BOARD # 200: Culturally Relevant Engineering Piñata Project for Elementary-Aged STEAM Programs (PK-12) (Work In Progress)

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Culturally Relevant Engineering Piñata Project for Elementary-Aged STEAM Programs (PK-12) (Work In Progress)

Abstract

This paper presents an innovative, culturally-relevant STEAM education approach using a piñata-inspired engineering project for elementary-aged children. Implemented in California and Massachusetts, the project aims to broaden participation in STEAM fields, particularly among traditionally marginalized communities. By reimagining a historical artifact through STEAM principles, students learn spatial visualization skills, engineering design, and 3D shape construction while personalizing their learning experience to reflect contemporary cultural identities. The curriculum, piloted in various settings including summer camps and after-school programs, incorporates sketching, hypothesis testing, and hands-on activities. Our research demonstrates that this approach increases interest, accessibility, and confidence in STEAM fields among diverse students. The high level of rigor combined with student choice and differentiation of both content and instruction process supports this being a culturally responsive activity. The methodology emphasizes tailored instruction and appropriate scaffolding to address regional, cultural, and individual differences, effectively bridging a cultural heritage artifact with contemporary relevance. Findings from multiple pilot implementations show increased student engagement and a stronger connection to STEAM subjects, creating an example of an inclusive and effective STEAM educational activity model that values diverse perspectives and experiences and is flexible to implement.

Introduction

There is an increased need for STEM professionals across all communities, but especially among those traditionally marginalized from STEM such as socioeconomically disadvantaged communities and women [1-7]. There are many challenges historically marginalized children face in STEM education, including gaps in knowledge, lack of early exposure, underutilized existing funds of knowledge, and a disconnect between children's experiences and STEM content, all of which can ultimately affect children's STEM identity and engagement [8]. To address these challenges, we need to expose children early to STEM through hands-on, problem-based, and socially relevant activities that allow them to make positive connections between their culture and STEM success [9, 10]. One method of broadening participation is through informal learning experiences which have been shown to inspire socioeconomically disadvantaged youth to leverage their own knowledge and practices and address science issues relevant to themselves and their communities [11, 12]. When projects are relevant to participants, they become intrinsically motivated by the project topic, which leads to more learning and long-term academic success than does the extrinsic motivation for a grade in school [13]. "Place-based" education engages children in their community, including their physical environment, local culture, history, or people [14]. The pedagogy is committed to the places in which learning is situated, the nature of the learner, and the stakeholders involved in the learning process. Moreover, personalization of activities has proven to be the key to engaging students from diverse ethnic and cultural backgrounds as students are more likely to relate to activities that mirror their communities and identities [9, 10, 15–18]. And the projects should be fun! We have developed a project based around piñata building and testing that incorporates these key elements and can be implemented in various contexts.

Making Activities and the Addition of Art to Promote Inclusion in STEM → STEAM

Hands-on learning in STEM education has emerged as a powerful approach for elementary students, fostering inclusivity, creativity, critical thinking, and success [19] - [22]. Implementing effective activities requires careful, flexible design that considers age-appropriate challenges, safety, and the balance between guidance and exploration [20]. The design should accommodate varying skill levels, interests, and resources [22]. This flexibility allows educators to tailor the learning experience to their objectives while maintaining an engaging approach that promotes inclusivity and success for all young learners in STEM education [22] and [23]. Providing scaffolding in the first step of a project is crucial for continued engagement. This paper introduces sketching as an easy initial step in Maker activities, as drawing is popular among children [24]. Sketching allows planning, personalization, and idea sharing [25] and [26]. STEAM advocates highlight that Arts integration engages young brains, promotes creativity, improves memory, and advances social skills [27]. Adding Art to STEM makes these disciplines more attractive, especially to underrepresented students [28]. By broadening STEAM's appeal, Maker activities can engage a more diverse population of young learners in these fields.

Meeting Learners Where They Are

Culturally responsive education goes beyond content, requiring educators to authentically implement teaching practices and curricula that resonate with diverse student backgrounds. The TRUCHA framework [29] guides teachers in creating inclusive learning environments, emphasizing the importance of genuine connections with students. To be effective, educators must build trust-based relationships with learners, acting as "warm demanders" who set high expectations while providing individualized support [30]. This allows students to feel safe, access challenging content, and form new neural connections. Ultimately, the goal is to cultivate independent learners by offering high-quality instruction in content, academic skills, metacognition, and social-emotional learning. Educators must provide varied scaffolding and resources to help all students, particularly those from marginalized groups, develop their intellectual capacity and engage in higher-order thinking, preparing them for lifelong learning and success [30].

This paper presents an innovative, culturally-relevant STEAM education approach using a piñata-inspired engineering project for elementary-aged children, demonstrating how personalized, hands-on activities that reimagine historical artifacts through STEAM principles can effectively engage diverse students, increase interest and confidence and create an inclusive learning environment that bridges cultural heritage with contemporary relevance across various educational settings, showcasing the project's adaptability.

STEAM Programs

OFFERS Summer Camp in California

The OFFERS (Opportunities For Future Engineers, Researchers & Scientists) camp offers week-long STEAM enrichment programs for 3rd-5th graders, running from June to August. The camps aim to inspire underserved children to engage with STEM subjects through joyful learning experiences. Recruitment focuses on reaching marginalized communities, with about 70% of participants coming from underserved, socioeconomically- impacted, and English-language learner populations. Teenage students assist in teaching, serving as near-peer mentors while developing leadership, communication, and cultural awareness skills, and

enhancing their own STEAM knowledge. In collaboration with local partners, the curriculum combines identity-building lessons and community-based activities to enhance children's STEAM interest. Lessons, partially prepared by scientists and delivered by diverse staff, connect STEM concepts to children's daily lives through engaging projects. Past examples include the Science of Tortillas, Spatial Reasoning using Laser Mazes, Understanding Geology by Making Volcanoes, and Aerodynamics & Flight.

Beachmont STEAM Club in Massachusetts

The Beachmont STEAM Club in Revere, Massachusetts, is an afterschool program for 4th and 5th graders, partnering with Northeastern University's Service Learning program. College engineering students lead weekly STEAM activities for elementary students under the supervision of a STEAM club advisor. This partnership benefits both groups: university students learn to communicate with diverse audiences, while elementary students gain exposure to STEAM activities under mentorship. Elementary students apply to join the club based on responsibility, teamwork, and creative problem-solving skills, not academic performance. The diverse group includes English Language Learners and students with learning disabilities. The club meets for 10 sessions each semester. Lessons, co-created by university staff and approved by the STEAM club teacher, follow the engineering design process. This structure allows students to focus on learning content rather than process. Activities are designed to be engaging and give elementary students agency over their final projects, encouraging creativity and authentic self-expression. Past projects have included Stomp Rockets, Islamic Geometric Art, and Water Filtration.

Pilot Implementations

California Pilot 2023

In 2023, the Offers Camp introduced the piñata project to 24 children. The curriculum taught 2D to 3D conversion, scientific method, iterative design, prototyping, and structural testing through sketching and hands-on activities. It included math calculations and aimed to showcase real-world engineering applications while boosting STEM career interest. Key project elements involved sketching, shape folding, testing, and personalization (Figure 1).

Figure 1: Pilot Piñata Project in the XXX Summer Camp 2023

The four-day piñata project at the camp introduced students to the engineering design process, math concepts, and 2D-3D shape identification. Using Spatial Kids software [31], children practiced sketching and spatial skills with automated feedback. Teams built and tested five piñata shapes, measuring tape usage, making strength hypotheses, and comparing predictions to results. The project emphasized learning through experimentation and failure. On Day 2, students

reviewed test results, identified weak points, and brainstormed improvements with limited resources. They learned about folded shapes and practiced flat pattern sketching using Spatial Kids software and paper models (Figure 2). Students completed assignments on shape placement and drawing nets, then selected shapes for their individual piñatas. On Day 3, children reviewed flat patterns, received laser-cut cardboard shapes, and tested pre-built folded shapes. They constructed individual piñatas, adding candy-filling mechanisms and rope attachments, using duct tape for reinforcement. On Day 4, they personalized and decorated their piñatas, allowing for creative expression and cultural connection. Throughout the project, children engaged with spatial visualization, math, engineering design, hypothesis testing, and creative problem-solving using a culturally relevant artifact.

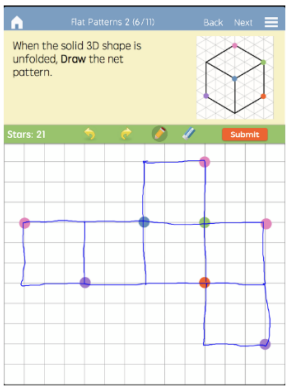

Figure 2: Spatial Kids

California Pilot 2025

The January 2025 implementation of the piñata project in CA differed significantly from the previous version. This iteration involved 25 second and third graders as part of a weekly after-school science club, condensed into two one-hour sessions. The project was aligned with an upcoming Noche de Ciencias event and uniquely combined engineering with biology by having the piñatas double as cell models. To accommodate the younger age group and time constraints, pre-cut cardboard shapes and unlimited tape were provided. The first session introduced the project, math concepts, cell types, and piñata construction, while the second focused on biological components and decoration (Figure 3). This adaptation demonstrates the project's flexibility in being tailored for younger students, integrated with other subjects, and compressed into a shorter timeframe while maintaining its core educational value.


Figure 3: Piñata Designs – CA 2025 Pilot

Massachusetts Pilot 2024

In spring 2024, the piñata project was adapted for the Beachmont STEAM Club, aligning with its existing format and condensing materials to fit 1.5-hour after-school sessions (n = 38). The project focused on spatial visualization, 3D folding, hypothesis testing, personalization, and cultural relevance, divided into two lessons. The first lesson introduced flat patterns and structural concepts. Students analyzed five piñata shapes, made predictions about potential failure points, and drew flat patterns for assembly. They built and tested their piñatas, recording results to compare with their hypotheses. The second lesson emphasized cultural connections and creativity. Students learned about piñatas' origins in Mexican and Chinese cultures before designing their own. They created flat patterns, assembled and decorated their piñatas, sealed candy inside, made predictions about durability, tested them, and took them home.

Massachusetts Pilot 2025

In January 2025, rather than implementing the piñata project in the afterschool STEAM program, it was implemented in three regular 4th-grade classes at Beachmont Elementary school and included all students in the school (41) and the same teacher as the 2024 pilot. The project spanned three 70-minute class periods. Primary objectives included drawing flat patterns, visualizing 2D shapes for 3D construction, building and testing piñatas, and reflecting on the process. On Day 1, students visualized 2D shapes within 3D models and sketched flat patterns for their chosen shape (cube, prism, cylinder, or pyramid). They transferred their designs to cardstock, cut them out, and began folding and taping. Many struggled with proportionality, folding, and fine motor skills. Day 2 introduced the cultural origins of piñatas in Mexico and China. Students used pre-printed templates to construct their piñatas, which eased earlier challenges. They decorated their creations and filled them with positive affirmations written on scrap paper. On Day 3, students predicted where the piñatas would break (edge, vertex, or side) before testing them by hanging and hitting them until affirmations emerged. They compared predictions to outcomes and reflected on the process through open-ended questions and a survey. This implementation differed from others by targeting all students in a formal classroom setting with pre-printed templates to address skill gaps. It also incorporated positive affirmations inside the piñatas as a unique feature. Figure 4 shows key elements of this project.

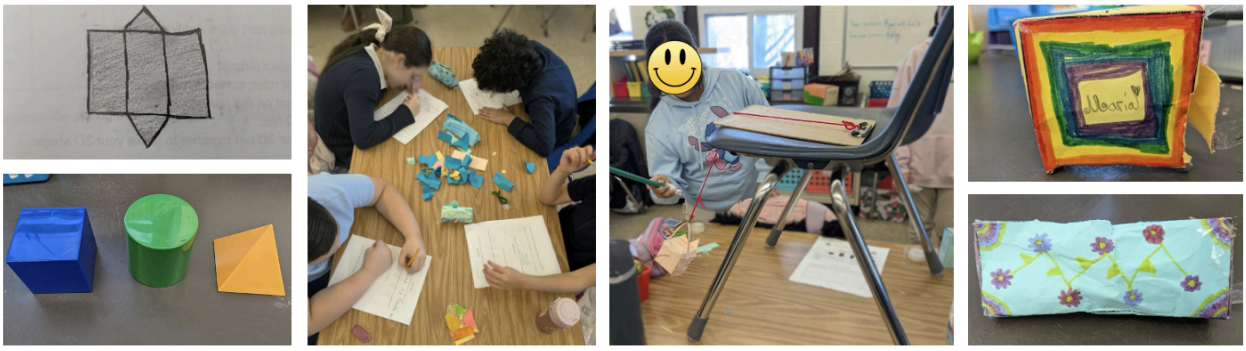

Figure 4: Elements of the Massachusetts 2025 Pilot from Sketching to Decoration and Testing

STEAM Program Comparisons

The 2023 CA and 2025 CA pilots had 24 and 25 participants, respectively. The 2024 MA and 2025 MA pilot had 38 and 41 students, respectively. The demographics of the California and Massachusetts piñata project implementations reflect efforts to engage traditionally marginalized groups in STEAM (Figure 5). Across all years, the programs served a diverse student population, with a consistent majority identifying as Latinx/Hispanic, followed by smaller percentages of Black/African American, Asian, and Multi-Race students. Gender representation varied, with a higher proportion of males in California 2023 but more balanced or female-majority participation in later years and Massachusetts programs. Notably, the Massachusetts 2025 implementation included a significant representation of Middle Eastern/North African students, highlighting regional differences in outreach. These variations demonstrate the programs' adaptability to local demographics while maintaining a focus on cultural relevance and inclusion.

The piñata project, implemented in California and Massachusetts from 2023 to 2025, demonstrated remarkable flexibility across diverse educational settings. A key success factor was encouraging students to personalize their piñatas, emphasizing that cultural relevance stems from

individual expression rather than assumed cultural familiarity. This approach transformed a historical artifact into a representation of students' current cultural experiences, ensuring meaningful connections for all participants. While all versions focused on core concepts of spatial visualization, flat patterns, and engineering principles, each implementation emphasized different STEAM aspects to suit its context. The California 2023 pilot made extensive use of Spatial Vis, integrated in-depth mathematics, and explicitly applied the scientific method. The Massachusetts 2024 version, condensed into an after-school format, emphasized hands-on learning and cultural relevance. The Massachusetts 2025 classroom integration focused on 2D to 3D visualization and reflection, while the California 2025 iteration took an interdisciplinary approach, combining engineering with biology for younger students. Durations varied significantly, ranging from four full days in California 2023 to just two one-hour sessions in California 2025. Despite these variations, the project consistently proved its adaptability to different time constraints, age groups, and learning objectives, establishing itself as a versatile and effective tool for STEAM education.

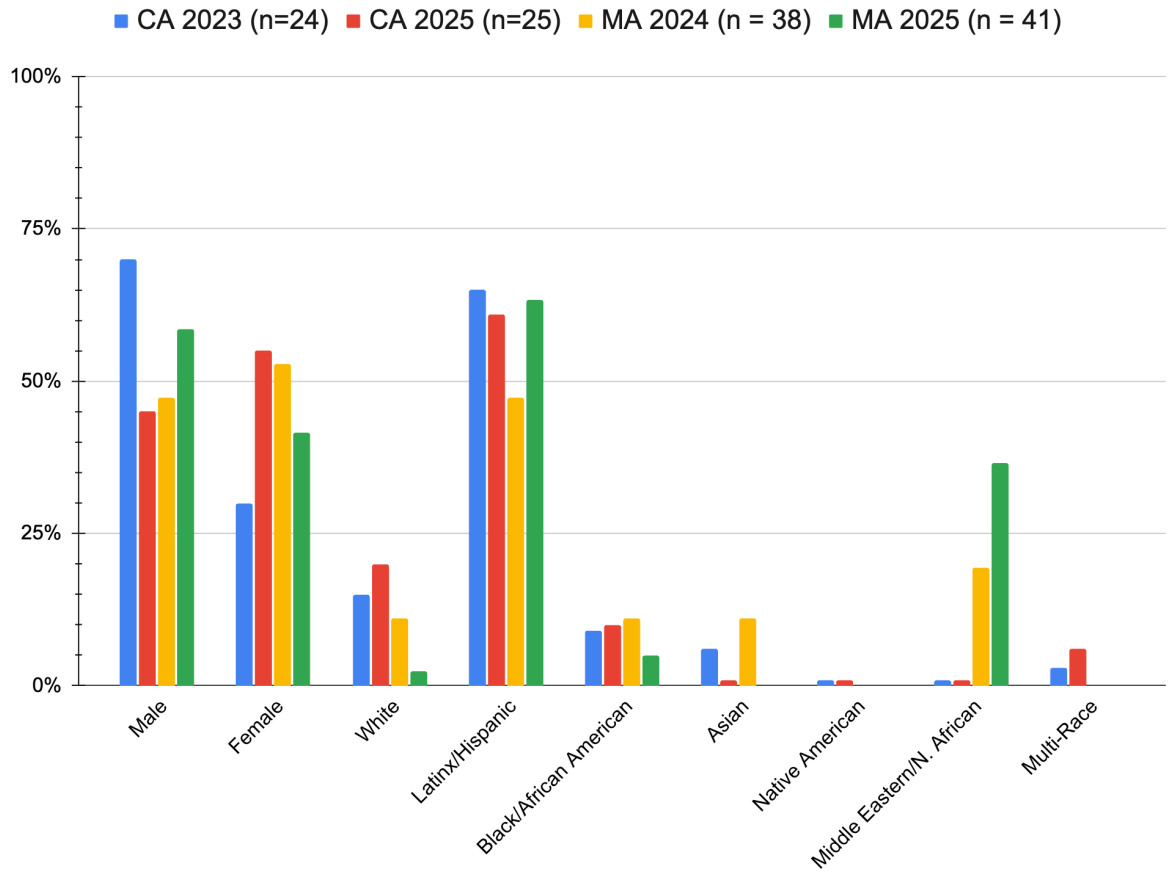

Figure 5: Demographics summary

Methodology, Analysis & Results

The evaluation of pilot implementations of the piñata project, including instructor feedback, demonstrated its effectiveness in engaging elementary students with STEAM concepts through hands-on, creative activities. The personalization of activities seems to be the key to engaging students from diverse ethnic and cultural backgrounds as students are more likely to relate to

activities that mirror their communities and identities. This was evident in the California 2023 trial, where a post-survey captured participants' perceptions and the project's impact on their STEM interest, accomplishment, self-efficacy, and creativity. The project showed high levels of student engagement, with 96% of participants feeling happy or very happy about it. The personalization aspect was particularly appealing, with 95% of students finding it more interesting than constructing undecorated shapes.

The project positively impacted students' confidence and STEAM learning outcomes, with 78% reporting increased confidence in building and 65% noting improved scientific method use. Students showed increased interest in engineering, science, and math (83%, 78%, and 73% respectively) with "very happy" about these subjects rising from 29% to 52%. Personalization was key, with designs ranging from food, nature, or animals (44%) to pop culture references (31.3%), reflecting students' diverse backgrounds and interests. 61% enjoyed the sketching aspect, highlighting the project's focus on spatial skills.

Qualitative responses revealed that students enjoyed various aspects of the project, including destroying the piñata (8.7%), building it (21.7%), decorating (13%), and the freedom and creativity aspects (30.4%). The incorporation of the Spatial Vis sketching app was well-received, with students appreciating the drawing aspect (42.9%) and learning about shapes or flat patterns (38.1%). These findings further underscore how personalization and cultural relevance contribute to student engagement.

The Massachusetts pilot employed a comprehensive two-part survey approach, revealing complex student perceptions about STEAM identity and inclusivity. While students generally believed STEAM was for them personally, there was a decrease in belief that STEAM is for people who look or speak like them, or are from the same country. This suggests internalized societal messages about who belongs in STEAM fields, despite classroom discussions on inclusivity and growth mindset. The piñata project section of the survey yielded more straightforward results, with 46% enjoying smashing the piñatas (compared to 8.7% in California), which is interesting since the piñatas had positive affirmations inside rather than candy. 41% liked the building process (21.7% in California), 24% enjoying decoration (13% in California), and 22% appreciating the choices in design (30.4% in California expressed this as freedom or creativity). Notably, students' piñata designs varied widely, including food, animals, flowers, hearts, geometric designs, and pop culture characters. This diversity in designs highlights the project's success in allowing personal expression and cultural relevance, further supporting the importance of personalization in engaging diverse students.

Instructor feedback from a short follow-up survey from the various pilots corroborated the high levels of student excitement and engagement and provided a more comprehensive understanding of the project's implementation and its cultural relevance across different settings. Instructors observed students "having a great time" and being "eager to make piñatas," with particular enthusiasm for breaking them open. Educators gained insights into their teaching methods. California instructors aimed to balance creativity and timing in future implementations, while Massachusetts focused on balancing student accountability with culturally responsive learning opportunities. Overall, both implementations highlight the piñata project's effectiveness in

engaging students with STEAM concepts through creative, hands-on activities that allow for personalization and cultural relevance.

The presence of a piñata is not what makes this activity culturally relevant. It is culturally relevant because it is student-centered, rigorous with scaffolds, adaptable, and has elements of choice. It can be tailored to different populations of students and different modalities of learning. It does not make assumptions about students but rather gives all learners the opportunity to explore, create, and take academic risks. It is also important to note that an educator must be culturally responsive and accept the students in front of them as their authentic selves in order to make any learning experience culturally relevant.

Conclusions and Future Work

The piñata project demonstrates a successful approach to culturally relevant STEAM education for elementary-aged students, effectively engaging diverse populations in California and Massachusetts. By reimagining a historical artifact through STEM principles, the project bridges cultural heritage with contemporary relevance, allowing students to personalize their learning experience to reflect their current cultural identities as children in the US. The project's flexibility allows for adaptation across various educational settings, time constraints, and age groups while maintaining core learning objectives in spatial visualization, engineering principles, and creative problem-solving. Key findings from the implementations include high levels of student engagement and enjoyment, positive impacts on STEM interest, confidence, and learning outcomes. Personalization of piñatas proved particularly effective in capturing student interest and allowing for cultural expression. Instructor feedback highlights the project's success in easing lesson planning and recognizing the importance of culturally responsive teaching.

While a single activity like the piñata project can be impactful, it alone cannot completely change students' mindsets about STEAM. The results suggest that there is more work to be done in creating an inclusive STEAM environment. Multiple opportunities for personalization and seeing themselves represented in STEAM spaces are necessary for students from diverse backgrounds to fully embrace STEAM fields. This underscores the need for ongoing, culturally responsive activities and representation throughout students' educational journeys to foster a lasting sense of belonging and identity in STEAM. However, limitations in the study methodology were identified, including a lack of consistent survey instruments and assessments across implementations, reliance on post-project surveys for attitude changes, and absence of quantitative measures for spatial visualization skills. Future work should focus on refining and expanding implementation, developing a tiered implementation model, creating a comprehensive framework for culturally responsive implementation, and implementing consistent pre- and post-assessment tools. By addressing these areas, the piñata project can further evolve as a versatile and effective tool for STEAM education, bridging cultural relevance with hands-on learning to broaden participation in STEM fields among diverse elementary-aged students.

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