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Engagement in Practice: Integrating Architecture and STEM through Community-Based Projects for High School Students

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Abstract

The City of Lubbock, Texas, is a rapidly growing urban area. A significant contributor to this growth is Texas Tech University, a Hispanic-serving institution with an enrollment exceeding 40,000 students and a statewide economic impact of $3.5 billion. As both the City of Lubbock and Texas Tech University continue to expand, the downtown area has become a focal point for revitalization efforts aligned with the city's Plan. In response to this initiative, the first author developed a summer camp project to engage local high school students in community-based architectural projects. The project aimed to provide local high school students with authentic design experiences, enhance their problem-solving skills, and cultivate their interest in STEM and architectural engineering. The one-week camp adopted Design Thinking (DT)-a holistic, iterative approach to creative problem-solving that emphasizes interdisciplinary collaboration and community engagement. Students were guided through the DT process, which included empathizing with community needs, defining problems, ideating solutions, creating prototypes, and testing their designs. Through hands-on activities, students learned how architecture and STEM can make their community more humanity-centered and environment-friendly. The camp concluded with a public presentation of the students' architectural models at the Texas Tech Museum. This project highlights the intersection of architecture with sustainability, well-being, and community engagement, demonstrating how educational initiatives like the summer camp can address real-world challenges and promote holistic community development in the city. The summer camp successfully fostered students' interest in STEM and architecture, enhanced their problem-solving skills, and empowered them to see their potential role in contributing to their community. A key takeaway was the importance of providing structured guidance to effectively mentor students and maximize human and social capital in the city.

Keywords: Summer Camp, STEM, Architecture, Community-based Project

1. Introduction

To promote students' design thinking, interest in STEM (science, technology, engineering, mathematics) and architecture, and awareness of local issues, we organized a summer camp that engaged local high school students in designing environmentally friendly, community-based architectural installations. Given its integration of art, STEM, and social science, architecture provides an interdisciplinary, human-centered context for learning [1]. Modern architecture practices emphasize sustainability, well-being, and community engagement. Sustainable architecture aims to minimize environmental impact throughout a building's lifecycle, from construction to operation [2]. This involves reducing embodied energy, optimizing resource use, and addressing environmental concerns such as water conservation and energy efficiency [3, 4]. To highlight these principles, we included a workshop focusing on sustainability in design and the use of environmentally friendly materials in architectural installations. Innovative architectural designs also enhance well-being by fostering social inclusion and improving quality of life [5]. Incorporating well-being principles into public space designs promotes a sense of belonging, comfort, productivity, and emotional wellness [6]. Accordingly, our project emphasized designing architectural models that support community well-being. Community engagement in architectural design integrates diverse perspectives, fosters collaboration with citizens, community members, and stakeholders, and influences public policies. This aspect especially encompasses the other two aspects of modern architecture design: well-being, highlighting equity and inclusivity, and sustainability [5].

The summer camp curriculum used the Design Thinking (DT) process as its framework. DT, originally developed by Stanford's Design School (d.school) and IDEO, is an iterative approach to real-world problem-solving beginning from empathy for community members' experiences and incorporating an interdisciplinary collaboration [7, 8]. DT is acknowledged and used to solve real-world problems and promotes creative and analytical skills essential for community engagement and architectural design [9]. The A+STEM Summer Camp adopted the DT process as an architectural model design principle to address local problems and inspire students to contribute to their communities using STEM and architectural knowledge and skills.

2. A+STEM Summer Camp Curriculum Design

2.1. Context

The A+STEM (Architecture plus STEM) Summer Camp curriculum emphasized community engagement, sustainability, and well-being, employing DT's real-life problem-solving approach. The city of Lubbock has been growing and expanding. However, its downtown is still underdeveloped compared to other cities and the nearest cities in the state. As a result, renovating downtown Lubbock has become a key priority in the city's strategic plan [10]. The A+STEM summer camp project aligned with the city's strategic plan by focusing on education efforts for local high students. Through an engaging community-based project, the camp aimed to raise awareness of local challenges and foster a mindset toward solving these issues with innovative

architectural designs. The project organized a five-day summer camp for high school students in the city of Lubbock, aiming to enhance participants' design thinking skills, cultivate an awareness of community needs, and promote their aspirations for STEM and architecture-related careers. Below, we present specific activities aligned with the DT process.

2.2. A+STEM Preparation and Curriculum Design

Eight high school students (campers/mentees) were enrolled in the summer camp, and seven undergraduate architecture students were selected as mentors. Each mentee was paired with one mentor, forming seven teams, except for one group that included two mentees and one mentor.

The summer camp curriculum was designed around the five stages of the DT process: Empathize, Define, Ideate, Prototype, and Test. The camp began with activities aimed at helping participants empathize with community members, gaining insights into their experiences and challenges. During reflection sessions with mentors, campers defined the problems they identified. Once problems were clearly defined, teams brainstormed solutions in the ideation phase. Based on their ideas, they created prototype architectural models. Through peer and expert feedback, teams refined and finalized their designs. Below, we provide a detailed description of the activities conducted on each day of the camp.

2.2.1. Orientation for Mentors

Two days before the camp began, we held an orientation session for undergraduate mentors majoring in architecture to introduce the camp curriculum and outline our expectations. During the session, we emphasized that mentors' role was not to provide direct answers to mentees' questions or design models by themselves but to facilitate their mentees' learning process. Mentors were also encouraged to build strong rapport with their mentees to create a supportive learning environment while maintaining boundaries.

2.2.2. Monday: Empathize Community Members' Experiences

We invited an expert in city design and social processes within the built environment to lead a workshop for the campers. The workshop introduced how the design of major cities, such as New York City, impacts citizens' lives and how environmental conditions and resources influence those designs. The expert then presented pictures of the City of Lubbock, inspiring campers to consider the factors shaping the city and to explore how they would redesign the city and why. Campers participated in hands-on activities, including reimagining the city of Lubbock using a collage method with a city map. The workshop emphasized designing the city to be more equitable and accessible for all community members. In the afternoon, we guided the campers on an exploration of the Texas Tech University campus, offering them opportunities to observe and evaluate architectural installations and landscape designs. They identified features thoughtfully designed to enhance human life and noted areas where design fell short.

2.2.3. Tuesday: Define Problems and Ideate Solutions

The second day focused on identifying community challenges and generating initial solutions. We hosted two workshops led by two experts: one specializing in sustainability in architecture and the other in well-being, inclusivity, and accessibility in design. The first workshop introduced key considerations for designing sustainable and environmentally friendly architecture. Campers saw and touched various building material models and examined their economic and environmental impacts and how these factors interact and influence one another. In the second workshop, they experienced the challenges faced by individuals with special needs and elders in their daily lives, gaining a deeper understanding of inclusive design principles. For example, campers wore special glasses to simulate visual impairment and used wheelchairs to navigate inside and outside the building. They then shared their experiences and discussed improvements in architectural design to enhance accessibility and mobility. After the workshops, we introduced an underutilized alley in downtown Lubbock (Figure 1), providing a map of the surrounding area. Campers reflected on what they had learned and observed within the space to identify key problems. They then brainstormed potential solutions for redesigning the area, applying the concepts and insights gained from the three workshops.

Figure 1. *An Underutilized Alley in Downtown Lubbock*

2.2.4. Wednesday: Prototype Models

The third day was dedicated to working on prototype models. The task was to design architectural installations aimed at revitalizing the underutilized alley in the city. We ensured that campers considered key factors such as accessibility, equity, and the creation of a culturally rich environment that could serve a broad range of community members. Time was allocated for teams to present their ideas and models to all camp members, receiving constructive feedback, including suggestions for using more sustainable and environmentally friendly materials. Mentors guided their mentees in articulating and visualizing their ideas without imposing suggestions, fostering a sense of ownership and personal investment in the projects.

2.2.5. Thursday: Prototype and Test

On Day 4, teams focused on refining prototype models. The day began with each team presenting their designs to the entire camp, including peer campers, mentors, and project leadership teams. Everyone had the opportunity to ask questions about the models and provide specific feedback related to aspects such as street layout, seasonal weather, and current and potential events that could help revitalize the alley. This feedback process served as the “Test” phase of the DT process.

After receiving feedback in the morning, campers spent the rest of the day revising their models and started printing them using 3D printers.

2.2.6. Friday: Final Test and Presentation

On the final day of the camp, the campers presented their revised models, showcasing their 3D-printed designs and explaining their intentions and goals for contributing to the community. Figure 2 shows one of the models- a trampoline park featuring five slides of various sizes, a water station, and two interconnected slides. The design also included an upper-level soda bar, offering visitors a view of the ground floor and children on the trampolines. Given the city's well-known dry heat and hot summers, the team used perforated tubing as trampoline walls and added safety nets to prevent accidents. The student included a water station and a lemonade stand in the park to address the risk of dehydration during summer. The team also incorporated bold colors for enhanced visibility, particularly for senior citizens. This idea was inspired by the camper who grew up in the city and noticed the lack of affordable, fun spaces for children and their families. Although it is downtown, the student witnessed a noticeable absence of safe spaces for families with children and elderly people.

Figure 2.

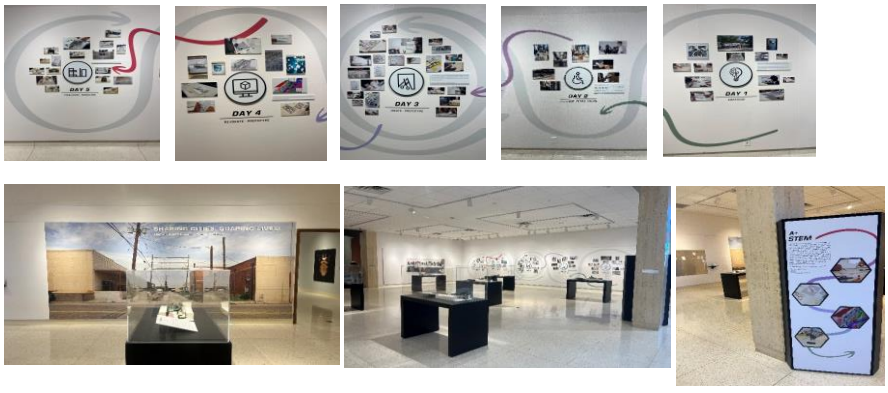
Trampoline Park

2.3. Showcase of The Project

To further expand community engagement, we collaborated with the university museum in the fall of 2024 to showcase the students' architectural models and highlight the camp program.

Figure 3.

Texas Tech University Museum Exhibition



3. Exit Survey

We administered an online survey to the camper students and received responses from six participants. The survey asked about their experiences during the camp and gathered feedback on the program. Table 1 shows examples of campers' responses to some survey items.

Table 1. Survey Response Examples

Item Content	Example response
What is your favorite activity	Getting to design was fun. Working with mentor to be able to come up with a design.
What is the least interesting activity	The workshops
Share your experience at camp	All is amazing and I was honored to have this experience. It was great and really fun.
How does this camp connect with your career interests?	STEM is important in my future so it really help me understand innovation better for my career.

The results indicated a preference for hands-on activities that allowed students to engage with their ideas over passive, lecture-style activities. This feedback suggested the need to incorporate more hands-on activities in future workshops and camp activities to enhance student engagement. When asked about their experiences working with their mentors, all students reported having excellent experiences, noting that their mentors made them feel comfortable, safe, and respected. This safe and emotionally supported learning environment was what we exactly intended to create. To evaluate the overall success of the camp, we asked if they would recommend it to others (Yes/No). Every response was affirmative ("Yes"). Also, as shown in Table 1, students reported positive experiences at the camp, which were also connected to their career interests. Overall, the survey results highlighted the camp's success and positive influence.

4. Reflections and Future Directions

The inaugural summer camp successfully demonstrated how STEM and architecture can address community needs. We aimed to provide local high school students with the opportunity to learn how STEM and architecture can positively impact everyday life and communities. Students often perceive a disconnect between their studies and real-life relevance [11]. During the camp, students have experienced in applying their learning to their community-based projects. The camp outcomes and students' responses to the exit survey demonstrated that DT served as an effective framework for raising awareness of community issues. All students attended for five days and engaged in all activities, as observed. Furthermore, the exhibition at the Texas Tech University Museum offered a broader platform for community involvement in the project.

We learned several key factors for the camp's success: 1) hands-on activities, 2) local issues and context as learning topics, and 3) strong rapport between mentor and mentees. We also identified areas for improvement for future camps. First, we faced challenges in inviting public officials and city planning or economic development professionals to participate. If they had been involved in hosting workshops or evaluating the students' models, students could have better understood how their outcomes relate to the community, considering various factors in their designs. Second, allowing students to identify local neighborhood issues would foster a deeper

sense of ownership and engagement in learning and outcomes. Lastly, considering the survey results, we need to incorporate more hands-on activities into the workshops.

This camp can be expanded to other locations and universities, encouraging community-engaged projects and scholarships. By involving students in community-based projects, we can foster a mindset of contributing to their community. This initiative would also raise students' awareness of local challenges and enhance their problem-solving skills by connecting their learning directly to their lives. This experience effectively supports students' aspirations to pursue careers in STEM and architecture.

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