”	B1: “Why do I need it?”
	application	G2: “We need batteries”	B1: “What part will make it close? Let’s try this.” B2: “We have to put it like this so we can connect it.”
	evaluation	G3: (to a boy) “It’s not going to work. You don’t have the right wire.”	B3: (after looking back at instructions after light failed to turn on) “Oh, the switch goes like this.”
emotion	positive	G1: “Yes!”	B3: “Light is turned on!”

		G2: "Ah ha!" G3: "It's so pretty!" G4: "Oh!"	
	negative	G2: "Move."	B2: "Let me see it"
behavior	interaction	G1: "It's an alien saucer." G2: "You probably shouldn't turn it on and off when you are trying to replace parts." G3: "Let's try it the other way."	B1: "I know how to do this. I have snap circuits at home." B4: "I'm trying to follow the instructions." B5: "Do you have L1? I have L2."
	irrelevant	G1: "Let's make a flying saucer" G2: "The aliens will come for us."	B1: "Pop, pop, boom." B1: "That's a tiny pack of batteries" B1: "Yo watch this." (student makes noises with his mouth)

Analysis of Children's Response to Snap Circuits Activity–Mixed Gender

What stood out to me in the tables above was that this activity produced nearly the same number of cognition-evaluative responses regardless of gender. Also, as the lesson continued, girls were more likely to have a positive response while working through the manual to close the circuit than boys did.

To be successful with the snap circuit kits, students had to understand what a closed circuit was and how to make one using the components in the kit. They also had to be successful in working collaboratively toward the same goal. Additionally, students needed to stop and evaluate their progress to determine whether to stay on the same path or adjust the plan.

Amount of Participation. I identified 151 instances of girls participating and 193 instances of boys participating. Although boys participated 42 more times than girls, the gap between boys' and girls' participation narrowed during this activity. For the last activity, boys participated in 121 more instances than girls. It is important to note that for rigamajig, students worked in large groups versus the snap circuits, where they worked in pairs.

Control of Design. Part of this activity replicated the real-world setting of what an electronic technician might do by following a manual or set of instructions to complete a task. Even though the lesson plan stated students should follow the manual and complete some of the activities following the instructions and for students to also make circuits on their own, the facilitator focused on using the manual. This was an instance where the girls began to shine. Below is an excerpt from one pair's conversation. Pseudonyms are used for the children's names.

Sarah: (props circuit manual up against box and reviews it)

Malik: What does it do? (places piece on the circuit board)

Sarah: No, not there (removes the piece that Malik placed on the board and picks up a different piece) We need another piece like this.

Malik: Oh. (picks up a few pieces like the one Sarah recommended) We need this to connect to a different circuit. (says to STEM Future Leader, a high student helper) How many do we have?

SFL: Two more.

Malik: Maybe we could do piece one and then two.

Sarah: (Malik puts those pieces on the circuit board) Yeah, now let's put the fan on.

(Sarah puts on the fan, and it works.)

Amount of Talk. Because students had to use a snap circuit manual during this lesson, it gave each pair a common source to talk about. Even though students were not required to use the manual the entire time, students still talked about snap circuits because all students work on making a closed circuit during the time allotted.

Roles. As shown with Malik and Sarah, depending on the strengths and ease of grasping the concept of open versus closed circuits, girls had an opportunity to take the lead. During rigamajig, the groups were larger. However, for snap circuits, students worked in pairs which allowed for more opportunities for students, regardless of gender, to speak and take the lead.

Promising Integration and Participation in Plant Wizards Girls-Only Camp

During camp two, 12 students participated in the study. All participants were girls since this was a girls-only week. There were nine White girls, two Black girls (who were sisters), and one Latina. One white girl attended all three weeks of camp, and one Black girl attended camp two and camp three.

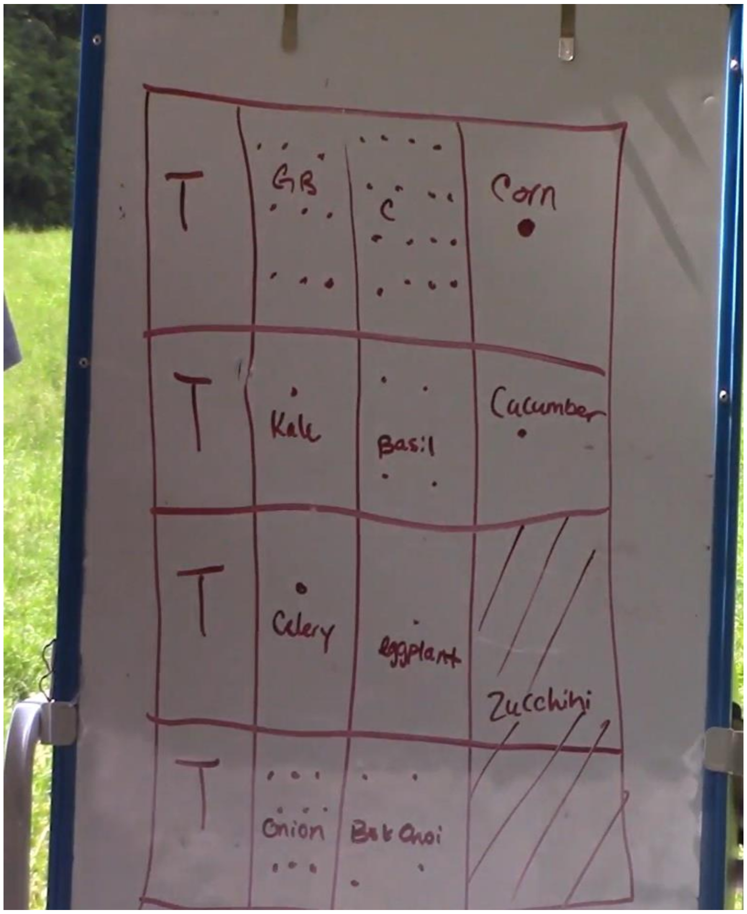
Children's Response to Square Foot Gardening–Girls Only

The same students who participated in the girls-only green invaders activity also participated in the square foot gardening lesson. During the lesson students had the opportunity to plan a garden for the farm.

The lesson began with students learning about plant parts and then tasting harvest from the farm. Then, the facilitator explained who Mel Bartholomew was. He invented the concept of square foot gardening. The facilitator held up pictures from Bartholomew's book, *Square Foot Gardening with Kids*. Then, they were given a square foot gardening guide. With the guide, all twelve girls worked together with the facilitator to plan the layout of one four by four raised garden bed on the farm. In each square foot was one plant. Some plants had one square foot and some plants had more than one square foot in the design. The girls determined how many of each plant could go into one square foot and which square foot would be next to each other based on the needs of the surrounding plant. The girls had to consider if a plant would grow too big and provide too much shade for the plant in the box next to it.

For the collectively planned box, students decided to plant: tomatoes, green beans, carrots, corn, kale, basil, cucumber, celery, eggplant, zucchini, onion, and Bok choi. Below is a picture of the plan.

Image 5.1 Square Foot Garden Plan



After the plan was completed, the facilitator wanted the girls to practice creating seed sheets. Each girl was given a 1x1 foot sheet. They had the option of making a carrot seed sheet or a radish seed sheet. These sheets could be kept by the girls to plant at home or donated to the organization for younger kids to plant at a later date.

Once the girls finished these seed sheets, there was not time for them to make the seed sheets for the garden they planned with the facilitator.

Table 5.8 Totals of Observed Participation – Square Foot Gardening – Girls Only

Category	Sub-category	Female
cognition	analysis	7
	application	12
	evaluation	9
emotion	positive	5
	negative	0
behavior	interaction	59
	irrelevant	2

Table 5.9 Examples of Observed Participation – Square Foot Gardening – Girls Only

Category	Sub-category	Female
cognition	analysis	G1: "Can we do basil?" (student was processing aloud if basil would be the appropriate square next to kale and cucumber) G2: "What about eggplant? (student was processing aloud if eggplant would be the appropriate square next to celery and zucchini)
	application	G2: "16" (student was able to determine how many carrots could go in one square foot) G3: "1" (student was able to determine how many tomato plants could go in one square foot)
	evaluation	G4: "Onion–onion medium. You could plant nine." (student realized that the big onion would yield less and reevaluated to suggest planting medium onions)
emotion	positive	G5: "I love celery."

	negative	n/a
behavior	interaction	G3: "How many seeds do we need?"
	irrelevant	G6: "We're coyotes!"

Analysis of Children's Response to Square Foot Gardening–Girls Only

Ten of the twelve girls verbalized ideas to contribute to the planning of the collective square foot, 4x4 raised garden bed. Not only did they have to determine how many seeds went in each square foot, but they also had to determine which plants grow the best next to each other. This activity allowed for the authentic planning of real garden space. Students had to negotiate ideas and determine which idea made the most sense.

The downside is that students did not have time to plant their squares for the garden they planned during this lesson due to running out of time.

Amount of Participation. I identified 94 instances of girls participating. During the previous activity, green invaders, the girls only participated 45 times. Participation doubled during this activity. Additionally, the participation was of a higher quality than during the last activity.

Control of Design. Part of this activity replicated the real-world setting of what a horticulturist would do to plan a garden space. In particular, the girls learned how to plan a square-foot garden for a space on STEM World's property. Below is an excerpt from the whole group garden planning session. Pseudonyms are used for the children's names.

Facilitator: What else do we like to plant?

Lila: Corn.

Facilitator: How much corn per square foot?

Lila: (reads seed packet) One.

Facilitator: (adds corn and the amount to the garden planning board) Perfect. What else? What else are we going to plant in our garden?

Sarah: Cucumbers.

Facilitator: How many cucumbers?

Sarah: (reads seed packet) One.

Facilitators: (adds cucumber and the amount to the garden planning board)

Lois: (reads zucchini packet) Two plants and two square feet?

Facilitator: So, zucchini needs a lot of space. If you are looking at a packet of zucchini, it'll say 24 inches which means two feet. If we did zucchini, we would have to do—(adds zucchini to the garden board but shades in two squares to show it is one plant across two square feet)—it would have to be in these two square feet

Lois: Wow.

Facilitator: So that takes up a lot of room. You might want to be like I don't want to give up that much room, so maybe you don't plant zucchini, or maybe you plant it somewhere else.

Amount of Talk. This collective garden planning allowed more individual participation. During the last activity, green invaders, girls had collective answers such as "yeah." However, during this activity, it wasn't a collective response of the same few girls responding each time. Instead, all girls, except for two, contributed at least one suggestion about what to plant and shared how many plants would go in each square foot.

Roles. The girls worked well together. No student took on a sole leadership role. Instead, the girls took turns, without the facilitator's prompting, which ensured that all girls had the opportunity to participate if they so desired.

Square foot gardening was a more meaningful activity than green invaders. Yes, students might enjoy playing a game based on tag; however, square foot gardening provided a more authentic experience. Students read seed packets and worked together with the facilitator to make a plan, and then had the opportunity to plant the garden on the farm at a later time in the future.

Summary of Literacy and STEM Integration in Promising Lessons

Amount of Integration

A key element of snap circuits and square foot gardening was the amount of literacy and STEM integration. Students truly had the opportunity to experience and participate in authentic STEM learning by engaging in literacy-rich experiences.

Even though the lesson plans did not address literacy explicitly, it was there. For instance, in snap circuits, students had the opportunity to engage with the snap circuit manual and engage in an authentic literacy practice of reading a manual to find information for executing a task. For STEM, this was more authentic because it expanded beyond simply learning about closed and open circuits from a trade book.

For square foot gardening, the facilitator implemented literacy best practices for deeper comprehension that were not outlined in the lesson plan. For example, she made text-to-text connections between the literature she used in the activity. She also made text-to-self connections and guided students in making their own text-to-self connections. Additionally, planning a real garden, not simply one in theory, allowed the girls to use all domains of literacy–reading, writing, speaking, and listening–while they were doing authentic horticultural tasks of planning a square foot gardening.

Structuring Participation

Success during the promising lessons was not rooted only in literacy and STEM integration. How participation was structured also had an impact on how students engaged in the activities during the lesson.

During rigamajig, students during that activity were divided into two large groups. Because of the large group size, students were not as productive as they could have been. Some students took a passive role. Eventually the students were the ones who asked if they could break into four groups and not only two. This resulted in moving from two male group leaders to four male group leaders. This produced more participation, especially in leadership roles for the males, but not the girls. Further, shifting the organization of the activity in the middle of the activity did not result in the outcome students wanted because there were not enough rigamajig pieces for all of the prototypes students were trying to build.

During snap circuits, students were in pairs. This gave students more opportunities to speak and engage with the task of making closed circuits so the lightbulb would turn on or the "Happy Birthday" song would play.

Also, during square-foot gardening, each student had a task which was to read the seed packets they had and to contribute to the joint activity of planning the garden. The girls during the girls-only week participated more partly because they each were given a task that required their individual participation to a larger whole.

Even if a lesson has literacy-rich STEM experiences, the activities might not elicit a high amount of participation if the ways the students are asked to participate do not set them up for success to participate.

Looking Forward

In chapter 6, I will highlight best practices for authentic literacy-rich STEM experiences. I will also provide thoughts on how to best involve girls in participating in both girls-only and mixed-gender settings.

CHAPTER 6: Comparing Girls Actual Participation to Planned Activities

To learn more about girls' participation and learning when exposed to and engaged in literacy-rich STEM experiences and creative arts integration-into-STEM experience, I identified the following research questions:

1. How does cross-curricular work that infuses literacy and creative arts into STEM activity influence girls' interactions and participation?
2. How does girls' participation vary across literacy-infused STEM activities? Which activities invite more participation? What STEM identities do girls take up in these activities?
3. How does girls' participation vary across girls-only and mixed gender groups**?**

To find answers to these questions, I observed three, one-week long, summer STEM camps at STEM World. Camp one and camp three were mixed-gender camps, and camp two was girls-only. Each STEM week was Monday to Thursday from 9 a.m. to 4 p.m. The first half of the day, before lunch is when two structured lessons took place. After lunch, there were free choice activities. An activity could have as few as one participant because there were multiple activities happening simultaneously that children could choose. This led me to focus on the structured lessons before lunch. I recorded all lessons and collected the students' science journals. The journals were part of the STEM World's programming and not added because of this research study. As a result, I collected video footage of 24 lessons. I focused on six lessons for the study.

Week one: rigamajig and snap circuits

Week two: green invaders and square foot gardening

Week three: green invaders and salt water vs freshwater

In chapter four, I included the lesson plan the facilitator was given to use for lesson facilitation. I also included the lesson plans of the 18 lessons I didn't focus on in the appendix. I situated my research in critical sociocultural perspectives because I wanted to explore ways people, in particular, girls, can break out of the socially constructed and perceived limitations of race, class, or gender. (Fay, 1987, as cited in Creswell and Poth, 2017). Additionally, I wanted to know if girls' participation increased or had the potential to increase based on the lessons during STEM World summer camp.

Comparing Potential and Actual STEM Participation in Mixed Gender Camp Activities

Rigamajig Comparison (Mixed Gender Camp)

Rigamajig Lesson Plan

For rigamajig, students had to create a prototype on their own, form groups, and then pick one prototype to create. The lesson plan had the following books listed at the top:

- *The Most Magnificent Thing* by Ashley Spires, a book about how to persevere when building a new item
- *Be A Maker* by Katey Howes and Elizabet Vuković, a book about how to use creativity when building a new item

There are books listed at the top of every single STEM lesson used during the three weeks of camp covered in my study. However, listing books at the top of the lesson plan is not enough nor does it set up the teacher to use the books as a read-aloud literacy practice nor as an authentic STEM literacy. Laminack (2009, p.35) asserts that a read-aloud should give students "more background that will help them fine-tune questions and build a more solid conceptual foundation." Additionally, he said read-alouds should be used to inspire students in new topics or ideas, invest them in new learning, or instruct them on key concepts" (Laminack, 2009, p. 49). As an authentic STEM literacy, Texley and Ruud (2018, p.19) state that science trade books should be more than "accumulations of facts," but also should "invite students to use the practices of science." These books could have been structured to hook students into learning or to introduce them to concepts they would expand upon later in the lesson. No place in the lesson plan does it state when to even use the book let alone how to use it.

The lesson also states that “the teacher and students establish the ground rules for positive cooperative play.” However, the lesson plan, as written, did not provide the teacher with directions on helping children to work together for the task at hand. Instead, there were some cooperation discussion questions listed.

- How do we ask for something that we need?
- How do we ask for a turn and say, "I’m using this right now, but you can use it when I’m done."
- How do we listen to another person’s idea or suggestion respectfully?
- How do we suggest other pieces or other configurations of pieces to one another if the one we first wanted wasn’t available?

Cooperative learning is a structure that must be taught and integrated into the lesson to ensure lesson success (S. Kagan & L. Kagan, 2010, p. 6). However, there were no specific cooperative learning strategies for the teacher to use, no directives on how to get the students to select one prototype, and limited information about how the other students should work to help with the implementation of building the chosen prototype.

On the first day of camp, all students are given a science journal to use for the week. Students can add to it at any time, and this is the place to complete reflections embedded into the lesson. There was a list of four points for students to reflect upon:

- What makes a good collaborator?
- Tell us about a problem you encountered and how you solved it.

- In their science journal, create drawings and descriptions or photographs and descriptions of work.
- Share and present work with each other, include discussions of how and why construction decisions were made.

It was not clear how students were to reflect for the first two points, and the facilitator would have to decide whether to have students complete this orally or in the journal. Point three specifically stated to put the response in science journal. The last reflection point asked students to present and share.

First, it is important to shift from the words science journal to science notebook and set the audience for the journals. Fulwiler (2007) provides a few suggestions:

- Teachers should use not use the words science journals because they can make students think about writing workshops during the literary block at school and the words science logs should be avoided since this has a focus on mostly ongoing data collection.
- Students should be told that the audience for the notebooks are scientists to help students write in a way that a scientist would.
- Science notebooks should be used during every lesson, and teachers should provide feedback on what students have written in the notebooks to help ensure they are aligning with what a scientist would track and write about.

The adjustments noted above would help improve this written lesson plan.

Rigamajig Implementation

Rigamajig had the potential for authentic STEM participation. Choosing one idea from those generated in a team and developing the chosen idea into a prototype is a realistic STEM task. What would be more helpful is having a process to use to select the idea and then having jobs or roles for the team as they build the prototype. Not only was this missing from the lesson, but the facilitator did not add her own strategies for collaboration.

The result was the boys dominated the discussion in the amount of time they talked, and in the group's decision-making: every group went with a boy's prototype. The boys whose prototypes were chosen then gave the most instructions on how to construct it. Thus, the boys' instances of participation were double that of the girls. Although the facilitator did go over the cooperative discussion questions from the lesson plan, the discussion mostly centered around what you would tell students going out to recess such as "share items," which is not the same guidance and instruction you would need in an authentic STEM environment.

Last, the lesson did not have a real wrap up. Once the time was up, students were instructed to clean up and return to the shelter. Even in a science lab or a technology lab, there would be some wrap up procedures.

Snap Circuits Comparison (Mixed Gender Camp)

Snap Circuits Lesson Plan

The snap circuits lesson plan goal was to get students to create a closed circuit. The lesson plan had the following books listed at the top:

- *Bright Dreams: The Brilliant Inventions of Nikola Tesla* by Tracy Dockray, a book about Nikola Tesla's early years working with electricity
- *The Boy Who Thought Outside the Box: The Story of Video Game Inventor Ralph Baer* by Marcie Wessels, a book about Ralph Baer, the father of video games
- *Oscar and the Bird: A Book about Electricity* by Geoff Waring a book about how electricity is made

Like with rigamajig, there were no directions on how or when to use the books.

The lesson then called for students to participate in making a circuit by standing in a circle, holding hands, and touching an energy ball. When one person lets go, the circuit breaks, shifting from closed to open.

Next, the lesson plan instructed students to work in partners. Each pair had a snap circuits kit. The lesson plan said, “Then, with a partner, participants will follow the directions in the booklet (snap circuits manual) in the set to create different circuits.” The teacher was instructed to ensure the battery packs were assembled correctly. If the circuit was built correctly but the power source was not working, it could make the students think that they had not followed directions correctly.

At the end of the lesson plan, it said, “they can explore other activities, with the manual or experiment with their own creations.” However, the written objective was, “Participants will learn basic engineering, electronics and circuitry concepts by using building components with snaps to assemble electronic circuits on a simple “rows-and-columns” base grid.” Although this objective is not as specific as it could be, based on the fact that lesson had students complete one activity from the manual and the lesson stated first that they should “explore other activities,” the lesson aim seems to be following a manual and executing the directives given which would align with an authentic science or engineering practice. Although creativity might be needed if an engineer or scientist cannot complete a task, the engineer or scientist would first have to be well versed in the skill at hand before experimenting with the skill.

Unlike rigamajig, where students were in larger groups, this lesson called for students to work in pairs which allows more time for both students to share and collaborate. As written, this activity provides students with ample opportunities to participate regardless of gender.

Snap Circuits Implementation

The facilitator did not follow the lesson plan with fidelity. She jumped right into reading the book without even telling the children the name of the book which was *Bright Dreams: The Brilliant Inventions of Nikola Tesla* by Tracy Dockray. She did not read any page in its entirety. Instead, she read one or two sentences and summarized what happened. She showed some of the pictures, but the students did not discuss them.

The lesson called for students to stand in a circle and link hands, and two students in the circle were connected to the energy ball. This would have allowed the students to create a circuit using their bodies. The facilitator skipped those directions, and the energy ball was not used. Instead, she gave a verbal example where she compared the concept to a switch. She told students when they turn off a switch, the light goes off because the circuit is now open. This prevented students from having a hands-on STEM experience.

The lesson plan said, “Then, with a partner, participants will follow the directions in the booklet in the set to create different circuits. Start with assembling the battery pack, making sure all groups have the batteries inserted correctly.” This lesson plan put the focus on having the facilitator ensure the battery packs were working. During the implementation, the facilitator, in addition to checking the battery packs, had students do the first activity altogether as a large group even though the instruction did not call for that. The lesson plan said, “they can explore other activities, with the manual or experiment with their own creations.” The facilitator made the focus sticking to the snap circuits manual. On one hand, following a guide to complete a STEM task can be an authentic STEM experience, but building your own creation based on knowledge you have learned is also part of authentic STEM tasks.

For this activity, the snap circuits materials could serve as an authentic STEM literacy tool if used for collaborative exploration in an expanded definition that included making and a design activity **(**Wohlwend et al., 2017), unlike the book used by the facilitator at the beginning of the lesson. Hadid (2022) states that, "Academic disciplines that engage diverse student populations in complex text consumption and production are particularly well suited to identity work." A focus of STEM World is building students' STEM identities. The organization has a particular focus on students of color and girls. According to the Indiana Department of Education (Lawson, 2022), in Indiana, there are a little over 100 STEM certified schools, and there are a little under 2,200 schools across the state of Indiana (IDOE, n.d.). Appropriately 5% of Indiana schools earned a STEM certification. This does not mean the cross-curricular work of the individual components of STEM is not happening, but there is, not at this time, a collective measure of what STEM looks like in non-STEM certified schools.

For students to develop STEM identity, especially girls, they need access to authentic STEM tasks, literature, and tools. Gale Beauchamp, Engineering STEM Identity project director, said "Student identity is the leading predictor of student persistence in STEM, so that is our focus" (US DOE, 2015). This activity provided students with a snap circuits manual replicating manuals that could be used by people in STEM careers.

Salt Water vs. Fresh Water: Hydrology Comparison (Mixed Gender Camp)

Salt Water vs Fresh Water Lesson Plan

The STEM career connection for this lesson was a hydrologist and the lesson stated objectives are: describing the differences between freshwater and saltwater, understanding that freshwater is a limited resource, and understanding density and buoyancy.

Just like rigamajig and snap circuits, this lesson had books listed at the top. The books on this lesson plan were:

- *Does It Sink or Float?* by Susan Hughes, a book about matter and characteristics that make items sink or float
- *All the Water in the World* by George Ella Lyon, a book about the water cycle through a text written in lyrical verse

Again, there were no specific instructions on how or when to use these books.

The lesson begins with students watching a video about the water on the earth and how much is fresh water versus how much is salt water is on planet Earth. After the video, the facilitator is instructed to:

- Discuss the amount of freshwater in the world (3%).
- Tell students that 97% of the water in the world is saltwater.
- What are the differences between freshwater and saltwater? Record ideas on white board.

These prompts and questions are not written in a way to elicit higher order thinking; they are right there questions which do not require synthesis or analysis.

After students have the discussion, the lesson plan has students make salt water and then return to the barn to watch a second video on density with more recall questions. Then, students determine if an egg will float in salt water versus fresh water. Before this activity occurred, the lesson could have directed the facilitator to use book *Does It Sink or Float* as a proper read aloud as mentioned earlier in this chapter in the rigamajig lesson section.

The lesson concludes with two reflection questions:

- What did you observe?
- Why did the egg float in saltwater?

Students are also asked to complete a graphic organizer comparing and contrasting the characteristics of salt water versus fresh water. However, there are no directions on how to do this reflection. It is not clear if the reflection is oral or written or whole group or individual. This activity could be elevated to an authentic task with their journals if the journals were treated as science notebooks as mentioned earlier in this chapter.

Salt Water vs Fresh Water Implementation

The facilitator followed the written lesson plan. However, the lesson plan did not call for deep higher order thinking, nor did the facilitator have the skills to help students tap more into cognition participation. The students watched two videos, one about the difference between salt water and fresh water and another about density.

The implementation of this lesson led to only a slight difference between male and female participation. I identified 33 instances of girls' participation and 42 instances of boys. After the students finished watching the video about density, the facilitator was instructed to do the following:

- Ask participants to share background knowledge.
- Watch video to learn about density: What is Density?
- Discuss vocabulary: mass, volume, density, weight, gravity

There is a facilitator at STEM World whose job is to prepare the videos students come to watch in the barn. This facilitator led the debrief with students. This is a smaller excerpt from the excerpt included in chapter five. Pseudonyms are used for the children’s names.

> Facilitator: Yeah. It is just to give you a visual. Because a lot of people think, oh there’s tons of water. I could just dump this on the gravel or the cement–especially now, we have been having a drought. Which means we haven’t been getting a lot of what?

Multiple students male & female: water, rain

Facilitator: Rain. Right. That's where we get a lot of our fresh water from the lakes and the creek, and stuff like that because, if we don't have a lot of water, it not only affects us but what else does it affect?

Tim: Animals.

Tessa: Plants.

Facilitator: So if our plants aren't growing, what do they give off?

Tim: Food, oxygen.

Facilitator: Right, oxygen and they provide us with a lot. If we don't have this, this also affects us by not having a lot of water.

This discussion focuses more on the first video about salt water and fresh water although it happened after the density video. The questions in the lesson plan for this video were not asked and the questions that were asked elicited mostly one-word responses such as, "animals" and "plants."

Earlier, I stated there were 33 instances of girls' participation and 42 instances of boys. This participation spans the three categories I tracked: cognition, emotion, and behavior. The most participation came from behavior, specifically the interaction sub domain, girls 20 and boys 30. The lowest was cognition, which had the subcategories of analysis, application, and evaluation. Evaluation was the lowest at one instance each for both girls and boys. Application and analysis were almost the same with four instances of application for boys and girls and four instances of analysis for girls and three for boys.

The questions and discussion facilitation did not bring out evaluative, analytical, or application participation.

Comparing Potential and Actual STEM Participation in Girls-Only Camp Activities

Square Foot Gardening Comparison (Girls-Only Camp)

Square Foot Gardening Lesson Plan

For this lesson, horticulturist was the focal career. What is interesting is that even though the organization labeled this lesson plan Square Foot Gardening, the section at the end of the lesson plan called square foot planning and planting was listed as an optional activity if another activity was needed to fill the time.

As with rigamajig, snap circuits, and salt water vs fresh water, this lesson plan had books listed at the beginning. Those books were:

- *Right This Very Minute: A table-to-farm book about food and farming* by Lisl H. Detlefsen, a book about agriculture and how food goes from the farm to the table -
- *Tops and Bottoms* by Janet Stevens, a book where students learn that we eat the tops or the bottoms of certain harvest
- *From Seed to Plant* by Gail Gibbons, a book to learn the stages of plant life starting from the seed stage
- *How a Seed Grows* (Let's-Read-and-Find-Out Science 1 Series) by Helene J. Jordan, a book to learn the steps to get a seed to grow into a plant
- *Square Foot Gardening with Kids* by Mel Bartholomew, a book to learn how to use gridded boxes to make a square foot garden

Again, it was not listed how or where to use these books.

Earlier in the lesson plan the facilitator is instructed to teach the girls about plants and their parts. The students are supposed to taste garden harvest, look at plants, make observations, and participate in dialogue about the gardening process. Learning about plants, tasting food, and talking about gardening does not get students involved in the actual execution of the horticulturist STEM skills. Having the square foot planning activity as optional leaves the inclusion up to the facilitator. Removing the word optional sends a message to the facilitator that the time for the activities before square foot gardening should be managed in a way to ensure they get to this part. This part of the lesson is the application component and without this being mandatory, students are potentially missing out on a key component of practicing a task a horticulturist would carry out.

Square Foot Gardening Implementation

I identified 94 instances of girls participating. This was double the participation during the other girls-only activity that I will highlight later in this chapter. The facilitator did not treat the square foot gardening as an extra activity. It was the activity she was striving to get to even though the girls only had time to plan but not plant that day.

She began by reviewing plant parts. Then, the girls participated in a plant tasting. Next, she talked about Mel Bartholomew. She shared that he was the engineer who invented the concept of square foot gardening. She then read the book *Square Foot Gardening with Kids* by Mel Bartholomew, a book to learn how to use gridded boxes to make a square foot garden, to help students understand what this task would include.

Students were then given a square foot gardening guide, and all twelve girls worked together with the facilitator to plan the layout of one four by four raised garden bed on the farm.

CREDE (Center for Research on Education, Diversity, and Excellence) has developed five standards for effective pedagogy and learning. One of those pillars is joint productive activity (JPA) where students and teachers construct knowledge and work together on a task (CREDE, n.d.). Hilberg et al.'s study (2000) focusing on math showed that when CREDE's principles are used students show academic improvement.

Although the lesson plan did not explicitly state that the teacher should use JPA, her use of it led to greater participation from the girls.

Comparing Potential and Actual STEM Participation in the Same Activity across Girls-Only and Mixed Gender Camps

Green Invaders Comparison (*Girls Only and Mixed Gender Camps)*

Green Invaders Lesson Plan

The focus career for the green invaders lesson plan was an invasion ecologist. The lesson plan instructed the facilitator to explain the difference between a native and invasive species, share about the invasive species that was previously on the farm, and have students review various invasive species in a pamphlet before playing a modified tag game.

As with rigamajig, snap circuits, salt water vs. fresh water, and square foot gardening, this lesson plan also includes a list of books. Those books were:

- *Plant Invaders (Smithsonian Readers)* by Vickie An, a book to learn how to stop a growing invasive species
- *Nature Out of Balance: How Invasive Species Are Changing the Planet (Orca Footprints, 19)* by Merrie-Ellen Wilcox, a book to learn about invasive species around the world and why humans are the most invasive species
- *Aliens from Earth: When Animals and Plants Invade Other Ecosystems* by Mary Batten, a book to learn about specific invasive species cases around the world and the impact on the ecosystem

This particular lesson did have a literature connection included in the lesson plan with instructions for the facilitator. However, it was not included in the literature connection list at the beginning of the lesson. To help students understand what an invasive species is the lesson plan says, "Show Invasive Species pamphlet and discuss what an invasive species is (a species that is not native to an area).” This pamphlet is an authentic STEM text, and an invasion ecologist would read about various invasive species to stay in the know about how they look and where they are currently a problem. To improve this lesson plan, this pamphlet should be added to the literacy connection list.

After the facilitator reviews what an invasive species is, the lesson shifts to invasive species tag which is also known as the green invaders game. During the invasive species tag, the parameters of the game changed during each round. The first round had no children in the responder role. The responder role saved the native species from being taken over by the invasive species. In some rounds, there were more invasive species taggers and, in some rounds, there were more invasion ecologist responders. After every round, the lesson plan directs the facilitator to count how many native species are left and how the number of invasive species and responders impacted the number of native species left. Additionally, there were reflective questions at the end with possible responses that children should have given.

Although there were no invasive species left on the farm, this modified tag game gave students the opportunity to participate in an accelerated scenario of how invasive species take over. The data debrief after each round is the critical component. It allows students to engage in STEM data synthesis to draw conclusions and plan next steps to solve a problem.

Green Invaders Implementation

This activity was the only activity that was repeated between two weeks of camps. Since this activity occurred during the girls-only week and then the next week during a mixed-gender camp, it was important to review girls’ participation even though some factors were not the same. An important difference was the preparation of facilitators; it was not the same. The facilitator of the girls-only week did not struggle with math concepts and made use of the STEM

Future Leaders (SFLs), who are older students who assist the facilitators to help with the lesson. This led to variation in the quality of instruction and how the lesson plan was implemented.

Girls Only. During the girls-only week, the facilitator (Facilitator A) followed the lesson plan. Additionally, she made connections between this lesson and the poison ivy lesson the girls had completed right before this lesson. This week there were also four interns, called STEM Future Leaders, who were high school students, available during this week. The facilitator got them involved with giving the instructions for the modified game of tag and with the data conversation after each round. The data was documented on the white board with a chart. The downfall of the data debrief is that the high school students did not have preparation or skills to facilitate this conversation. For example, there was too much "teacher" talk and not enough student talk. There was not enough wait time for students to think through the data questions. Additionally, the data conversations felt rushed because the girls wanted to get back to playing tag. It was evident that the girls enjoyed the tag game.

For participation, there were 14 instances of emotion and 30 for behavior. What was concerning is that this activity only triggered one instance of cognition, specifically the sub category of application. The downfall of the implementation is that the facilitator, in an effort to include the SFLs, had them facilitate the data collection debrief conversation. Although the girls appeared to be happy based on their comments to the SFLs about their participation in invaders tag, the SFLs facilitation of the debrief did not allow the girls to participate in a meaningful way.

Below is the dialogue from debrief after round one of the games.

STEM Future Leader (SFL): So we started with 12 native species and ended with 2. Why do you think that is?

Beth: Because we weren't fast.

Jen: We didn’t run fast enough; we were too slow.

SFL: Because there was no one to help you when–there was nobody to help you if got you tagged. Right?

Several girls: (in unison) Yeah.

SFL: Alright, so now one person is gonna be a responder. Who wants to be a responder?

When the SFL said, “Because there was no one to help you when–there was nobody to help you if got you tagged. Right?” he answered the question which shut down the possibility of the students taking the cognitive load of figuring out a better answer than “we didn’t run fast enough; we were too slow.” I wonder how the conversation would have changed if the facilitator who had elicited meaningful conversation from the girls when they were planning the square foot gardening facilitated the data debriefs.

Mixed Gender. It is important to note that two girls, a Black girl and a White girl, who attended the girls-only week also attended the mixed gender week where the green invaders game was repeated.

Facilitator A from the previous girls-only week did not read a book. However the facilitator (Facilitator B) in the mixed gender camp did. She read *Nature Out of Balance: How Invasive Species are Changing the Planet*. Like the all the other activities, the lesson plan has a literature connection which is a list of books at the top of each lesson. There were no instructions on how to use the book in the lesson or which book would go best with each part of the lesson. Without any guidance, the facilitator chose to read the book while the students sat and silently listened.

Like the girls-only week, there was a chart on the white board to track the data after each round. The difference was that students were asked to copy the chart into their science journals.

According to the data collected during the girls-only week, there was only one instance of cognitive participation. However, the two girls who attended that week showed cognitive participation when the facilitator could not figure out the math computation for the data and when it came time to discuss the reflection questions. Here is a brief excerpt from that dialogue:

> Facilitator: So we did for 45 seconds for this one. Go ahead and put that on your table. So the number of invasive species to start with was three; we had three people to begin with. Our number of native species, to start with, was the rest of you, which was 13. The number of responders that we did that first round was zero. In the end, the number of invasive species that we had was—
>
> Martie: Three.
>
> Facilitator: Seven, and we had six native species at the end. Whoops! Eight and five. I wrote down the wrong ones.
>
> Cindy: How many?
>
> Facilitator: Eight invasive and five native. Alright. Our second round–our second round was a short exposure to invasives, so the invasive species is here, but it's only for a small amount of time comparatively, so we only did 15 seconds. We did 15 seconds in that second round. The number of invasive species we started with was three. The number of native was 13. The number of responders was still zero. In the end, we had four invasive species, and we had nine native species.
>
> Tessa: There is a problem.
>
> Facilitator: Ugh! That's not right.

This shows that having a second opportunity to participate in the same activity not only gave the students the confidence to correct and help the facilitator but also to speak up in a mixed-gender setting with confidence in their responses.

Although there were limited literacy opportunities when it came to reading, students were able to participate in data conversations and plan actionable steps.

Summary

Conclusion 1: Authentic STEM Literacy is More than Only Trade Books

On each lesson plan, STEM World has a literacy connection component at the top of the plan. This section did not have an intentional purpose which left it up to the facilitators to determine when, where, and how the book would be used during the lesson. The lesson plan neglected to acknowledge authentic literacies outside of trade books. For example, the snap circuit manual was a non-trade book text. Also, the invasive species pamphlet was another example of a text that a scientist, specifically a horticulturist would use. However, they were not included in the literacy connection section. There were also no literacy standards identified.

Additionally, Harste (2003, p.175, as cited in Lewison et al. 2015) states that four major components of engaging in literacies should include: “meaning making, language study, inquiry, and critical literacy.” When any text is included, it should help students make meaning and have a purpose.

Conclusion 2: Authentic STEM-literacy Integration Increases Authentic STEM Participation

The most successful integration of literacy-rich STEM experiences happened during the girls-only square foot gardening lesson. Although the facilitator was not directed to use the book *Square Foot Gardening with Kids* by Mel Bartholomew, she did. After that, the students engaged in reviewing a square foot gardening packet as well as reading the information on the back of the seed packet to determine the best way to plant.

The female facilitator shared with the girls that she is a gardener and grows food at home in her backyard. She did not tell the girls what to do, she co-constructed knowledge with them and they co-planned a square foot garden for STEM World that was actually implemented, an example of joint productive activity (JPA).

Yamauchi and Kuwahara (2008, p. 37) state that the “hands-on nature of many JPAs supports language expression among everyone involved. Working with physical objects creates a context in which there are things to talk about including the shared group process.” This research is situated in critical sociocultural perspectives which includes an understanding that perspectives and engagement must be more than surface, that culture and background play a role, and that knowledge is co-constructed and shaped by the knowledge sharing of others. To ensure that girls continue to grow their STEM identity, they need to see females doing STEM in action like the facilitator, an actual gardener.

Conclusion 3: Clear Lesson Plans and Facilitator Training are Needed for Student Success

The facilitator for both mixed gender camps was the same. The girls-only week had a different facilitator who was stronger in facilitating STEM lessons. The mixed gender facilitator struggled with putting data into the chart and understanding how she would need to add based on how many responders there were in each round.

Nothing should be included in a lesson plan that does not have a clear mapped out purpose such as listing books without explaining when, where, or how to use them.

Once there is a clearly articulated lesson with all components explained, teachers need opportunities to work through the lesson. Horn (2010, p. 254) states, “through teaching replays and teaching rehearsals, teachers create vivid and often emotionally compelling scenes to illustrate and examine problems of practice." This is to say that when teachers have the opportunity to practice lessons (teaching rehearsal) or share with colleagues how a lesson went (replays) to get feedback, teaching can improve. A strong lesson plan with weak teaching might not lead to student success.

Recommendations for Supporting Girls' Participation in STEM Activities

From this study, I have learned what happens when girls have opportunities to try a variety of STEM activities, across STEM disciplines by analyzing the factors that influence the amount and quality of girls' participation. The girls were able to engage in STEM and get some exposure to developing a STEM identity. However, there are a few key takeaways, I want to emphasize.

Have a Purpose for Books in STEM Lesson Plans

Books should not be listed on a lesson plan without meaningful integration into the lesson plan. Instructions should be given on how to use the book, how much of the book to use, and when during the lesson it should be used. Additionally, for true cross-curricular impact among the STEM areas, there needs to be a balance of using STEM focused literacies such as the snap circuits manual or the square foot gardening planning chart. Literacy includes more than just books.

Train Facilitators in Implementing Lesson Plans and Facilitating STEM Conversations

Lesson plans can be impeccable, but that does not matter if the implementation is not solid. STEM World does provide training for its staff. However, evaluating that training was not within the scope of this research study. Having facilitators practice teaching a lesson before implementing could help the lesson plan writer make adjustments to the lesson plan and help the facilitator get better with the implementation.

Provide Girls with More than One Opportunity to Engage in the Same STEM Activity

One unexpected outcome was seeing how the two girls engaged in the STEM activities when they participated twice during green invaders in camp two and camp three. Although two girls are a small sample size, it is encouraging to see the girls' confidence rise during their second experience during the second week of camp with the same activity. It is important to note that one girl was Black, and one was White. The girls took the same amount of initiative to lead other students and to help the instructor. Future studies should focus on the amount of exposure girls need before their confidence and exposure increases. Additionally, further studies should look at the impact of intersectionality of race and gender when it comes to identifying other relevant factors that determine how girls participate during literacy-rich STEM experiences.

Revisiting Research Questions

For one of my research questions, I asked, what STEM identities do girls take up in these activities? The data I collected did not allow me to fully address this question. To better address this question, I would need more information about how girls saw themselves when it came to STEM and how their identities shifted due to participating in activities such as a STEM camp. Future research should address which type of activities help girls develop a strong STEM identity.

Suggestions for Teacher Professional Development and Policy Makers

As times, elementary teachers might be seen as jack of all trades because they have to teach multiple subjects. Secondary teachers focus on one content area which means their professional development is typically centered around that content area especially during department meetings. With multiple subject areas, this might not be the case for elementary teachers. To ensure that elementary teachers have resources and knowledge to integrate STEM and literacy, whether they are in the classroom or teaching as part of an out-of-school activity, interdisciplinary strategies have to be intentionally addressed and included in professional development planning especially if there is a cross curricular aspect such as integrating literacy and STEM.

As stated earlier, Indiana has just over 100 STEM-certified schools. However, there are nearly 2,200 schools in the state, which means only a small percentage of schools are STEM certified. Policy makers and leaders should look at ways to better support schools to become STEM-certified and to meaningfully integrate STEM in an impactful way in schools.

Conclusion

Although I was only with the girls for a short period of time, I really enjoyed seeing their aha moments whether they were only with girls or also with boys. As more Indiana schools continue to earn STEM certification, I am encouraged by the opportunities offered at STEM World and what this could potentially mean for other summer programming and its ability to help increase participation and possibly lead to students pursuing post-secondary education and employment in that field. To ensure girls have those opportunities, we must continue to remove barriers that could lower their confidence and their willingness to participate.

My wish for girls can be summed up in this haiku I wrote (Barnes, 2023):

Freedom to Be

fulfill your desires

you owe no explanations

emancipation

I want girls to have the freedom to pursue any path their heart desires and not feel that STEM is not for them because they are girls.

References

Allina, B. (2017). The development of STEAM educational policy to promote student creativity and social empowerment. *Arts Education Policy Review*, *119*(2), 77-87. https://doi.org/10.1080/10632913.2017.1296392

Angelou, M. (2015). *The Complete Poetry.* Random House.

Barnes, S.S. (2023). *Reflective Haiku: Poems for Growing, Healing, and Restoring the Soul*. Brave Brothers Books.

Case, R (1996). Changing views of knowledge and their impact on educational research and practice. In D. R. Olson & N. Torrance (Eds.) *The handbook of education and human development: New models of learning, teaching, and schooling* (pp. 75-99). Blackwell.

Chappell, B. (2015). *Nobel laureate in hot water for 'Trouble with girls' in labs*. NPR. https://www.npr.org/sections/thetwo-way/2015/06/10/413429407/nobel-laureate-in-hot-water-for-trouble-with-girls-in-labs

Chen, G. (2022). *How the arts benefit your children academically and behaviorally*. Public School Review. https://www.publicschoolreview.com/blog/how-the-arts-benefit-your-children-academically-and-behaviorally

Collins, P. H. (2002). *Black feminist thought: Knowledge, consciousness, and the politics of empowerment.* Routledge.

CREDE. (n.d.). *The CREDE five standards for effective pedagogy and learning*. University of Hawaiʻi at Mānoa College of Education. https://manoa.hawaii.edu/coe/credenational/the-crede-five-standards-for-effective-pedagogy-and-learning/

Crenshaw, K. (1989). Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. *University of Chicago Legal Forum, 1989*, 139–168.

Creswell, J. W., & Poth, C. N. (2017). *Qualitative inquiry and research design: Choosing among five approaches.* Sage Publications.

Cunnington, M., Kantrowitz, A., Harnett, S., & Hill-Ries, A. (2014). Cultivating common ground: Integrating standards-based visual arts, math and literacy in high-poverty urban classrooms. *Journal for Learning through the Arts: A Research Journal on Arts Integration in Schools and Communities, 10*(1). https://doi.org/10.21977/d910119294

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59-109. https://doi.org/10.3102/00346543074001059

Froschauer, L. (2016). *Bringing STEM to the Elementary Classroom*. NSTA Press.

Fulwiler, B. R. (2007). *Writing in science: How to scaffold instruction to support learning*. Heinemann Educational Books.

González, N., Moll, L. C., & Amanti, C. (2005). *Funds of knowledge: Theorizing practices in households, communities, and classrooms.* Routledge.

Gravel, B. E., Tucker-Raymond, E., Kohberger, K., & Browne, K. (2017). Navigating worlds of information: STEM literacy practices of experienced makers. International Journal of Technology and Design Education, 28(4), 921-938. https://doi.org/10.1007/s10798-017-9422-3

Guenaga Gómez, M., & Fernández Álvarez, L. (2020). Inspira STEAM: breaking the confidence gap with female roles. *Investigaciones Feministas, 11*(2), 273–276. https://doi-org.proxyiub.uits.iu.edu/10.5209/infe.65836

Guyotte, K. W., Sochacka, N. W., Costantino, T. E., Walther, J., & Kellam, N. N. (2014). Steam as social practice: Cultivating creativity in Transdisciplinary spaces. *Art*

Education, *67*(6), 12-19. https://doi.org/10.1080/00043125.2014.11519293

Hadid, J. (2022). Identity Exploration as a Tool to Enhance Academic Engagement and Growth. In L. Haas and J.T.Tussey (Eds.), *Disciplinary Literacy As a Support for Culturally and Linguistically Responsive Teaching and Learning* (pp. 188-216). IGI Global.

Halverson, E. & Sawyer, K. (2022). Learning in and through the arts. *Journal of the Learning Sciences*, 31(1), 1-13.

Hambek, J. (2016). *Arts programs in schools often in danger of being cut.* The Washington Times. https://www.washingtontimes.com/news/2016/mar/14/arts-programs-in-schools-often-in-danger-of-being-/

Hilberg, R., Tharp, R. G., & DeGeest, L. (2000). The efficacy of CREDE's standards-based instruction in American Indian mathematics classes. *Equity & Excellence in Education, 33*(2), 32-40. https://doi.org/10.1080/1066568000330206

Horn, I. S. (2010). Teaching replays, teaching rehearsals, and re-visions of practice: Learning from colleagues in a mathematics teacher community. *Teachers College Record: The Voice of Scholarship in Education, 112*(1), 225-259. https://doi.org/10.1177/016146811011200109

Indiana Department of Education. (2022). 2022 ILEARN grade 3-8 statewide summary results – disaggregated. IDOE Data center & reports. https://www.in.gov/doe/it/data-center-and-reports/

IDOE. (n.d.). *Indiana Department of Education Overview*. INview. https://inview.doe.in.gov/state/1088000000

Indiana Department of Education. (2022). *Indiana's Priorities for STEM Education*. IDOE STEM Education. https://media.doe.in.gov/news/indianas-priorities-for-stem-education-final.pdf

Ireland, D. T., Freeman, K. E., Winston-Proctor, C. E., DeLaine, K. D., Lowe, S. M., & Woodson, K. M. (2018). (Un)hidden figures: A synthesis of research examining the intersectional experiences of black women and girls in STEM education. *Review of Research in Education*, *42*, 226–254. http://www.jstor.org/stable/44668720

Johnson, D. M., & Ginsberg, A. E. (2015). *Difficult dialogues about twenty-first-century girls*. State University of New York Press.

Kagan, S., & Kagan, L. (2010). *Kagan Professional Development: It's All About Engagement!* Kagan Publishing.

Kennedy, M. J., & Wexler, J. (2013). Helping students succeed within secondary-level STEM content. *TEACHING Exceptional Children*, 45(4), 26-33. https://doi.org/10.1177/004005991304500403

Kuchynka, S. L., Eaton, A., & Rivera, L. M. (2022). Understanding and addressing gender-based inequities in STEM: Research synthesis and recommendations for U.S. K-12 education. *Social Issues and Policy Review, 16*(1), 252-288. https://doi.org/10.1111/sipr.12087

Laminack, L. L. (2009). *Unwrapping the read aloud: Making every read aloud intentional and instructional*. Scholastic Teaching Resources.

Lawson, H. (2022). *Indiana K-12 school enrollment grows for 2021-2022 school year*. IDOE. https://www.in.gov/doe/about/news/indiana-k-12-school-enrollment-grows-for-2021-2022-school-year/https://www.in.gov/doe/about/news/indiana-department-of-education-announces-stem-certified-schools/

Lee, C. D. (2008). 2008 Wallace Foundation distinguished lecture—The centrality of culture to the scientific study of learning and development: How an ecological framework in education research facilitates civic responsibility. Educational Researcher, 37(5), 267-279. https://doi.org/10.3102/0013189x08322683

Lewison, M., Leland, C., & Harste, J. C. (2014). *Creating critical classrooms: Reading and writing with an edge* (2nd ed.). Routledge.

Liao, C., Motter, J. L., & Patton, R. M. (2016). Tech-savvy girls: Learning 21st-Century skills through STEAM digital Artmaking. *Art Education, 69*(4), 29-35. https://doi.org/10.1080/00043125.2016.1176492

Ma, L., Luo, H., Liao, X., & Li, J. (2022). Impact of gender on STEAM education in elementary school: From individuals to group compositions. *Behavioral Sciences, 12*(9), 308. https://doi.org/10.3390/bs12090308

Mansfield, K.C., Welton, A., & Grogan, M. (2014). Truth or consequences: A feminist critical policy analysis of the STEM crisis. *International Journal of Qualitative Studies in Education*, 27(9), 1155-1182. https://doi.org/10.1080/09518398.2014.916006

Mills, K. (2016). *Literacy theories for the digital age: Social, critical, multimodal, spatial, material and sensory lenses*. Bristol: Multilingual Matters.

National Academies of Sciences, Engineering, and Medicine (2018): *How people learn II: Learners, contexts, and cultures.* National Academies Press.

National Research Council, National Academy of Engineering, Committee on Integrated STEM Education, Heidi Schweingruber, Greg Pearson, & Margaret Honey. (2014). *STEM Integration in K-12 Education : Status, Prospects, and an Agenda for Research*. National Academies Press.

National Science Resources Center of the National Academy of Sciences and the Smithsonian

Institution, & Center for Science; Mathematics; and Engineering Education. (1997). *Science for all children: A guide to improving elementary science education in your school district*. National Academies Press.

Nelson, S., Beecher, C. C., & Heid, J. (2019). Checkout STEM: Expanding access to STEM-literacy experiences. Children and Libraries, 17(2),12. https://doi.org/10.5860/cal.17.2.12

The New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard educational review*, 66(1), 60-93.

Panetta, K., & Williams, K. (2018). *Count Girls In: Empowering girls to combine any interests with STEM to open up a world of opportunity*. Chicago Review Press.

Peshkin, A. (1988). In Search of Subjectivity—Ones Own. Educational Researcher, 17(7), 17–21. doi: 10.3102/0013189x017007017

Privitera, G. J., & Ahlgrim-Delzell, L. (2018). *Research methods for education*. SAGE Publications.

Ruef, J. L., Jacob, M. M., Walker, G. K., & Beavert, V. R. (2020). Why Indigenous languages matter for mathematics education: A case study of Ichishkíin. Educational Studies in Mathematics, 104(3), 313-332. https://doi.org/10.1007/s10649-020-09957-0

Sadker, D., Sadker, M., & Zittleman, K. R. (2009). *Still failing at fairness: How gender bias cheats girls and boys in school and what we can do about it.* Scribner.

Saujani, R. (2015). *Reshma Saujani discusses challenge of keeping girls interested in STEM fields*. Prendismo, LLC.

Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. Educational Researcher, 27(2), 4-13. https://doi.org/10.3102/0013189x027002004

Sieghart, M.A. (2022). *The authority gap: Why women are still taken less seriously than men,* *and what we can do about it.* W.W. Norton & Company.

Sochacka, N. W., Guyotte, K. W., & Walther, J. (2016). Learning together: A collaborative autoethnographic exploration of STEAM (STEM + the arts) education. *Journal of Engineering Education, 105*(1), 15-42. https://doi.org/10.1002/jee.20112

Soules, A., Nielsen, S., LeDuc, D., Inouye, C., Singley, J., Wildy, E., & Seitz, J. (2014). Embedding multiple Literacies into STEM curricula. *College Teaching*, 62(4), 121-128. https://doi.org/10.1080/87567555.2014.935699

Sullivan, A.A. (2019). *Breaking the STEM Stereotype: Reaching Girls in Early Childhood.* Rowman & Littlefield Publishers.

Technical Training Assistance Center (2018). *Creating Literacy-rich Preschool Environments*. Technical Assistance and Training System. https://tats.ucf.edu/wp-content/uploads/sites/9/2018/07/literacy-rich.pdf

Texley, J., & Ruud, R. M. (2017). *Teaching stem literacy: A constructivist approach for ages 3 to 8*.

Timotheou, S., & Ioannou, A. (2021). Collective creativity in STEAM making activities. *Journal of Educational Research, 114*(2), 130-138. https://doi.org/10.1080/00220671.2021.1873721

Tuck, E. (2009). Suspending Damage: A Letter to Communities. *Harvard Educational Review, 79*(3), 409-428. doi: 10.17763/haer.79.n0016675661t3n15

U.S. Bureau of Labor Statistics. (2021). *Fastest growing occupations*. U.S. Bureau of Labor Statistics Occupational Employment and Wage Statistics. https://www.bls.gov/emp/tables/fastest-growing-occupations.htm

U.S. Bureau of Labor Statistics. (2021). *OEWS publications by topic*. U.S. Bureau of Labor Statistics Occupational Employment and Wage Statistics. https://www.bls.gov/oes/topics.htm#stem

US Census Bureau. (2021). Income and poverty in the United States: 2020. https://www.census.gov/library/publications/2021/demo/p60-273.html

United States Department of Education. (2015). *Developing a STEM identity*. Office of Educational Technology. https://tech.ed.gov/stories/developing-a-stem-identity/

Voicu, C. D., Ampartzaki, M., Dogan, Z. Y., & Kalogiannakis, M. (2022). STEAM Implementation in Preschool and Primary School Education: Experiences from Six Countries. In M. Ampartzaki, & M. Kalogiannakis (Eds.), Early Childhood Education - Innovative Pedagogical Approaches in the Post-modern Era [Working Title]. IntechOpen. https://doi.org/10.5772/intechopen.107886

Wahyuningsih, S., Nurjanah, N. E., Rasmani, U. E., Hafidah, R., Pudyaningtyas, A. R., & Syamsuddin, M. M. (2020). STEAM learning in early childhood education: A literature review. *International Journal of Pedagogy and Teacher Education, 4*(1), 33. https://doi.org/10.20961/ijpte.v4i1.39855

Wajngurt, C., & Sloan, P. (2019). *Overcoming gender bias in STEM: The effect of adding the arts (STEAM). InSight: A Journal of Scholarly Teaching, 14,* 13-28. https://doi.org/10.46504/14201901wa

Wang, C., & Frye, M. (2019). MiniGEMS 2018: A mixed methods study exploring the impact of a STEAM and programming camp on middle school girls' STEM attitudes. *2019 ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--33113

Wohlwend, K. E., Peppler, K. A., Keune, A., & Thompson, N. (2017). Making sense and nonsense: Comparing mediated discourse and agential realist approaches to materiality in a preschool makerspace. *Journal of Early Childhood Literacy*, *17*(3), 444-462. https://doi.org/10.1177/1468798417712066

Worth Jansen, J. (2010). A grammar of Yakima Ichiskiin/Sahaptin (3420340) [Doctoral dissertation]. ProQuest Dissertations and Theses Global.

Yamauchi, L. A., & Kuwahara, R. H. (2008). Joint Productive Activity: Collaboration That Builds New Understandings. *YC Young Children*, *63*(6), 34–38.

Zollman, A. (2012). Learning for STEM literacy: STEM literacy for learning. *School Science and Mathematics*, 112(1), 12-19. https://doi.org/10.1111/j.1949-8594.2012.00101.x

APPENDIX

Although I only focused on six lessons from the three weeks of camp, I felt that it would be of an benefit to provide the other formal lessons that occurred during lunch below.

Camp 1 - Creative Innovators

Day 1 - What's an innovator?

Lesson 1 - Ephemeral Art

Grades: 4-5

Time: 30 - 45 minutes

Standards:

- VA:Cr2.1.4a Explore and invent artmaking techniques and approaches.
- VA:Cr1.1.5a Combine ideas to generate an innovative idea for art-making

Objectives: Participants will be able to create art with nature that is temporary (ephemeral). STEM Career Connection: STEM Career Connection: Florists, or floral designers, sell flowers and floral arrangements to customers. They cut and arrange flowers and greenery to make decorative displays.

Literature Links: *Camille and the Sunflowers* by Laurence Anholt, *Land Art for Kids* by Richard Shilling and Julia Brooklyn, *Natural: Simple Land Art Through the Seasons* by Marc Pouyet

Materials: found natural materials (leaves, rocks, flowers, petals, sticks, etc), play doh, flat rocks

Procedures:

1. Introduce the concept of ephemeral art. Ask participants if they have made a sandcastle - that is an example of ephemeral art - art that is created using nature that is temporary. Ask participants if they know of or have seen other examples of ephemeral art.

2. We will be creating ephemeral art today. Have students watch ephemeral nature art video to learn more
3. Give participants a container of play doh. Have participants create their favorite animal - when they are done, they will put the play doh away - remind them that their art is temporary.
4. Take a hike and collect things from nature. Remind participants not to collect insects.
5. Use collected natural materials to create a piece of nature art on the sidewalk, driveway, patio, or table.
6. Facilitators will take a picture of your ephemeral artwork, but nature items collected will go back into nature.
7. Give participants some flat stones. Challenge participants to create cairns - towers of rocks. Background: Rock cairns have appeared countless times throughout history. The name originates from a Gaelic term that means "heap of stones." It was likely first coined by Scots who used them to mark trails across grass-covered, hilly landscapes.

STEM	• plant identification • STEM vocabulary
Creative Arts	• arranging nature into temporary art
Literacy	• skimming and/or read through book with examples of ephemeral art

Day 2 - Innovative design

Lesson 1 - Duct tape creations

Grades: 4-5

Time: 45 minutes

Standards:

- 3-5.E.2 (Engineering Design Standards) Construct and compare multiple plausible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- SEPS.3 (Science & Engineering Process Standards) Constructing and performing investigations

Objectives: Participants will learn the history of duct tape and then use duct tape to make an innovation.

STEM Career Connection: An engineer is a person who designs and builds complex products, machines, systems, or structures. Anything that is built must first be engineered, or planned out. Engineers want to know how and why things work. They have scientific training that they use to make practical things.

Literature Connections: *Duct Tape and Tag-A-Long* by Shawn Duncan; *Lucy the Duct Tape Warrior* by Samantha Riggi

Materials: a variety of colors and designs of duct tape, scissors

Procedures:

1. Show participants duct tape. Ask “What is this? How do you use it?”
2. Tell participants that we will watch a video to learn about the history of duct tape.
3. Watch video: Why Is Duct Tape So Strong?
4. Reflect on what they learned about duct tape.

5. Talk about the inventor of duct tape - Vesta Stout. Why did she invent duct tape? Do we use duct tape for the reason it was invented? How do we use duct tape? Where have you seen duct tape used?
6. Is it duct tape or duck tape?
    a. Duct tape
        i. Modern duct tape was first invented in 1942 in the midst of World War II. Vesta Stoudt, a worker at an ordnance plant, is recognized as having originated the idea of a strong, cloth-based watertight tape. Recognizing the utility and value the product offered, it was quickly approved for manufacture by the government. Throughout the war, soldiers made frequent use of the product.
        ii. After the war, duct tape became popular with the general public. One popular use was holding together ventilation ducts. Ironically, while this is a use that duct tape does not normally have today, the name stuck and is used to this day. Today, duct tape refers to a range of tapes manufactured using three components – a rubber-based adhesive, cloth, and a backing.
    b. Duck Tape®
        i. The term “duck tape” today refers to a specific brand of duct tape. Duck Brand® duct tape takes its name from the original name of duct tape. This name came from two factors. First, the tape was originally made from an army green cotton duck fabric. And second, the water-resistant properties of the tape were said to repel water like the back of a duck.

ii. Today, Duck Brand® duct tape is well-known – but some still inaccurately refer to all duct tapes generically as “duck tape”. However, only one brand has the original Duck Tape® – Duck Brand® – and any references to a generic “duck tape” shouldn’t capitalize the name. Just remember – duct tape refers to a broad range of tapes, while Duck Tape® refers to a specific brand of duct tape.

7. Tell participants that being an innovator means using something in a different way. There are lots of things you can make using duct tape.
8. Give some tips on how to use duct tape, like how to fold the tape over to cover the sticky side.
9. Participants will work with a partner or independently to come up with an innovation using duct tape.
10. Brainstorm as a group things that they can make (bag, wallet, cup holder, flower, etc.)
11. Participants will get pieces of duct tape and scissors to make something unique.
12. Along the way, observe and support participants with their ideas.

STEM	• explore various ways to create an item out of duct tapedevelop a prototype • use feedback to improve a prototype
Creative Arts	• determine how to craft an item out of duct tape
Literacy	• listen to history about duct tape versus duck tape • discuss best ways to craft items out of duct tape

Day 3 - Innovative artists

Lesson 1 - Print making

Grades: 4-5

Time: 45 minutes

Standards:

- 3-5.E.3 Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- VA:Cr1.1.5a Combine ideas to generate an innovative idea for art-making.
- VA:Cr2.1.4a Explore and invent artmaking techniques and approaches.

Objectives: Participants will create a pattern and make prints.

STEM Career Connection: A printmaker works with woodblock prints, silk screening, digital printmaking programs, lithography, etching, or engraving.

Literature Connections: *Swimmy* by Leo Lionni: The illustrations of Swimmy and his fellow fish are examples of a simple stamping technique reminiscent of potato prints. *Ed Emberley's Complete Funprint Drawing Book* by Ed Emberley: A step-by-step drawing guide on how to transform your fingerprints into fun little creatures and animals.

Materials: pictures of sample prints, cardboard, bubble wrap, fruit mesh bags, rubber bands, pipe cleaners, yarn, string, bottle caps, corrugated cardboard, paint, glue, scissors, copy paper, brayer

Required Prep: Read through the instructions on the website and see illustrations.

Procedures:

1. Introduce the concept of printmaking. Show pictures of prints. Ask participants if they know how prints are made.

2. Tell participants that there are many ways to create a print. They will be using cardboard as a base and found objects to create an image that can be used to make many prints.
3. Show participants the supplies they will use. Create an example and model how to use it to make multiple prints.
4. Give participants time to create and test print-making creations.Groups will have 8 colors of ink. The brayer stays with the ink. Participants take turns using the brayers, making sure not to mix the colors.
5. Encourage exploration - use different materials, use different types of paint with paint brushes. Notice what happens when you try different techniques.
6. Reflection:
    - Did the print look like you thought it would?
    - Does it change if you twist the tile around?
    - What does it remind you of?
    - What happens if you overlay one print on top of another?

STEM	● learn vocabulary such as brayer, digital printmaking ● determine how to use tool to make a pattern
Creative Arts	● create a stamp to print a pattern ● use paint color combination to bring visual depth to the stamp
Literacy	● review book on how to make animals and creatures using fingers ● reflect and write finding in science journal

Lesson 2 - Chihuly sculpture

Grades: 4-5

Time: 30-45 minutes

Standards:

- VA:Cr2.1.4a Explore and invent artmaking techniques and approaches.
- VA:Cr1.2.5a Identify and demonstrate diverse methods of artistic investigation to choose an approach for beginning a work of art.

Objectives: Participants will be innovators in the style of Dale Chihuly and create glass-blown like creations using markers and plastic bottles, bowls and cups.

STEM Career Connection: A glass blower creates designs ranging from simple to complex, using molten glass. Glass jars and vases, jewelry, art work, and figurines all may emerge from the end of a narrow tube, the skill and tools of the glass blower determining the final shape of the glass.

Literature Connections: Dale Chihuly, Glass Artist, *Craft It: Hand-Blown Glass* by Madison Spielman, *Mr. Hoopeyloops and His Amazing Glass by* Andi Cann

Materials: Clear plastic plates, cups, bowls, etc. – look for recycling number 6, sharpies, cloth covered stem wire, 18 gauge, glue gun, scissors, toaster oven

Procedures:

Introduction:

1. Tell participants that they will learn about an innovator who is well known for glassblowing. Ask participants if they have seen the Fireworks of Glass exhibit at the Children's Museum. That artist is Dale Chihuly. Show images of the exhibit.
2. Ask participants what they know about glass blowing? Discuss background knowledge.
3. Watch the video: Dale Chihuly, Glass Artist
4. Discuss what they learned about Chihuly and glassblowing.

Activity:

Participants will make a model of Chihuly's glass blown artwork. They will not be using glass, they will use plastic plates and bowls to make a replica of the Fireworks of Glass.

1. Preheat the toaster oven to 350 ºF.
2. Color your plates, cups & bowls with Sharpies. Color them as completely as possible, especially in the very center because that's where the glue to hold the stem goes. The glue shows if you don't color that part.
3. Cut slits in the sides of each using scissors. Careful as sometimes plastic pieces go flying.
4. Place plastic pieces on a foil covered baking sheet and bake for 2-5 minutes. Be sure to watch your pieces in the oven, both because it's cool to see them melt and curl up, but also to make sure you don't leave them in too long. Also, it's a good idea to put the fan on or open a window for ventilation because melting plastic can get a little smelly.
5. Let cool and hot glue gun your covered floral stem to the back center of the flower. You can also glue on additional pieces of plastic that you want to add to the flower.
6. Flowers can be taken home or be put in a vase to stay at the farm.

What's the Science Behind These Flowers?

This flower forming works because of the characteristics of the plastic in the cups & plates. The heat of the oven changes the alignment of the polymer chains within the plastic. In the cup and plate manufacturing process, a polymer resin is heated, extruded, rolled into flat sheets and then molded. This process aligns the polymers into an orderly pattern, but the heat of the oven returns them to their naturally disordered, clumped state. Gravity and the placement of the cuts define how they crumple. #6 plastic works well in this project because its melting point is low enough for the oven to reach.

Reflection:

This project is a great way to learn some scientific method stuff, too. Here are a few discussion points:

- What do you think impacts the final shape of the flower? Form a hypothesis, then try varying the number and size of the cuts as well as the time in the oven. Did the results match your hypothesis? Form your conclusion.
- What would happen if you changed the temperature of the oven? The type of plastic?
- Would this work with other kinds of markers? Why or why not? You can test it to be sure.

STEM	● learn about the glassblowing process ● use heat to enact a chemical change
Creative Arts	● compose design using marker
Literacy	● listen to video about Chihuly artist ● discuss connections to glassblowing

Day 4 - Innovative engineers

Lesson 1 - Rosie Revere - Build a flying machine

Grades: 4-5

Time: 40-60 minutes

Objectives: Children will listen to *Rosie Revere, Engineer* and then use the Engineering Design Process to create their own Flying Machine. .

STEM Career Connection: An engineer is a person who designs and builds complex products, machines, systems, or structures. Anything that is built must first be engineered, or planned out. Engineers want to know how and why things work. They have scientific training that they use to make practical things.

Literature Connections: *Rosie Revere, Engineer* by Andrea Beaty

Materials: 1 Rosie Revere cutout, 2 feet of tape, 6 pipe cleaners, 1 piece of construction paper, 4 large popsicle sticks, scissors, pencils and STEM journals, 2 binder clips (1 for the zip line and 1 to make the Rosie Revere cut out stand up), string, ribbon, or fishing line (for zip line) *Note: Fishing line works best since there is less friction, Copies of TSC EDP process for participants to look at.

Required Prep: Set up zipline, copy Rosie Revere cut outs (in Resources for Summer folder), Print out EDP and put into page protectors.

Standards:

- 3-5-ETS1-2 Engineering Design Generate and compare multiple solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3 Engineering Design Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Procedures:

1. Read the book *Rosie Revere, Engineer* by Andrea Beaty.
2. Tell participants that they will be an engineer like Rosie and will make their own flying machine.
3. Discuss steps of EDP and show diagram with steps.
    a. Ask - Engineers ask or are asked a question about a problem.
    b. Imagine - Engineers imagine possible solutions to the problem. Then they pick the one that they think will work best.

c. Plan - Engineers plan a design (on paper or using computer programs) for the object they will try to build to solve the problem.
d. Create - Engineers construct the object they designed using materials available to them.
e. Test - Engineers test their products to see if they work.
f. Reflect - Engineers determine what worked well and what needs to be changed or edited.
g. Improve - Engineers change or edit their designs to make them better.

4. Complete Rosie Revere Flying Machine Challenge.
    a. Ask - Can you create a flying machine?
    b. Imagine - Have the children imagine how to solve the challenge and explain any specifications: time, independent or group, amount of materials, etc. The students will design a flying machine for Rosie Revere. The flying machine must have wings and it must contain Rosie inside so that she doesn't fall out. Show the materials that the children will have for their creation.
    c. Plan - Have the children plan. Give students 10 minutes to plan individually and then 10 minutes to plan as a team. Children should share ideas with each other, discuss the materials they want to use, and draw a sketch of their design in their journals.
    d. Create - Students will have 20 minutes to construct their design.
    e. Test - When the time limit is up, have students test their flying machines by sliding them down a zipline. Set up the zipline by taping one end of a piece of string up on the wall (ex. on top of the whiteboard) then tape the other end to a

student desk or table a few feet away from the wall. To test the flying machines students will clip their designs to the zipline using the binder clip. Be sure that the binder clip can move on the zipline. Students will start their flying machine at the top of the zipline and let it slide down without pushing it. See if students can get their flying machine to travel all the way down the zip line. Adjust the angle of the zipline and have students predict how it will affect their flying machines. (A steeper angle should increase the speed of the zipline.)

f. Reflect - When time is up, gather together to share creations. Work together to identify successes and struggles and review the EDP to help them see where it was used in finding a solution. If you had different supplies, do you think you could make a different type of flying machine? What would you do differently? What other supplies would you like to use to make a flying machine? Do you need to have the machine on a zipline or could you have the machine move in a different way?

g. Improve - Schedule time to improve the design either the same day or another time. Improving is a very important step.

STEM	• understand how to use and implement the engineering design process
Creative Arts	• create a seat for Rosie on the flying machine
Literacy	• listen to book *Rosie Revere, Engineer* • discuss concepts in *Rosie Revere, Engineer* • use science journal to document and reflect on findings

Lesson 2 - Build a fort

Grades: 4-5

Time: 45 minutes

Standards: 3-5.E.1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

Objectives: Children will listen to the story and then use the Engineering Design Process to create their fort or hug machine.

STEM Career Connection: An engineer is a person who designs and builds complex products, machines, systems, or structures. Anything that is built must first be engineered, or planned out. Engineers want to know how and why things work. They have scientific training that they use to make practical things.

Literature Connection: *How to Build a Hug: Temple Grandin and Her Amazing Squeeze Machine* by Amy Guglielmo

Materials: cardboard, paper, popsicle sticks, other found items, tape, twine/rope, stuffed animal

Procedures:

1. Introduction:
    a. Define what STEM stands for/means. (Science, Technology, Engineering, Math)
    b. Identify characteristics of scientists, technology experts, engineers, and mathematicians. Help students identify themselves in these roles because they have characteristics of them.
    c. Scientists, technology experts, engineers, and mathematicians all have lots of ideas. Ideas about ways to make something better, or a new invention, or how to solve a problem.

d. Engineers and scientists work together in teams, or collaborate, to solve problems and create inventions.

2. STEM Activity:

   a. Read aloud *How to Build a Hug*

   b. Introduce the Engineering Design Process (EDP).

      i. All engineers, or people who design and create things, use the same steps to help them solve problems.

      ii. If possible, show Engineering Design Process video clip: http://education.nationalgeographic.com/media/nasa-kids-intro-engineering/

      iii. Discuss steps of EDP and show diagram with steps.

         1. Ask - Engineers ask or are asked a question about a problem.
         2. Imagine - Engineers imagine possible solutions to the problem. Then they pick the one that they think will work best.
         3. Plan - Engineers plan a design (on paper or using computer programs) for the object they will try to build to solve the problem.
         4. Create - Engineers construct the object they designed using materials available to them.
         5. Test - Engineers test their products to see if they work.
         6. Reflect - Engineers determine what worked well and what needs to be changed or edited.
         7. Improve - Engineers change or edit their designs to make them better.

c. Today we are going to take on an engineering challenge so you can practice the steps of the engineering design process. You will work in teams to create your structure. Structure can be sized down to be created to fit a stuffed animal instead of a person.

d. Complete Hug Machine Challenge.

    i. Ask - Can you create a machine that will fit a person inside and hug them?

    ii. Imagine - Have the children imagine how to solve the challenge and explain any specifications: time, independent or group, amount of materials, etc. The specifications will vary depending on the age of the children. Show the materials that the children will have for their creation.

    iii. Plan - Have the children plan. Children should share ideas with each other, discuss the materials they want to use, and draw a sketch of their design in their journals.

    iv. Create - Set the timer and begin creating.

    v. Test - As children create, ask questions about what they are making, how the process is going, where they are in the EDP, etc.

    vi. Reflect - When time is up, gather together to share creations. Work together to identify successes and struggles and review the EDP to help them see where it was used in finding a solution.

    vii. Improve - Schedule time to improve the design either the same day or another time. Improving is a very important step.

3. *Example of a Squeeze Machine: http://www.therafin.com/squeezemachine.htm*

4. Reflection:
    a. What is an engineer?
    b. What is an example of a time, other than today, when you worked with a group to create something or to solve a problem? Is working with a team easier or harder than working alone?
    c. What did you create today? How does it work? Who could it help?
    d. What could you do or use to improve the structure you created today?

STEM	• learn how to build a machine • understand the engineer design process • learn how to use machine failure to inform changes in updated machine version
Creative Arts	• create a functional, yet unique hug machine
Literacy	• listen to *How to Build a Hug: Temple Grandin and Her Amazing Squeeze Machine* • capture details and reflections about the engineer design process

Camp 2 - Plant Wizards

Day 1 - Plant structures and needs

Lesson 1 - Specimen bracelet hike

Grades: 4-5

Time: 45-60 minutes

Standards:

- 4.LS.3 (Next Generation Science Standards) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction in a different ecosystems.

- 5.LS.2 (Next Generation Science Standards) Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

Objectives: Participants will be able to identify poison ivy. Participants will observe the habitat around them as they look for specimens. They will understand the term "specimen" and use that understanding to choose specimens to place on the "bracelet" to be able to closely observe after the hike.

STEM Career Connection: A botanist is a scientist who studies plants, including flowering plants, and plant-like things such as moss and seaweed. Botanists study plant growth, structure, and uses.

Literature Connections: *Wildflowers, Blooms, and Blossoms* & *Berries, Nuts, and Seeds* (Take Along Guides) by Diane Burns, *Leaflets Three, Let It Be!: The Story of Poison Ivy* by Anita Sanchez and Robin Brickman; *Poison Ivy Makes Me Itch* by Jennifer Colby, *Fancy Nancy: Poison Ivy Expert* by Jane O'Connor

Materials: duct tape, packing tape, scissors, magnifying glass

Procedures:

1. Introduction before going on a hike:
    a. Ask participants what they know about poison ivy.
       Read *Fancy Nancy: Poison Ivy Expert* by Jane O'Connor.
    b. What does it look like? Learn to identify it. Show an illustration of poison ivy.
    c. Why shouldn't we touch it? Call on 1 or 2 for answers. The name tells us it is poisonous. It is considered poisonous because if the oil on the plant gets on your

skin it can cause a blistering rash that itches. All parts of the plant have the oil: the leaves, stems, flowers, berries and roots. Remember: “Leaves of three, let it be.”

d. Ask or describe if anyone has had a reaction to poison ivy. Often when poison ivy oil has come into contact with skin, it will be itchy and red with small bumps, and often larger raised areas. Blisters usually develop later with fluid that may leak. This clear liquid is not poison ivy oils and is therefore not contagious. The oil in poison ivy is called urushiol. The urushiol compound is not a defense mechanism for the plant: it is a mechanism that helps the plants retain water.

e. Ask “What should you do if you touch poison ivy?” Wash the area immediately with soap and cool water. If water is not available, clean the skin with alcohol based wipes. Wash the affected area within 3 hours with COLD water and soap. Why cold water? Warm water opens pores and helps the oil soak into your skin. Wash the clothes you were wearing as soon as possible. Smoothing calamine lotion on the affected area may help limit itching and decrease allergic reactions.

f. Tell students that there is poison ivy at the farm. We need to stay on the trail because that is clear of poison ivy. Show participants how to use your hands to identify poison ivy.

g. Discuss the term “specimen” and how it applies to scientific exploration. Participants will discuss and create criteria for taking specimens without harming the environment. For this hike, specimens chosen must fit on the tape. You will probably need to discuss that only plant materials will be used. Insects or animal evidence should not be used.

h. Place duct tape around the wrist of each participant like a bracelet, sticky side out. Make sure it is loose enough to be comfortable on their wrist.

2. During the Hike:
   a. As participants hike, they will find small specimens of flowers and plants that they see along the trail. Instruct students that they may carefully pick a specimen and add it to the duct tape bracelet.
   b. Look out for poison ivy. When you do find a sample of poison ivy, stop and discuss what it looks like, notice where it is located and what is around poison ivy.
3. After the Hike:
   a. Upon completing the hike and filling the specimen bracelet, you will cut the bracelet off the student and cover it with packing tape to seal in the specimens.
   b. Participants can observe the specimens with magnifying glasses and sketch some of the specimens in a nature journal. Have plant identification books available for students to try to identify the specimens they have chosen.
   c. “How can you avoid getting poison ivy?” Cover your skin (wear gloves, long sleeves and pants). Know what it looks like and avoid it. Wash clothing and shoes when coming in from the outdoors. Avoid touching pets who have been in the poison ivy, because they often carry the poison on their fur
   d. Participants should draw poison ivy in their journal.
   e. Participants can use the creation to decorate a nature journal, use it as a bookmark, or just take home.
   f. Throughout the week, continue to identify poison ivy as you take hikes.

STEM	• understand the job of a botantist • learn what a specimen is • identify poision ivy
Creative Arts	• design a bracelet using duct tape and specimen in nature
Literacy	• listen to various books about poison ivy • explain what a speciman is • discuss ways to treat poison ivy

Day 2 - Garden plants

Lesson 1 - Plants we use and eat

Grades: 4-5

Time: 45 minutes

Standards:

- 4.LS.2 (Next Generation Science Standards) Use evidence to support the explanation that a change in the environment may result in a plant or animal will survive and reproduce, move to a new location, or die.
- 4.LS.3 (Next Generation Science Standards) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction in a different ecosystems.
- 5.LS.2 (Next Generation Science Standards) Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

Objectives: Participants will identify the food we get from the different parts of a plant, and be able to identify the difference between vegetables and fruits.

STEM Career Connection: Many of the foods we consume contain both natural and artificial flavors. The term artificial, of course, means man-made: specifically, made by scientists. Food flavorists focus on improving product taste and product nutrition, ensuring that any added chemicals do not jeopardize the safety of food consumption. A background in chemistry for this career is super important, as you're dealing with chemicals and their effects on a daily basis.

Source: http://www.stemjobs.com/awesome-stem-careers-for-food-lovers/

Literature Connections: *How We Use Plants* Series by Sally Morgan (*How We Use Plants for Food, How We Use Plants for Shelter, How We Use Plants for Making Everyday Things, How We Plants for Medicine and Health), We Can Eat the Plants* (Learn to Read Science Series) by Rozanne Lanczak Williams, *Tops & Bottoms* by Janet Stevens

Materials: Samples of common non-food plant products (wood, cotton, perfume, aloe, etc.), copies of Parts of a Plant diagram, samples of some fresh fruits and vegetables (for example, asparagus, bell peppers, broccoli, carrots, cucumbers, lemons, lettuce or spinach, radishes, tomatoes, etc.), plastic knives, paper plates

Procedures:

1. Introduction
    - Questioning:
        - What are some plants that we eat? From what part of the plant does each of these foods come?
    - Activity: Look at the samples of common non-food plant products (wood, cotton, perfume, aloe, etc). Try to identify each one and how it is a plant product. What other items can you think of that come from a plant? Turn and table with a buddy to come up with a list.
2. Review the main parts of plants.

a. Using prior knowledge participants will create a diagram of a plant in their journal.

b. Discuss the different parts of a plant and what they know about each part.

a. Today we will be focusing on the different parts of plants that we eat as food. We eat different parts of many different plants. We eat fruit, vegetables, seeds, leaves, stems, and even flowers.

3. Activity:

   a. Discuss the difference between fruits and vegetables

      i. Fruit = the edible part of the plant that contains the seeds.

      ii. Vegetable = any edible portion of the plant that does not have seeds

      iii. Give participants time to brainstorm as many fruits and vegetables as they can. Can they name one fruit or vegetable for every letter of the alphabet?

   b. Tell participants that they will work with their groups to carefully dissect each item on their plate. They need to figure out if each is a fruit or vegetable.

   c. Pass out plates with fruit/vegetable samples and plastic knives.

   d. Allow the participants to dissect and categorize the food items into fruits and vegetables.

   e. Discuss results. For each vegetable, have participants identify which part of a plant it is.

Plant Parts	**Vegetable**
Leaves	Cabbage, lettuce, spinach
Roots	Carrot, radish, turnip

Flowers	Broccoli, cauliflower
Stems	Celery, asparagus, potato

f. Have participants make a t-chart of fruit and vegetables in their journals. While discussing results, ask what other vegetables would fit into each category.

g. Have participants make sketches of the outside and inside of some sample of fruits and vegetables.

h. Extension: Allow students to taste a sample of each fruit and vegetable. Be sure there are no allergies.

i. If there is time, take a walk to the garden to notice what is planted. What parts of the plant are vegetables they like?

4. Reflection:

- What are some parts of different plants that we eat?
- What is the difference between fruits and vegetables?
- What about the foods we looked at and learned about today surprised you?
- Other than as food, what are some ways people use plants?

STEM	• understand the difference between natural and artificial food • learn the importance of food quality control • learn how the field of chemistry is important for food quality control • catergorize food
Creative Arts	• draw a diagram of various food
Literacy	• label a diagram of various food

	• listen to books such as *Tops and Bottoms* • discuss difference between fruits and vegetables

Day 3 - Water and plants

Lesson 1 - Water surface tension

Grades: 4-5

Time: 45 minutes

Standards:

- SEPS.3 (Indiana Science and Engineering Process Standards) Constructing and performing investigations

Objectives: Participants will learn about and explore surface tension and the properties of a liquid to resist force through 3 different experiments (penny experiment, zooming fish, and tie dye milk). To extend, can take students to creek either before or after the experiments to notice water striders and other insects that are on the surface of the water.

STEM Career Connection: Hydrologists study the physical characteristics, distribution, and movement of water on, above, and below the Earth's surface, and assist in water conservation.

Literature Connections: : *Water Insects* by Sylvia Johnson, *A Drop Of Water: A Book of Science and Wonder* by Walter Wick, *Water! Water! Water!* by Nancy Elizabeth Wallace

Materials: All groups: picture of water strider, eye droppers, one per camper, Cups of water, one per camper, Pennies, one per camper, pepper, 9X13 aluminum pans, 1 per 2-3 campers, Several pitchers of water, Buckets to put used water into, Dish soap, Craft foam sheets (non-adhesive), Scissors

Coyotes and Eagles only: Whole milk (1 gallon should be enough), Food coloring (2 sets of 4-6 colors will be enough to share), Q-tips

Procedures:

Introduction:

1. Show a picture of a water strider. Ask participants if they have ever seen this insect. Discuss any background knowledge.
2. Show the video: Water strider - walking on water
3. Introduce the term “surface tension.” Explain that it means that water molecules hold tightly to each other and resist being separated.
4. Show the SQW - Wonderful Water - Exploring cohesion and surface tension of water
5. Now, in stations, participants will be able to try each activity.
    a. Explain each experiment.
    b. Set up each experiment at a different table. Have 3-4 participants at each station. Have an intern/SFL at each table.
    c. Give participants about 5-10 minutes at each station to explore surface tension.
    d. Switch stations until participants have had an opportunity to try all stations.

1. Coin Challenge:
    a. Place a coin on a flat surface.
    b. Predict how many drops of water will fit on the coin.
    c. Use an eye dropper, pipette, or straw to drop one drop of water at a time on the coin. Keep going until a dome of water appears on top of the coin. Observe.

d. Continue adding drops of water until they spill over. How many drops was the coin able to hold? What property of water makes the water drops collect like this? (Cohesion of water molecules holds them together.)

2. Zooming Fish:
   a. Make a fish shape out of foam sheet or paper.
   b. Pour enough water into the 9X13 pan so that it's about ½-1 inch deep.
   c. Place the fish in the water. Observe.
   d. Put a drop of dish soap behind the fish. Observe.
   e. What does the fish do on the water? (Surface tension of the water is like a wrapper that's holding the water together. The soap breaks the wrapper open like a pair of scissors and pushes the fish ahead of it.)
3. Pepper on water:
   a. All you need is a bowl of water, some pepper and a small amount of dishwashing liquid.
   b. Sprinkle the pepper over the surface of the water so that it is completely covered.
   c. Next, dip your finger into some dishwashing liquid. Now dip your finger right into the center of the bowl of water and….wow! Watch as the pepper instantly disperses to the sides of the bowl.
   d. What just happened? The surface of the water is like a stretchy elastic skin on top of the water. The surface tension is broken by the dishwashing liquid and it snaps away quickly. As the water molecules try to straighten up again, they quickly move to the sides of the bowl, and the pepper moves with them.

Tie dye milk experiment

a. First, add enough milk to cover the bottom of the dish.

b. In a separate small container, mix together about a half cup of water with a squirt of dish-soap (a teaspoon or so.)

c. Put several drops of different colored food coloring into the milk (two drops of each color.)

d. Dip Q tip in soapy water then touch Qtip to milk. You don't need to stir. The detergent will break the surface tension of the milk and the food coloring will swirl around in interesting patterns, as if by magic.

e. What happened? When the skin of the liquid is broken, whatever is underneath will be able to escape, like the air rushing out of a balloon. In this experiment, the surface of milk is like the elastic skin and dish detergent is what breaks the "skin" of the milk, sort of like a pin popping a balloon. Food coloring and more milk then escape from underneath the milk's surface, swirling to the top.

Reflection:

a. What is surface tension?

b. Explain what happened in each experiment?

c. How would surface tension help certain types of living things?

STEM	• understand what surface tension is • conduct three experiments about surface tension
Creative Arts	• N/A
Literacy	• explain the results of each experiment • write reflection about the results and what they learned during the experiments

Lesson 2 - Mapping the creek

Grades: 4-5

Time: 60 minutes

Standards:

- ○ 4.ESS.3 (Indiana Academic Science Standards) Describe how geological forces change the shape of the land suddenly and over time.
- ○ 4.ESS.4 (Indiana Academic Science Standards) Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans.
- ○ 5.ESS.3 (Indiana Academic Science Standards)Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Objectives: Participants will collect qualitative data of Eagle Creek and use it to map the creek.

STEM Career Tie In: Cartographer - A map maker is formally called a cartographer. A cartographer is trained in cartography, which incorporates elements of both science and art. Cartography involves both learning to illustrate maps and learning about the science behind maps. Some maps are much simpler to illustrate and understand than others. These maps, classified as general cartography, are simple maps created for the masses. Maps can depict geographical features on top of simple land mass shapes. One example of this is including contour lines to illustrate elevation changes. Finally, maps can be drawn to scale, which is especially important when used for navigation purposes.

Literature Connections: *About Habitats: Rivers and Streams* by Cathryn Sill, *The Wonders of Rivers* by Clare Pillarkins, *The Secret Life of Streams* by Lynell Marie Garfield

Materials: Honeybees and Coyotes: clipboards, pencils, measuring tape

Eagles only: Sheets from Hoosier RiverWatch Training Guide - pg 26 survey sheets, pg 29 map sheets, pg 30 streamflow

Procedures:

1. Focus question: Is Eagle Creek Healthy?
2. Today, we will collect data and then work together to come up with a way to begin to answer the question, Is Eagle Creek Healthy?
3. Show pictures of healthy and unhealthy creeks pg 22 and 23. Ask children to compare the two kinds of waterways and share what they notice about them.
4. Have students make a list of things that show that a waterway is healthy or unhealthy. Encourage them to look at the images to help add new ideas to their list. Focus on the ideas from above about Stream Bottom, Water Odor, Depth and Width of Stream, Channel Shape, Water appearance, In Stream Organic Matter, Streambank Cover & Shading, and Adjacent Land Use.
5. Give pairs of children a copy of the CQHE form to record their observations.
6. Walk to the creek and notice how our creek looks, focusing on ideas they identified during discussion. (creek sides are crooked, not straight; water is clear enough to see the bottom; bottom of creek has rocks and sand, algae, and living creatures; trees and plants along edges of creek, etc)
7. Upon return to tables, children will create a diagram of the creek that shows healthy attributes from CQHE. Use a whiteboard to record their observations to help them label their drawings of healthy attributes.

STEM	• participate in creek analysis • collect qualitative data

	• complete a circuit
Creative Arts	• N/A
Literacy	• complete CQHE form • discuss observations with other participants

Day 4 - Forest plants

Lesson 1 - Forest plants

Grades: 4-5

Time: 45 minutes

Standards:

- 4.LS.2 Use evidence to support the explanation that a change in the environment may result in a plant or animal will survive and reproduce, move to a new location, or die.
- 5.LS.2 Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.
- 5.LS.1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Objectives: Participants will learn to identify the four layers of plants that make up a forest/woodland community. Participants will be able to identify the Indiana state tree - Tulip Tree.

STEM Career Connection: A forester is a scientist who studies forests, or is skilled in planting, managing, or caring for trees.

Literature Connections: *A Walk in the Deciduous Forest* by Rebecca L. Johnson

Materials: illustrations of deciduous forest; Coyotes and Eagles - journal and pencil

Procedures:

1. Spark interest by watching the video “If you find a bent tree in the forest”
2. Tell participants that they should keep their eyes open for a trail tree. Predict - do you think we will find one in our forest? Tell why or why not.
3. Explain that they will be going into the forest and will be looking at the layers of a deciduous forest. Have participants share any knowledge they have.
4. Show participants the diagram of the deciduous forest. There are 5 parts. Briefly describe each layer.

   - Canopy

   This is the top layer of the forest. The tallest and most mature trees grow here, many times blocking out much of the sunlight, especially in the case of broadleaf trees.

   - Understory

   This layer is just below the canopy and is made up of shorter, more shade-tolerant tree species or younger versions of the taller canopy trees.

   - Shrub and seedling layer

   In this layer you can find woody shrubs, such as blueberries or elderberries. Shrub is another name for bush. Shrubs have many stems coming out from the base, while trees have one central trunk. There are also saplings, or very young trees, growing here—usually very slowly due to the lack of light. Once a large tree dies and falls, it will open up a space for light to enter the forest floor, allowing these long-time saplings to grow upwards relatively quickly. This is called gap-dynamics, where essentially all little saplings are waiting for a bigger tree to die so that they can grow quickly and take its space in the canopy.

- Groundlayer

This is the lowest layer of live plants: grasses, ferns, wildflowers, mosses, creeping shrubs, and liverworts live here. All of these plants are able to live in low light and some will even die with too much light exposure. Vines are plants with climbing or trailing stems or runners. They grow on objects like fences, trellises, trees, posts, rocks, and buildings. They can also grow along the ground.

- Forest floor

This is the layer tucked underneath all the living plant material. Dead rotting trees, fallen leaves, and branches cover the top soil and humic layers that are full of different decomposing organisms such as fungi, invertebrates like millipedes and springtails, and microscopic bacteria. The soil in these forests tends to be very rich and packed with nutrients, allowing for very complex interactions both in the soil and above it.

5. Once you arrive in the forest, stop and have participants look around and observe. Describe each layer of the forest. As you explain each layer - have participants observe what they see in that layer. Give participants an opportunity to name plants and animals they see in the layer.
6. Participants will draw a picture in their journal to show the layers of the forest.
7. Take a hike to the Tulip Tree. Once you arrive, have participants observe the tree. Point out how the leaf looks like a tulip. This is our state tree.
8. Look for insects buzzing around the tulip tree flower, if present and visible from the ground. If the branches are too high, look on the ground for fallen twigs and blossoms. If possible, look for caterpillars eating the leaves or stems of leaves and draw a picture of

the insects or caterpillars on the parts of the tree. Ask: Write about why you think insects and caterpillars are attracted to the tulip tree.

9. After the hike: discuss what animals they might find in each layer. Brainstorm a list of animals with a partner. Share their ideas with each other.

STEM	• receive facts about a forester's job • make observation on the hike • learn about forest layers
Creative Arts	• draw observations from the hike
Literacy	• write hypothesis about insects attraction to the tulip tree • listen to *A Walk in the Deciduous Forest*

Lesson 2 - Life in a leaf liter

Grades: 4-5

Time: 45 minutes

Standards:

- 3-5.E.3 (Next Generation Science Standards) Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- 4.LS.3 (Next Generation Science Standards) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction in a different ecosystems.
- 4.LS.2 (Next Generation Science Standards) Use evidence to support the explanation that a change in the environment may result in a plant or animal will survive and reproduce, move to a new location, or die.

- 5.LS.2 (Next Generation Science Standards) Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

Objectives: Students will define leaf litter; will collect and observe and describe a sample of leaf litter looking for different plants, animals, and materials. Students will think about which human actions help or harm different habitats/ecosystems.

STEM Career(s): Conservation scientists and foresters evaluate data on forest and soil quality, assessing damage to trees and forest lands caused by fires and logging activities. In addition, they lead activities such as suppressing fires and planting seedlings.

Literature Connection(s): *Treecology*, Russo; *Leaf Litter Critters*, Leslie Bulion

Materials: Garden gloves, zip baggie or plastic containers with lids, trays, small clear plastic containers (to hold insects for observation and identification), journals/paper and pencils, rulers, clothespins (olde tyme ones - Eagles only); discussion questions half sheet "leaf litter search card"

Procedures:

1. Read a few poems from *Leaf Litter Critters*.
2. Discuss what lives on the forest floor.
3. Explain the term "leaf litter". (material forming a surface-covering layer, in particular; decomposing but recognizable leaves and other debris forming a layer on top of the soil, especially in forests.) Clear any misconceptions related to the word "litter". Leaf litter isn't trash, but actually a habitat for many insects, fungi, and other living things that thrive in the forest.

4. Explain that we'll be finding an area where we can take a closer look at the leaf litter in our forest. We'll be taking samples to look at, count how many different kinds of insects we can find in our leaf litter, and then returning the leaf litter and insects to where we found them. We don't want to remove them because our forest needs them!
5. Explain our leaf litter observation materials: garden gloves to scoop up leaf litter, ruler to measure location, ziploc bags to place it in for transport, white trays to place it on for close observation, containers to keep insects in.
6. Once you arrive at the leaf litter location, students will work in small groups of 2-3 to scoop up leaf litter into the ziploc bag. First, lay down the ruler. Then, scoop leaf litter in a 1 foot area. They should try to go about 2-3 cm into the top layer of soil, if possible. Place all the material in the ziploc bag and seal.
7. Take the bags back to the observation area. Carefully dump the bag onto the white tray. Observe closely, removing any insects into the plastic container. Try to identify all the materials. Use Leaf Litter Search cards to find and identify different layers of leaf litter. (found at the end of the lesson)
8. After observing, carefully return all materials and insects to the area they were removed from.

Reflection:

- How was the top layer different from the bottom layer, as you were scooping up the leaf litter? Why do you think it was that way? What is happening to the leaves and twigs as they stay on the ground?

- How many different kinds of insects did you find? The greater the number, the greater the biodiversity in our forest!

Challenge: Participants may use the Leaf Litter brochure to identify the critter that is being described. (Brochure found in the resources section of Summer Camp shared drive)

Critter Clues -

- This critter has many legs. Its body looks like a long tube made of rings, with at least two pairs of legs on each ring. Which one is it? (Millipede.)
- This critter has no legs. It is fattest in the middle of its body, and it has feelers on its head. On its back it has a hard shell. Which one is it? (Snail.)
- This critter has six legs. It has very short wings on its back. At its tail end it has two long, sharp, curved pincers. Which one is it? (Earwig.)
- This critter has eight legs. It has a small round body and its legs are very long and skinny. Which one is it? (Daddy longlegs.)
- This critter has many legs. Its body is long and thin and it has one pair of legs on each body ring. It twists its body side to side like a snake. Which one is it? (Centipede.)
- This critter has no legs. Its body is like a long tube made of many rings. It has no eyes or antennae but it has a band near one end. (Earthworm.)
- This critter has fourteen legs, two antennae, and a body shaped like a turtle's shell. Which one is it? (Isopod.)
- This critter has – no wait! It just disappeared! Oh, there it is again. It is tiny and has six legs and a tail folded under its belly that it uses to jump. Which one is it? (Springtail.)

Extension Activity: ELF HOUSES

Objective: To design and build small houses for imaginary people using natural materials from the forest floor.

Have participants work in pairs or small groups to build a home for an imaginary clothespin-sized person, using materials they find on the forest floor such as bark, twigs, cones, and leaves. Ask them not to disturb living things like mosses, ferns, or animals. Encourage children to use their imaginations as they create their houses. Allow time for groups to take turns visiting other teams' "elf houses" and explaining their designs.

Materials: any natural materials found on the forest floor, but nothing living

Leaf Litter Search Card

Look for leaves in different stage of decay: freshly fallen leaves, brown dry leaves, skeletonized leaves, bits of slimy brown rotting leaves

Look for nuts and seeds. How are they important?

Look for tree seedlings. Why are they important?

Look for roots and rootlets.

Look for white fuzzy coating or threads (fungal hyphae) on things like twigs, leaves, bark pieces, roots. Why are they white?

STEM	● understand what leaf litter and decay is ● identify critters ● analyze leaf litter
Creative Arts	● create an elf house using nature
Literacy	● listen to poetry from *Leaf Litter Critters* ● discuss what happens in leaf litter

Camp 3 - Earth Superheros

Day 1 - Earth system's overview - Geosphere

Lesson 1 - Earth systems

Grades: 4-5

Time: 45-60 minutes

Standards:

- K-8 Process Standards: SEPS.2 Developing and using models and tools
- 4.ESS.3 Describe how geological forces change the shape of the land suddenly and over time.
- 4.LS.2 Use evidence to support the explanation that a change in the environment may result in a plant or animal will survive and reproduce, move to a new location, or die.
- 5.ESS.4 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- 5.LS.1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- Social Studies 4.3.6 Describe Indiana's landforms (lithosphere), water features (hydrosphere), and plants and animals (biosphere).

Objectives: Participants will be able to identify four of the spheres on Earth (geosphere, hydrosphere, atmosphere, biosphere); explain interrelationships between the spheres as related to local spaces (the farm).

STEM Career Connection: Atmospheric scientists study the weather and climate and examine how those conditions affect human activity and the earth in general. Environmental scientists understand how the natural world interacts with its surroundings. Often, they consult on how construction projects will impact the natural environment. Biologists work with wildlife, marine life and vegetation. They analyze how living things, flora and fauna are composed including their structure and composition. For example, marine biologists understand ocean life. But wildlife biologists may specialize in birds, amphibians and mammals. Geologists study bedrock and surface rocks. More specifically, they best understand how Earth's landforms and rock change over time. In a geology career, it relates rocks with the physical/chemical structure and the processes that act on it.

Literature Connections: *Earth's Spheres* by Rebecca Woodbury PH D; *Teacher Created* Materials - *Science Readers: Content and Literacy: The Four Spheres of Earth* by Paul Larson;

Procedures:

1. Show students the globe. Guide discussion of what they notice about the globe and what it tells us about Earth.
2. Watch Four Spheres Part 1 (Geo and Bio) Guide discussion to talk about the geosphere/lithosphere (terms are used interchangeably) and the biosphere.
3. Students will then work to create their own model on a big circular paper.
    a. Draw lines to divide paper into fourths.
    b. On one fourth, glue brown paper. Label it "geosphere." Students cover the section with glue and sprinkle soil on it to represent land.
    c. On another fourth, glue green paper. Label it "biosphere" Students will glue moss and models of small insect/animal to this section to represent living things.
4. Watch Four Spheres Part 2 (Hydro and Atmo) Guide discussion to talk about the hydrosphere and the atmosphere.

a. On another fourth, glue blue paper. Label it “hydrosphere.” Students will glue blue crinkle paper to this section to represent water.

b. On the last fourth, label it “atmosphere.” Students will glue cotton balls to represent air.

c. Discuss as a group how the different spheres interact with each other and draw that on the model. (trees produce oxygen for the atmosphere, water enters the geosphere and allows plants to grow, water evaporates into the atmosphere, etc)

5. Students will go out around the farm and draw a picture of a section of the farm ecosystem. They’ll label the different spheres that they can identify. Use arrows to show ways the spheres interact. See example below.

6. Reflection - Discuss how the different spheres work together. Share pictures and connections that they made. Are there things that are in multiple spheres?

STEM	● identify four earth spheres ● create sphere model
Creative Arts	● draw farm ecosystem
Literacy	● label sphere diagram ● discuss ways the Earth spheres work together

Lesson 2 - Soil science

Grades: 4-5

Time: 45 minutes

Standards:

- 4.ESS.3 Describe how geological forces change the shape of the land suddenly and over time.

- 5.ESS.3 Investigate ways individual communities within the United States protect the Earth's resources and environment.
- 5.ESS.4 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- 6.LS.4 Investigate and use data to explain how changes in biotic and abiotic components in a given habitat can be beneficial or detrimental to native plants and animals.

Objectives: Participants will observe soil using science tools and their senses and record and discuss what they see. Participants will test soil samples for organic matter to determine which soil is healthiest to grow plants. Participants will look for evidence of interactions among the geosphere (land), biosphere (life), hydrosphere (water), and atmosphere (air). Participants will consider ways humans impact and influence soil health.

STEM Career Tie In: Pedology is the scientific study of soils, including their physical and chemical properties, the role of organisms in soil production and in relation to soil character, the description and mapping of soil units, and the origin and formation of soils. Pedology embraces several subdisciplines, namely, soil chemistry, soil physics, and soil microbiology.

Literature Connections: *Jump Into Science: Dirt* by Steve Tomecek, *Soil Basics* by Mari Schuh, *Dirt: The Scoop on Soil* (Amazing Science) by Natalie M. Rosinsky

Materials: Soil samples from around the farm (garden, creek, potting soil, etc.), containers/buckets, small shovels, spoons or small scoopers, hand lenses, tweezers, paper plates, trays, pencils or permanent markers, small containers of hydrogen peroxide, pipettes or droppers.

Procedures:

1. Introduction

a. At the farm there are lots of different living things.
b. What are some of the living things found at the farm? (let participants share ideas)
c. What are some nonliving things found at the farm? (let participants share ideas)
d. One of the most important nonliving things we have at the farm is soil. Why is soil important? (it's home/shelter for living things; it makes up the ground; plants grow in soil, etc.)
e. Today we are going to observe and test some soil from the farm to help us determine if the soil is of good quality for growing plants/crops.

2. STEM Activity: Soil Observation
    a. What is soil? (let participants share thoughts)
    b. Soil is the material found on the surface of the Earth that is composed of broken down organic, or once living, materials like dead plants/animals, and inorganic, or nonliving, materials like rocks.
    c. Soil can be different based on the types of rocks that broke down to make up the soil and how much the rocks have broken down.
    d. Have participants observe soil samples and describe them using senses. (This can be done from the containers in which the soil was collected or by having participants fill the jar they will use for the sedimentation activity ½ full of soil.)
        i. How does the soil look?
        ii. How does the soil feel?
        iii. How does the soil smell?
3. STEM Activity: Soil Sedimentation Jar

a. Introduce:

   i. Soil is made up of different types of sediment. Soil sediments are classified based on their size.

      1. When rocks start to break down, they form sand particles. Sand particles are the largest soil sediments. They are large enough to see and feel rough or gritty (like salt).
      2. When sand particles break down, they form silt particles. Silt particles are small (almost too small to see) and feel soft (like flour).
      3. When silt particles break down, they form clay particles. Clay particles are so small they cannot be seen individually without a microscope. Clay particles tend to clump together when wet.

   ii. When we add water to soil and mix it up, heavier sediment will settle at the bottom and lighter sediments will layer on top of heavier ones.

b. Question: What types of soil sediments are found in the soil we collected?

c. Predict: Have participants predict which type of sediment(s) will be found in the soil sample they collected.

d. Experiment/Observe: We can set up a soil sedimentation jar to test soil samples for the presence of different types of soil sediment.

   i. Label the jar with the type of soil (if testing more than one sample).
   ii. Fill a jar ½ full of soil.
   iii. Add water until the jar is about ⅔ full.
   iv. Close the jar and shake it vigorously for 1-2 minutes.

v. Let the jar sit for a few minutes.

NOTE: While participants are waiting for the sediment to settle, have them draw a picture of what they think the jar will look like after the wait time.

e. Conclude: Discuss results of the soil sedimentation test.

i. Do you notice layers of material in the jar?

ii. What different layers do you notice? What is on top, what is in the middle, and what is on the bottom?

iii. How many layers of soil sediment do you notice at the bottom of the jar? What types of sediment are there?

iv. How do the layers of soil sediments compare? Which type of sediment makes up the biggest layer and the smallest layer?

v. Look at the Soil Sediment Layers Diagram (shown below). Would the soil you tested be good to use in the garden or crop fields to grow plants?

4. Reflection:

a. What is soil? How is it made/formed?

b. What are some ways in which soil can be different?

c. Why is soil important?

d. How can you tell if soil is good for growing garden plants or crops?

e. What are some things humans can do to help ensure soil on Earth is healthy for the organisms that need it?

STEM	● understand what soil and sediment are ● identify the types of sediment in soil
Creative	● N/A

Arts	
Literacy	• listen to various books about soil • discuss what soil is and how to tell if it is healthy

Day 2 - Earth system's overview - Biosphere

Lesson 2 - Plate tectonics

Grades: 4-5

Time: 45 minutes

Standards:

- 3-5.E.3 Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- 4.ESS.3 Describe how geological forces change the shape of the land suddenly and over time.

Objectives: The participants will use food to model and observe the plate movement and consequences of plate movement associated with the theory of plate tectonics.

STEM Career Connection: A geologist is a scientist who studies the solid, liquid, and gaseous matter that constitutes Earth and other terrestrial planets, as well as the processes that shape them. Geologists usually study geology, although backgrounds in physics, chemistry, biology, and other sciences are also useful.

Literature Connections: *Plate Tectonics (Let's Find Out!)* by Julia J. Quinlan

Materials: 4 dollops of frosting, Marker, Paper plate, ½ rice cake, Small dish of water, Spoon, 4 graham cracker squares

Procedures:

1. Participants watch the ice age video clip.

   https://www.youtube.com/watch?v=TzzGPfVx32M

2. After watching the video clip ask participants the following questions:

   a. What did you observe from the video?

      Participants' responses may vary but could include that they observed the layers of the Earth, the separation and movement of the continents, the "ball" at the center of the Earth, etc.

   b. How does this video relate to Earth's layers?

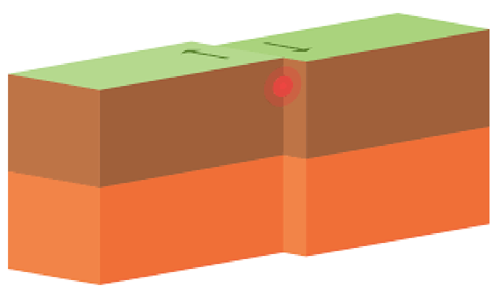
      Participants' responses may vary but could include that they saw the squirrel go through the different layers of the Earth, they saw the squirrel land on the inner core, etc.

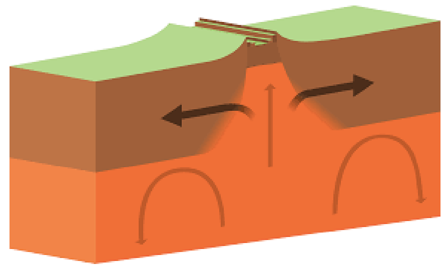
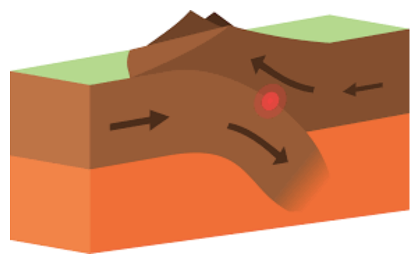
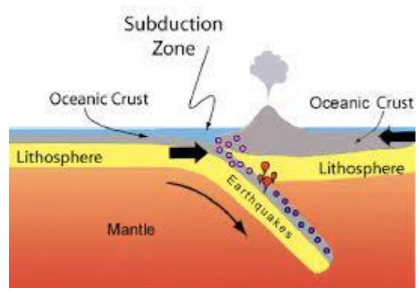
   c. What did you observe about what was happening to the crust in the video?

      Participants' responses may vary but could include that they saw it splitting into pieces, they saw pieces moving apart, etc.

3. Have participants re-watch the video and ask them what other details they noticed?

   Introduce vocabulary:

Transform boundary	Plate boundary where the plates slide past each other 

Divergent boundary	Plate boundary where the plates move apart 
Convergent boundary	Plate boundary where the plates collide 
Subduction	One tectonic plate is pushed beneath another plate 

Part 1: Divergent Plate Boundaries

1. Using a marker, divide your paper plate into four equal sections.
2. Put a dollop of frosting in each section.
3. Break one graham cracker square in half. In one section of your plate, lay the two pieces of graham cracker side by side on top of the frosting. The graham cracker

pieces should lay so that they are touching. Press down on the crackers as you slowly pull them apart in opposite directions. You've just made a model of diverging oceanic plates!

Part 2: Convergent Plate Boundaries – Oceanic and Continental Subduction

1. In a different section of your plate, take another graham cracker and lay it on top of the frosting next to the straight side of the rice cake half so that they are almost touching. The graham cracker represents an oceanic plate, and the rice cake represents a continental plate.
2. Push the two "plates" slowly towards each other. Which plate rides up over the other? The oceanic plate (graham cracker) is subducted, or sinks, under the continental plate (rice cake).

Part 3: Convergent Plate Boundaries – Continental Mountains

1. Take another graham cracker square and break it in half. Each piece represents a continental plate.
2. Dip one end of each of the two cracker pieces into a cup of water. Don't let them soak too long or they will fall apart!
3. In a third section of your plate, lay the crackers end to end on the frosting with the wet edges almost touching.
4. Slowly push the two crackers together. What happens? What feature is formed?

Part 4: Transform Plate Boundaries

1. Take your last graham cracker square and break it in half. In the last section of your plate, lay the two pieces side by side on top of the frosting so that the pieces are touching.

2. Push the pieces together while sliding them in opposite directions – one towards the top of the plate and one towards the bottom of the plate. This can be a bit tricky, but if done correctly the cracker will eventually break due to the opposite forces!

Reflection:

1. What did you learn about plate tectonics?

If there is time, watch the video Plate tectonics on a cocoa Earth to see plate tectonics on cocoa.

STEM	• learn about plate tectonics and plate movement • create a plate tectonics visual
Creative Arts	• N/A
Literacy	• listen to *Plate Tectonics (Let's Find Out!)* • discuss knowledged learned about plate tectonics

Day 3 - Earth system's overview - Hydrosphere

Lesson 2 - Macro invertebrate count

Grades: 4-5

Time: 45 minutes

Standards:

- Science and Engineering Process Standards K-8th
- 4.ESS.4 Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans.
- 4.LS.2 Use evidence to support the explanation that a change in the environment may result in a plant or animal will survive and reproduce, move to a new location, or die.

- 4.LS.3 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction in different ecosystems.
- 5.ESS.3 Investigate ways individual communities within the United States protect the Earth's resources and environment.
- 5.LS.2 Observe and classify common Indiana organisms as producers, consumers, decomposers, or predator and prey based on their relationships and interactions with other organisms in their ecosystem.

Objectives: Participants will search the creek for benthic macroinvertebrates; participate in citizen science to collect data about Indiana waterways; determine if our portion of Eagle Creek is healthy.

STEM Career Tie In: Hydrologist

Hydrology is the study of all aspects of water: availability, quantity and quality. Hydrologists examine the physical characteristics, distribution, and circulation of water above and below the earth's surface. They study rainfall and other precipitation, the paths precipitation takes through the soil and rocks underground, and its return to the oceans and air. Hydrologists generally perform research at a variety of outdoor sites, but they also work in laboratories. Hydrologists may monitor wells, record water depths, and measure stream flows or runoff rates. They frequently collect and analyze water samples and historical data on storms and floods.

Materials: tools for creek stomping and recording the macroinvertebrates in the creek; macroinvertebrates poster or other images of macroinvertebrates

Literature Connections: *About Habitats: Rivers and Streams* by Cathryn Sill, *The Wonders of Rivers* by Clare Pillarkins, *The Secret Life of Streams* by Lynell Marie Garfield

Procedures:

Focus Question: Other than fish etc. what organisms might you find in a stream? What are insects? What does biotic and abiotic mean? What about the creek and creek area make it a good area for animals to live? What is biodiversity?

1. Read all of the sections of *The Secret Life of Streams*, especially the parts about caddisfly larvae (as those are easily found in our creek). Show poster or pictures of macroinvertebrates.
2. Discuss "macroinvertebrate" as having no backbones and being able to be seen without a microscope. Discuss what macroinvertebrates they saw in the book and what they hope to find at the creek. Show Macroinvertebrate poster and p 67/71 of HRW Manual Ch 5 to see images of the variety of aquatic insects/invertebrates that may be found in our creek.
3. Have students draw an aquatic insect (from the book or from the identification key). Then discuss the life-cycle and common features aquatic insects have.
4. Write biotic/abiotic on whiteboard or chart paper. Have students talk about the meaning of both. Then, talk about what biotic organisms need to survive. Have them predict what the larvae from the book/poster will need to survive in our creek. What would make it hard for these living things to survive in the creek?
5. Walk to the creek with poster, small containers to collect creatures, magnifying glasses, paper/notebook, pens to keep track of findings. As you walk, review creek safety procedures and strategies to find creatures.
    a. Campers can be in water to a depth approximately mid shin, below the knee.

b. Walking slowly along the creek edge and disturbing the water as little as possible, will help find living things.
c. While we encourage participants to find and closely observe living creatures at the creek, we always leave nature where we find it. This means we can catch creatures to observe them closely, then return them to their natural environment. We do not remove creatures, rocks, shells, or any other natural materials from the creek. Any trash found can be brought up to the barn for disposal.

6. At the creek, show students in small groups how to pick up rocks and look on the bottom for the sticky, small piles of pebbles and sand. These are the cases that the caddisfly larvae build for themselves.
7. Optional: Using D-net and procedure outlined on p4 of HRW Manual Ch 5 to collect a sample from the creek. Dump it into a white bottomed container. Students can sift through the material collected to look for macroinvertebrates, comparing to poster images to identify their findings. Return all collected material to the creek as close to where it was collected as possible.
8. As students find living things, help them to identify them using the poster and/or pictures of macroinvertebrates.
9. Upon return to the barn/shelter, work together to create a list of all the different kinds of living creatures they found at the creek. What does this say about the health of our creek?

STEM	• use microscope • learn about macroinvertebrates • conduct observations in nature

Creative Arts	• N/A
Literacy	• listen to *The Secret Life of Streams* • write list of creatures • discuss creek health

Day 4 - Earth system's overview - Atmosphere

Lesson 1 - Air pollution catcher

Grades: 4-5

Time: 45 minutes

Standards:

- 4.ESS.4 Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans.
- 5.ESS.4 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Objectives: Participants will define air and air pollution and identify ways air pollution gets into the air; construct a device used to collect and observe air pollutants; discuss ways to decrease the amount of air pollution that goes into the air.

STEM Career tie in: Air Pollution Analysts and Air Quality Field Technicians will measure, sample, and analyze data gathered from polluted air. After theorizing or discovering the source of the pollutants, they work with other specialized scientists to develop future techniques for reducing or eradicating air pollution. Air Pollution Analysts play the vital role of controlling human pollution outputs to preserve our precious atmosphere and the air we breathe.

Source: https://www.environmentalscience.org/career/air-pollution-analyst

Literature Connection(s): *Air Pollution! Environment & Ecology Fact Book For Children* by Bold Kids; *The Earth Book* by Todd Parr, *Air* (Environment Collection for Kids) by David Palatnik, *Air Is All Around You* (Let's-Read-and-Find-Out Science 1) by Dr. Franklyn M. Branley, *Pollution: Problems Made by Man* (Nature Books for Kids - Children's Nature Books) by Baby Professor

Materials: Chart paper and markers, device on which to to show air pollution video clip (optional), paper plates, markers, hole punchers, string/yarn, petroleum jelly, spoon, disposable gloves (optional), a way to wash/clean hands, magnifying glasses, poster board, iPads, markers/crayons, spoon or knife

Procedures:

1. Engagement/Introduction:
    a. Let's think about the Earth. What basic materials cover the Earth? (land, water) What material surrounds the Earth? (air)
    b. What is air? (a mixture of gases that surrounds the Earth)
    c. Is air the same everywhere? (No, air can be made up of different mixtures of gases, some air is dirtier/cleaner than other air, amount of water in air is different in different places, etc.)
    d. Even though air is made up of mostly invisible gases, we can still make observations of air and conduct scientific investigations of and with it.
    e. Let's observe the air around us. We are going to observe the air around us for 1-2 minutes, paying particular attention to what we see in the air. Be sure to look in all directions throughout your observation time.

f. Have students observe air for 1-2 minutes and then share observations. Observations can be recorded on chart paper and/or in journals.

g. Some things in the air are easy to see and identify, like birds, leaves, seeds, airplanes, etc. There are other particles in the air that are harder to see and can be bad for humans and other organisms. These harmful particles are called air pollutants.

h. What are some ways air pollutants get into the air? (natural disasters like wildfires, volcanic eruptions, and dust storms, human activity like burning fossil fuels, spraying chemicals, etc.)

2. Activity:

   a. Today we are going to set up an experiment to check the air pollutants in the air around the farm.

   b. In order to monitor the air for pollutants, we are going to construct air pollution catchers and use them to test the air.

   c. Pass out paper plates, markers, hole punchers, and string. Have students write their name on the back of a paper plate and punch 1-2 holes in the plate. String string/yarn through hole/holes and tie ends together to make a loop for hanging the air pollution catcher.

   d. Pass out petroleum jelly and have students use a knife or a spoon to scoop out the jelly and spread it so that it covers the entire front side of the paper plate.

   e. Clean hands.

   f. Take air pollution catchers and hang them in a spot for testing.

g. Leave pollution catchers out for your designated amount of time, it could be a few hours, days, or even weeks.

h. After the testing period, collect air pollution catchers and observe them. All the little black specks are air pollutants.Use magnifying glasses to take a closer look at particles. Have students compare their catchers to other students' catcher and identify similarities and differences. Discuss results.

3. Reflection

   a. To extend this concept, participants will create posters or videos to answer the following questions: How can humans help limit the amount of air pollution that is in the air? How can humans help to clean air pollutants from the air? These videos/posters will be shared to inform others about how humans can do their part to "Give a Hoot. Don't Pollute."

   b. Participants may use iPads to make a video or google slide poster, or actual posterboard.

STEM	● understand the vocabulary air pollution and pollutant ● create air pollution catchers ● make observation after air pollution catcher has been on the fence for an extended period of time
Creative Arts	● N/A
Literacy	● listen to various books about pollution ● create pollution awareness poster

Lesson 2 - Cotton ball clouds

Grades: 4-5

Time: 45 minutes

Standards:

- 4.ESS.4 Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans.
- 5.ESS.4 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Objectives: Participants will be able to identify how clouds are formed and name the different types of clouds.

STEM Career Connections: Meteorologists study the environment and lower levels of the atmosphere in order to track and predict weather patterns. Nephologists study the location, formation, characteristics, and movement of clouds.

Literature Connections: *Clouds (Let's-Read-and-Find-Out Science 1)* by Anne Rockwell, *Weather Words and What They Mean* by Gail Gibbons, *Shapes in the Sky: A Book About Clouds* by Josepha Sherman

Materials: blue construction paper, cotton balls, markers, scissors, school glue

Procedures:

1. Activity Prior Knowledge: Discuss what the participants know about clouds. How are clouds formed? What are the different types of clouds?
2. After general cloud discussion, introduce NASA's S'COOL citizen science project.
   a. NASA scientists are interested in learning how clouds affect our atmosphere. It is the clouds, in part, that affect the overall temperature and energy balance of the Earth. The more we know about clouds, the more we will know about our Earth as a system! And *YOU* can help!
   b. S'COOL stands for Students' Cloud Observations On-Line.

c. S'COOL's Citizen Scientists are called Rovers, they are *roaming* S'COOL Cloud Observers. Rovers will collect data on cloud type, height, cover and related conditions. Your observations help us to validate satellite data and give us a more complete picture of clouds in the atmosphere and their interactions with other parts of the integrated global Earth system. Observations are sent to NASA for comparison to similar information obtained from satellites. Reports from a wide range of locations are helpful to assess the satellite data under different conditions.

d. Today we will be collecting data to input in NASA's database.

3. Pass out and discuss the S'COOL Report Form and Cloud Chart.
4. Have students collect cloud data and record it on the Report Form.
5. Record data on https://scool.larc.nasa.gov/en_rover_obs.html

STEM	• identify clouds • collect cloud data for NASA
Creative Arts	• create a circuit different from the instuctions
Literacy	• explain how clouds are formed • complete NASA cloud form

Shawnta S. Barnes

EDUCATION

2023	Ed.D. Literacy, Culture, & Language *Minor - Learning Sciences* Indiana University – Bloomington, Indiana
2012	M.S. Language Education IUPUI – Indianapolis, Indiana
2006	B.A. English Education Purdue University – West Lafayette, Indiana

LICENSURE

2017-Present	Building Level Administrator P-12 Proficient Practitioner's License Indiana Department of Education – Indianapolis, Indiana
2015-Present	Reading P-12 Professional Educator's License Indiana Department of Education – Indianapolis, Indiana
2013-Present	Library/Media P-12 Professional Educator's License Indiana Department of Education – Indianapolis, Indiana
2013-Present	English as a New Language P-12 Professional Educator's License Indiana Department of Education – Indianapolis, Indiana
2006-Present	Reading 5-12 Professional Educator's License Indiana Department of Education – Indianapolis, Indiana
2006-Present	Language Arts Professional Educator's License Indiana Department of Education – Indianapolis, Indiana

CERTIFICATIONS

2015	Orton Gillingham
2015	Responsive Classroom
2014	IB Primary Years Progamme

PROFESSIONAL LEADERSHIP & SERVICE

2023-Present	RISE Indy Circle City Leaders Fellow
2021-Present	Black Excellence in Education Awards Committee Member

2021-Present	Washington Township Community Coalition
2019-Present	IUPUI Committee on Teacher Education (COTE)
2020-2021	IPS Superintendent Advisory Council
2019	WIDA ACCESS for ELLs Writing Grades 6-12 Bias & Sensitivity Review Member
2017-2021	IDOE Cultural Competency Advisory Council Member
2017-2020	The STEM Connection Executive Board Member
2017-2020	Renaissance Kids, Inc. Board Member
2017	IDOE ESSA Student Supports Technical Working Group Member
2016-2018	IPS Mental Health Stakeholder Group Member
2016-2017	Teach Plus Policy Fellow
2016-2017	Indianapolis Public Schools Change Agent Teacher Leader Mentor
2005-2006	Purdue University Saving Our Souls Campus Ministry President

AWARDS

2021	Brightbeam Top 30 Education Influencer
2019	Indiana Black Expo Excellence in Education Journalism Award
2019	Indiana Black Expo Excellence in Education Award
2017	Hubbard Life-Changing Teacher Award Semi-Finalist
2017	Big Green (formerly The Kitchen Community) Learning Garden Recipient
2017, 2015 & 2014	DonorsChoose.org Grant Recipient
2006	Purdue University Semester Honors GPA 4.00/4.00
2006	Black Cultural Center Haraka Writers Service Award
2006 & 2005	Purdue University Black Caucus of Faculty and Staff Academic Honors
2005	Purdue University Advanced Undergraduate Research Traineeship Award
2001	Lawrence North High School Four Year Perfect Attendance Award

PRESENTATIONS

Barnes, S.S. (2023, Jul 10, 12, 17 & 19). *Blooming verses: Planting poetic seeds – Youth summer poetry workshop* [Workshop]. Neighborhood Literary Art Park, Indianapolis, IN, United States.

Barnes, S.S. (2023, March 2). *Developing anti-bias curriculum and resources* [Virtual Presentation]. Kokomo School Corporation lecture series.

Barnes, S.S. (2022, November 3). *Importance of school partnerships* [Virtual Presentation]. Ball State University SCCO 660 – Partnerships & Collaboration in Schools.

Barnes, S.S. (2022, June 13). *Collaborating culturally responsively to implement and support school discipline initiatives* [Presentation]. Ball State University Indiana School Counselor and Administrator (ISCACI), Muncie, IN, United States.

Barnes, S.S. (2022, June 10). *Incorporating local Black history into instruction* [Presentation]. 100 Black Men of Indianapolis Summer Academy, Indianapolis, IN, United States.

Barnes, S.S. (2022, June 10). *Supporting learning* [Presentation]. 100 Black Men of Indianapolis Summer Academy, Indianapolis, IN, United States.

Barnes, S.S. (2022, May 21). *A conversation about DEIA work as a board member* [Presentation]. The STEM Connection, Indianapolis, IN, United States.

Barnes, S.S. (2022, April 30). *How to navigate the school system.* [Presentation]. Allen Chapel A.M.E. Church, Indianapolis, IN, United States.

Barnes, S.S. (2021, Sept 16). *People and places that inspires us* [Panel Discussion]. Indiana Housing Conference, Indianapolis, IN, United States.

Barnes, S.S. (2021, Jun 30). *Embracing equity to strive towards excellence* [Virtual Presentation]. Keep Indiana Learning.

Barnes, S.S. (2021, Apr 10). *Are you listening? Perspectives from Black educators* [Virtual Panel Discussion]. Teach Indy Educators Conference.

Barnes, S.S. (2020, Jul 17). *A conversation about burnout and self-care* [Virtual Presentation]. University of Michigan College Advising Corps.

Barnes, S.S. (2020, Jun 24). *A conversation about cultural responsiveness part II* [Presentation]. The STEM Connection, Indianapolis, IN, United States.

Barnes, S.S., Johnson, L.M., Stewart, C. (2020, Jun 4). *What if the best way to teach struggling students is unpopular with educators?* [Virtual Panel Discussion] Citizen Ed Show.

Barnes, S.S. & Stewart, C. (2020, Mar 30). *Teaching at home while Black* [Virtual Panel Discussion] Citizen Ed Show.

Barnes, S.S. (2019, Jun 21-22). *The stigma of mental health among teachers of color* [Presentation]. Teacher Self-Care Conference, Atlanta, GA, United States.

Barnes, S.S. (2019, Jun 5). *A conversation about cultural responsiveness part I* [Presentation]. The STEM Connection, Indianapolis, IN, United States.

Barnes, S.S. (2019, Feb 13). *Black excellence in scholarship* [Presentation]. The Black Cultural Center, Purdue University, West Lafayette, IN, United States.

Barnes, S.S. & Peterson, L.I. (2019, Jan 29). *Building relationships with parents and families* [Presentation]. Children's Policy and Law Initative of Indiana Positive School Discipline Instiute, Indianapolis, IN, United States.

Barnes, S.S. (2019, Jan 25). *What to consider when choosing a school for your kindergartener* [Presentation]. Indianapolis Moms, Indianapolis, IN, United States.

Barnes, S.S. (2018, Dec 1). *Strategies for a positive parent/teacher relationship* [Presentation]. Teach-A-Rama, Marian University, Indianapolis, IN, United States.

Barnes, S.S. (2018, Oct 27). *Mental health and how we view ourselves* [Presentation]. Teacher Self-Care Mini-Conference, John B. Murphy Elementary School, Chicago, IL, United States.

Barnes, S.S., McGriff, D.M., McNeely, J., Stewart, C. (2018, Aug 2). *The importance of education for our Black children* [Panel Discussion]. National Association of Black Journalists Convention, Detriot, MI, United States.

Barnes, S.S. (2018, Jun 15-16). *Extending your future by becoming a better you* [Presentation]. Teacher Self-Care Conference, Atlanta, GA, United States.

Barnes, S.S. (2018, Apr 16). *ESSA, equity, and student supports for Teach for America's Teach Plus policy externs* [Presentation]. Teach Plus Indianapolis, Indianapolis, IN. United States.

Barnes, S.S. (2018, Feb 23). *Family Black history night* [Workshop]. Wendell Phillips Elementary School, Indianapolis, IN, United States.

Barnes, S.S. (2017, Nov 5). *The power of food: Growing together* [Speech]. The Spirit & Place Power Festival. Shortridge High School, Indianapolis, IN, United States.

PUBLICATIONS

Barnes, S.S. (2023, Jul 11). *What are we willing to lose so our kids can gain?* Education Post. https://www.edpost.com/stories/what-are-we-willing-to-lose-so-our-kids-can-gain.

Barnes, S.S. (2023, Jun 30). *The Supreme Court on affirmative action: Who will you blame now?* Education Post. https://www.edpost.com/stories/the-supreme-court-on-affirmative-action-who-will-you-blame-now.

Barnes, S.S. (2023, Jun 7). *Anti-racist education: The n-word is not a word for school* Education Post. https://www.edpost.com/stories/anti-racist-education-the-n-word-is-not-a-word-for-school.

Barnes, S.S. (2023, Mar 30). *We need partnership between Black and White women educators* Education Post. https://www.edpost.com/stories/we-need-partnership-between-black-and-white-women-educators.

Barnes, S.S. (2023, Mar 29). *Black excellence breeds unrecognized jealously among White women teachers* Education Post. https://www.edpost.com/stories/black-excellence-breeds-unrecognized-jealousy-among-white-women-teachers.

Barnes, S.S. (2021, Dec 2). *Black boys should not have to have a teacher for a mom to learn how to*

read. Education Post. https://educationpost.org/black-boys-should-not-have-to-have-a-teacher-for-a-mom-to-learn-how-to-read/.

Barnes, S.S. (2021, Nov 23). *Teachers, any lesson about Thanksgiving should include Native American perspectives*. Education Post. https://educationpost.org/teachers-any-lesson-about-thanksgiving-should-include-native-american-perspectives/

Barnes, S.S. (2021, Nov 12). *COVID didn't give us much to celebrate, but we need to keep virtual conferences.* Education Post. https://educationpost.org/covid-didnt-give-us-much-to-celebrate-but-we-need-to-keep-virtual-conferences/.

Barnes, S.S. (2021, Oct 11). *How to move beyond land acknowledgments on Indigeneous Peoples Day.* Education Post. https://educationpost.org/how-to-move-beyond-land-acknowledgements-on-indigenous-peoples-day/.

Barnes, S.S. (2021, Sep 21). *4 ways administrators can better support educators this year.* Education Post. https://educationpost.org/4-ways-administrators-can-better-support-teachers-this-year/.

Barnes, S.S. (2021, Sep 9). *I hope my Black students become educators, too.* Education Post. https://educationpost.org/i-hope-my-black-students-will-become-educators-too/.

Barnes, S.S. (2021, Aug 6). *Teachers can't expect to be held to the whims of every parent.* Education Post. https://educationpost.org/teachers-cant-expect-to-be-held-to-the-whims-of-every-parent/.

Barnes, S.S. (2021, Jun 2). *We never learned about Black Wall Street. So, What else is missing from our curriculum?.* Education Post. https://educationpost.org/we-never-learned-about-black-wall-street-so-what-else-is-missing-from-our-curriculum/.

Barnes, S.S. (2021, Apr 14). *I'm sorry (but not sorry) my child is not going to Zoom detention.* Education Post. https://educationpost.org/im-sorry-but-not-sorry-my-child-isnt-going-to-zoom-detention/.

Barnes, S.S. (2021, Mar 29). *Parent partnerships are key to student success.* Education Post. https://educationpost.org/parent-partnerships-are-key-to-student-success/.

Barnes, S.S. (2021, Feb 19). *Black excellence: 30 Black Hoosier profiles – part V.* Keep Indiana Learning.

https://keepindianalearning.org/black-excellence-30-black-hoosier-profiles-part-five/.

Barnes, S.S. (2021, Feb 25). *What will happen in your school when Black History Month is over?*. Education Post. https://educationpost.org/what-will-happen-in-your-school-when-black-history-month-is-over/.

Barnes, S.S. (2021, Feb 19). *Black Excellence: 30 Black Hoosier rofiles – part IV.* Keep Indiana Learning. https://keepindianalearning.org/black-excellence-30-black-hoosier-profiles-part-4/.

Barnes, S.S. (2021, Feb 10). *Black excellence: 30 Black Hoosier profiles – part III.* Keep Indiana Learning. https://keepindianalearning.org/black-excellence-30-black-hoosier-profiles-part-3/.

Barnes, S.S. (2021, Feb 8). *For Black History Month, start with local history.* Education Post. https://educationpost.org/for-black-history-month-start-with-local-history/.

Barnes, S.S. (2021, Feb 5). *Black Excellence: 30 Black Hoosier profiles – part II.* Keep Indiana Learning. https://keepindianalearning.org/black-excellence-30-black-hoosier-profiles-part-2/.

Barnes, S.S. (2021, Feb 4). *Will your Black teachers still matter when Black History Month is over?.* Education Post. https://educationpost.org/will-your-black-teachers-still-matter-when-black-history-month-is-over/.

Barnes, S.S. (2021, Feb 3). *Black excellence: 30 Black Hoosier profiles – part I.* Keep Indiana Learning. https://keepindianalearning.org/black-excellence-30-black-hoosier-profiles-part-1/.

Barnes, S.S. (2021, Feb 2). *5 ways to make Black lives matter at school.* Education Post. https://educationpost.org/5-ways-to-make-black-lives-matter-at-school/.

Barnes, S.S. (2020, Nov 24). *Black students are waiting for a 'Jingle Jangle' moment.* Education Post. https://educationpost.org/black-students-are-waiting-for-a-jingle-jangle-moment/.

Barnes, S.S. (2020, Nov 24). *Let's get back to grace and gratitude this Thanksgiving.* Education Post. https://educationpost.org/lets-get-back-to-grace-and-gratitude-this-thanksgiving/.

Barnes, S.S. (2020, Aug 26). *Our school already started and it's not like anything I've ever seen.* Education Post. https://educationpost.org/our-school-already-started-and-its-not-like-anything-iveever-seen/.

Barnes, S.S. (2020, Jul 31). *Getting pepper-sprayed by school police shouldn't Be a Part of My Job*. Education Post. https://educationpost.org/getting-pepper-sprayed-by-school-police-shouldnt-be-a-part-of-my-job/.

Barnes, S.S. (2020, Jul 29). *Here's how you can prepare your children for remote instruction.* Education Post. https://educationpost.org/heres-how-you-can-prepare-your-children-for-remote-instruction/.

Barnes, S.S. (2020, Jul 1). *I was the only Black teacher, and I quit my first job after six months.* Education Post. https://educationpost.org/i-was-the-only-black-teacher-and-i-quit-my-first-job-after-six-months/.

Barnes, S.S. (2020, Jun 17). *This Juneteenth I'm challenging educators to emancipate themselves from a colonized curriculum?.* Education Post. https://educationpost.org/this-juneteenth-im-challenging-educators-to-emancipate-themselves-from-a-colonized-curriculum/.

Barnes, S.S. (2020, Jan 17). *Teachers, why are we quicker to call parents about kids' behavior than about their academic performance?.* Education Post. https://educationpost.org/teachers-why-are-we-quicker-to-call-parents-about-kids-behavior-than-about-their-academic-performance/.

Barnes, S.S. (2020, Jan 15). *Here's Why Every Teacher Needs a Mentor*. Education Post. https://educationpost.org/heres-why-every-teacher-needs-a-mentor/.

Barnes, S.S. (2019, Dec 17). *The week before winter break doesn't have to be a nightmare*. Education Post. https://educationpost.org/the-week-before-winter-break-doesnt-have-to-be-a-nightmare/.

Barnes, S.S. (2019, Dec 2). *These students let their textbook publisher know nobody 'needed' slavery*. Education Post. https://educationpost.org/these-students-let-their-textbook-publisher-know-nobody-needed-slavery/.

Barnes, S.S. (2019, Nov 15). *Using chosen names and pronouns for students is important*.

Education Post. https://educationpost.org/using-chosen-names-and-pronouns-for-students-is-important/.

Barnes, S.S. (2019, Oct 18). *4 tips for parents to get the most out of parent-teacher conferences*. Education Post. https://educationpost.org/4-tips-for-parents-to-get-the-most-out-of-parent-teacher-conferences/.

Barnes, S.S. (2019, Oct 2). *When your child becomes a victim of bullying*. Safer Campus Life. http://safercampuslife.com/when-your-child-becomes-a-victim-of-bullying/.

Barnes, S.S. (2019, Sept 23). *If we don't give students the freedom to choose what they read, they may choose not to read at all*. Education Post. https://educationpost.org/if-we-dont-give-students-the-freedom-to-choose-what-they-read-they-may-choose-not-to-read-at-all/.

Barnes, S.S. (2019, Jul 12). *Here are 8 things that make a good school*. Education Post. https://educationpost.org/here-are-8-things-that-make-a-good-school/.

Barnes, S.S. (2019, Mar 26). *Let's not forget Native American students when speaking up for underserved students of color.* The 74. https://www.the74million.org/article/lets-not-forget-native-american-students-when-speaking-up-for-underserved-students-of-color/

Barnes, S.S. (2019, Jan 16). *Barnes: Changing school start times detracts from more pressing issues and poses serious challenges for some families.* The 74. https://www.the74million.org/article/barnes-changing-school-start-times-detracts-from-more-pressing-issues-and-poses-serious-challenges-for-some-families/

Barnes, S.S. (2018, Nov 27). *Barnes: Indianapolis consolidated everything but its schools – Leaving 11 different districts where Black children are often left behind.* The 74. https://www.the74million.org/article/barnes-indianapolis-consolidated-everything-but-its-schools-leaving-11-different-districts-where-black-children-are-often-left-behind/

Barnes, S.S. (2018, Nov 13). *I'm a teacher and I stopped saying the Pledge of Allegiance a long time ago*. Education Post. https://educationpost.org/im-a-teacher-and-i-stopped-saying-the-pledge-of-allegiance-a-long-time-ago/.

Barnes, S.S. (2018, Aug 6). *4 things every parent needs to prepare their kids for school this year*. Education Post. https://educationpost.org/4-things-every-parent-needs-to-prepare-their-kids-for-school-this-year/.

Barnes, S.S. (2018, Jan 24). *Want more diverse schools? Try school choice*. Education Post. https://educationpost.org/want-more-diverse-schools-try-school-choice/.

Barnes, S.S. (2017, Nov 21). *My principal saw I needed compassion not punishment, and that made all the difference*. Education Post. https://educationpost.org/my-principal-saw-i-needed-compassion-not-punishment-and-that-made-all-the-difference.

EDUCATION EXPERIENCE

2023-Present **Graduate Instructor**
IUPUI – Indianapolis, Indiana

- Instruct one section of Language Foundations for ESL/EFL Teachers & one section of Teaching & Learning in Middle School.
- Support students with applying theory from class into their current classroom setting.
- Collaborate with the former instructors to ensure students receive the best instruction.

2021-Present **Education Consultant**
Blazing Brilliance – Indianapolis, Indiana

- Design and facilitate professional learning in literacy, diversity, equity, inclusion, and access (DEIA), culturally responsive teaching, multilingual learners, and school culture.
- Coach teachers and school leaders in reaching professional goals.
- Improve schools' digital footprint through the written word.

2021-Present **University English as a New Language Student Teacher Coach**
IUPUI – Indianapolis, Indiana

- Observe and provide feedback to English as a New Language student teachers.
- Facilitate seminars to help support student teachers during their eight week student teaching placement.
- Provide resources to support student teachers' implementation of academic standards.

2018-Present **Graduate Instructor for the Fred S. Klipsch Educators College**
Marian University – Indianapolis, Indiana

- Create new course, Linguistics for Teachers of English Language Learners, for Marian University that was launched for the first time in the summer of 2020.
- Redesign Second Language Learners course from face-to-face format to online format.
- Instruct Second Language Learners, Linguistics for Teachers of English Language Learners, and Assessment of Learning I.

2017-Present **Education Editor-in-Chief & Writer**
Indy Kids Winning (formerly Indy K12) – Indianapolis, Indiana
- Write local, state, and national education articles with a focus on Black students
- Serve as Editor-in-Chief and manage writing team and publication tasks

2022-2023 **Columnist**
Education Post – Chicago, Illinois
- Wrote Hey Shawnta! column and answers questions about education.
- Made short videos answering educational questions.

2020-2023 **EdGems Moderator**
Indianapolis Recorder – Indianapolis, Indiana
- Moderated monthly education show with a focus on identifying ways to improve education for K-12, college, and adult education students.

2020-2022 **Education Editor-in-Chief**
Edlanta – Atlanta, Georgia
- Helped Edlanta produce local, state, and national education articles with a focus on diverse students.
- Served as Editor-in-Chief and edited articles for Edlanta.

2019-2021 **Middle School Academic Dean**
Enlace Academy – Indianapolis, Indiana
- Observed and provided feedback to 5-8 English and K-8 special/elective teachers; included the social studies department for one school year.
- Facilitated weekly coaching meetings with coachees.
- Co-planed, team taught, and modeled lessons.
- Developed staff knowledge and skills through targeted professional development based on school data.
- Supported teacher mentors in mentoring new teachers.
- Completed evaluations of all middle school 5-8 English teachers and K-8 special/elective teachers; included the social studies department for one school year.
- Worked with co-middle school academic dean to implement and oversee policies and procedures for the middle school.

2018-2019 **Library/Media Specialist**
MSD of Wayne Township – Indianapolis, Indiana
- Taught literacy and digital citizenship mini-lessons.
- Helped children build a passion for reading.
- Managed library and diversified library inventory.

2018-2019 **Education Editor**
Citizen Education – Indianapolis, Indiana

- Edited articles for the following publications: One Public Ed (L.A.), Memphis K12, D.C. K12, and Second Line Blog (New Orelans) under the Citizen Education umbrella.

2017-2019 **Education Editor & Writer**
The Educator's Room – Indianapolis, Indiana

- Wrote education articles with a focus on instructional practices and teacher self-care.
- Edited articles for The Educator's Room
- Managed a team of education writers across the United States and abroad remotely.
- Presented at The Educator's Room Teacher Self-Care Conference three times.

2015-2018 **Literacy Coach (K-6 & 9-10), Change Agent Coach, District New Teacher Mentor, K-6 High Ability Building Facilitator & Test Administrator**
Indianapolis Public Schools – Indianapolis, Indiana

- Coached high school English teachers, elementary teachers, and secondary Change Agent teacher leaders.
- Co-planned lessons, observed teachers, and provided timely feedback, professional development, and resources.
- Taught two sections of remedial English 11 classes and one section of English 10.
- Mentored early career educators and supported them in their growth as professionals.
- Ensured high ability students received appropriate instruction at their level.
- Managed all K-2 standardized assessments and high ability census test and helped managed I-STEP, IREAD 3, and 9th grade SRI.
- Organized after-school STEM Challenge Club.
- Obtained learning garden grant and led school learning garden.

2014-2015 **English as a New Language Teacher**
MSD of Washington Township – Indianapolis, Indiana

- Instructed English language learners grades K-5.
- Collaborated and co-taught with general education teachers to help English language learners develop English language skills and academic English in: reading, writing, science, math, and social studies.
- Helped teachers develop IB Primary Years Programme lesson plans.

2013-2018 **Undergraduate Instructor of Psycholinguistics for Reading Teachers K-12 Hybrid Course**
IUPUI – Indianapolis, Indiana

- Instructed of one section of Psycholinguistics for Reading Teachers.
- Collaborated with the former instructor to ensure students receive the best instruction.

2009-2014 **Seventh and Eighth Grade English Teacher and English Learner Building Lead**
MSD of Wayne Township – Indianapolis, Indiana

- Instructed three sections of English.

- Taught on an English as a New Language inclusion team & special education inclusion team.
- Co-taught two English as a New Language inclusion English classes and was an ENL remediation teacher.

2007-2009 **Sixth and Seventh Grade Language Arts Teacher, Ninth Grade Creative Writing Teacher, Sixth Grade Team Leader, and Yearbook Advisor**
Indiana Math and Science Academy – Indianapolis, Indiana

- Instructed one section of Honors English and three sections of regular English for middle school and one section of creative writing for high school.
- Tutored students in language arts after school three days a week for 60 minutes.
- Led African American literature club, mythology club, science club, and managed the creation of the yearbook.

2006-2007 **Eighth Grade English and American Studies Teacher**
Brownsburg Community Schools – Brownsburg, Indiana

- Instructed five sections of English and co-taught one section with the special education teacher.
- Instructed one section of American Studies, a hybrid course of English & history.