Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #48049

Increasing Opportunity in Pre-College Engineering Camps Using Research Partnerships

Mrs. Kelly Anderson, University of North Carolina at Charlotte

Kelly Anderson is an Associate Director of Outreach in the William States Lee College of Engineering at UNC Charlotte. Her research interests include K-12 STEM education, outreach education, accessible pathways to engineering, curriculum development, science education, and standard development.

Gretchen Dietz, Western Carolina University

Gretchen A. Dietz is the Director of the Engineering Discovery Program at Western Carolina University. Her research interests include diversity in engineering and qualitative methodologies.

WIP: Increasing Opportunity in Pre-College Engineering Camps Using Research Partnerships

Abstract

This abstract represents the first attempt to increase sponsored spots in high school summer camp program programming in order to be more responsive to area population. As we looked at those able to access high-quality engineering summer camps in the Charlotte area we realized that there was a huge gap due to the rising financial burden of summer programming. By partnering with the Charlotte AIR Institute, a research group on campus, we were able to not only our students and up-and-coming research, but also to have financially supported spots for local students. This paper follows the logistical considerations we faced during the planning and implementation of the Pre-College Engineering camp, what we learned, and how we will move forward with programming.

A particular highlight of the partnership with the AIR Institute was not only provided the opportunity to students who would otherwise not have the option to go to this camp, but also created more timely, relevant and authentic experiences to all students involved by leveraging partnerships with our international airport and the aviation museum.

During the writing of this paper, we had a shift in one of the writer's roles to be in charge of the Discovery Program at Western Carolina University in rural Cullowhee, North Carolina. As such, we shifted from a single university focus to a collaborative program, then two-program approach. We look forward to the impact this program will have on the region through this approach. These changes influenced our change to a Work In Progress.

The Role of Summer Camps in Promoting STEM Education

Summer camps are attended by millions of students K-12 each year. Summer camps serve a number of purposes from childcare needs, reduction of "summer slide" or learning loss over the course of time that schools are not in session, as well as exposing students to topics that are not covered fully within the curriculum of the traditional school year. Beyond these areas, summer camps offer students the opportunity to develop soft skills such as cooperation, communication, creativity, and collaboration. These soft skills positively impact students development, including their career development [1]. STEM Summer Camps, especially those who focus on hands-on learning and laboratory experiences can improve students' interest in and persistence in STEM fields [2]. In addition to the skills and knowledge developed, Camps on Campus allow students to engage with faculty, staff, students, and university facilities to enrich their experiences and allow for a greater sense of self efficacy as campers see themselves as university students.

The access to high quality facilities, including university laboratories and faculty who lead these labs, is an important aspect of our campus. Not only are these facilities often inaccessible for students in their daily lives and public school environments, but they also experience mentorship and role models who can inspire.

To support career development, interest needs to be sparked, maintained, and internally motivating. Interest development theory includes 4 stages; Phase 1: Triggered Situational Interest, Phase 2: Maintained Situational Interest, Phase 3: Emerging Individual Interest, and Phase 4: Well-Developed Individual Interest. During these 4 stages, there is a shift from facilitator action to student action. During Phase 1: Triggered Situational Interest, interest is triggered by an event, activity, or other external stimulant. During Phase 2, Maintained Situational Interest, attention is sustained through a meaningful task and is supported by external conditions. During Phase 3: Emerging Individual Interest, the individual begins showing value to the topic, although the attention is still likely triggered in part externally. During Phase 4: Well-Developed Individual Interest individuals are able to sustain interest even with adverse events. Attention may be from external or internal factors [3].

Challenges

With all the benefits of summer programming, there is a high demand, and a high cost for most programs. In contrast to many after school programs offered during the school year, summer programs require transportation, increasingly high costs of attendance, and often require students to bring or purchase lunch for additional fees, unlike the free or reduced lunch that many low income students depend on during the school year.

Camps on Campus at the University of North Carolina at Charlotte charge a rate of $275 per week per camper for a program which lasts from 9:00 a.m. to 4:00 p.m. Last year, these camps served over 2,000 K-12 students for a week or more. These camps fill rapidly, usually within hours or days of being opened. Campers are able to apply for scholarships, but these scholarships are typically from donor fundraising throughout the year. These funds typically cover less than 30 of the 2,000+ total students. The demand for these scholarships is much higher, and the cost offers a significant barrier for many students.

The county which the urban research campus is located in and serves, currently has a rate of 13.9% poverty in the under 18. These students lack the access to high quality camps when they come at such a significant cost [9]. Beyond the financial burden that high quality camps pose, there are demographic disparities involved as well. Families on the email list receive the first notification of sign up, of which many register instantly to ensure a spot for their child. Furthermore, families must provide transportation to and from campus, resulting in many higher income families, and children of university employees being overrepresented in camp groups.

As an urban campus who works closely with the community, we understand that the city of Charlotte has an immense amount of students who are underserved, especially in STEM topics such as engineering. It is critical that these students have the opportunity to engage with the STEM field in order to have the skills, knowledge, and understanding of the future of Charlotte's economic needs. In order to gain entry into careers which can decrease income gaps, students need to have opportunities to be exposed to career education while still in secondary school. Additionally, students in low income families are disproportionately affected by summer learning loss so access to academic camps and programs is especially important.

Phased Implementation

A positive shift occurred during this process with the change in roles within the writing team. Initially, both writers were part of The William States Lee College of Engineering at UNC Charlotte and planned to collaborate on the camp program implementation described in this WIP. As the process unfolded, one team member embraced a new role as Director of the Engineering Discovery Program at Western Carolina University, which brought about exciting new opportunities and fresh perspectives, enhancing the project in unexpected and rewarding ways. This allows for a larger reach with our efforts. This turnover of educators is increasing quickly, and this situation allows us to not only broaden participation in this project, but also shows how a model built for the original university, could be replicated for unlike places. This has created a multi-year plan for us to collaborate on the original camp, create opportunities for the region between universities, and ultimately host programs on both campuses and regional centers.

In the Western Carolina University (WCU) campus county, Jackson, the poverty rate is nearly double at 27.2% [9]. These poverty rates indicate a clear financial challenge for a significant number of students when looking for summer programming.

In the Cullowhee region, students have even less access to STEM education due to limited industry participation, more economically disadvantaged schools, and less curriculum opportunities. The university has not historically had outreach opportunities, especially those in STEM education. The funding from research collaborations will be exceptionally important to create opportunities for students as well as generate funding, interest, and participation from faculty in the college. Here, the proven model, collaborative first year, and structure from the existing programming that UNC Charlotte runs will be an essential component to the program creation. This will serve as a further model for universities without existing programming. It will allow a creative collaboration, and an exploration of the experiences of students at two institutions. This is the first time the camp has been replicated, and allows us to study a broad range of experiences.

Camp Design and Structure

Utilizing the four Phases of Interest Development, we structured our camp to create and maintain interest in engineering. In Phase 1, Triggered Situational Interest, we worked to provide a daily challenge in the day's engineering discipline. Each day focuses on a different engineering discipline. We felt that this was an important approach from conversations with our first year faculty who shared that students often have a very rudimentary understanding of engineering, but struggle to select courses for a particular major since they have not been exposed to the nuances of each engineering field. Following this experience and a brief lunch break, we created a second, but different experience through laboratory tours which provided a secondary attention grabber and a deeper understanding and the work that engineers do and the importance of it to society. This helped to maintain situational interest in Phase 2. During Phase 3, we used reflection to begin to create value, personal connection, and internal appreciation and interest in each topic. To support Phase 4: Well-Developed Individual Interest, we created actionable steps and resources for students and parents. This includes getting to attend a college information

session, a daily blog to families recapping the day's events, and links and resources to topics discussed.

During each day, we created important routines and structures but will use the same basic structure each day. The pattern of these events was predictable for students, while the topics varied each day to create interest. Using this approach, we were able to support interest development while showing the great variety that engineering has in order to connect students to topics that are most related to their passions and existing interests.

Daily Schedule Structure:

Time	**Structure**	**Example:** **Civil Engineering**
9:00am	Arrival	Arrive
9:15 AM – 9:45	Daily Teamwork Time	IceBreaker and Team Building
10:00 AM-11:30 AM	Introduction to Engineering Discipline and Engineering Challenge	Use Engineering Design Process to Bridge Building Small Group Project Goal: Testing for Weight held
11:30 AM-12:30 PM	Lunch	Lunch
12:30 PM-1:30	Lab visit/guest speaker	Lab Tour: EPIC High Bay
1:30-3:15	Individual Engineering Challenge	Sphero BluePrint Bridge Design
3:15 PM- 3:45 PM	Self Directed Engineering Activities (choice of building materials, engineering games, or take apart activities)	Afternoon Snack Break, Finish Projects, Free Build
4:00 PM	Departure	Departure

As we evaluated the financial challenges, as well as our desire to create and maintain interest, we were repeatedly drawn to the innovative research happening on campus. As we approach camp, we have formed a partnership with the AIR institute, a research group on campus. Through our partnership, we have created 5 fully funded slots specific to our camp which can help to allow

for this camp to be an experience for any student in the area, regardless of their income level. In addition to this increase in opportunity for these select students, we believe that this partnership will help to increase the opportunities for all participants through experiential programs that the partnership provides. Not only are we able to visit their associated lab, but also able to benefit from their extensive relationships with their partner organizations to create deeper interest and understanding of the engineering field.

In addition to this daily plan, we wanted to create a tangible example of the intersectionality of academics, industry, and research. This was done through a day-long immersive experience that we coordinated through our AIR Institute, a research group in the college. This group works closely with our international airport and specifically functions to primarily utilize research in the civil engineering field to support the airport in cutting edge best practices. They also have a relationship with a vibrant aviation museum which has a strong emphasis on careers in aviation, including being a pilot, but going vastly beyond that to encompass the varied skills, careers, and economic impact that the aviation industry has on the city. Using interest theory, we planned for the morning to create situational interest by delivering the opportunity for students to do a behind the scenes tour of the airport which allows for an exciting opportunity in areas of the airport not typically seen by the public. Using the airport museum in the afternoon, we will work to connect to personal interest by allowing students to explore various career pathways and find personal connection and interest. In Appendix A, a full Daily schedule is available to include this immersion day.

Methodology

This work in progress presents preliminary data in order to launch a study on accessibility for STEM summer camps. Much of the methodology for this paper included a literature review as well as gathering quantitative institutional data of camp statistics.

For future work, quantitative data analysis will be used to assess the effectiveness of the camp in relation to their perceptions, interests, relations and futures within engineering. Similar to Dell et al. [4]; Fleming et al. [5], and Phelan et al. [6], we will administer anonymous pre and post surveys to the campers. We will ask questions such as demographics, their perception of engineering, and their understanding of the profession [4], as well as their engineering identity development [7], and social capital [8] around engineering. The same survey will be administered on the first day of camp, as well as the last day of camp. This will be voluntary participation, and any data collected will be de-identified and approved by institutional review board (IRB) protocols.

The pre and post surveys will be composed of questions that ask students to rate on 3-point or 4-point Likert scales. Example questions in the survey include items from Dell et al. [4]:

- Engineers work on things that change the world.
- Engineers are professional problem solvers.
- Engineers make a big salary.
- Engineers get to work with great people.
- Engineering is a team effort.
- Engineers have lots of career options and can work

- anywhere.
- An engineering degree is good preparation for many
- different careers.

As well as questions about engineering identity development and social capital:

- I am interested in engineering
- I see myself as an engineer
- I have the skills needed to be an engineer
- I know an engineer
- Someone in my family is an engineer
- I have a mentor that is an engineer

We will also ask open ended questions in the post camp survey in order to assess the quality of the camp. This will help us improve and update for future iterations.

Future Work

This work in progress paper represents the project's initial stages of development. Summer 2025 we hope to build more industry partnerships and regional collaborations across Piedmont and Mountain regions. In Fall 2025 we will launch our summer camp proposals, as well as start an Institutional Review Board (IRB) approval for data collection. Upon receiving IRB approval, we will be able to access, collect, and analyze further data about the camps on campus population as compared to the general population of the region. This will further inform our outreach efforts to advertise scholarship opportunities as an effort to create a more representative population of students in camp programming. In Spring 2026, we will have approved IRB, and we will work to recruit campers. Summer 2026 we will launch and assess our camp. We will publish findings in Fall 2026.

The model for expanding this will be moving from a joint camp, to camps hosted at each of our campuses (one rural and one urban). From here, we hope that our Fall 2026 published paper will allow for other institutions to use our model to increase engineering camps across the country. For us, this will serve as a model that will be recommended during grant collaborations. Our team collaborates on Broader Impact sections of grant proposals by creating outreach opportunities for PIs which benefits society and highlights their research contributions. One of these options will become summer programming using this model. This experience will utilize our model, estimated costs, and data to request funding for camp sponsorships and immersive experiences. We hope that by providing this model, detailed camp schedule, costs, and logistics, we can inspire camps across the county. In addition, we feel that as the idea grows, we will eventually have multiple summer camps at each of our institutions annually.

Reference

[1] M. Terzian, Ph.D., M.S.W., K. A. Moore, Ph.D., and K. Hamilton, M.A., *Effective and promising summer learning programs and approaches for economically-disadvantaged children and youth*, ERIC Document No. ED506969, 2009. [Online]. Available: https://eric.ed.gov/?id=ED506969.

[2] S. A. Phelan, S. M. Harding, and A. S. Harper-Leatherman, "BASE (broadening access to science education): A research and mentoring focused summer STEM camp serving underrepresented high school girls," *J. STEM Educ.: Innovations and Res.*, vol. 18, no. 1, 2017.

[3] S. Hidi and K. A. Renninger, "The Four-Phase Model of Interest Development," *Educ. Psychol.*, vol. 41, no. 2, pp. 111–127, 2006. doi: 10.1207/s15326985ep4102_4.

[4] E. Dell *et al.*, "WE-IMPACT: Women in Engineering-Improving Program Assessment Tools for Outreach and Retention Programs," in *2011 ASEE Annual Conference & Exposition Proceedings*, Vancouver, BC: ASEE Conferences, Jun. 2011, p. 22.1671.1-22.1671.29. doi: 10.18260/1-2--18770.

[5] G. Fleming, K. Fernandez, C. Julien, and M. Mastronardi, "Evaluation of Summer Camp Recruitment Methods and Campers' Perceptions of Engineering (Evaluation, Diversity)," in *2023 ASEE Annual Conference & Exposition Proceedings*, Baltimore , Maryland: ASEE Conferences, Jun. 2023, p. 43467. doi: 10.18260/1-2--43467.

[6]

[6] S. A. Phelan, S. M. Harding, and A. S. Harper-Leatherman, "BASE (Broadening Access to Science Education): A Research and Mentoring Focused Summer STEM Camp Serving Underrepresented High School Girls," vol. 18, no. 1, 2017.

[7] G. A. Dietz, "A narrative exploration of the influences of internship experiences on the identities of Black engineers," University of Florida, Gainesville, Fl, 2022.

[8] G. A. Dietz, L. Wishah, E. P. Douglas, and E. D. McCray, "WIP: Assessing Community Cultural Wealth and Funds of Knowledge for Students Attending a Co-Op-Based Engineering Program," presented at the ASEE Annual Conference Proceedings, Online Conference, Jul. 2021. Accessed: Aug. 25, 2021. [Online]. Available: https://peer.asee.org/wip-assessing-community-cultural-wealth-and-funds-of-knowledge-for-students-attending-a-co-op-based-engineering-program

[9] United States Census Bureau, “Explore Census Data,” United States Census Bureau. https://data.census.gov/

Appendix A

	Monday	Tuesday	Wednesday	Thursday	Friday
Daily Objective:	**Civil Engineering**	**Airport tour**	**Mechanical Engineering**	**Construction Management**	**Environmental**
9:00am	Arrive	Arrive	Arrive	Arrive	Arrive
9:15 AM – 9:45	Ice Breaker and Team Building	Tour of Charlotte International airport and Sullenberger Aviation Museum	Ice Breaker and Team Building	Ice Breaker and Team Building	Ice Breaker and Team Building
10:00 AM-11:30 AM	Engineering Design Process introduction, Bridge Building Group Project, Testing for Weight held		Balloon Car Building and racing	The Built World- Introduction to Construction Engineering/ Construction Management Catapult activity with cost estimating	Intro to Environmental Engineering, Runoff in the Watershed Activity
11:30 AM-12:30 PM	Lunch		Lunch	Lunch	Lunch
12:30 PM-1:30	Lab Tour: EPIC High Bay		Lab Tour: Kulwicki Lab, Duke Centennial Hall	Lab Tour: Smith Building	Lab Tour: Environmental Science
1:30-3:15	Sphero BluePrint Bridge Design		Free circuit mechanical build (3 project options)	Tour of Construction, Construction simulators	Engineering Information Session, student/faculty panel
3:15 PM-3:45 PM	Afternoon Snack Break, Finish Projects, Free Build		Afternoon Snack Break, Finish Projects, Free Build	Afternoon Snack Break, Finish Projects, Free Build	End of Camp Celebration
4:00 PM	Departure	Departure	Departure	Departure	Departure