2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #53310

Evaluating an Engineering Summer Camp: A Pre/Post-Analysis of Student Awareness, Interest, and Agency

Dr. Samieh Askarian Khanamani, University of Cincinnati

Dr. Samieh Askarian Khanamani holds a degree in Engineering Education from the University of Cincinnati with ten years of experience as a vice principal and STEM teacher in elementary schools. Designer and organizer of educational informal programs and workshops for children and parents that focus on engineering and hands-on STEAM activities. Researcher in improving creativity specifically divergent thinking among children by using innovative tools like origami. Having an engineering background from both master's and undergraduate studies.

Elizabeth Adelman, FHI 360

Dr. Elizabeth Adelman specializes in workforce development, engineering education, teacher development, and education in fragile and conflict-affected settings, with a focus on understanding and improving how education systems shape students' learning, identity development, and long-term opportunity.

Dr. Whitney Gaskins, University of Cincinnati

Dr. Gaskins is the Associate Dean of Inclusive Excellence and Community Engagement in the University of Cincinnati College of Engineering and Applied Science, the only African-American female currently teaching in the faculty of the College of Engineering

Kyle Turner, University of Cincinnati
Elizabeth Meintel, University of Cincinnati

I'm Elizabeth Meintel, I recently defended my dissertation to receive my Ph.D. in the Department of Engineering and Computing Education at the University of Cincinnati. My background is in Computer Engineering and I have entered into the engineering education field with a passion for increasing the accessibility of engineering to students of all identities and abilities. My research area is in diversity, community engagement, and the issues that LGBTQIA+ students encounter within the field of engineering.

Caitlin Kim

[Traditional Research Paper] Evaluating an Engineering Summer Camp: A Pre/Post-Analysis of Student Awareness, Interest, and Agency

As engineering fields confront increasingly complex social, technological, and environmental challenges, the demand for an engineering ready workforce has become more urgent [1, 2] . Early and meaningful exposure to engineering plays an important role in shaping young people's understanding of what engineering is, who engineers are, and how engineering connects to real-world problems [3-5]. When such exposure is limited, students are less likely to develop sustained interest in engineering or to consider engineering as a viable career pathway [6, 7]. Yet many students reach high school having had few opportunities to engage with engineering in substantive ways. In traditional school settings, engineering is often peripheral to the curriculum, leaving students with incomplete or abstract understandings of the field and little sense of how engineering aligns with their interests, identities, or values [8, 9].

Consistent with this pattern, declines in students' interest in engineering during adolescence are often described through the "leaky pipeline" metaphor [10]. Rather than reflecting differences in ability, such exits are frequently linked to limited access to authentic, identity-relevant engineering experiences. Opportunities to engage in engineering practices, interact with engineers, and receive recognition help young people imagine themselves within the field [11-13]. In response, informal learning environments, such as engineering summer camps, have emerged as a common strategy for introducing young people to engineering in ways that differ from traditional schooling [14-17]. While such programs are often designed to spark interest and confidence, far less is known about how short-term experiences shape students' understanding of engineering, their engagement in engineering practices, and their sense of themselves as potential participants in the field.

This study addresses this gap by examining whether participation in a short-term engineering summer camp can produce measurable shifts in how young people understand, engage with, and position themselves in relation to engineering. Drawing on data from the Next Engineers (NE) Engineering Camp, a one-week immersive program designed around a research-based theory of change, we examine changes in students' engineering awareness, interest, habits of mind, and identity from pre- to post-program. Rather than treating participation alone as evidence of impact, this study asks whether and how an intentionally designed short-term experience can support movement from general interest in science, technology, engineering and math (STEM) toward beginning to think, feel, and act like engineers.

Background

Pre-College and engineering summer camps

Expanding interest in engineering depends in part on young people having access to meaningful STEM learning opportunities prior to college, particularly during middle and high school when students begin to form more concrete ideas about academic and career pathways [15, 18]. Without access to such experiences, students may know too little about engineering to consider it as a future pathway. In response, informal learning programs, especially engineering-focused summer camps, have emerged as a common strategy for broadening access to engineering

experiences outside of traditional school settings [19]. Prior research suggests that these camps offer learning environments distinct from classrooms, emphasizing learning through hands-on engagement with engineering practices [20, 21].

A growing body of research indicates that participation in pre-college engineering camps is associated with positive outcomes, including increased interest in engineering, improved attitudes toward the field, and greater likelihood of considering STEM majors in postsecondary education [22-24]. Studies have also documented gains in students' engineering self-efficacy, particularly when students engage in problem-solving and design activities [25]. Much of this literature focuses on broad attitudinal outcomes such as interest or confidence, leaving open questions about how short-term camp experiences influence deeper developmental processes, such as how students come to understand engineering work, adopt engineering ways of thinking, and begin to see themselves as potential participants in the field [26].

Next Engineers engineering camp theory of change

This study is guided by a theory of change that conceptualizes students' movement toward engineering as a developmental process shaped by exposure, practice, and recognition rather than interest alone. Prior research on engineering identity suggests that young people's decisions to pursue engineering are influenced by their awareness of the field, evolving interest, and the extent to which they begin to see themselves as capable participants in engineering spaces [11, 12]. Students must move from simply expressing interest in STEM to engaging in the practices and roles associated with engineering, a shift often described as moving from "liking math" to "acting like an engineer" [27]. From this perspective, simply introducing students to engineering is insufficient; meaningful engagement requires opportunities to act like engineers by engaging in design, problem-solving, collaboration, and iteration.

Building on this work, the NE Engineering Camp was intentionally designed to support progression across five interrelated constructs: engineering awareness, interest, engineering habits of mind, engineering identity, and agency. Awareness refers to students' understanding of what engineering is and what engineers do; interest reflects students' developing orientation toward further engagement with engineering; habits of mind capture ways of thinking characteristic of engineering practice, such as problem identification, visualization, and iteration; and identity reflects students' willingness to see themselves as potential engineers. Agency is understood not as an attitudinal belief but as enacted intention. In this case, students' readiness to take concrete steps toward further engineering opportunities. Within a short-term camp context, these constructs provide a structured framework for examining whether and how intentionally designed experiences can support early positioning along the engineering pathway.

Methods

Program context

The NE Engineering Camp is a one-week program for rising 9th and 10th grade students, part of a global education and college-readiness initiative funded by the GE Aerospace Foundation in the Midwest USA that aims to broaden participation in engineering among youth ages 13–18.

NE Engineering Camp engages students in extended, hands-on engineering design challenges, site visits, and mentorship from practicing engineers, with the goal of increasing students' awareness of engineering, supporting the development of engineering habits of mind (EHoM), and fostering emerging engineering identities through authentic engagement with engineering practices.

This study examines outcomes from 2022 to 2025, during which activities were held on the R1 public university campus in the Midwest USA. Data was drawn from pre- and post-test surveys administered to all Camp participants, with the pre-test completed during enrollment and the post-test administered at the conclusion of Camp. Across four years of Camp implementation, 736 students completed at least one survey instrument (Table 1). Pre- and post-test responses were matched to enable student-level analysis of changes in key outcomes over the course of the one-week Camp experience.

Participants and samples

Survey responses from the first year of camp implementation did not achieve a sufficiently high pre–post match rate to support reliable analysis and were therefore excluded from the analytic sample. In each of the subsequent three years, we successfully matched between 83 and 87 students per year among those who submitted survey responses, resulting in a total matched sample of 253 students across Years 2 through 4 (Table 1).

Table 1. Survey match rate by year

Survey Sample Overview	**2023**	**2024**	**2025**	**Total**
Camp participants	207	109	105	421
Survey count (pre/post)	172/109	99/94	97/91	368/294
Matched surveys	87	83	83	253
% of participants matched	42%	76%	79%	60%

The camp student survey was designed to align with the study's theory of change and to capture shifts in students' relationships to engineering over the course of the camp experience. Survey items were drawn from existing literature on engineering development constructs. The instrument was iteratively refined across implementation years based on item performance, with open-ended questions added in Year 4 to provide deeper insight into students' perceptions of engineering.

The survey includes two complementary components. The first consists of Likert-scale items aligned with four engineering-related constructs: engineering awareness, engineering interest, EHoM, and engineering identity (Table 2). Item responses were aggregated to generate composite scores for each construct and rescaled to a standardized 100-point metric. The second component includes open-ended items inviting students to reflect on changes in their interest in and understanding of engineering. These qualitative responses were used to contextualize and deepen the interpretation of the quantitative findings. The engineering agency was operationalized behaviorally through a post-Camp item asking students whether they were interested in applying to an advanced NE program, capturing students' expressed intention to pursue further engineering opportunities. As this program was only available to Year 2 and Year 3 participants, there is no data from Year 4.

Table 2. Camp survey measures

Construct	Definition	Example Items
Awareness	Knowledge of engineering careers, understanding of what engineers do, and recognition of engineering practices, applications and processes [28].	"I know the difference between types of engineering fields."
Interest	Expressed enjoyment of engineering-related activities and the learning of engineering skills and ideas [12, 29].	"I enjoy learning how things fit and work together."
EHoM	Ways of thinking and acting that shape how individuals approach engineering problems and enable them to engage in authentic engineering reasoning, iteration, and design [27].	"When I solve a problem I use drawings or sketches to think through how my idea will work."
Identity	The extent to which individuals understand, enact, and are recognized in relation to engineering roles, integrating interest, belief in competence, and recognition as an engineering person [12, 30].	"I can imagine myself as an engineer."

Analytic approach

Quantitative analyses examine pre–post changes in each of the four focal constructs using matched student data. For each construct, paired sample t-tests were used to assess differences in mean scores within each camp year. Because survey items were refined over time, analyses were conducted separately by year rather than pooled across cohorts. Quantitative results were complemented by qualitative analysis of students' open-ended responses to contextualize observed patterns of change and to deepen understanding of how students experienced Camp. While this work focuses solely on more general findings across the sample, more in-depth analysis and findings are reserved for future work done by the team.

Results

This section presents results from pre- and post-Camp student surveys administered during Years 2, 3, and 4 of implementation. Results for Year 2 and 3 are presented together as survey items were identical. As the Year 4 survey included new items, including qualitative responses, we analyzed this data separately.

Pre–Post changes in Years 2 and 3

Across Years 2 and 3 of Camp implementation, students demonstrated positive pre–post changes across all four measured constructs (Table 3). The largest gains were observed in engineering awareness, with average increases of 12.60 percentage points in Year 2 and 15.26 percentage points in Year 3. Changes in engineering interest, EHoM, and engineering identity were more modest, with identity gains notably larger in Year 3 than in Year 2 (+8.54 versus +2.38 percentage points). Baseline scores were lowest in awareness, followed by identity, while baseline scores in interest and EHoM were relatively high and remained similarly high at post-test. Measures of agency showed that in Year 2, roughly 68% of students who completed Camp expressed interest in applying for NE Academy, and in Year 3 this figure increased to 80% of Camp participants.

Table 3. Average pre- and post-scores

	Survey Version 1.0						Survey Version 2.0		
	Year 2			Year 3			Year 4		
Construct	Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
Awareness	57.8	70.44	12.60***	55.3	70.6	15.26***	69.58	84.24	14.66***
Interest	76.61	79.79	3.18	78.7	80.8	2.16	84.76	82.96	-1.81
EHoM	75.05	77.02	1.98	74.50	76.00	1.5	77.36	79.37	2.01
Identity	63.14	65.52	2.38	61.50	70.00	8.54*	71.69	78.01	6.33*

*p < .05, **p < .01, ***p < .001

Pre–Post changes in Year 4

In Year 4 (Table 4), students demonstrated the largest gains in engineering awareness (+16.44 percentage points), followed by more modest gains in engineering identity (+6.33 percentage points). Scores in engineering interest and EHoM remained relatively stable from pre- to post-test, with high baseline and post-test averages across constructs.

Patterns in student-level data

Aggregate averages suggest limited net change for some constructs. However, student-level analyses reveal substantial heterogeneity in how students' scores shifted over time. Table 4 presents this analysis for Year 4, which includes the largest matched sample. For example, in engineering awareness, most students (81%) demonstrated increases from pre- to post-test. In contrast, interest exhibited more varied trajectories: 28% of students reported increases, 28% reported no change, and 45% reported decreases. Item-level analyses indicate that these declines were driven primarily by shifts in responses to items related to experimentation and understanding how systems work.

Table 5. Student-level differences from pre to post

	% of students with a change from pre to post			Average pre/post scores		
Construct (n=83)	Decrease	No change	Increase	Pre	Post	**Diff**
Awareness	9.64%	9.64%	80.72%	69.58	84.24	**14.66*****
Interest	44.58%	27.71%	27.71%	84.76	82.96	**-1.81**
EHoM	48.19%	3.61%	48.19%	77.36	79.37	**2.01**
Visualizing	28.92%	20.48%	50.60%	66.57	72.19	**5.62**
Problem-identification	39.76%	21.69%	38.55%	80.02	80.3	**0.28**
Adapting	28.92%	37.35%	33.73%	80.42	81.93	**1.51**
Improving	31.33%	34.94%	33.73%	82.43	83.08	**0.65**
Identity	19.28%	25.30%	55.42%	71.69	78.01	**6.33***

*p < .05, **p < .01, ***p < .001

Although declines were observed on particular facets of interest at the item level, qualitative feedback suggests that many students' broader interest in engineering as a field strengthened through their Camp experience. Students frequently described feeling "more motivated to dive deeper into engineering" and noted that Camp increased their interest by "giving me a preview of what being an engineer is like." As one student reflected, "Knowing I enjoyed Camp, I will

probably enjoy being in the engineering field." Together, these responses suggest that apparent quantitative declines may reflect students developing a more concrete and realistic understanding of engineering rather than a loss of engagement with the field.

EHoM showed a similar pattern to interest, with approximately half of students demonstrating increases and half demonstrating decreases. Changes in EHoM were closely aligned with changes in interest, as 65% of students whose interest declined also demonstrated declines in EHoM. Disaggregated analyses by construct indicate that declines were concentrated in the problem-identification and improving sub-constructs, which align closely with the interest items showing the greatest decreases. This pattern suggests that shifts in students' engagement with specific aspects of engineering practice, particularly those involving iteration and refinement—may underlie changes observed in both interest and EHoM.

Engineering identity showed a different trajectory. While average identity scores increased modestly from pre- to post-Camp, more than half of students reported individual-level gains, including many whose interest declined or remained unchanged. Among students whose interest scores decreased, 48% still demonstrated increased identity and an additional 30% reported no change. Qualitative reflections help explain these patterns: for some students, Camp made engineering feel more attainable ("It showed how truly reachable engineering is"), while for others it opened engineering as a viable option without requiring immediate commitment ("I enjoyed knowing I can be an engineer if I decide to"). At the same time, limited change among some students appears related to high initial identity, particularly for those who entered Camp already confident in their intention to pursue engineering. Together, these findings suggest identity development during Camp often occurred through clarification and affirmation rather than uniform growth.

Discussion

Across multiple years, results indicate that short-term engineering camps influence some dimensions of students' relationships to engineering more readily than others [18, 31, 32]. The largest gains were observed in engineering awareness, with more modest increases in identity, while interest and engineering habits of mind remained relatively stable due to high baseline levels. These patterns suggest that Camp participation was particularly effective in helping students develop clearer, more concrete understandings of engineering and begin to see themselves in engineering roles, even when initial enthusiasm for STEM was already present [19, 33].

Student-level analyses further clarify this pattern. Rather than uniformly increasing interest, Camp experiences appeared to support differentiation in how students engaged with and understood engineering practice [18, 34, 35]. Notably, engineering identity often increased even among students whose interest declined or remained unchanged, indicating that identity development during short-term programs may occur through processes of clarification and affirmation rather than simple growth in enthusiasm. Together, these findings highlight how short-term engineering camps can refine students' understanding of engineering and support early identity development, even when interest stabilizes or differentiates [36, 37].

Conclusion

This study demonstrates that short-term engineering camps, when intentionally designed around a theory of change and paired with appropriate measurement strategies, can produce meaningful and measurable shifts in how young people understand engineering and see themselves in relation to the field. Rather than uniformly increasing interest, Camp supported gains in awareness and identity while enabling students to develop more realistic and differentiated perspectives on engineering practice. These findings point to the value of intentionally designed, theory-driven programs and nuanced measurement approaches for understanding what engineering outreach efforts can realistically accomplish within limited time frames.

Reference

[1] R. Adams *et al.*, "Multiple perspectives on engaging future engineers," *Journal of Engineering Education,* vol. 100, no. 1, pp. 48–88, 2011.

[2] W. Gaskins, S. Askarian, and K. Eason, "Black is Gold: The Importance of Racial Identity to Black Undergraduate Students in Engineering," in *2022 ASEE Annual Conference & Exposition*, 2022.

[3] N. DeJarnette, "America's Children: Providing Early Exposure to STEM (Science, Technology, Engineering and Math) Initiatives," *Education 3-13,* vol. 133, pp. 77–84, 2012.

[4] D. Spencer and G. Mehler, "Opportunities in engineering education: Pathways to better-prepared students," *The Bridge,* vol. 43, no. 2, pp. 24–30, 2013.

[5] H. Ehsan, A. P. Rehmat, and S. Askarian Khanamani, "Developing STEM Wisdom in Neurodiverse Gifted Learners: An Asset-Based Approach to Engineering Design for Autistic Children," *Roeper Review,* vol. 48, no. 1, pp. 51–62, 2026.

[6] W. C. J. Mau and J. Li, "Factors influencing STEM career aspirations of underrepresented high school students," *The Career Development Quarterly,* vol. 66, no. 3, pp. 246–258, 2018.

[7] J. Agarwal, S. Askarian, G. Bucks, and T. Murphy, "State of evaluating the effectiveness of teaching development programs for students in engineering," in *2022 ASEE Annual Conference & Exposition*, 2022.

[8] R. W. Habash and C. Suurtamm, "Engaging high school and engineering students: A multifaceted outreach program based on a mechatronics platform," *IEEE Transactions on Education,* vol. 53, no. 1, pp. 136–143, 2009.

[9] E. Towers, J. A. Simonovich, and Y. V. Zastavker, "Students' perceptions of the engineering profession and implications for interest in the field," in *2011 Frontiers in Education Conference (FIE)*, 2011: IEEE, pp. F3D–1–F3D–7.

[10] A. V. Maltese and R. H. Tai, "Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students," *Science Education,* vol. 95, no. 5, pp. 877–907, 2011. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/sce.20441.

[11] H. B. Carlone and A. Johnson, "Understanding the science experiences of successful women of color: Science identity as an analytic lens," *Journal of Research in Science Teaching,* vol. 44, no. 8, pp. 1187–1218, 2007. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/tea.20237.

[12] A. Godwin, "The development of a measure of engineering identity," presented at the ASEE Annual Conference & Exposition, June 24–28, 2016.
[13] E. Litzler and C. Samuelson, "How underrepresented minority engineering students derive a sense of belonging from engineering," in *2013 ASEE Annual Conference & Exposition*, 2013, pp. 23.674. 1–23.674. 20.
[14] T. Roberts *et al.*, "Students' perceptions of STEM learning after participating in a summer informal learning, experience," (in eng), *International Journal of STEM Education,* vol. 5, no. 1, p. 35, 2018.
[15] W. Gaskins, P. D. Lampley, and K. L. Cabrera-Toro, "Leveling the playing field: A virtual summer camp for women of color," in *2021 ASEE Virtual Annual Conference Content Access*, 2021.
[16] P. Lampley, K. Cabrera-Toro, W. Gaskins, M. Mensah, and S. Askarian, "Engagement in practice: the road to higher education—is the pipeline half empty or half full? an analysis of student experiences, perceptions and backgrounds when considering a career in engineering," in *2022 ASEE Annual Conference & Exposition*, 2022.
[17] E. Meintel, S. A. Khanamani, B. M. Bartish, W. Gaskins, and K. Turner, "Draw an Engineer," in *2024 ASEE Annual Conference & Exposition*, 2024.
[18] T. Robinson, A. Kirn, J. Amos, and I. Chatterjee, "The effects of engineering summer camps on middle and high school students' engineering interest and identity formation: A multi-methods study," *Journal of Pre-College Engineering Education Research (J-PEER),* vol. 13, no. 2, p. 6, 2023.
[19] C. Amanova, P. M. Wright, and K. Brynteson, "From camps to careers: analyzing the impact of summer STEM camps on students' career choices," *Journal of Pedagogical Research,* vol. 9, no. 5, pp. 159–179, 2025.
[20] T. Roberts *et al.*, "Students' perceptions of STEM learning after participating in a summer informal learning experience," (in eng), *International Journal of STEM Education,* vol. 5, no. 1, p. 35, 2018, doi: 10.1186/s40594-018-0133-4.
[21] B. Hynes, Y. Costin, and I. Richardson, "Educating for STEM: Developing entrepreneurial thinking in STEM (Entre-STEM)," in *Enhancing entrepreneurial mindsets through STEM education*: Springer, 2023, pp. 165–194.
[22] A. Cloutier *et al.*, "Modification and assessment of a residential summer program for high school women," *Journal of Pre-College Engineering Education Research (J-PEER),* vol. 8, no. 2, 2018.
[23] J. M. Faber, L. G. Grzech, M. M. Mahmoud, and K. H. Becker, "The effect of summer engineering camps on students' interest in STEM," in *2020 ASEE Virtual Annual Conference Content Access*, 2020.
[24] A. Qasrawi, T. Sulbaran, and S. Langar, "Diversity trends in STEM summer Ccamps over the last two decades," in *2024 ASEE Annual Conference & Exposition*, 2024.
[25] M. D. Hughes, "Exploring the impact of pre-college STEM exposure on first-year engineering student self-efficacy," Doctoral dissertation, University of Kentucky University of Kentucky Libraries, 2021.
[26] A. Caspi, P. Gorsky, R. Nitzani-Hendel, and B. Shildhouse, "STEM-oriented primary school children: participation in informal STEM programmes and career aspirations," *International Journal of Science Education,* vol. 45, no. 11, pp. 923–945, 2023.
[27] B. Lucas and J. Hanson, "Thinking like an engineer: using engineering habits of mind and signature pedagogies to redesign engineering education," *International Journal of*

Engineering Pedagogy (iJEP), vol. 6, no. 2, pp. pp. 4–13, 05/12 2016. [Online]. Available: https://online-journals.org/index.php/i-jep/article/view/5366.

[28] S. M. Randol, C. Herran, S. Ramos-Montanez, T. Shagott, and M. R. Benne, "Engineering awareness at design challenge exhibits (fundamental)," in *2021 ASEE Virtual Annual Conference Content Access*, 2021.

[29] P. M. Sadler, G. Sonnert, Z. Hazari, and R. Tai, "Stability and volatility of STEM career interest in high school: A gender study," *Science Education,* vol. 96, no. 3, pp. 411–427, 2012. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/sce.21007.

[30] A. Godwin and A. Kirn, "Identity-based motivation: Connections between first-year students' engineering role identities and future-time perspectives," *Journal of Engineering Education,* vol. 109, no. 3, pp. 362–383, 2020. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/jee.20324.

[31] R. Hammack, T. A. Ivey, J. Utley, and K. A. High, "Effect of an engineering camp on students' perceptions of engineering and technology," *Journal of Pre-College Engineering Education Research (J-PEER),* vol. 5, no. 2, p. 2, 2015.

[32] A. M. Johnson, S. A. Khanamani, M. O. Onyango, and W. Gaskins, "Board 179: Campus Climate, STEM Students: Examining Structural Obstacles for BW Student Success," in *2024 ASEE Annual Conference & Exposition*, 2024.

[33] S. A. Khanamani, A. M. Johnson, M. Onyango, and W. B. Gaskins, "WIP: STEM Culture from Faculty Perspectives: How Faculty See Climate in STEM and its Effect on the Sense of Belonging of Traditionally/Historically Excluded Students," in *2024 IEEE Frontiers in Education Conference (FIE)*, 2024: IEEE, pp. 1–4.

[34] B. Bilgin, D. Nazimuddin, L. Edano, and N. Nikolova, "Fostering early engineering identity through K-12 outreach: insights from a three-week summer program," in *2025 IEEE Global Engineering Education Conference (EDUCON)*, 2025: IEEE, pp. 1–7.

[35] K. Eason, W. Gaskins, B. Guy, S. Martin, and S. Askarian, "We lose the game before we start to play: How Black women make meaning of their experiences in engineering education," *Journal of Black Excellence in Engineering, Science, & Technology,* vol. 1, 2023.

[36] S. Weiner, M. Lande, and S. Jordan, "The engineer of 2020, in the making: Understanding how young adults develop maker identities and the implications for education reform," *International Journal of Engineering Education,* vol. 34, no. 2, pp. 833–842, 2018.

[37] F. Ranjbar, J. Wang, S. A. Khanamani, J. Agarwal, and P. Imbrie, "WIP: Negative and Positive Behaviors Exhibited by Students in the Context of Engineering Project Team," in *2025 IEEE Frontiers in Education Conference (FIE)*, 2025: IEEE, pp. 1–5.