COMMUNITY PROJECT: STEAM IN K-2 WHITE PAPER

CEISMC EVALUATION

Go STEAM

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WHAT IS STEAM?

STEAM stands for Science, Technology, Engineering, Arts, and Mathematics, but can mean many different things. For example, some use the "A" in STEAM to represent different arts disciplines (e.g., visual arts, music, or theatre), while others use the "A" to represent broader ideas, like creativity, problem solving skills, or making [1, 2]. Some use STEAM as a way to engage students in STEM through arts projects, such that the arts play a supporting or "subservient" role [3]. Others see STEAM as a transdisciplinary approach to integrating different disciplines, with each discipline valued equally and receiving equal attention in instruction and assessment [4]. We recognize the validity of different ways of defining STEAM, their unique purposes, and the important role of teachers in defining the STEAM approach that works best in their classroom.

Because there is no cohesive definition for STEAM or established set of STEAM best practices [5, 6], we looked for "high-quality lessons learned" in the STEAM literature [7]. We drew on existing models of integration, including Bresler's model of arts integration [3] and the National Research Council's STEM integration framework [8] to develop our own working definition of STEAM. For us, high-quality STEAM instruction involves student-centered instructional pedagogies (e.g., project-based learning, problem-based learning, inquiry learning), group learning, and real-world application to increase cross-disciplinary content knowledge through learning goals for students in both STEM and arts disciplines [9]. We understand that implementing STEAM can be complex and challenging. Thus, we envision STEAM as a continuum, moving from low to high levels of integration, collaborative practices, and complexity of STEAM projects.

WHY STEAM?

STEAM is being used across the globe in an effort to improve student outcomes in STEAM disciplines [10]. Studies in K-12 settings have shown that STEAM can increase students' STEM content knowledge, increase their intent to continuing studying or participating in STEAM, generate positive attitudes towards STEAM, and improve gender dynamics in the classroom [11-15]. With training and support, studies find positive pedagogical benefits for teachers, such as using authentic assessment, integrating technology in instructional approaches, and forming connections with resources and experts outside the school building to support STEAM instruction [16-18]. STEAM aligns well with approaches that allow teachers to step into a facilitator role, supporting student-led exploration, and to engage in collaborative relationships with their colleagues.

GoSTEAM@TECH

GoSTEAM@Tech is a professional development program designed to promote authentic integration of the arts into K-12 computer science, engineering, and invention instruction. The primary goal of GoSTEAM is therefore to create safe, interdisciplinary spaces where meaningful, cross-disciplinary collaborations can occur. Teachers from different disciplines, with the support of university-based coaches and Innovators-in-Residence, come together to design and implement novel STEAM lessons and initiatives in their schools. You can read more about the GoSTEAM@Tech program here: https://steam.ceismc.gatech.edu/.

COMMUNITY PROJECT: STEAM IN K-2

LESSON BACKGROUND

This series of lessons engaged Kindergarten and 2nd grade-students in STEAM activities related to beautifying the community through plants and gardening. A school-wide problem-based learning (PBL) unit inspired the creation of the STEAM lessons, as teachers sought to answer the driving question, "How can we make our school a healthier environment?" The lessons were designed by the school's GoSTEAM Innovator in collaboration with two elementary-school teachers to address the following standards:

- Kindergarten: Obtain, evaluate, and communicate information to compare the similarities and differences in groups of organisms.
- 2nd grade: Obtain, evaluate, and communicate information about how weather, plants, animals, and humans cause changes to the environment.

The lessons leveraged the school's garden to provide hands-on opportunities to explore plant growth and the design thinking process.

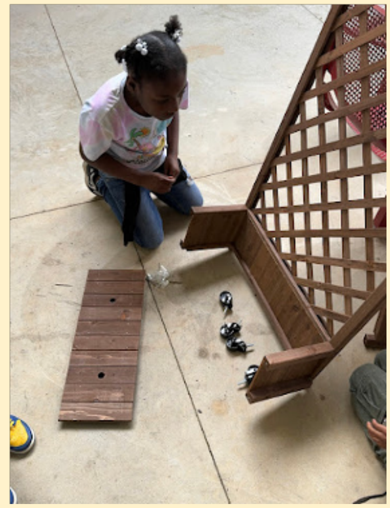
Driving question:
How can we make our school a healthier environment?

LESSON IMPLEMENTATION

STEAM units were implemented by two general education teachers in their Kindergarten and 2nd grade classrooms during the 2023-2024 school year. Multiple, related lessons were conducted to introduce students to the plant lifecycle, relevant vocabulary, and design thinking processes, summarized below.

A vision board created by students.

Students were introduced to the idea of green spaces by first considering the existing green spaces in their community. Students took a field trip driving tour around the school's neighborhood, observing how green spaces were incorporated throughout the area (and they also noticed that some parts of the neighborhood had nicer amenities- a nicer grocery store, for example). This prompted conversations about equity and helped them think about using green spaces for recreation, aesthetics, and access to nature. Following the driving tour, students started work on a vision board that highlighted components they felt were important for green spaces in their community, while introducing them to vision boarding as an important step in the design process. Students were presented with various images of greenspaces and were asked to examine what they saw. This activity helped students generate words associated with greenspaces and review vocabulary words related to light and plant life (light, sun, transparent, opacity, shadow, waves, reflection, chlorophyll, photosynthesis). Students used their word bank to guide their choices of magazine images to use for the vision board. Students agreed that sunshine is vital for greenspaces, so the Innovator found a method of creating a translucent vision board. The resulting vision board was an artistic representation of their understanding of green spaces and served as inspiration for enhancing green spaces at their school.



A student builds a trellis.

After this introduction to green spaces, 2nd grade students explored adding green spaces to their playground area. Ultimately, students decided that they needed a movable grow box with a trellis to enhance the green spaces in their school. Students engaged in the design thinking process to create the grow box and cardbox garden boxes, practicing modeling, comparison, measuring, and assembling. After building their boxes, students blended soil, filled the beds, and planted a garden bed with a variety of herbs they decided were good for their school and classmates. Math and science concepts were emphasized through a class pet named ‘Sweetie’, the sweet potato. Taking care of Sweetie prompted discussions about maintaining a healthy habitat for a growing plant with ants for neighbors. Students practiced measuring by checking Sweetie’s growth weekly in inches and centimeters.

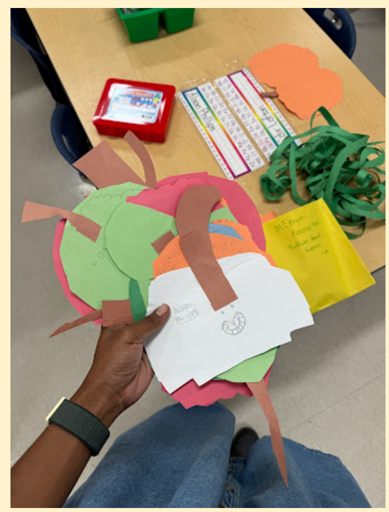
A student cares for plants in the school garden.

In the Kindergarten classroom, students spent a semester learning about nutrition and how a community garden can support a healthy community. They participated in various activities, from blending soil to planting herbs and beans seeds. Students were able to discuss the life cycle of plants, learning relevant vocabulary, like biodiversity and photosynthesis, and compost. They harvested herbs, learning their unique names and smells. Math content was integrated through counting and graphing the number of seeds planted and the growth of the various plants. The idea of biodiversity was reinforced through several small activities. In one, a 10 bean soup bag was used as a teaching tool. Students used the beans to respond to a variety of sorting prompts (e.g., large to small, light to dark), drawing on math skills related to patterns and sorting. In another activity, students collaged letters in the phrase ‘community garden’ using pages of a seed catalog. Each page of the catalog showed multiple varieties of the same plant, illustrating the many types of corn and carrots, for example, there are in the world. This activity also reinforced students' understanding of collage as an artistic medium. Teachers were also able to integrate English/Language Arts (ELA) content by reading books about plants and having students complete writing prompts related to plants and their garden activities.

A student completes the "Let's Build a Flower" activity.

Using plant-themed activities, teachers helped students review foundational content connected to the work students were doing in the garden. For example, students reviewed plant anatomy, shapes, and measuring through a "Let's Build a Flower" activity. Students were given worksheets in which they drew five different floral designs, making sure to always include specific parts of a flower. In Kindergarten, this activity highlighted simple shapes and colors as students labeled plant parts. The activity was extended for 2nd grade students, such that they were tasked with using construction paper to build one of the flowers they designed out. They then used rulers to measure their creations, taking notes in their reflection journals.

During the fall months, Kindergarten students explored biodiversity through pumpkins. They were introduced to a rainbow image of squashes and told what biodiversity means. Students played a Pumpkin themed matching game to sharpen their memory and characteristic discernment skills. The matching game cards were also used to play a "guess who" style game, in students had to ask descriptive questions to find their match. These same cards were used to practice handwriting while students described the traits of their pumpkins.



Old pumpkins, ready to be torn up and made into new paper.

As the seasons changed, students learned about pollinators and decomposers in the garden. Students learned about composting food waste, including pumpkins, and the important role of compost in the garden. Mirroring this process, students tore up their old pumpkins, among other saved classwork papers, and created paper with it. This helped students understand how decomposers break objects down into dissolvable materials for new nutrients to be made available. The colorful bits of old paper seen in the new paper that students made represented all of the nutrients that biodiversity offers. One teacher reported that this lesson was particularly enjoyable for students, as they connected the lesson to students' observations about litter in areas around the school. Through papermaking, the teacher and students were able to discuss how recycling can be used to reduce waste.

Teachers appreciated the ability to help connect student learning to their school community, beautifying the garden, playground, and other school areas. In each STEAM lesson, teachers emphasized hands-on learning, which was engaging for students, as one teacher described, "it wasn't just direct teaching, they [the students] got to make things and participate." The teachers credited the support of GoSTEAM in helping them develop a better understanding of how to integrate the arts into their lessons. One teacher stated, "I've learned how to integrate and make learning fun for the kids." This teacher described a shift in their integration practices, noting that before GoSTEAM, the only art students might do in a plant lesson would be to "draw a picture and label the plants…, but now they [the students] are designing plants, creating plants, growing plants, and they'll make them out of art materials to make sure they understand, you know, have a deep understanding of what they're learning about."

CHALLENGES & RECOMMENDATIONS

Having the support of the Innovator and GoSTEAM staff was extremely useful for teachers, who appreciated the hands-on help, ideas to support their lesson planning, and funding for supplies. Despite this support, teachers described challenges making time for STEAM lessons in the midst of test preparation, particularly towards the end of the semester. In this way, smaller lessons throughout the year allowed students to engage continually in STEAM activities, with teachers adjusting lesson timing to fit into testing schedules. Another challenge was absenteeism, with teachers navigating lesson implementation with a high number of students occasionally missing.

While the school had a STEM focus that prompted the school-wide PBL, teachers noted that the school did not have dedicated time for science or social studies during the school day. Thus, it was up to general education teachers to infuse science and social studies into their math and ELA classes. Teachers valued the role of STEAM in allowing them to integrate science and art content into their math and ELA lessons. The Innovator was crucial for ensuring that STEAM projects occurred, especially as administrative priorities shifted throughout the year to prioritize literacy. Teachers experienced tension navigating expectations to deliver specific literacy content, ultimately having the Innovator push in to lead STEAM lessons during reading blocks. Importantly, the STEAM lessons described above leveraged connections to math and ELA, demonstrating that STEAM can support teachers' efforts in these areas.

Given these findings, others who are interested in implementing similar STEAM community projects in K-2 settings should consider opportunities for smaller, "bite sized" lessons throughout the school year. In addition, teachers who are facing pressure to emphasize certain subjects or skills (e.g., literacy) should consider how STEAM projects can be embedded into those subjects to enhance learning. Teachers can consider external partners who may be able to enhance STEAM implementation through in-class support, financial support, or lesson planning.

KEY TAKEAWAYS

Through a series of activities exploring green spaces, students were able to explore STEAM learning and develop an understanding of the role of green spaces and gardens in their community. The activities that students completed allowed for hands-on engagement with the school's garden, creating tangible connections for teaching science content related to light, habitats, plant anatomy, and biodiversity. Using art and the design thinking process to facilitate certain activities allowed students to demonstrate their learning through tangible works, such as collages or constructed garden boxes. Having multiple STEAM lessons throughout the year allowed teachers to adapt to accommodate testing schedules and was highly engaging for students, who enjoyed working on hands-on projects that directly impacted their community.

RESOURCES

Below are links to resources that may support implementation of similar STEAM projects:

STEAM Pedagogical Approaches: A brief compilation of different pedagogical approaches for STEAM teaching. https://steam.ceismc.gatech.edu/pedagogical-approaches/
Community Project Tool Kit: A tool kit of activities used to implement the Community Project lessons. https://steam.ceismc.gatech.edu/gosteam-learning/community-project-steam-in-k-2-classes/

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