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Career Interest Development Through Academia-Industry Collaborative Construction Summer Academy for Pre-College Students

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Case Study: Career Interest Development Through Academia-Industry Collaborative Construction Summer Academy for Pre-College Students

Abstract

The persistent underrepresentation of youth pursuing construction careers underscores the need for early, experiential learning interventions that cultivate career awareness, confidence, and a sense of belonging in construction career pathways. Despite the critical demand for a skilled and diverse construction workforce, pre-college students often have limited exposure to the construction industry, lack accurate knowledge of educational routes into construction management, and hold misconceptions about the nature of construction field. Therefore, the academia-industry collaborative construction management summer academy was designed and implemented to engage pre-college students early in construction education and bridge the current gaps between engineering education and industry needs. This study presents a case study of a one-week construction management summer academy program designed to introduce high school students to construction careers and education.

The university faculty and industry partners collaboratively designed and developed the construction management summer academy to foster pre-college students' career interests in construction management and science, technology, engineering, and mathematics (STEM) fields. The program integrated technical lectures, project-based learning, hands-on activities, and site visits to active construction projects, providing students with authentic exposure to professional practices. A mixed-methods evaluation was conducted to assess pre- and post-academy changes across four domains: (1) career interests, (2) technical knowledge and awareness, (3) confidence and self-efficacy, and (4) engagement and communication.

Results demonstrate significant gains in students' knowledge of construction management college programs, along with improved teamwork and communication skills. Career interests toward construction management and STEM showed positive increases after the summer academy among student participants. These findings indicate that the academia-industry collaborative construction summer academy effectively enhanced students' awareness of postsecondary education opportunities and improved technical knowledge, teamwork, and communication skills through hands-on, industry-collaborative learning experiences. Engagement with construction professionals and visits to local construction sites enhanced students' engagement, communication, and interest in construction careers by connecting academic learning with real-world professional practice. The findings of this research suggest that future program development would benefit from extended program duration and the integration of sustained mentorship and structured reflection to support deeper technical confidence, strengthened long-term self-efficacy, and sustained engineering career interest development among pre-college students.

Introduction

Construction engineering and management requires a blend of technical and project-management knowledge, alongside soft skills, such as communication and leadership [1], [2]. In 2025, the U.S. construction industry needs to hire an estimated 439,000 net new construction workers to meet its growing demand, yet 76% of firms report having difficulty finding qualified construction project managers or supervisors to hire [3]. Despite the strong industry demand, there is a significant pipeline gap from high school to post-secondary education in construction

engineering and management [4]. According to the 2025 State of the Future U.S. Workforce Report, only 4% of middle and high school students expressed both aptitude and interest in construction career fields [5]. This misalignment between student interest and industry demand for construction workforce often stems from limited awareness of construction careers [6] and lack of construction career education programs or curricula in high school [7]. Many high school students have limited exposure to construction-related careers, which can delay or prevent their pursuit of opportunities in the construction field [8]. The previous research has implemented experiential learning programs such as summer camp to help students explore career pathways and education opportunities, build confidence, and develop foundational knowledge [9]. The findings of previous research have reported the effectiveness of hands-on engagement in improving students' interest in STEM careers [6], [8], [10].

To address persistent awareness gaps in construction engineering and management and to provide early, authentic exposure for pre-college students, the Construction Management program at Wayne State University (WSU) developed and launched a Summer Academy program for rising high school students in grades 9 to 12. This summer academy program was uniquely designed and developed through close collaboration with industry partners to advance beyond traditional outreach programs that mostly rely on faculty-led instruction and campus-based activities [9], [11]. The WSU construction management summer academy program integrated industry guest lectures, hands-on learning activities using real-world projects, guided site visits to local construction projects, and direct interactions with industry professionals, faculty, and current college students. Participant students engaged directly with professionals from leading construction and engineering organizations, including Walbridge, General Motors, and the National Electrical Contractors Association (NECA), gaining firsthand exposure to real-world engineering applications in their local communities.

The impact of the summer academy program was evaluated through participant surveys before and after the program as a part of a single-site case study. The changes in participant students' (1) career interests, (2) technical knowledge and awareness, (3) confidence and self-efficacy, and (4) engagement and communication were measured to answer the following research questions:

1. How does participation in the academia-industry collaborative construction management summer academy influence students' interest in construction management-related careers and postsecondary education pathways?
2. How does participation in the summer academy improve students' technical knowledge of construction management concepts and their awareness of industry practices?
3. How does participation in the summer academy affect students' confidence and self-efficacy in applying STEM-related skills?
4. How does participation in the summer academy influence students' levels of engagement and their communication skills during collaborative, hands-on, and industry-engaged learning activities?

The findings of this research show that the academia-industry collaborative components of the summer academy program at WSU created an immersive learning environment that enabled student participants to bridge theoretical knowledge and professional practice within the regional construction industry and fostered students' interests in engineering education and related career pathways.

Literature Review

Social Cognitive Career Theory (SCCT) explains how students develop career interests and make educational choices through the interaction of personal beliefs, environmental factors, and learning experiences [12]. The theory identifies self-efficacy, outcome expectations, and personal goals as key factors that influence whether students become interested in and pursue specific career paths [12]. Students are more likely to express interest in a field when they believe they can successfully perform related tasks and expect positive outcomes from participating in that field [13]. Prior studies using this framework have shown that self-efficacy and positive attitudes toward STEM are strong predictors of students' persistence and intention to pursue technical and engineering related pathways, particularly during the high school years when career decisions begin to take shape [13]. SCCT builds on Bandura's social cognitive theory of self-efficacy and incorporates elements of developmental career perspectives, allowing it to explain both confidence formation and the progression of career interests over time [12].

In addition, SCCT emphasizes the importance of learning environments and social support in shaping students' career development [12]. Participation in structured STEM learning experiences, enrichment programs, and extracurricular activities has been associated with higher levels of sustained interest in STEM careers over time [14]. Contextual influences such as encouragement from teachers, parents, and industry professionals also play a significant role in shaping students' motivation and educational expectations [14]. Based on this theoretical framework, the Academia Industry Collaborative Construction Summer Academy was designed to provide hands on learning experience, professional mentoring, and exposure to real world construction practices in order to strengthen students' confidence and expectations about construction careers, which in turn is expected to promote greater career interest in construction and engineering pathways.

The study's outcome measures were conceptually aligned with key SCCT constructs. Survey items assessing students' confidence in applying technical skills and collaborating on construction-related tasks reflect self-efficacy development, while items measuring career awareness, educational pathway knowledge, and interest in construction professions correspond to outcome expectations and early-stage career goal formation. This alignment enabled evaluation of how immersive outreach experiences influence students' construction career perceptions.

Existing studies have explored the impact of early exposure strategies such as summer camps and outreach programs on strengthening the construction workforce pipeline as presented in Table 1. The findings of the existing studies show the impacts of hands-on STEM outreach programs on students' career interests, technical knowledge and skills, engineering awareness, confidence, and self-efficacy across different participant groups.

Table 1. Findings of previous studies on outreach programs

Study	Outreach Program Type	Target Group	Main Findings
[10]	Engineering Summer Academy	Middle and High School Students	Engineering summer academies increased students' interest in engineering as well as their identity as future engineers.

[15]	Construction Summer Camp / Trades Outreach	High School Students	Pre–post analysis showed meaningful improvements in students' knowledge of construction trades and interest in related programs.
[16]	Construction Management Summer Academy	Middle and High School Students	A week-long construction management summer academy enhanced awareness, understanding, and interest in construction management careers through technical lectures and experiential learning activities such as a tiny house construction on wheels.
[17]	Construction Outreach Event (Family/Community-Based)	High School Students and their Parents	The interactive outreach event improved students' and parents' understanding of construction management careers and educational pathways, particularly supporting first-generation and underrepresented students.
[18]	School-Based AEC Hands-On Workshops	Elementary and Middle School Students	School-based AEC workshops with hands-on activities significantly increased students' interest in construction and architecture careers, with pre–post survey results showing that interest in AEC careers doubled after participation.
[19]	XR-Based Summer Outreach Program	High School Students	Summer camp showed that Extended Reality (XR) outreach improved student engagement and career awareness in Architecture, Engineering, and Construction (AEC) field, indicating strong potential for recruitment-focused outreach programs.
[20]	Mentorship-Based AEC Outreach Camp	High School Girl Students	The outreach camp was rated highly effective by industry professionals, with hands-on learning and mentorship identified as key factors in motivating students toward AEC careers.
[21]	Longitudinal STEM Summer Camp Outreach	High School Students	Follow-up surveys showed that 75% of former camp participants enrolled in STEM majors and nearly half pursued engineering or computer science, indicating strong long-term impact of summer camp outreach on educational pathways.
[22]	VR-Based Construction Outreach Workshop	Middle School Students	Post-workshop surveys showed significant increases in interest in and understanding of construction management careers following hands-on and Virtual Reality (VR)-based outreach activities.

Research Methods

This research employed a single-site case study design to evaluate the implementation and outcomes of the academia–industry collaborative construction management summer academy. This case study is focused on one academia-industry collaborative construction management summer academy at Wayne State University (WSU). As a case study of a single program, the intent is to provide preliminary insights about how this specific academy program was implemented and how participating students' perceptions and career interests evolved, rather than producing statistically generalizable claims to all summer STEM programs.

Participant Recruitment

Prior to initiating this study, research design and protocol were submitted to the WSU Institutional Review Board (IRB). The IRB determined that this study constituted program evaluation of summer academy activities and outcomes and therefore did not meet the definition of human participant research under the Common Rule (45 Code of Federal Regulations (CFR) 46) or applicable Food and Drug Administration (FDA) regulations. Accordingly, no IRB review or approval was required for the current study.

A total of 16 high school students from the Metro Detroit area were recruited for the study. Parental consent for data collection for education and research purposes was obtained for all student participants prior to the start of the summer academy. The participant group included 5 females (31%) and 11 males (69%), as shown in Figure 1. Participants represented four grade levels: 2 students from 9th grade, 6 from 10th grade, 5 from 11th grade, and 3 from 12th grade (Figure 2). The largest proportion were 10th-grade students (n = 6), followed by 11th grade (n = 5). Fewer students were from 12th grade (n = 3) and 9th grade (n = 2). This distribution suggests that the academy attracted the most engagement from students in the middle years of high school, with reduced participation from both incoming freshmen and graduating seniors.

In terms of racial and ethnic background, most participants identified as Black/African American (n = 8), followed by Asian (n = 4), White (n = 3), and American Indian/Alaska Native (n = 1) (Figure 3). This diversity highlights the academy's ability to engage students from varied demographic backgrounds.

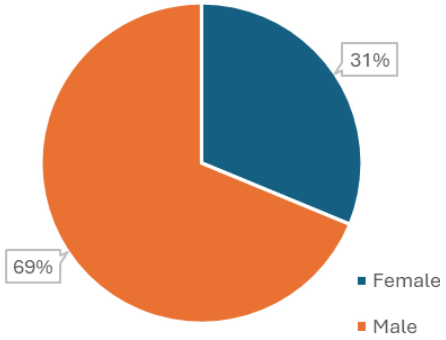

Figure 1. Participants

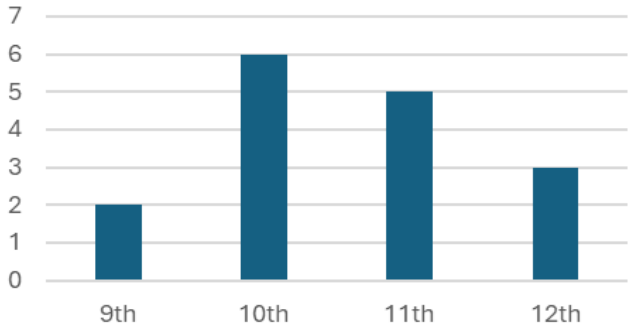

Figure 2. Grade Distribution

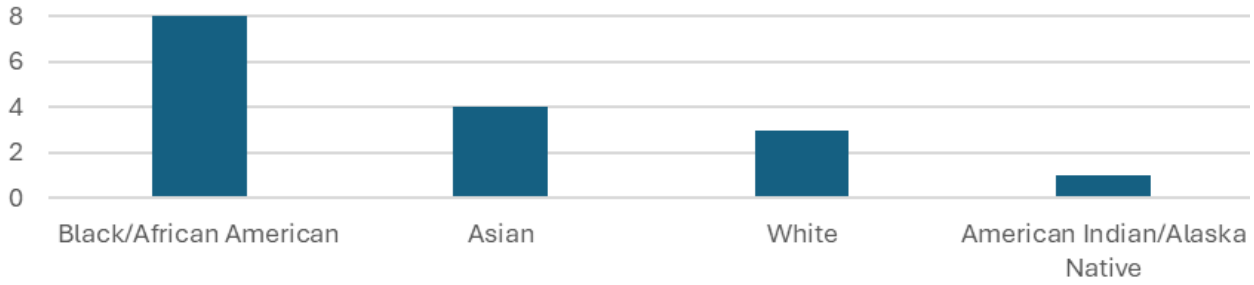

Figure 3. Race/Ethnicity of the Participants

Summer Academy Schedule Development

The inaugural week-long summer academy was collaboratively designed by WSU construction management faculty and industry partners and implemented in June 2025. The summer academy integrated classroom lectures, hands-on teambuilding workshops, industry speaker sessions, and site visits to provide students with direct exposure to real-world construction education and practices. Table 2 summarizes the program schedule, which integrates instructional and experiential learning activities, including drone-flying competitions for construction inspection purposes, building design activities using LEGO materials, guided site visits to local construction firms and projects, and structured interactions with industry practitioners.

Table 2. Program schedule of the construction management summer academy.

Topic	Key Activities
1: Introduction to Construction Management	• Introduction to construction engineering and management (WSU faculty) • Hands-on teambuilding workshop: Flying Drones for Inspection • Student guest talk on college life in construction management • Hands-on teambuilding workshop: Building a Small Structure
2: Design and Planning	• Field visit to a local construction firm • Introduction to design software (Speaker: industry professional) • Hands-on teambuilding design workshop • Hands-on teambuilding construction project management workshop
3: Safety and Leadership in Construction	• Field visit to an active construction site in Detroit • Introduction to construction safety (Speaker: industry professional) • Safety equipment demonstration and hands-on safety exercises • Leadership in construction: skills & challenges (Speaker: industry professional)
4: Construction Trades and Trends	• Field visit to the National Electrical Contractors Association (NECA) • Construction industry trends and career pathways (Speaker: industry professional) • Networking session with industry professionals • Summer academy program reflection and wrap-up

Data Collection and Analysis

Data were collected using a mixed-methods approach to evaluate changes in students' career interests, technical knowledge, confidence, and engagement resulting from participation in the academia-industry collaborative construction management summer academy. Quantitative data

were gathered through pre- and post-academy surveys administered to all participating students. The survey instrument included 5-point Likert-scale items designed to measure four primary domains: (1) career interests in construction management and STEM fields, (2) technical knowledge and awareness of construction-related educational and career pathways, (3) confidence and self-efficacy in technical and collaborative tasks, and (4) engagement and communication skills. The survey items were adapted from prior STEM outreach and career development literature to ensure content validity [11], [23], [24]. The measured outcome domains were conceptually aligned with SCCT constructs, particularly those related to self-efficacy, career awareness, and outcome expectations, enabling interpretation of students' developmental shifts within a career interest framework.

The survey instrument was developed through adaptation of previously published STEM outreach and career interest assessment measures to ensure contextual relevance to construction management education. Survey items were tailored to reflect the experiential and industry-integrated nature of the summer academy, capturing changes in students' career interests, technical awareness, confidence, and engagement. Item development in Table 3 was informed by SCCT constructs, particularly those related to self-efficacy, outcome expectations, and career interest development, enabling interpretation of program-related shifts in students' confidence, career awareness, and perceived construction career pathways [25].

After the quantitative data were collected from pre- and post-academy surveys, paired-sample *t*-tests were employed to assess changes in responses across each domain. The paired-sample *t*-tests allowed for within-subject comparisons of students' self-reported outcomes before and after participation in the summer academy [26].

In addition to quantitative analysis, qualitative data were collected through student reflections before and after the academy, informal discussions, and observational notes recorded during hands-on activities, site visits, and industry-led sessions. Specifically, students responded to short open-ended reflection questions prior to activities (e.g., *What do you currently know about construction management careers?* and *What do you hope to learn or experience from this camp?*) and after completing the program (e.g., *What was your favorite activity and why?*, *What new careers or technologies did you learn about during the camp?*, and *How has this camp influenced your future career or education plans?*). These qualitative data were analyzed using a thematic analysis to identify recurring patterns related to student engagement, teamwork, communication, and perceptions of construction careers [27].

The analysis of qualitative data followed an inductive, multi-step process. First, all qualitative responses and observational notes were reviewed in full to achieve familiarity with the data, and initial analytic memos were used to document emerging ideas. Second, open coding was conducted to identify meaningful units of text representing students' prior knowledge, expectations, learning experiences, and perceived career impacts. Third, codes with similar meaning were iteratively grouped into broader categories, and preliminary themes were developed through constant comparison across data sources. Finally, coding framework and theme definitions were refined to ensure internal consistency and clear distinctions between categories. The use of multiple qualitative sources (reflections, discussions, and observations) supported data triangulation and strengthened interpretive credibility. The integration of quantitative and qualitative findings enabled methodological triangulation of results and

provided a more comprehensive understanding of how the industry-integrated summer academy influenced students' career interest development [28].

Results

Social Cognitive Career Theory (SCCT) posits that career interests and choices are shaped by self-efficacy beliefs, outcome expectations, and choice goals, influenced by contextual supports and barriers. In this study, these constructs are reflected in the survey measures as shown in Table 3, which maps specific items to SCCT components in Table 4. Survey items measuring students' confidence in their abilities and interactions represent the self-efficacy construct, including sense of belonging in STEM learning environments (Q5), confidence in using tools and technologies (Q6), belief in performing well in STEM or construction-related coursework (Q7), confidence in sharing ideas in team settings (Q11), comfort asking questions to professionals (Q12), and confidence presenting ideas publicly (Q13). These measures capture both task-specific and social self-efficacy, which are central mechanisms in SCCT influencing career interest development. Students' awareness of career pathways and perceived opportunities reflect outcome expectations, including knowledge of college programs in construction management and STEM (Q2) and understanding of career options in construction management (Q9). These items assess students' perceptions of the potential benefits and opportunities associated with pursuing construction-related careers.

Career-related interests are reflected through items measuring interest in construction management careers (Q1), desire to explore related majors (Q3), and perception of oneself in a STEM career (Q4). Students' future-oriented goals and intentions, another key SCCT component, are captured through intentions to pursue engineering education after high school (Q8). Behavioral engagement and collaborative experiences, such as enjoyment of group projects (Q10), provide additional indicators of learning experiences that contribute to self-efficacy development.

Table 3 presents the results of paired *t*-tests measuring the changes in student 5-point Likert scale responses before and after the summer academy. According to the results of the paired t-tests, students demonstrated statistically significant improvements in knowledge about postsecondary construction management education and career options, engagement in group projects, and presentation skills. Also, students show increased interest in construction management careers at the end of the summer academy. Although this increase was not statistically significant, the positive trend suggests that the summer academy improved students' awareness of construction management as a viable career pathway.

Table 3. The results of paired *t*-tests for pre- and post-academy survey responses

Survey Question	Pre (M)	Pre (SD)	Post (M)	Post (SD)	t-stat	p-value
1. I am interested in a career in construction management.	3.56	1.26	4	0.97	-1.13	0.28
2. I know about college programs in construction management and STEM.	2.13	1.31	4.25	0.93	-5.51	0.00***
3. I want to explore college majors related to	3.88	1.36	3.88	1.03	0.00	1.00

construction, architecture, or engineering.						
4. I see myself in a STEM-related career in the future.	3.56	1.15	4.06	0.68	-1.83	0.09*
5. I feel like I belong in STEM learning environments.	3.63	0.96	3.69	1.01	-0.24	0.82
6. I feel confident using new tools or technologies (e.g., drones, software).	3.13	1.67	3.5	1.37	-0.64	0.54
7. I believe I can do well in STEM or construction-related classes.	3.44	1.67	3.38	1.31	0.13	0.9
8. I intend to go to engineering college after high school.	4.06	1.69	3.94	1.29	0.25	0.81
9. I understand the different career options available in construction management.	2.13	1.31	3.94	1.29	-3.5	0.00***
10. I enjoy working on group projects.	2.5	1.67	3.56	1.41	-2.11	0.05**
11. I feel confident sharing my ideas in a team setting.	2.81	1.47	3.94	1.48	-2.00	0.06*
12. I am comfortable asking questions to faculty or professionals.	3.38	1.59	3.5	1.37	-0.34	0.74
13. I feel comfortable presenting my work or ideas in front of a group.	2.56	1.67	3.81	1.47	-2.48	0.03**

Notes: Pre (M) represents the mean scores of students' responses on the 5-point Likert-scale pre-camp survey items; Pre (SD**)** represents the corresponding standard deviations; Post (M) represents the mean scores of students' responses on the 5-point Likert-scale post-camp survey items; and Post (SD) represents the corresponding standard deviations.
*** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level.

Table 4 maps the survey items onto key SCCT constructs, including self-efficacy, outcome expectations, interests, and goals. This mapping is informed by foundational SCCT research and measurement approaches [29].

Table 4. Mapping of Survey Items to Social Cognitive Career Theory (SCCT) Constructs

SCCT Construct	**Survey Items**	**Measurement**
Self-efficacy	Q5, Q6, Q7, Q11, Q12, Q13	Confidence in skills, belonging, social competencies [30], [31]

Outcome expectations	Q2, Q9	Perceived knowledge of opportunities/rewards [30]
Interests	Q1, Q3, Q4,	Affective attraction to career paths [32], [33]
Goals / Intentions	Q3, Q8	Future academic/career commitments [32], [33]
Learning experiences / engagement	Q10, Q11, Q12, Q13	Teamwork, professional interactions [34], [35]

Figure 4 illustrates the mean scores of students' responses to 13 five-point Likert-scale survey items administered before and after the summer academy. For most items, post-academy survey mean scores exceeded pre-academy survey means, indicating students' improvements in four primary domains: (1) career interests in construction management and STEM fields, (2) technical knowledge and awareness of construction-related educational and career pathways, (3) confidence and self-efficacy in technical and collaborative tasks, and (4) engagement and communication skills.

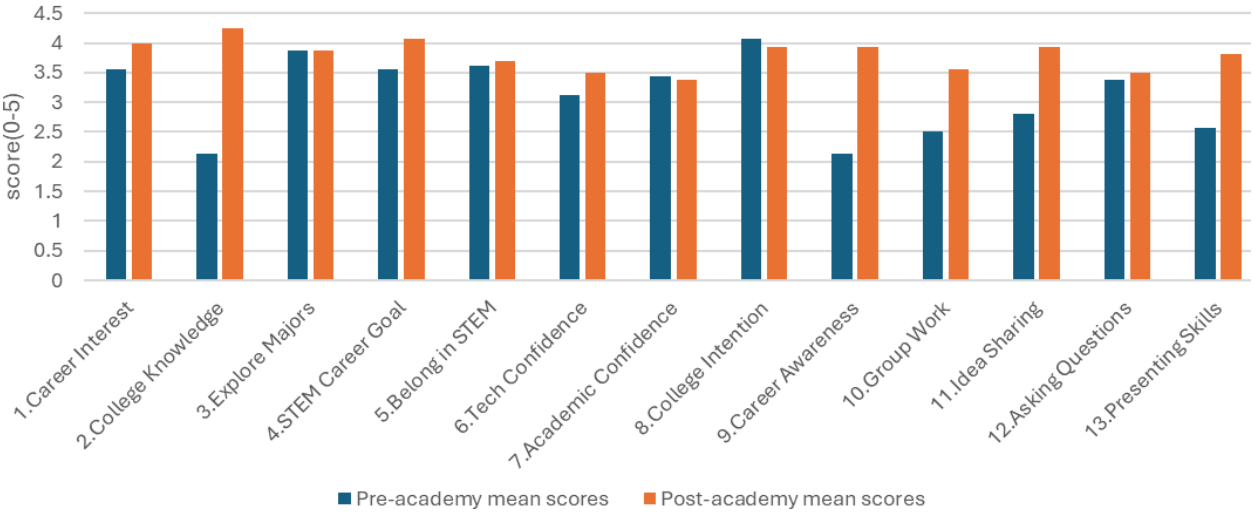

Figure 4. The mean scores of students' responses to pre- and post-academy survey items

Career Interests in Construction Management and STEM Fields

Overall changes in career interest were positive but modest. Career interest in construction-related pathways slightly increased from 3.56 to 4.00, while interest in exploring construction-related college majors remained unchanged at 3.88. Both changes were not statistically significant at the 5% significance level. However, perceived likelihood of pursuing a STEM-related career goal in the future increased from 3.56 to 4.06, which was statistically significant at the 5% level. Intention to attend engineering college upon high school graduation showed nonsignificant change before and after the construction summer academy. These results suggest that students entered the summer academy program already with relatively high interest, with the academy reinforcing the student participants' existing STEM-related career goals.

Knowledge and Awareness of Construction-related Educational and Career Pathways

The largest gains after the summer academy were observed in students' knowledge and awareness outcomes. Knowledge of college programs in construction management and related STEM fields increased significantly from 2.13 to 4.25 ($p < 0.01$). Understanding and knowledge of construction management career options also improved significantly from 2.13 to 3.94 ($p <$

0.01). These results of paired *t*-tests demonstrate substantial improvements in students' knowledge and awareness about construction management and STEM-related educational and career pathways.

Confidence and Self-efficacy in Technical and Collaborative Tasks

Changes in self-efficacy were small and not statistically significant. Confidence in using new tools or technologies increased slightly from 3.13 to 3.50 after the summer academy but was not statistically significant. Similarly, confidence in performing well in STEM or construction-related classes showed statistically nonsignificant changes. These findings suggest that while students gained exposure to technical tools and engineering coursework concepts, short-term participation in the academy may be insufficient to produce statistically significant improvements in perceived academic self-efficacy, which often develops over longer periods of sustained learning experiences.

Engagement and Communication Skills

Several measures related to engagement and communication skills showed meaningful improvements. Students demonstrated increased enjoyment of working on group projects from 2.50 to 3.56, which was statistically significant at the 5% level. Students reported increased confidence in sharing ideas in a team setting from 2.81 to 3.94. Students' comfort in presenting their work or ideas in front of a group increased significantly from 2.56 to 3.81 ($p < 0.05$). In contrast, the participant student's sense of belonging in STEM learning environments showed only a small increase from 3.63 to 3.69 and perceived comfort in asking questions to faculty or professionals increased from 3.38 to 3.50. Overall, the construction summer academy for pre-college students appeared particularly effective in improving student's engagement, teamwork, and presentation confidence, which are critical components of collaborative learning and professional skill development.

Qualitative Results

Pre-academy responses indicated that most students had extremely limited prior knowledge of construction management careers, with many stating that they knew "nothing" or "not much" about the field (e.g., *I don't know anything about construction and I come here to learn about that*). Students primarily hoped to learn the basics of construction processes, technologies, engineering knowledge, and how buildings are designed and built, and to gain direct exposure to engineering and construction-related careers (e.g., *I want to learn how buildings are actually made and what steps happen before construction starts; I want to see what people do in construction jobs and how engineers are involved in projects*). Several students also expressed interest in receiving an introduction to the industry and understanding possible career paths, reflecting high motivation but limited prior awareness of educational and professional opportunities (e.g., *I'm hoping this camp will show me different career options and help me decide if engineering or construction is something I want to do*).

Post-academy responses demonstrated greater awareness of construction processes, technologies, and career roles (e.g., *Before the camp, I didn't know construction management was a college major, but now I understand there are many career paths in this field*). Students identified specific careers such as electricians and referred to technical topics, taught and discussed during the summer academy, including mechanical and electrical systems and construction equipment (e.g., *I learned about mechanical and electrical systems and how they are planned before*

construction starts. That was new to me and made engineering seem more interesting; *The camp introduced me a new construction company, Walbridge; I want to work as a construction manager at GM*). Many highlighted hands-on activities as particularly impactful, including LEGO-based building challenges using blueprints (e.g., *It taught me more about building structure; It helped me understand different areas played in construction; I learned about the VR in a building, where they could simulate walls and furnishing*), drone flying challenges (e.g., *The drone activity was my favorite because it showed how technology is used in real construction projects*), and site visits (e.g., *I enjoyed seeing construction work in action at the GM construction site*), which helped them understand project planning, teamwork, and how designs are translated into real-world structures and infrastructure systems. These experiences suggest improved understanding of how construction projects are engineered, managed, and executed.

Overall, the qualitative findings align with the quantitative results, demonstrating a shift from minimal pre-program knowledge to a more specific and applied understanding of construction engineering and management practices, as well as STEM-related career pathways, following completion of the construction summer academy.

Discussions of Results

The findings of this research show that the academia-industry collaborative construction management summer academy was particularly effective in enhancing students' knowledge and awareness of postsecondary construction management education and career options, while also reporting meaningful gains in students' engagement and communication skills. These outcomes are particularly salient for pre-college student populations, for whom limited exposure and incomplete information often constrain early career exploration.

The paired *t*-test results indicate statistically significant improvements in students' understanding of construction management college programs (Q2) and awareness of diverse career pathways within the field (Q9). The magnitude of these gains (i.e., mean increases of more than two points on a five-point Likert scale) suggests that the construction summer academy successfully addressed a foundational barrier to career interest development: lack of accurate and concrete information about what construction management entails and how students can pursue it academically and professionally. Prior research has shown that early awareness of educational pathways is a critical precursor to sustained career interest, particularly in applied STEM fields that are less visible to K-12 students [36], [37], [38]. The present findings align with the findings of prior research by demonstrating that even a short-term, intensive intervention can improve students' understanding of construction management as a viable postsecondary option [38].

Although increases in career interest in construction management (Q1) did not reach statistical significance, the observed positive trend is nonetheless meaningful in the context of pre-college outreach. According to Donald Super's Life-Span, Life-Space theory, high school students are in the Exploration stage, where career interests remain exploratory and fluid rather than firmly established [39], [40]. Consequently, shifts in career awareness and interests may precede measurable changes in stated responses to Q1. The stability observed in students' interest in exploring related majors (Q3) and intention to attend engineering college (Q8) further suggests that the program functioned less as a recruitment mechanism and more as an informational and exposure-based intervention, expanding students' understanding of options rather than immediately redirecting their plans. This pattern aligns with career development literature

emphasizing that early interventions primarily influence career awareness and openness, which later translate into sustained interest and choice [41].

In contrast, outcomes related to confidence and self-efficacy showed smaller and largely non-significant changes. This result may reflect the relatively short duration of the academy, as self-efficacy beliefs typically develop through repeated mastery experiences over longer periods [42]. However, modest upward trends in confidence using new tools and technologies (Q6) suggest that hands-on exposure to construction-related technologies, such as drones and software demonstrations, may begin to lay the groundwork for future gains in technical confidence when reinforced through longer or repeated programming.

The strongest non-cognitive gains were observed in the domain of engagement and communication skills. Statistically significant improvements in enjoyment of group projects (Q10) and comfort presenting work (Q13), along with near-significant gains in confidence sharing ideas in team settings (Q11), indicate that collaborative, project-based, hands-on activities played a central role in shaping students' learning experiences. These outcomes suggest that industry engagement and team-based project structures not only supported active participation but also created socially supportive environments conducive to career exploration.

The findings of this research suggest that career interest development in construction management is strongly mediated by increases in knowledge, awareness, and meaningful engagement, rather than immediate shifts in declared career intentions. The summer academy's impact appears to operate through an indirect pathway: by learning construction management education and careers, providing real-world examples of professional practice, and enabling students to participate actively in collaborative tasks, the program broadened students' perceptions of the field and increased its perceived accessibility. Also, this study demonstrates the potential of academia–industry collaborative summer academies to address persistent awareness gaps in construction management and related STEM fields. By providing early, authentic exposure to professional practices and educational pathways, such programs can play a critical role in diversifying and strengthening the future construction workforce.

The findings suggest that even short-term interventions can meaningfully influence pre-college students' perceptions of construction management, particularly by expanding awareness and developing knowledge of educational and professional pathways in STEM fields. This has implications for workforce development, as increased early awareness may lead to more informed educational choices and improved alignment between students' interests and post-secondary education and career pathways.

Despite these findings, internal validity limitations should be considered. The study employed a single-group pre–post design without a comparison or control group, which limits the ability to attribute observed changes exclusively to participation in the summer academy. Improvements in survey responses may partially reflect alternative explanations such as maturation effects, prior exposure to STEM experiences, testing familiarity, or social desirability bias. Therefore, the results should be interpreted as preliminary evidence of potential program impact within this specific cohort rather than definitive causal effects.

Future research could strengthen internal validity by incorporating quasi-experimental or experimental designs that include comparison groups. Random assignment, when feasible, would provide stronger causal inference regarding program effectiveness. In addition, longitudinal follow-up assessments conducted several months or years after program participation would

allow examination of the persistence of career interest and educational pathway decisions over time. Multi-site implementation across different institutions, geographic regions, or demographic populations would further enhance external validity and generalizability while enabling larger pooled samples for more robust statistical analysis.

Conclusions

This study evaluated the impact of the academia-industry collaborative Construction Management Summer Academy on pre-college students' career interests, technical knowledge and awareness, confidence and self-efficacy, and engagement and communication skills. The findings show that the program effectively enhanced students' knowledge of educational pathways and strengthened teamwork and communication skills through hands-on, industry-connected learning experiences. Significant gains in understanding construction management college programs and improved engagement during group activities demonstrate the potential of immersive outreach programs to positively influence early career exploration in construction and STEM fields. These results highlight the value of structured exposure, site visits to local construction firms and projects, and direct professional interactions in bridging the gap between academic concepts and real-world practice.

The findings of this research offer several actionable insights for improving future iterations of construction-focused summer academies. First, the strong gains in knowledge and awareness underscore the value of explicit, repeated exposure to post-secondary education and career pathways, including structured sessions on college programs, degree requirements, and career trajectories. Future programs may further strengthen these outcomes by incorporating guided reflection activities that help students connect newly acquired information to their personal goals and interests. Second, the comparatively smaller changes in confidence and self-efficacy point to the importance of extended program duration or follow-up experiences. While short-term academies are effective for awareness-building, longer or multi-phase programs such as multi-week academies, academic-year mentoring, or alumni follow-ups may be necessary to produce stronger gains in technical confidence and self-efficacy that support sustained career interest. The academia-industry collaborative summer academy program in this study will be iteratively refined, expanded, and implemented based on continuous evaluation and participant feedback. Third, the significant improvements in engagement and communication highlight the effectiveness of collaborative, project-based learning, and industry interaction. Expanding opportunities for students to work in teams, present their work to professionals, and receive feedback from industry mentors may further enhance students' engagement and confidence while reinforcing their understanding of construction management as a dynamic, people-oriented profession.

While the findings of this study demonstrate meaningful improvements in students' awareness of construction management pathways and their engagement in collaborative tasks, several limitations should be recognized. First, the findings are based on a relatively small sample of participants, which reduces statistical power and may limit the extent to which the results represent broader high school populations. Accordingly, the findings should be interpreted as exploratory indicators of potential effects rather than definitive evidence of impact. The primary contribution of this work is therefore to generate preliminary insights into how an academia-industry collaborative summer academy can influence students' construction career perceptions and interests, rather than to provide population-level estimates of effect sizes. Also, as a single-group pre–post evaluation without a comparison cohort, the study design limits the ability to

attribute observed changes exclusively to program participation, as external influences or maturation effects cannot be fully ruled out. Although the data offer useful insight into how students respond to immersive construction-focused learning, the patterns observed here may vary for larger or more diverse groups of learners.

Second, because paired *t*-tests were conducted at the individual survey item level with a limited sample, we caution against overinterpreting individual *p*-values. Future research should employ a longitudinal design implemented over multiple summers and/or pool data across cohorts to increase sample size, improve statistical power, and allow for more robust modeling of changes in students' attitudes and career interests over time. Such designs would substantially strengthen the evidence base and enable stronger inferences regarding the effectiveness and generalizability of the academy model. The academy's one-week duration constrained the depth of change that could be measured. Because both surveys were administered within a short period, the study captures only immediate effects rather than long-term shifts in attitudes, confidence, or career interests. Constructs such as self-efficacy typically develop gradually, and a short intervention may not be sufficient to observe substantial or lasting change.

Third, because all participants were from the Detroit metropolitan area, the findings may not fully reflect the perspectives or needs of students in other regions or educational environments. Finally, because this research is a case study of a single construction management summer academy, the findings should be interpreted as context specific and illustrative, rather than assumed to generalize to all institutions or program models.

Despite these limitations, the study offers preliminary evidence that industry-integrated experiential programs can strengthen students' understanding of construction career pathways and improve their teamwork skills. Future research should include a larger and more diverse group of participants, extend the duration of the academy, and incorporate follow-up assessments to determine whether the observed changes are sustained over time. Moreover, future research could build upon the present findings by employing comparative program evaluations, extending assessment windows to capture sustained developmental outcomes, and implementing similar outreach initiatives across varied institutional and geographic contexts to evaluate consistency and scalability. Integrating qualitative methods such as interviews or focus groups may also provide deeper insight into how students develop confidence and career interests in construction-related fields. Replicating the summer academy in other cities or adapting it for younger learners could further demonstrate the broader applicability and impact of this educational model.

Overall, this study contributes to construction management education and workforce pathway development by providing an evaluative case study of an academia–industry collaborative summer academy and its influence on students' construction career awareness, interest, and confidence. The findings highlight the value of integrating industry participation within experiential learning environments to support early exposure to the construction career pathways.

By grounding the program design in Social Cognitive Career Theory and integrating experiential learning with industry engagement, the study demonstrates a theoretically informed approach to supporting early career exploration in construction and engineering pathways. Methodologically, the mixed-methods design offers a more comprehensive understanding of students' learning experiences and perceived impacts, while the pilot implementation provides a replicable model for academia–industry partnerships aimed at workforce pipeline development. Although exploratory in nature, the findings offer practical insights for educators, industry partners, and

policymakers seeking to broaden participation in construction-related STEM careers and establish a foundation for future longitudinal and multi-site research.

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