# TINY HOUSE PROJECT WHITE PAPER

CEISMC EVALUATION

Go STEAM

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## SPECIAL THANKS

The lesson described in this paper was developed as part of the GoSTEAM@Tech Program, a collaborative partnership between Georgia Tech's Center for Education Integrating Science, Math, and Computing (CEISMC), K-12 school districts, and local community organizations. The GoSTEAM@Tech Program is generously funded by a private funding organization. This work would not have been possible without the dedicated teachers who designed and refined these lessons in their classes.

**Suggested Citation:** Jackson, J. & Kessler, T. (2024). Tiny House White Paper. https://steam.ceismc.gatech.edu/research-and-evaluation/

# 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/.

# TINY HOUSE PROJECT

## LESSON BACKGROUND

Inspired by an interest in developing real-world connections to relevant community issues, GoSTEAM teachers developed the "Tiny House Design Challenge." Participating teachers taught at the elementary-school level, and represented several subject areas, including the performing arts, language arts, and math. In this lesson, teachers wanted to connect students' learning to an issue of importance in their local community: affordable housing. Through this project, teachers hoped to help students develop agency to propose potential solutions to complex issues through inquiry-based learning. The Tiny House STEAM lessons were part of a "Creative Engineering" unit implemented with 3rd- 5th grade students. Based on a project-based learning design, students used the engineering design process to design and construct a prototype of a tiny house. Students engaged in real-world problem-solving while utilizing math, research, and visual arts skills as they designed both the exterior and the interior of a house. The learning standards included the application of mathematical concepts (such as geometry and measurement) and arts-based design standards for building 2-dimensional and 3-dimensional designs. The driving questions are indicated below:

Driving questions:
*What are the different types of houses that you know of?*
*What are the necessary requirements for designing a house?*

## LESSON IMPLEMENTATION

Teachers began the unit using the driving questions to facilitate a discussion around the types of houses that exist, and the requirements of what is needed to design a house. With this context, the students continued to discuss with their teachers the types of houses, with the introduction of the tiny house concept. Once students had a better idea about the characteristics of a tiny house, the teachers introduced a script to prompt students to think about the project:

> *Your city council has reached out to you to design a tiny house to be presented at the Tri-City Realtor Convention and be selected to get your design built in town. The design of a tiny house should include the constructs of a home including the* ***exterior layout****,* ***interior floorplan****, and comes* ***fully furnished****. A list of requirements that must be included in the tiny house have been provided. Your goal is to review the requirements and respond to the request of building the house with the components included.*

Students reviewed the design requirements, including the dimensions and necessary elements (furnishings, size, design elements). This phase of the project included a guiding question to explore: "What are the essential skills necessary for engineers and homeowners to have when constructing and furnishing a home?" The students worked on 2-dimensional blueprints to plan for the building phase. During this planning phase of the design cycle, students reviewed the pros and cons of the design and made revisions as needed. They then worked to convert their 2-dimensional blueprints into 3-dimensional models. The teachers organized build days once a week for the 4th and 5th grade students from multiple classes. They met in the cafeteria to complete the building of their tiny houses. Students used various materials (computers, papers, printers, writing tools, popsicle sticks, crayons, and colored pencils) to complete the building process. The students worked in groups to complete the building of the houses. This included the development of the floor plan, walls, roof, and ceiling. Additionally, the students were tasked with recording the area, perimeter, and shape of the elements and furnishings. A GoSTEAM Innovator was present to help with construction and teachers circulated to help guide students through the engineering design process, reinforcing that iteration was a natural process in engineering. The building phase took roughly 4 weeks (about 6-8 class periods). Upon completion the 5th grade students were invited to share and reflect on their design process.

An Innovator helps students construct their tiny house model.

Following the building phase, the 4th grade students were tasked with creating "real estate listings" using persuasive writing. The descriptions were checked for spelling and punctuation, in alignment with English Language Arts (ELA) standards. Finally, in the last part of the Tiny House unit, 3rd graders played a modified game of "LIFE" and were assigned a career, requested a loan, and wrote a check to purchase the home of their choice. Math content was integrated as students prepared their loan applications, making calculations based on their assigned salary, house cost, and interest rates.

Teacher survey and focus group findings suggest that teachers perceived high levels of student engagement and interaction with the content and with classmates. Based on observations of the classroom implementation, the students typically worked independently with teachers as facilitators to help guide as needed. This self-directed process provided students the opportunity to explore their designs and execute their tasks. Students enjoyed the creative elements of the design process, making decisions about the types of additions they would add, color, and create. There were instances where teachers needed to manage classroom behavior to help students stay on task. The GoSTEAM Innovator was able to provide additional support preparing materials and helping students with construction. Integrating teachers from multiple disciplines and grade levels required careful planning, with teachers using Slack or text messages to collaborate and further develop their lessons.

# CHALLENGES & RECOMMENDATIONS

This lesson was implemented across several classes and grade levels, requiring significant teacher coordination and administrative support. It would be possible to implement this lesson using a smaller group of students or completing the various steps within one grade level. As with other types of lessons where students are working in groups or in a self-directed manner, teachers should help students understand the expectations for participating by empowering them to demonstrate positive interactions with each other. The GoSTEAM teachers used Google docs to allow students to work collaboratively on this project. While the use of Google Docs increased collaboration between teachers and students, it was also a challenge to teach version control to elementary students. Thus, it may be necessary to help students better understand version control and the use of Google products to support group work.

The Tiny House unit incorporated content and skills from multiple disciplines. While the unit primarily emphasized math and arts standards, the inclusion of the 4th grade students resulted in additional emphasis on ELA standards. Teachers interested in implementing a similar STEAM unit can explore additional cross-disciplinary collaborations, such as music, computer science, or engineering. We recommend leveraging collaborative planning time, and seeking support from administrators, to facilitate interdisciplinary collaborations among teachers.

# KEY TAKEAWAYS

Teacher collaboration was critical to the success of this multi-grade level project, as was administrative support. Teachers described developing increased "*comfort,*" confidence, and patience for the inquiry process and STEAM content. They described taking on a facilitator role to allow for students to explore and ask questions. Teachers also became more aware of content and standards across grades as they worked to integrate various disciplines at the 3rd, 4th, and 5th grade levels. This required increased communication among teachers from different grades and content areas. It also exposed some of the ways in which elementary schools might consider planning that provides more opportunities for teachers to work together, especially arts specialists and grade level teachers. Teachers expressed that they were taking more creative risks in the classroom because of what they learned through the process of implementing STEAM projects and STEAM professional development. The teachers described how students noticed the change related to the integration of the subject areas, and this sparked more critical thinking and creativity.

## 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/
Math in Action: A guide for creating scale model tiny homes.
https://www.mountmadonnaschool.org/math-in-action-students-create-scale-model-tiny-homes/
Tiny House Challenge: A project guide for designing a 2-D or 3-D prototype for a tiny house.
https://static1.squarespace.com/static/54a08126e4b038053fec29c3/t/57d1cc396a49639327192a86/1473367098595/TinyHouse_Activity.pdf

## REFERENCES


1. Ge, X., D. Ifenthaler, and J.M. Spector, *Moving forward with STEAM education research*, in *Emerging Technologies for STEAM Education*. 2015. p. 383-395.
2. Perignat, E. and J. Katz-Buonincontro, *STEAM in practice and research: An integrative literature review.* Thinking Skills and Creativity, 2019. **31**: p. 31-43.
3. Bresler, L., *The subservient, co-equal, affective, and social integration styles and their implications for the arts.* Arts Education Policy Review, 1995. **96**(5): p. 31-37.

4. Quigley, C.F., et al., *STEAM designed and enacted: Understanding the process of design and implementation of STEAM curriculum in an elementary school.* Journal of Science Education and Technology, 2020. **29**: p. 499-518.
5. Colucci-Gray, L., et al., *Reviewing the potential and challenges of developing STEAM education through creative pedagogies for 21st learning: How can school curricula be broadened towards a more responsive, dynamic, and inclusive form of education?* 2017.
6. Katz-Buonincontro, J., *Gathering STE(A)M: Policy, curricular, and programmatic developments in arts-based science, technology, engineering, and mathematics education.* Arts Education Policy Review, 2018. **119**(2): p. 73-76.
7. Patton, M.Q., *Evaluation, knowledge management, best practices, and high quality lessons learned.* American Journal of Evaluation, 2001. **22**(3): p. 329-336.
8. Honey, M., G. Pearson, and H.A. Schweingruber, *STEM integration in K-12 education: Status, prospects, and an agenda for research*. Vol. 500. 2014: National Academies Press Washington, DC.
9. Boice, K.L., et al., *Supporting teachers on their STEAM journey: A collaborative STEAM teacher training program.* Education Sciences, 2021. **11**(3): p. 105.
10. Lee, B. and E. Chang, *A cross cultural study on STEAM education in Korea and United States.* Korea Science & Art Forum, 2017. **30**: p. 277-288.
11. Engelman, S., et al., *Creativity in authentic STEAM education with EarSketch*, in *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education*. 2017. p. 183-188.
12. Hayman, *Investigating STEAM: Integrating art and STEM to spark innovation.* Curriculum and Instruction Undergraduate Honors Theses, 2017. **16**.
13. Jeong, S. and H. Kim, *The effect of a climate change monitoring program on students' knowledge and perceptions of STEAM education in the republic of Korea.* Eurasia Journal of Mathematics, Science and Technology Education, 2015. **11**(6): p. 1321-1338.
14. Kong, H., & Hwang, *The effect of theme based STEAM activity programs on self efficacy, scientific attitude, and interest in science learning.* International Information Institute, 2014. **17**(10(B)): p. 5153-5159.
15. Peppler, K., *STEAM-powered computing education: Using e-textiles to integrate the arts and STEM.* Computer, 2013. **49**(9): p. 38-43.
16. Herro, D. and C. Quigley, *Exploring teachers' perceptions of STEAM teaching through professional development: Implications for teacher educators.* Professional Development in Education, 2016. **43**(3): p. 416-438.
17. DeJarnette, N.K., *Implementing STEAM in the early childhood classroom.* European Journal of STEM Education, 2018. **3**(3).
18. Herro, D., C. Quigley, and L.A. Jacques, *Examining technology integration in middle school STEAM units.* Technology, Pedagogy and Education, 2018. **27**(4): p. 485-498.