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Assessing Student Impacts from an Interdisciplinary Summer Research Program Modeled on Problem-Based Learning

Mohammed K. Faris

Dr. Mohammed K. Faris is a Lecture in the Department of Civil Engineering at the University of Mosul / Iraq, finished his PhD at the University of South Carolina in 2020. He is also a Member of The American Society of Civil Engineers (ASCE) since 2021. His current interest is to use active learning strategies to teach Civil Engineering classes, and to make the students more aware about the problem-solving techniques.

Charles Pierce

Dr. Charles E. Pierce is an Associate Professor and Director for Diversity and Inclusion in the Department of Civil and Environmental Engineering at the University of South Carolina. He is also the ASEE Campus Representative and a Senior Faculty Associate in the Center for Integrative and Experiential Learning (CIEL). His current educational interests include designing and implementing problem-based learning strategies for within-the-classroom and beyond-the-classroom experiences, creating and evaluating inclusive learning environments, and facilitating critical student reflection in engineering education.

Gurcan Comert

Gurcan Comert received the B.Sc. and M.Sc. degree in Industrial Engineering from Fatih University, Istanbul, Turkey, and the Ph.D. degree in Civil Engineering from the University of South Carolina, Columbia, SC, in 2003, 2005, and 2008 respectively. He is currently with Computer Science, Physics, and Engineering Department, Benedict College, Columbia, SC. He is interested in exploring different approaches for engineering education and research to reach students more efficiently. He has collaborated with researchers and students in NSF HBCU UP targeted infusion, broadening participation and excellence in research projects.

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1. Introduction

There are significant benefits derived from undergraduate student engagement in learning opportunities with students from other disciplines. Some of the benefits identified in the literature include advancing critical thinking skills, subjecting students to different perspectives on solving problems, exchanging knowledge of technical skills, exposing students to real-world collaboration, and becoming more adaptable and flexible. Summer research programs are one common mechanism for bringing students together from different disciplines.

A literature search of interdisciplinary and multidisciplinary summer research programs was conducted using the ASEE Papers in Engineering Education Repository (PEER). Table 1 provides a representative list of eight programs [1-13] designed to integrate undergraduate students from engineering and the sciences. Depending on the program, participants are either recruited from multiple institutions or limited to students from the host institution. Cohorts ranged from about 10 students per summer to as large as 100+ students in one program. Research projects are often broad in scope to encourage participation from students across several majors. Examples include multi-scale systems bioengineering [3], the Learning Enhanced Watershed Assessment System (LEWAS) Lab [4], and Interdisciplinary Research in Sustainable Energy and the Environment across Disciplines, or IR-SEED [11].

Most summer programs are hosted at doctoral or master's institutions that support robust graduate programs and sponsored research activities. According to The Carnegie Classification of Institutions of Higher Education® [14], there are 532 Baccalaureate Colleges, which is on par with the number of Doctoral Universities (469) and Master's Colleges and Universities (667). Yet, there is limited information on similar experiences at predominantly undergraduate institutions (PUIs). Of the 532 baccalaureate-focused institutions, 45 are listed in the National HBCU Inventory [15]. Our research found that about 30% of these 45 historically black colleges or universities have at least one engineering degree program. In addition, there are other institutions in this list with pre-engineering and dual-degree engineering programs with partner institutions. It is common for engineering and pre-engineering programs at HBCUs to be embedded in an integrated department or school of science, technology, engineering, and mathematics (STEM). Having an administrative unit focused on STEM can further facilitate interdisciplinary research experiences for its undergraduate students.

The goal of this paper is to assess the impacts of a summer research experience on interdisciplinary student teams at Benedict College, which is a recognized HBCU and classified as Baccalaureate Colleges – Diverse Fields. Like other interdisciplinary student experiences, this summer program combines two signature high-impact practices, undergraduate research and collaborative assignments and projects. High-impact practices have been shown to provide meaningful educational benefits for students, especially those from underserved populations, and often lead to higher rates of student retention, engagement, and academic success [16].

Table 1. Representative Interdisciplinary or Multidisciplinary Summer Research Programs

Summer Research Host		Student Participants		Citation
Carnegie Classification®	Institution	Number per cohort	Undergraduate majors	
R1: Doctoral Institutions – Very High Research Activity	Oklahoma State University	10-11, from multiple institutions	bioengineering, biomedical, chemical, and mechanical engineering; biotechnology; chemistry; innovation and entrepreneurship; materials science; physics	[1]
	University of Colorado Boulder	105-194, from host institution	civil & environmental engineering; environmental science; biology, chemistry; geology; physics	[2]
	University of Virginia	31, from multiple institutions	not specified, but applicants recruited from science, mathematics, or engineering-based curriculum that includes introductory biology, chemistry, and calculus	[3]
	Virginia Polytechnic Institute and State University	8-12, from multiple institutions	chemical, civil & environmental, and computer engineering; computer and environmental science	[4-6]
R2: Doctoral Institutions – High Research Activity	North Carolina A&T State University	44-76, from multiple institutions	biomedical, chemical, computer, electrical, and mechanical engineering; biological, computer, earth, and environmental science; information technology; kinesiology; mathematics	[7]
	Texas A&M University-Kingsville	10-12, from multiple institutions	not specified	[8-11]
M1: Master's Colleges & Institutions – Larger Programs	California State University-Chico	31, from host institution	agriculture; computer science; engineering (mechanical only major specified); construction management; natural sciences	[12]
	California State University-Northridge	40-42, from host institution	computer science; engineering (majors not specified); mathematics; physical sciences	[13]

2. Summer Research Program at Benedict College

An interdisciplinary summer research experience for undergraduate students at Benedict College (BC) was conducted over a five-year span from 2017-2021. The program was developed in partnership with a neighboring R1 flagship institution, University of South Carolina (UofSC), which is located within 2 miles. BC offers ten STEM-related baccalaureate degrees, including four engineering degree programs. Students in engineering, computing, mathematics, and sciences were recruited to work in interdisciplinary teams on a research problem associated with autonomous vehicles. A civil engineering professor at BC, whose expertise is in transportation engineering, supervised all student teams. A civil engineering professor at UofSC supported the development and implementation of a problem-based learning research environment.

The program was designed to be in alignment with institutional strategic plans at Benedict College. One of the institutional objectives is to increase student learning outcomes. Two of the strategies for meeting this objective are:

- Enhance additional training and development for soft skills and technology literacy for all students to enhance their competitive position in a fast paced, increasingly global, technology driven workplace; and
- Initiate annual signature events for academic programs designed to highlight employment and graduate school opportunities.

There is a recognized responsibility for BC to prepare more underrepresented students in STEM in response to diversity and inclusion initiatives in academic graduate programs and the professional workplace. To that end, the principal goal of the summer program is to expand the pipeline from BC to graduate schools in the U.S., focusing on those within the southeastern region. The research experiences for undergraduate students were built upon the following principles:

- Students should demonstrate knowledge of fundamentals and be proficient with computational tools as preparation for graduate studies and, ultimately, to be more marketable for competitive jobs;
- Students deserve opportunities in supportive learning environments to develop as independent thinkers within cutting-edge research projects; and
- Students should be encouraged to explore their passion and developed interest field, as it might not be as present in their home institution, which in turn should facilitate understanding the value of more education.

2.1 Problem-Based Learning (PBL) Research Environment

Starting in 2018, teams progressed through their collaborative experience using an adaptation of problem-based learning (PBL) pedagogy, which was selected to facilitate the beneficial impacts of students working across disciplines. In earlier summer research experiences, students seemed less engaged and the program lacked sufficient structure to support a higher level of collaborative learning. Creating a PBL research framework was a new contribution, and its influence on improving student engagement and sustaining research interest needed to be studied.

A PBL-oriented research environment was established through modifications of the Environments for Fostering Effective Critical Thinking, or EFFECTs, framework for classroom instruction [17,18]. In the modified approach, each cohort is posed with a research question at the start of the summer program. Within each cohort, students worked in pairs or teams of three on selected aspects of the research question. A sequence of planned learning activities is conducted throughout the summer to facilitate the acquisition of conceptual knowledge and development of skills needed to answer the question. A more detailed description of the program can be found in [19].

Although a PBL-based approach was infused in each summer program from 2018-2021, the onset of the COVID-19 pandemic in spring 2020 had a significant impact on the summer 2020 experience and, to a lesser extent, in summer 2021. In 2018-2019, the student experience was highly interactive and included numerous team activities, frequent discussion on important topics, and short trips to other institutions, including the partner institution. Because of this intentional structure focused on student engagement, project control and time management were much better. Students were able to spend more meaningful time on tasks.

The summer program in 2020, however, was limited to a virtual research experience launched on short notice. Students were not on campus and most were living with families, relatives, or friends. Their living arrangements might not have been optimal for learning or research. For some international students this was an especially difficult time. One of the benefits of the virtual environment, however, was it enabled more demonstrations of computational tools and scripts. That cohort was able to process and analyze real data that had been collected from prior cohorts. During summer 2020, students engaged in a set of activities designed to help them develop needed technical and conceptual skills, mainly with programming in Python and R. Most virtual activities were limited to Fridays, and the rest of the week students worked on data analysis. In addition, they participated in online workshops on general research topics, including research and ethics, preparing effective presentations, and graduate school applications.

The summer program in 2021 was also virtual due to COVID-19 concerns with on-campus research. This program improved upon lessons learned from summer 2020. First, advisors and students were more experienced and comfortable with working and communicating in an online environment. Second, there was more intentional scheduling of time for student teams to work together online. Third, there was a more diversified team of research advisors, which included four faculty members from BC and faculty members and graduate students from two other institutions that were invited to collaborate. This expansion increased the opportunities for interdisciplinary mentorship and resulted in more sustainable interactions between advisors and students (e.g., task sharing, one-on-one troubleshooting). Still, the summer 2021 research program was an advisor-driven experience rather than student-driven. It was somewhat less flexible and open-ended compared to the programs in 2018 and 2019.

2.2 Interdisciplinary Student Cohorts

A total of 32 students from nine STEM majors participated during the five-year period from 2017-2021. Table 2 summarizes the number and distribution of student participants in each cohort. Most students are either pursuing a computer engineering (9) or computer science (11) major. All other majors have three or fewer participants. Each cohort, however, had at least three student majors represented to promote an interdisciplinary experience.

Table 2. Student Cohorts from 2017-2021

2017 [n=3]	2018 [n=9]	2019 [n=10]	2020 [n=10]	2021 [n=18]
S1-EE	**S2-ENVE**	**S3-MATH**	**S4-CE**	**S4-CE**
S2-ENVE	**S3-MATH**	**S4-CE**	**S5-CE**	**S12-CE**
S3-MATH	S4-CE	**S5-CE**	**S6-CE**	**S13-CS**
	S5-CE	**S7-CE**	**S9-CS**	**S17-CS**
	S6-CE	**S8-CS**	**S12-CE**	**S19-TRANS**
	S7-CE	S11-BIOL	**S13-CS**	S20-BIOL
	S8-CS	S12-CE	S16-CE	S21-BIOL
	S9-CS	S13-CS	S17-CS	S22-CE
	S10-MATH	S14-ENVHS	S18-CS	S23-CE
		S15-MATH	S19-TRANS	S24-CE
				S25-CS
				S26-CS
				S27-CS
				S28-CS
				S29-CS
				S30-CS
				S31-EE
				S32-PHYS

BIOL = biological sciences | CE = computer engineering | CS = computer science | EE = electrical engineering | ENVE = environmental engineering | ENVHS = environmental health sciences | MATH = mathematics | PHYS = physics | TRANS = transportation engineering
bold text = returning student

green shading = survey respondent

Overall, the population represents a diverse group of domestic and international students at different academic levels from first-year students to seniors. In terms of gender identity, there is an equal representation of male (16) and female (16) students. However, more than half (9) of the total number of female students were first-time participants in the 2021 cohort. Twelve of the 32 students were repeaters, or students who participated in two or more summer experiences. These students are identified in bold in Table 2. Three of the 12 repeaters are female, but this represents three of the seven female students (43%) who participated prior to 2021. Yet, nine of the 12 male students (75%) who participated prior to 2021 had multiple experiences. Possible reasons for a higher repeater rate of males compared to females are not explored in this paper. In fact, the impacts of gender identity, ethnicity, and national identity on the student experience are not studied here.

3. Student Impacts of Summer Research Experience

3.1 Survey Development

A post-experience survey instrument was created to evaluate student impacts over the period of the five-year program. It contained four main sections on participant information, overall experience, benefits, and highlights. There are 18 numbered questions and a total of 50 elements. Most survey questions were derived from three published surveys on undergraduate research experiences: Undergraduate Research Student Self-Assessment (URSSA) [20] and the Survey of Undergraduate Research Experiences (SURE) instruments, SURE III and SURE Follow-Up [21,22].

Some of the published questions were modified and new questions were added to evaluate salient features of an interdisciplinary research experience that are not clear or present in the URSSA and SURE instruments. These included questions to evaluate student self-perceptions of their holistic understanding of a problem; exposure to different perspectives; using real-world approaches to solving a current problem and translating it to the professional world; collaboration and effective communication with people across disciplines; and working with a diverse team.

3.2. Survey Results

Surveys were distributed to all student participants from 2017-2021. It was released at the end of the fall 2021 semester and remained open through the start of the spring 2022 semester. In Table 2, the student identifiers who responded are highlighted in green. The individual response rate was 21 of 32 students (65.6%), and the completion rate was 18 of 21 students (85.7%). Both rates are sufficient for using the data to describe the overall student experience. The cohort response rate ranged from a minimum of 50% (5 of 10 students from 2019) to a maximum of 100% (3 of 3 students from 2017). These rates indicate that sufficient data were acquired to represent each summer of the five-year program period.

There is representation from eight of the nine student majors. No response was received from the single student in environmental health sciences. Response rates for the other majors are shown (in parentheses) from highest to lowest number of total respondents: computer engineering (8 of 9); computer science (6 of 11); electrical engineering (2 of 2); biological sciences (1 of 3); environmental engineering (1 of 1); mathematics (1 of 3); physics (1 of 1); and transportation engineering (1 of 2).

Tables 3-5 summarize student expectations, satisfaction, and reflection on their summer research experience(s). These results reveal a highly favorable opinion of the overall student experience. The level of satisfaction was the most positive indicator, with 85% of respondents expressing that they were *very satisfied* with this experience. Across all three questions, just one response indicated a negative opinion of summer research as a learning experience. As shown in Table 5, one respondent selected *"Well, it was better than working just for a salary, but I don't think I learned a lot."*

Table 3. Student Expectations of Research Experience

Q: Think about the **expectations** you had about the research experience before it began. Use the scale below to evaluate your current feelings.	
The experience was worse than I expected.	
The experience was a little worse than I expected.	
The experience met my expectations.	6 (30%)
The experience was a little better than I expected.	2 (10%)
The experience was much better than I expected.	**12 (60%)**
Prefer not to answer.	
Other (please specify)	

Table 4. Student Satisfaction with Research Experience

Q: Evaluate your overall sense of **satisfaction** from your research experience by choosing one statement below.	
I am very dissatisfied with this experience.	
I am mildly dissatisfied with this experience.	
I feel neutral about the experience.	1 (5%)
I am mildly satisfied with this experience.	2 (10%)
I am very satisfied with this experience.	**17 (85%)**
Prefer not to answer.	
Other (please specify)	

Table 5. Student Reflection on Learning from the Research Experience

Q: Now that time has passed, how do you **reflect** on summer research as a learning experience?	
Summer in the lab was a waste of time for me - I didn't learn much.	
Well, it was better than working just for a salary, but I don't think I learned a lot.	1 (5%)
I feel neutral about it - there are definitely good things, but also not so good things about a summer in the lab.	1 (5%)
I had a good time, I learned a lot, I'd do it again. The summer was fantastic!	6 (30%)
In my mind, this is the way to learn what science/engineering is about.	**12 (60%)**
Prefer not to answer.	
Other (please specify)	

Two crucial elements of the program structure were that students should (1) explore a real interdisciplinary problem within the broad topic of autonomous vehicles and (2) work with students from other majors. It can be inferred from Tables 3-5 that the interdisciplinary program design was successful in that the experience exceeded expectations and contributed to a high degree of satisfaction. That inference is validated with the data shown in Table 6, which summarizes the self-reported impact of the research topic and student teams on their experience.

Almost all (90-95%) respondents indicated that their research topic and student teams either *moderately enhanced* or was *one of the best parts* of the summer program. Of note is the single *Other* response about working with other students. This student was part of the summer 2020 cohort that had a virtual research experience due to COVID-19 restrictions. She explained that *"My partner was having a number of technical issues throughout the research experience so most of the work I had to complete by myself."*

Table 6. Impacts of Interdisciplinary Research Topics and Research Teams

Describe your experience …	Impact on Research Experience					
	One of worst parts	Moderately detracted	No effect	**Moderately enhanced**	**One of best parts**	Other
with the research topic.			1 (5%)	**6 (30%)**	**13 (65%)**	
working with other students.			1 (5%)	**7 (35%)**	**11 (55%)**	1 (5%)

Figures 1 and 2 show the distribution of perceived gains in technical research skills and personal research traits, respectively. Overall, the respondents indicated substantial gains across the board. On a five-point Likert scale from 1 (no gain) to 5 (great gain), the weighted average for all statements ranged from 4.11 to 4.61. This translates to a programmatic impact of good-to-great gains in transferable research attributes and skills.

The four highest rated technical skills were:

- analyzing data for patterns (referred to as data analysis in Figure 1);
- figuring out the next step in a research project (next steps);
- problem-solving in general (problem solving); and
- understanding the relevance of research to coursework (connect courses).

The four highest rated personal characteristics or traits were:

- understanding what everyday research work is like;
- comfort in working collaboratively with others;
- developing a holistic understanding of how to approach solving real-world problems; and
- confidence in my ability to do well in future science/engineering courses.

There are a couple of items of particular interest in these findings. First, the high ratings associated with connecting courses to research was surprising and somewhat unexpected because the students came from multiple disciplines outside of engineering, even though the research was focused on solving an engineering problem. Second, the top three personal characteristics are recognized as important facets of an interdisciplinary research experience. Such favorable ratings help to validate the nature and structure of the problem-based learning research environment that was created.

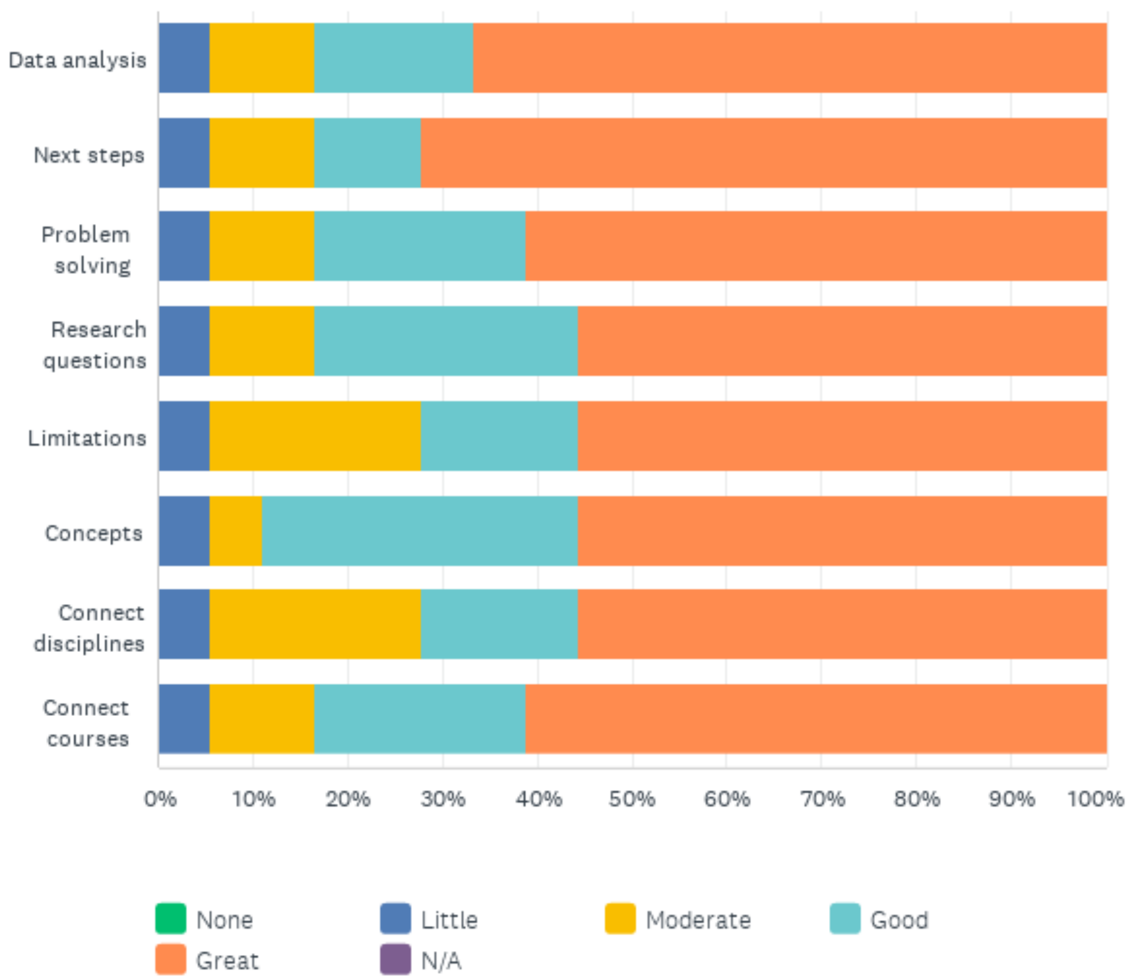

Figure 1. Perceived Gains in Technical Research Skills

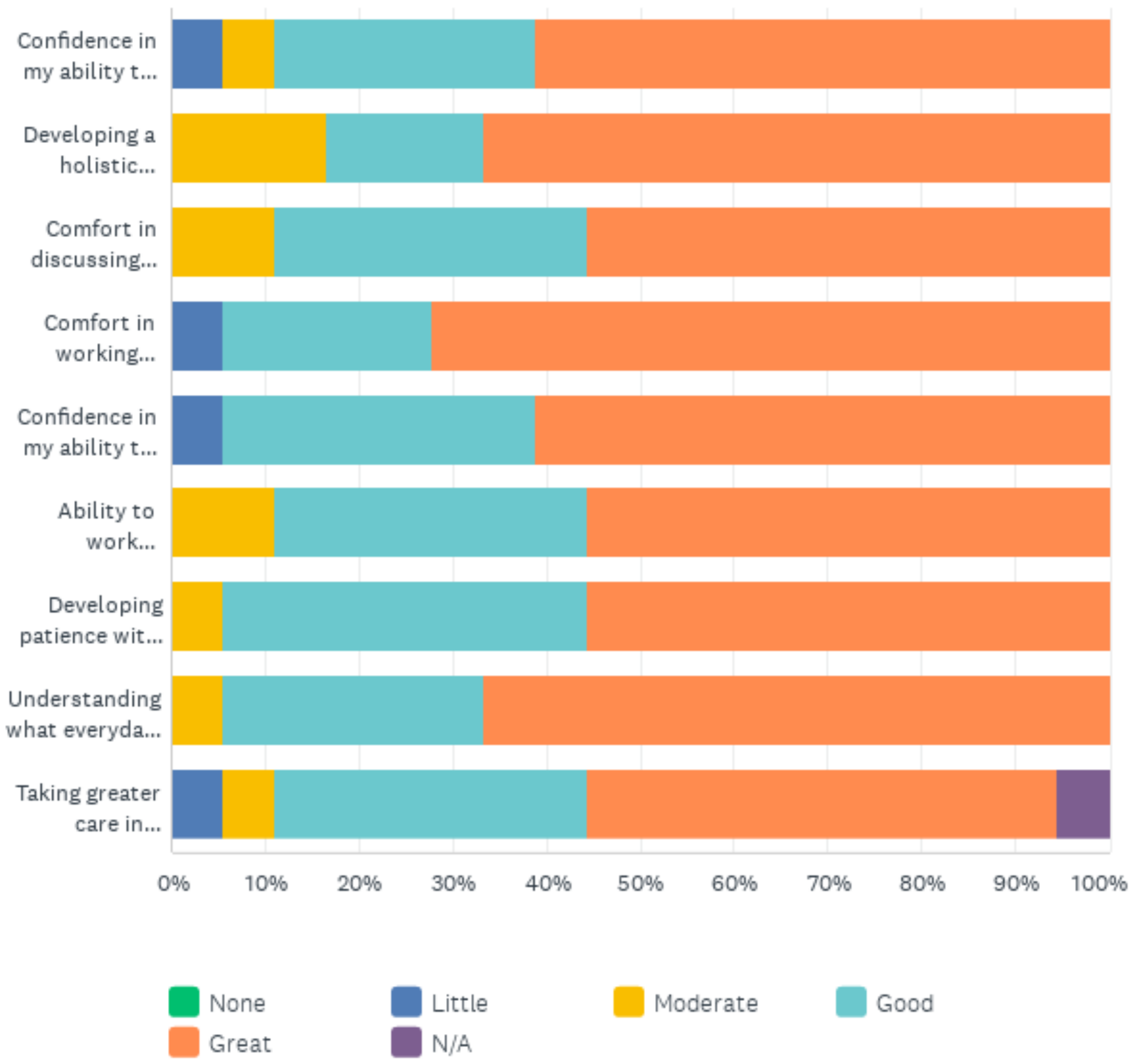

Figure 2. Perceived Gains in Personal Research Traits

3.3 Qualitative Evaluation of Summer Research Highlights

A few recurring themes were identified from the open-ended prompt, *"Please tell us in a few sentences what was most important to you about your research experience."* These themes can be grouped into either tangible outcomes or intrapersonal and interpersonal developments. Some of the common tangible outcomes included opportunities outside school like attending conferences and presentations, authoring a technical publication, and learning to use computer program applications with real data. Most respondents focused on less tangible outcomes as described below.

Willingness to explore new things and growth in self-confidence stood out as the two most significant *intrapersonal* developments. There were several comments that revolved around working in a new or unfamiliar environment. One student appreciated the *"opportunity to explore a new concept, software, or academic/research areas"* while another realized it *"opened my mind to the endless possibilities out there in the field of computer science/engineering."* Two others highlighted how important it was to have *"the possibility to stand out of my comfort zone"* and be *"working outside my comfort zone."* For others, the summer research program helped them gain confidence. One student wrote that *"every day I learnt something new ... that builds me up more ..."* He continued with, *"Even though there were adversities and time of struggle, the most important part was that [I] was able to conquer them and complete the project ..."*

Interpersonal developments focused on building positive relationships with their research mentor and peers. Having a supportive mentor was viewed as critical. One stated, *"It was really important to me that I was supported by my professor during the program. I have learned a lot and it was an amazing experience."* Another student recognized that mentoring improved his self-confidence: *"I had a mentor who could guide me and help me whenever I felt that I was confused or stuck. This made me feel confident in the information I presented when it was time to discuss the research."*

Teamwork was a common thread in a number of responses. Comments associated with teamwork include:

- *"Building teamwork with an efficient team of students and professors";*
- *"Be[ing] able to cooperate in different disciplines related with my major";*
- *"Without being able to communicate among team partners, work wouldn't have gotten completed"; and*
- *"Working in teams with great people and preparing myself for a real world job."*

A sense of gratitude was evident in the tone and language of several of the responses. That sentiment is best captured in this response from one student: *"All in all, the entire research was an awesome experience. I am glad that I was afforded this opportunity because it allowed room for me to sharpen my problem solving skills, polish my knowledge and much more. Again, I [am] very grateful for this past summer research opportunity and for that I say Thank you! Indeed it was one to remember!"*

4. Impact of Undergraduate Research on Graduate Studies

The principal goal of this summer program is to increase the pipeline of students from Benedict College to STEM graduate degree programs at other institutions. Similar programs have shown a considerable impact on students pursuing advanced degrees. Conrad et al. [23] reported 76% of students who participated in a robotics-based summer research program at the Georgia Institute of Technology attended graduate school upon receiving their B.S. degrees. Allen [3] stated that 9 of 17 summer participants in a program at the University of Virginia have since graduated and are now enrolled in STEM PhD programs, all at R1 institutions, plus another student who enrolled in a Master's program for data science. Both programs supported underrepresented minorities in STEM as part of their cohorts. After an interdisciplinary summer program on computational research at an HBCU, North Carolina A&T State University, four of 16 participants who since graduated were enrolled in graduate school [7].

Since some of the BC program participants have graduated, most of which are from the first three cohorts (2017-2019), there was an opportunity to assess the potential impact on graduate studies. In the survey, all respondents identified as either *"still an undergraduate student at Benedict College"* (14 students) or *"pursuing a Master's degree in a science or engineering-related field"* (7 students). No other options were selected. This means that all respondents, but not all participants, who have graduated from BC are in a graduate program for a science or engineering degree. Such high impact on students pursuing postgraduate education is remarkable, which is further highlighted in Table 7.

Table 7. Influence of Research Experience on Postgraduate Education

Q: This question is about how your research experience influenced your plan for postgraduate education. Please choose one.	Undergraduate Students [n=13]	Graduate Students [n=6]
I had a plan for postgraduate education before I began this research project and the plan has not changed.	7	
I was considering postgraduate education and my research experience confirmed this choice.	2	1
I had no plan for postgraduate education, but my research experience changed my mind.	1	
Now I plan to continue my education in science/engineering.	3	3
I had a plan for postgraduate education in science/engineering, but my research experience convinced me that this is not what I want.		1
I had no plans for postgraduate education before I started the research project, and I have not changed my mind.		1

As the results show, almost 70% of the 13 respondents who are still undergraduate students either had plans or were considering postgraduate education prior to the research experience. These data indicate, at least in a quantitative sense, that most students self-selected an undergraduate research experience because of their interest in a graduate degree program. None expressed negative sentiments about post-baccalaureate studies after completing the summer program.

However, data collected from current graduate students were mixed. Looking at most of the responses, some confusion or misunderstanding is apparent with regards to the question context and/or phrasing of response choices. Three of the six students selected *"Now I plan to continue my education in science/engineering"* even though these students earned a baccalaureate STEM degree and are enrolled in a Master's degree program. This statement is intended to refer to their interest in continuing their *undergraduate* education in science/engineering, although perhaps that distinction is unclear. Two other graduate students chose statements that indicate postgraduate education would not be pursued, which contradicts their current academic status. Given the somewhat unexpected responses from current graduate students, it is recommended to revise the answer choices in future iterations of this instrument. It is also proposed to include a follow-up open-ended question to *"Explain your selection in one or two sentences."*

Data was also gathered on the graduate student status of participants who have either graduated from BC or are about to graduate in spring 2022. These data were not collected as part of the survey instrument. The findings are summarized in Table 8.

Table 8. Graduate Student Status of Participants in Summer Research Program

<table>
<tr><th>Student ID</th><th>No. Summer Experiences</th><th>Graduate Degree | Discipline or Program</th><th>Graduate Institution Classification</th></tr>
<tr><td>S1-EE</td><td>1</td><td>MS | Civil Engineering (Transportation)</td><td>R1</td></tr>
<tr><td rowspan="2">S2-ENVE</td><td rowspan="2">2</td><td>current: MS | Civil Engineering (Water Resources)</td><td>R2</td></tr>
<tr><td>completed: MS | Transportation Engineering</td><td>M2–HBCU</td></tr>
<tr><td>S3-MATH</td><td>3</td><td>MS | Civil Engineering (Transportation)</td><td>R1</td></tr>
<tr><td>S4-CE</td><td>4</td><td>MS | Computer Science
accepted but not enrolled as of spring 2022</td><td>M1–HBCU</td></tr>
<tr><td>S6-CE</td><td>2</td><td>MS | Computer Science</td><td>R2</td></tr>
<tr><td>S9-CS</td><td>2</td><td>MS | Data Science
applications submitted</td><td>N/A</td></tr>
<tr><td>S12-CE</td><td>3</td><td>MS | Computer Science
accepted but not enrolled as of spring 2022</td><td>R2</td></tr>
<tr><td>S16-CE</td><td>1</td><td>PhD | Computer Science
accepted but not enrolled as of spring 2022</td><td>R1,R1</td></tr>
<tr><td>S19-TRANS</td><td>2</td><td>MS | Urban Planning
applications submitted</td><td>R1,R2</td></tr>
<tr><td>S29-CS</td><td>1</td><td>MS | Civil Engineering (Transportation)</td><td>R1</td></tr>
</table>

It includes those students who are known to have applied for, been accepted to, or are enrolled in a graduate program. Based on these data, there appears to be a significant impact of having multiple summer experiences on the decision to pursue graduate studies. Seven of the ten students identified in Table 8 were repeaters, and two of the three non-repeaters participated as seniors and therefore were not eligible for a second summer experience.

It is also hypothesized that our interdisciplinary research program influenced student choices to pursue a graduate degree in a discipline that is different from their undergraduate major. There is a clear trend of that occurring with all ten students in Table 8, although the contributing factors that informed their decisions were not studied here. The potential to link these outcomes with the holistic and multi-perspective nature of interdisciplinary research deserves further exploration. It is notable that four students are enrolled in a master's program in civil engineering, even though these students earned undergraduate degrees in computer science, electrical engineering, environmental engineering, or math. The fact that all four concentrated their studies in transportation engineering is evidence of the positive influence of a research advisor with expertise in the field.

5. Conclusions and Limitations

The following conclusions are based on an interdisciplinary summer research program for undergraduate students at a predominantly undergraduate, historically black college. Our findings are limited to the experiences of five cohorts of students from 2017-2021.

- Participants in this program are much more likely to be enthusiastic about research than to become disenchanted with it. This is evidenced by the high degree of satisfaction with the experience and the high number of students who chose to participate more than once.

- Collaborating with students from other disciplines and learning to work in effective teams were recognized as highlights of the program and important for success in academic and workplace environments.

- The summer program appears to be functioning as a steppingstone to graduate school, which is consistent with what other interdisciplinary programs have reported. Application to and matriculation in graduate programs is high. This paper did not identify or evaluate the factors influencing student decisions about graduate school. Future studies should explore these factors and their relative impacts on student participation in a summer research experience.

- As Kuh and Kinzie [16] point out, determining the value of a high-impact practice (HIP) should link the desired outcome of students who have been involved in one or more HIPs compared with that of their peers who have not had such experiences. Thus, the impact of this summer research program on students pursuing graduate studies needs to be compared to students who did not participate. This will be explored in future work.

6. Acknowledgments

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