(Case Study) Inspire Young Civil Engineers through Transportation & Civil Engineering Summer Camp for High School Students

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Introduction

Inspiring and attracting high school students to pursue specific fields as their college major and future career is crucial for universities to maintain steady enrollment and ensure an adequate workforce pipeline. This is particularly true for civil engineering, where workforce demand has dramatically increased while student enrollment has decreased nationwide in recent years. Reflecting these dynamics, this paper introduces a transportation & civil engineering summer camp held in summer 2025 at the University of Hartford, aims to raise high school students' awareness and interest in transportation and civil engineering, and potentially encourage them to pursue these areas as their college major and future career.

Literature Review

Prior studies in STEM education indicate that collaboration between universities and industry through targeted K-12 outreach - such as internships and career-focused events - can effectively attract students to engineering majors [1]. Many of these efforts take place in informal learning environments, which provide experiential learning opportunities outside traditional classrooms and have been shown to stimulate student interest and engagement in STEM fields [2].

Engineering summer camps, in particular, have been shown to positively influence students' perceptions of engineering, enhance self-efficacy, and increase interest in engineering disciplines and careers through hands-on, project-based learning experiences [3] - [6]. Prior studies, including construction-focused camps at California State University and Mississippi State University, demonstrated improvements in students' awareness of construction-related fields and attitudes toward engineering programs [7], [8]. Longitudinal evidence from the University of Utah further suggests that sustained summer camp can influence college enrollment decisions, with a substantial proportion of participants later enrolling in STEM majors [9].

Beyond positive outcomes, literature emphasizes that effective camp design is critical to student engagement. Successful engineering summer camps consistently integrate experiential learning, real-world applications, and opportunities for collaboration and mentoring, including interaction with faculty, industry professionals, and student mentors [9] - [13]. These elements collectively support student motivation, self-efficacy, and interest in pursuing engineering pathways, underscoring the importance of intentional program design in civil engineering camps.

Research Significance

Workforce demand for civil engineers continues to grow, with national projections indicating the need for approximately 25,000 new civil engineers annually and substantial job creation driven by infrastructure investment [14]. In contrast, civil engineering enrollments at many universities remain flat or are declining [15], intensifying the gap between workforce supply and industry needs. In this context, well-structured civil engineering summer camps offer a promising approach to increasing public awareness of the profession and encouraging pre-college students

to consider civil engineering as an academic and career pathway. While prior research has examined STEM summer camps broadly, relatively few studies have focused on a dedicated, week-long civil engineering summer camp, and even fewer have documented camp preparation and recruitment strategies in detail [3], [4], [6], [7], [8], [9], [16].

This paper presents a comprehensive case study of a week-long transportation & civil engineering summer camp, encompassing camp planning and preparation, outreach and recruitment campaigns, program implementation, and assessment. The study seeks to address the following research questions:

- What advertising and recruitment strategies most effectively attract student participants?
- How does participation in a civil engineering summer camp influence students' perceptions of the field and interest in pursuing civil engineering careers?

Camp Overview

The camp was held in summer 2025 at the University of Hartford and was fully funded by the Connecticut Department of Transportation (CT DOT) and the Federal Highway Administration (FHWA), allowing students to participate at no cost. The one-week program was offered over two consecutive weeks with 21 campers per week, for a total of 42 participants, with enrollment constrained by state-mandated staff-to-camper ratios and facility capacity. Campers brought their own lunches, while snacks were provided. Photos and videos collected during the camp were later used for promotional purposes.

Camp Program Design

The camp program was designed by first establishing core module themes (e.g., structural, geotechnical, transportation, environmental, etc.), supplemented by field trips, guest lectures, and a graduation ceremony (Table 1). Instructors were coordinated to finalize schedules, activities, space reservations, and required materials, using a standardized module template (Appendix A) to document instructional objectives, activity details, and logistical needs for each module.

Table 1. Summer camp modules and schedule

Session 1		7/7/2025	7/8/2025	7/9/2025	7/10/2025	7/11/2025
Session 2		7/14/2025	7/15/2025	7/16/2025	7/17/2025	7/18/2025
Time	Block	Monday	Tuesday	Wednesday	Thursday	Friday
8:50 - 9:15		Check-in & Welcome	Morning Gathering & Team Building			
9:15 - 10:20	A	Materials	Transportation	Geotechnical	CT DOT Visit	Water Resource
		HC 112 Concrete	D 115 Transportation & UT111	D 127 Geotechnical	Newington Headquater	UT 105 Thermal Fluid & Campus
		Song Wang & Clara Fang	Clara Fang & Song Wang	Saleh Keshawarz & Song Wang	Fang & Wang; CT DOT: Scott Bushee	David Pines & Todd Brown
10:20 - 10:35		Break (15 mins)				
10:35 - 11:40	B	Structural	Transportation	Railway	CT DOT Visit	Water Resource
		UT111 Computer Classroom	D 115 Transportation & UT 111	HC 216 Makerspace	Newington Headquater	UT 105 Thermal Fluid
		Yang Yang & Song Wang	Clara Fang & Song Wang	Ted Sussmann & Clara Fang	Fang & Wang; CT DOT: Scott Bushee	David Pines & Todd Brown
11:40 - 12:15		Lunch (35 mins)				
12:15 - 13:20	C	MDC Field Trip	WTS: Complete Street	Materials	CT DOT Visit	Graduation
		Hartford Pump Station Site	HC 216 Makerspace	HC 110 High-Bay Structural	Newington Headquater	HC 216 Makerspace
		Song Wang & Clara Fang	Katherine Yale & Obesebea Aye-Addo	Song Wang & Ted Sussmann	Fang & Wang; CTDOT: Scott Bushee	Fang, Wang, & Guest Speakers
13:20 - 13:35		Break (15 mins)				
13:35 - 14:40	D	MDC Field Trip	CSCE: Intersection Control	Surveying	CT DOT Visit	Campus Tour
		Hartford Pump Station Site	HC 216 Makerspace	HC 112 Concrete & Campus	Newington Headquater	Campus
		Song Wang & Clara Fang	Ariana Antonucci & Tom Wamser	Song Wang & Ted Sussmann	Fang & Wang; CT DOT: Scott Bushee	Clara Fang & Song Wang
14:40 - 15:00		Afternoon Wrap UP				

In addition to university faculty, the camp also engaged industry professionals from the Women's Transportation Seminar (WTS) Connecticut Chapter, Connecticut Society of Civil Engineers

(CSCE), and the American Concrete Institute (ACI) New England Chapter to deliver instructional modules and a guest lecture. They provided campers with exposure to real-world engineering practice and career pathways, which has been shown to enhance students' professional awareness and motivation in precollege engineering program [17], [18].

The camp operated daily from 9:00 am to 3:00 pm, with each instructional module allocated 65 minutes. Due to space constraints and to promote effective student engagement, all instructional modules were delivered to half of the cohort at a time. For example, on Monday morning, the Materials and Structural modules were conducted concurrently, each serving half students from 9:15 to 10:20; students then rotated to the alternate module for the second morning session.

Camp Staffing

In addition to the two authors serving as co-directors, the camp team included two student counselors who supported daily operations, assisted with instructional activities, led team-building exercises, and documented camp activities through photos and videos for promotional use. Beyond logistical support, the student counselors also served as near-peer mentors, fostering informal interaction, engagement, and a sense of belonging among campers [13].

The camp was further supported by administrative and professional staff, including a budgeting manager responsible for procurement and financial coordination, and a marketing communications manager who assisted with the design of the camp website, development of promotional materials, and dissemination of targeted recruitment emails.

Recruitment and Outreach Campaign

A dedicated camp website [19] was launched in early February 2025 to support recruitment efforts. Outreach strategies included targeted emails to local high school teachers, counselors, and prospective students (e.g., prior university open house attendees), in-person promotion at local career fairs, and mailing of printed flyers to students and high school counseling offices. Application data indicate that email outreach - particularly through high school teachers and counselors - was the most effective recruitment channel (Fig. 1).

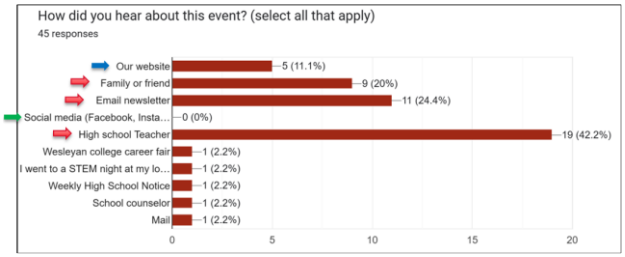

Figure 1. Source of camp awareness among applicants

Analysis of application timestamps (Fig. 2) shows that most applications were submitted during the final three weeks before the deadline. This pattern suggests that camp organizers should not interpret low early application numbers as a lack of interest, as many students tend to submit applications close to the deadline. Sustained outreach and patience throughout the application period are critical for successful recruitment.

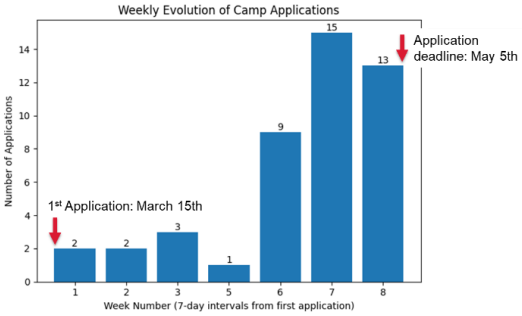

Figure 2. Camp application count and timeline

Camp Policy and Pre-Camp Parental Communication

The camp co-directors completed the university's required training on minors in university-sponsored programs and developed codes of conduct for both authorized adults and participants. These policies were distributed via online Google Forms to facilitate clear communication and digital signatures. All camp instructors signed the forms and completed background checks. Parents acknowledged all required policy documents, including camp policies, liability releases for lab and field trips, photo release, and health information. In addition, an online information session for parents was held approximately one month prior to the camp start date. The session provided an overview of camp program and logistical details with a Q&A session.

Camp Essential Materials

In addition to the tools and materials required for each camp modules and personal protective equipment for field trips, essential logistical items were prepared in advance. Engagement materials included camper welcome bags containing camp T-shirts, water bottles, program schedules, campus maps, name tags, and ASCE promotional items, as well as graduation certificates. Safety and operations materials consisted of sign-in/sign-out sheets and emergency contact lists. Wayfinding and facility signage included a camp promotional banner stand, directional signage from the designated parking area to the camp center, and restroom door signage reserved for camper use.

Daily Camp Activities

Each day of the camp began with randomized team assignments using poker cards, followed by icebreaker and team-building activities such as fast-friend introductions, the marshmallow challenge, cup tower, paper relay, and marble coaster. Each instructional module started with a brief introductory lecture and transitioned into hands-on activities. Detailed descriptions of the daily modules are provided below.

Monday: In the Materials module, campers prepared cement mortar with varying water–cement ratios and chemical admixtures using small mixers, cast standard mortar cubes for testing on Wednesday, and created custom-shaped specimens as take-home souvenirs using plastic molds and natural clay. In the Structural module, campers learned basic truss bridge concepts and explored their designs using the West Point Bridge Designer software. The ACI professional delivered a guest lecture on the concrete industry during the lunch period. The day concluded with a field trip to the local MDC wastewater treatment plant, where campers learned about plant operations, treatment processes, and an active tunneling construction project.

Tuesday**:** Tuesday was a transportation-themed day. Campers began with traffic signal timing counts at a nearby signalized intersection, followed by developing signal phase plans in Excel, running traffic simulations using Synchro Studio, and experiencing an advanced driving simulator. The WTS team introduced the concept of complete streets and led a walking tour of nearby corridors to observe relevant design features; students then worked in groups to propose improvements based on complete street principles and concluded with group presentations. The

CSCE team introduced different intersection control methods using mini-cone intersection layouts, allowing students to act as drivers and simulate traffic flow under different controls.

Wednesday: In the Geotechnical module, students learned the importance of soil compaction in roadway construction and performed compaction tests using the Harvard miniature compaction device. In the Railway module, they explored key aspects of rail transportation and assembled a train wheelset to demonstrate the steering effect of wheel conicity. In the Materials module, students were introduced to common construction materials and tested their cement mortar specimens they prepared on Monday, along with steel coupons, using a load frame. The Survey module introduced traditional and advanced land surveying techniques, with students' hands-on practice using total stations for leveling and distance measurements.

Thursday: Thursday was dedicated to a full-day visit to the CT DOT, where students learned about the diverse roles of traffic engineers and their work, toured the highway operations center, and explored the application of drone surveying, including a live drone flight demonstration.

Friday: In the Water Flow module, students explored the connections between natural and engineered open-channel flow systems and conducted experiments using a laboratory flume. In the Water Infrastructure module, they learned about infrastructure systems for potable water, wastewater, and stormwater and participated in a campus-wide water infrastructure scavenger hunt, including opening manholes. The camp concluded with a Friday afternoon graduation ceremony attended by parents and families, featuring remarks from CT DOT administrators, dean of the College of Engineering, Technology, and Architecture (CETA), and practicing engineers, followed by a highlight video showcasing key moments from the camp, the awarding of camp completion certificates, and group photos. A campus tour for students and parents, led by student counselors, marked the close of the camp.

Survey and Results Discussion

An anonymous student survey was conducted at the beginning and end of the camp. Survey items, thematic groupings, and response scales are summarized in Table 2. The groupings were informed by factor analysis, item wording and conceptual intent. In Week 1, 18 of 21 students (86%) completed both the pre- and post-surveys, while in Week 2, 19 (90%) and 17 (81%) of 21 students completed the pre- and post-surveys, respectively. Descriptive results for all survey items are presented in Table 3 and Fig. 3, indicating increased post-camp ratings across all items, with particularly notable gains for Q5 and Q6, which assess awareness and knowledge of civil engineering, as well as reduced response variability for most items.

Table 2. Student survey items, themes, and scale

Theme	Survey Items with Scale (1 = Strongly Disagree to 5 = Strongly Agree)
STEM Interest and Confidence (IC)	Q1: I am interested in science, technology, engineering, and mathematics (STEM) subjects.
	Q2: I enjoy solving problems in my math or science classes.
	Q3: I have considered majoring in an engineering field (such as civil engineering) in college.
	Q4: I feel confident that I can succeed in engineering or other STEM courses.
Awareness (A)	Q5: I know what civil engineers do in their jobs.
	Q6: I know what types of careers are available in civil engineering (e.g. transportation, structural).
Career Interest (CI)	Q7: I think engineering could be a good career choice for me.
	Q8: I am interested in learning how things like roads, bridges, and buildings are designed and built.
	Q9: I want to learn more about careers and projects in civil and transportation engineering.

Table 3. Pre- and post-survey responses for all question items

Item	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
pre_mean	4.4	4.1	4.2	4.2	3.4	3.2	3.9	4.1	4.3
pre_std*	0.69	0.89	0.78	0.89	1.07	1.04	1.01	1.03	0.90
post_mean	4.5	4.3	4.4	4.3	4.5	4.5	4.3	4.5	4.4
post_std*	0.70	0.78	0.77	0.87	0.70	0.51	0.83	0.74	0.88

*std = sample standard deviation

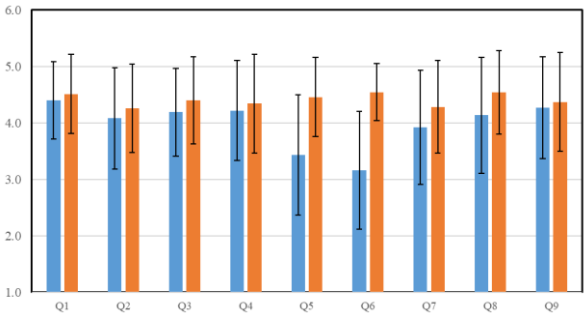

Figure 3. Pre- and post-camp student survey results

Independent sample t-test (N = 72) was conducted to examine pre–post changes in three composite outcomes (Table 4). Statistically significant increase in students' awareness (A) was observed ($p < 0.01$), indicating that the camp was effective in improving students' understanding of the civil engineering field. Although STEM interest and confidence (IC) and career interest in civil engineering (CI) did not demonstrate statistically significant changes, both outcomes exhibited positive mean increases from pre to post exhibited positive mean increases from pre to post, suggesting favorable shifts that may not have reached statistical significance due to the relatively small sample size.

Table 4. Independent sample t-test results comparing pre- and post-survey responses for composite outcomes (N = 72)

Outcome	Pre_Mean	Post_Mean	Mean Difference (Pre - Post)	t	Degree of Freedom	two-sided p
IC	4.16	4.35	-0.19	-1.23	70	0.22
A	3.30	4.50	-1.20	-6.59	56.35	<0.01
CI	4.20	4.44	-0.24	-1.43	70	0.16

An anonymous parent feedback survey was conducted at the end of the camp and yielded predominantly positive responses. Two key suggestions emerged: incorporating a residential component to enhance the college experience and providing parents with a daily course outline to better understand student learning. The camp team will consider a residential option for future camps and plans to share detailed activity descriptions and learning outcomes with parents, which may also further increase broader public awareness of the civil engineering field.

Conclusion

This study described the design, preparation, implementation, and assessment of a week-long transportation & civil engineering summer camp conducted at the University of Hartford to increase high school students' awareness of the civil engineering profession and interest in related academic and career pathways. The camp integrated hands-on learning, industry engagement, and mentoring within an informal learning environment. Key findings include:

- Email outreach through high school teachers and counselors emerged as the most effective recruitment strategy for attracting student applicants.
- Student counselors played a critical role in camp operations, providing logistical support while also fostering peer engagement and mentoring through near-peer interaction.
- Ice-breaking and team-building activities were effective in establishing a positive camp climate and promoting student engagement throughout the program.
- The camp substantially enhanced students' awareness and understanding of civil engineering, while also encouraging greater interest in pursuing civil engineering careers.

Acknowledgement and Disclaimer:

This work was sponsored by the Connecticut Department of Transportation and Federal Highway Administration. This paper does not constitute a standard, specification or regulation. The contents of this publication reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the views of the Connecticut Department of Transportation or University of Hartford, or the Federal Highway Administration. This publication is based upon publicly supported research and is copyrighted. It may be reproduced in part or in full, but it is requested that there be customary crediting of the source.

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Appendix A. Civil Engineering Summer Camp Module Template

Module Title: (*Enter the title of the module here. The title can be professional, student-friendly, or both. For example: "Unlocking the Flow: Traffic Analysis in Action"; "Bridge Design Challenge"; or "Railway Engineering.")*

Instructors Information: *(Please provide the instructor's full name, position/title, institutional affiliation, email address, and phone number.)*

Module Description: *(Provide a brief overview of the module.)*

Activities:

*(Describe what students will learn and engage in during this module, using the template form below. Include interactive, hands-on components such as model construction, experiments, data analysis, or software applications. Note that the overall time for each module is **65** mins. It is recommended to develop a step-by-step activity guide/handout to support student participation.)*

Activity Name	Duration (min)	Activity Description
Concrete material presentation	10	…
Concrete batching and casting	40	…
…	…	…

Materials Needed and Estimated Costs: *(Please list all materials necessary for the proposed activities, including but not limited to modeling supplies, software, laboratory equipment, printed handouts, or other instructional tools. If the purchase of any materials is required, include an estimated cost for each item along with relevant ordering details.)*

Learning Outcomes: *(List 2–3 key takeaways that students should gain from this module.)*