PURM
Perspectives on Undergraduate Research & Mentoring

Challenges, Opportunities and Outcomes of Developing a Unique REU Program in Biology Focusing on Community College Students between their First and Second Years

Corey L. Cleland, Ph.D., James Madison University (clelancl@jmu.edu)
Bisi T. Velayudhan Ph.D., James Madison University

Introduction

Nationally, community colleges contribute significantly to post-secondary education. Community college students constitute 40% of all college students (Current Term Enrollment Estimates, 2025), a number that has been increasing (Chen, 2019), and 20-33% of those enrolled in four-year institutions are community college transfers, a number that is also increasing. However, only 40% of community college students that transferred to four-year institutions complete the bachelor's degree within four years, and 18% within two years (Transfer & Progress, 2024), which underscores the challenges of transferring (Chen & Soldner, 2013; Wachsmuth et al., 2017) and the value of developing programs to facilitate successful transition to four-year institutions.

Community colleges enroll higher proportions of under-represented groups than four-year institutions, with 51% (28% Hispanic, 12% Black, 11% other) enrolled in community colleges (Parham, 2026) versus 27% (16% Hispanic, 9% Black, 2% other) enrolled in a public institution (National Student Clearinghouse Research Center, 2025). Furthermore, first generation students are three times more likely to attend community colleges than four-year institutions and twice as likely to self-identify as Hispanic or Black (Postsecondary National Policy Institute., 2018). STEM majors, in particular, are under-represented in community colleges. There is an upward trend in STEM participation in community colleges (Chen, 2019) but still only 9% of students pursue studies in STEM compared to 24% of students at four-year institutions (American Council on Education, 2021). While 17% (23/136) of Biological Science REUs explicitly encourage community college applicants, only 3% (4/136; based on 2021 NSF abstracts) exclusively target community colleges, and none of these REUs focused solely on students between their 1st and 2nd years.

Students transferring from a community college to a four-year institution face substantial academic, mentoring, financial and logistical hurdles (Ordway, 2025). Academically, transfer students, having completed introductory biology and chemistry courses at their community college, are suddenly faced with much more rigorous upper-level STEM classes. Further, many completed all or most of their general education requirements before transferring, resulting in a difficult, STEM heavy course load to complete at the four-year institution. Regarding academic mentoring, which is crucial due to the diversity of incoming transfer students, caseloads can be higher than for non-transfer students and mentors may not be adequately trained to meet the unique needs of community college transfers (Fink, 2021). Further, increased costs, differences in the application process at different schools, and stigma associated with transfer also contribute to challenges faced by community college transfers (Fink, 2021; Ordway, 2025).

Obtaining a mentored research experience in faculty research programs is a valuable aspect of any undergraduate experience (Webb, 2007). However, there are several specific roadblocks for community college transfer students. First, transfer students only have a short window of time, typically two years, to identify and participate in faculty research. The problem is exacerbated because faculty research mentors often seek students in their 1st or 2nd years, so that the students have time to substantially contribute to the mentor's research program. Further, transfer students come from a school culture where research may not be emphasized, further slowing integration into a research focused STEM program. Transfer students are also more likely to need employment, consuming hours that would be necessary for research (Penn Wharton Budget Model Blog Post, 2021). Finally, transfer students may be more likely to lack the basic STEM and data science skills needed to engage in the research process. At our institution, surveys of graduating transfer students in Biology revealed that a lack of research opportunity was a primary complaint.

To better serve the research experience needs of community college students, we developed an NSF funded (2021-2023) summer residential biology REU program at James Madison University (JMU) which focused exclusively on community college students between their first and second years of community college. To the best of our knowledge, ours is the only REU program to focus on this population of students. The program, like many summer REU programs, revolved around one-on-one student-faculty mentorship, with students conducting authentic research over 10 weeks. In conjunction with research, our program included emphasis on data science (Wageningen University and Research Centre, 2015) and close integration with three other concurrent REU programs in Geology, Chemistry, and Mathematics at JMU. Our experience revealed unique challenges and solutions, opportunities, and outcomes associated with mentoring community college students in their early years.

Challenges and Solutions

Focusing on early-career community college students presented several unique challenges. First, students at four-year research and primarily undergraduate institutions (PUIs) are often familiar with the value and opportunities for summer research. In contrast, community college students, and probably most of their faculty, are not aware of summer research opportunities available for them; consequently, it was necessary for us to reach out to them. We adopted two approaches. One approach was to develop formal partnerships with five regional community colleges, through which we could disseminate information, participate in career workshops, and importantly identify specific individuals likely to benefit from our program. The other approach was to develop a national database of academic contacts at community colleges, which was done by searching every community college website (>2000) for biology faculty or program directors that could connect with their students. The database was started in the second year, once we were aware of the need for additional recruitment, and completed in the third year. We then sent emails to all of the contacts describing our program and inviting feedback from faculty. Both approaches were ultimately successful, with 18% of participants recruited through partnerships, 18% from other Virginia community colleges, and notably 64% through our national search in the third year. Interestingly, although our program was advertised on the NSF and our institution's websites, few of the applicants (11%) and matriculated students (9%) identified our program without assistance from our two recruited methods.

Second, because the students applied after only one community college semester, they had a limited community college academic record and struggled obtaining letters of recommendation. Consequently, we considered high school transcripts, only required one letter of recommendation, and were willing to accept that one letter from a high school teacher. Because of their limited academic and research related achievements, we (the PI and co-PI) focused on evaluating the

potential of each applicant. We found there was a significant learning curve for evaluating applications.

Third, students often arrived with quite limited biology and data science background; most even had little understanding of the process of research and discovery. Further, basic skills in laboratory techniques (e.g., weighing, pipetting) were often lacking. Consequently, in the second year we developed a week-long immersion workshop ("boot camp") targeted at basic skills needed to conduct research that specifically addressed the needs of this population of students. Skills included understanding the research process (starting with "what is research?"), laboratory conduct, basic concepts and necessity of statistical analysis to draw conclusions, data management (Excel), and visualization (R). Later workshops picked up communication skills, professional development and library skills.

Fourth, we found that students were highly diverse in their backgrounds, expectations, and needs; consequently, we focused on individual mentoring over group training. This was done in three ways, including the training of faculty mentors who had limited previous experience with early community college students in their research program, through individual faculty mentoring, and by peer mentoring. The need for individual mentoring became clear in the first summer where we found that group workshops were often ineffective in providing academic, career and social guidance. Consequently, we added at least two, one-on-one meetings between the students and REU directors throughout the 10 weeks, which were valuable to the students. We also created numerous informal opportunities for faculty to chat with the students individually. Finally, peer mentors helped the community college students with socialization, local help, and assistance with projects in some cases. Overall, we found that individual mentoring by faculty and peers was essential and critical to the success of many students, especially those for which this was their first time living away from home.

In summary, early community college students presented a unique set of challenges compared to REU participants from four-year institutions. Consequently, we needed approaches targeted to their specific needs, which were often individualized and revolved around multiple forms of mentorship. In many instances, we only developed our approaches after gaining experience in the first year of the program.

Opportunities

Focusing on early community college students also presented opportunities for student growth in academics and professional development. Young students between their first and second year, at both community college and four-year institutions, often have inadequately formed academic and career plans, as would be expected. Consequently, there were numerous opportunities to provide academic and career guidance through curricular studies, experiences, and mentorship. In fact, we found that our young community college participants were especially limited, often having little understanding of research, data science and career opportunities related to biology. Consequently, we had the opportunity to provide transformational mentorship.

Further, as also would be expected and in contrast to even young students at four-year institutions, our participants had almost no research experience. In fact, some had little understanding of research and the process of scientific discovery. Consequently, we had the opportunity to nurture their introduction to scientific research.

Finally, our students were often insecure academically or came from challenging personal spaces. Consequently, through individual mentoring, small group workshops, and peer support we could

provide opportunities for their personal and social growth in the context of an academic environment.

Outcomes

During the first year, before we developed a national database of contacts, only 26 students applied. In the second year, with a partial database of contacts, applications nearly doubled to 44. In the third year, when we had a full database of contacts, applicant numbers again nearly doubled reaching 71 applicants, together suggesting the development and use of the national database was essential for obtaining a significant number of applications. Note that in absolute numbers the 71 applicants in the third year was a small group compared to traditional REU programs where applicant numbers can be in the hundreds. This was expected, since we were drawing from a limited population of potential applicants (community college students, and only those between their 1st and 2nd year).

Figure 1 shows the demographics of the applicants: 46% were from under-represented minorities and 35% were first generation students (Figure 1A); percentages of applicants according to self-reported racial or ethnic identities are shown in Figure 1B.

Figure 1. *Demographics of applicants, 2021-2023*

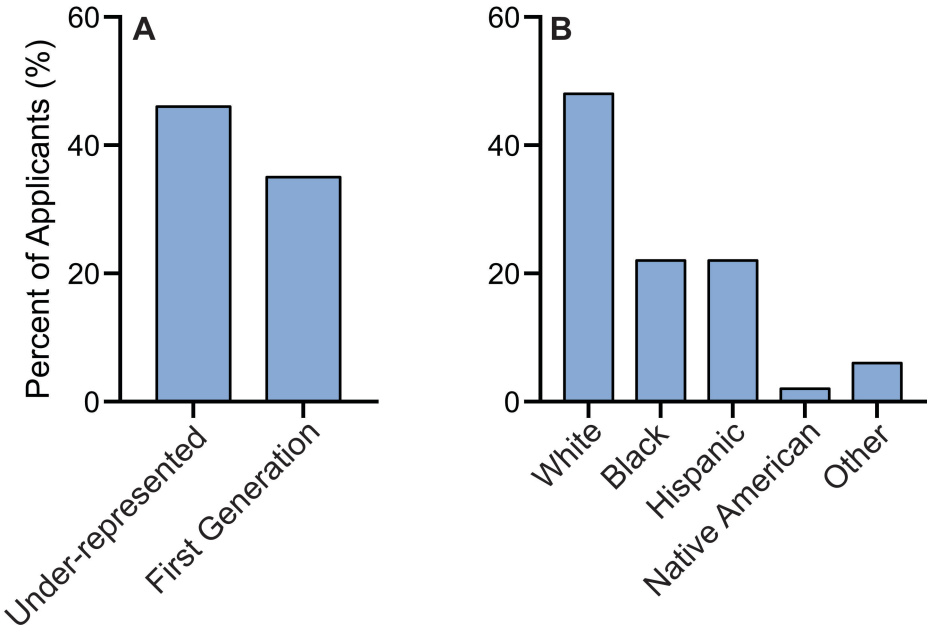
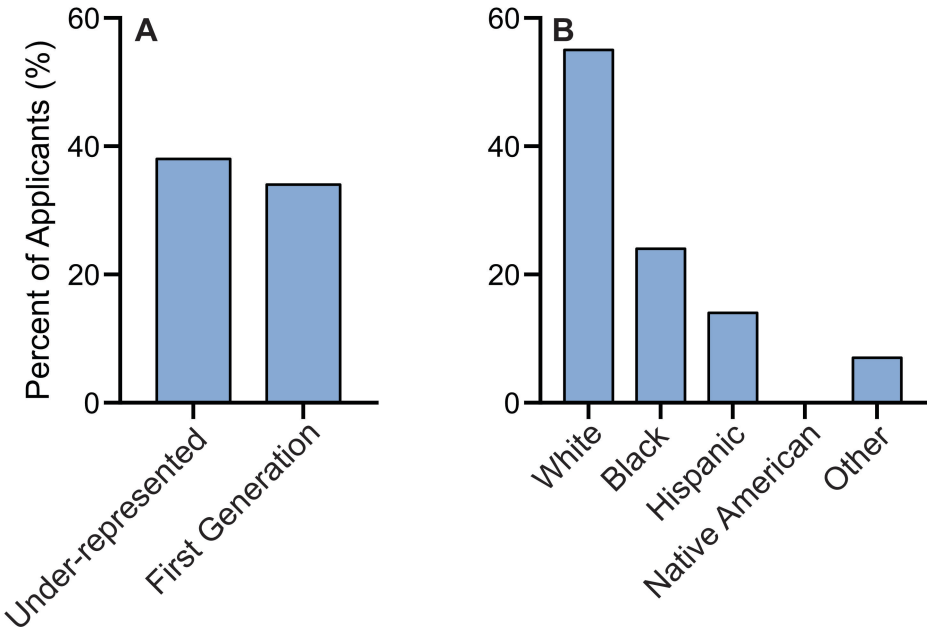


Figure 2 shows the demographics of the accepted students; 38% were from under-represented minorities, starting to approach our target of 50%, and 34% percent were first generation students (Figure 2A); percentages according to self-reported racial or ethnic identities are shown in Figure 2B. While we made progress in recruiting under-represented minorities, the majority of accepted students were white, perhaps reflecting our limited applicant pool in the first two years. Given the challenges of recruitment in the first two years, we were satisfied with these demographic outcomes.

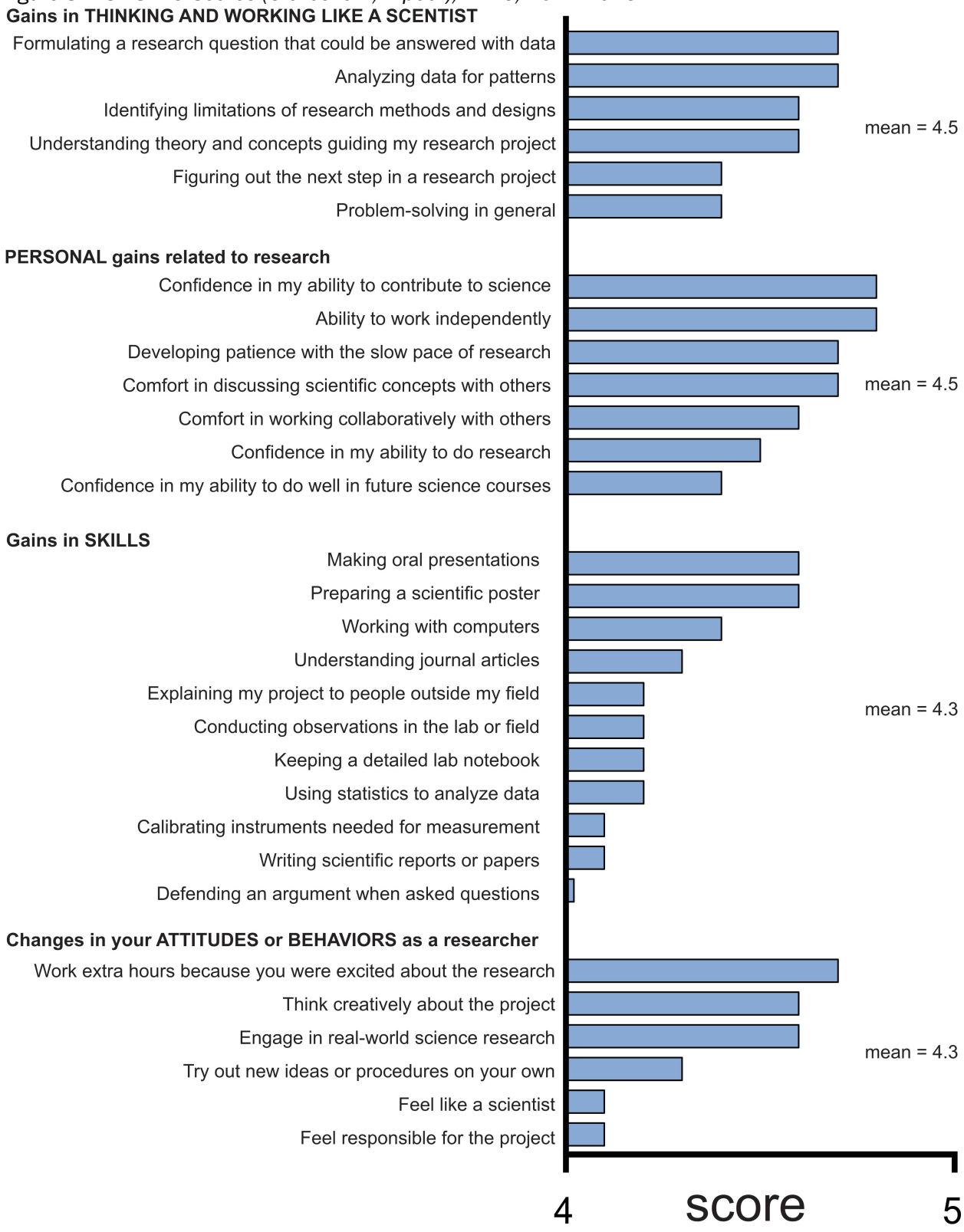
Figure 2. *Demographics of accepted students, 2021-2023*



We evaluated our program through the standard NSF SALG (Student Assessment of their Learning Gains) questionnaire and long-term qualitative follow-up. SALG is a standard assessment tool developed by the University of Colorado at Boulder in 1997 (Seymour et al., 2000) with support from NSF and has been required to be used with REU programs. Dissemination of our outcomes was approved by the James Madison University Institutional Review Board.

Quantitatively, the overall (2021-2023, n=25) SALG results are shown in Figure 3. Overall, students reported on average strong gains (4.4/5.0, 1=poor, 5=excellent) over the four areas covered by the SALG. The lowest scores were 4.1, which were generally in areas not covered explicitly by our REU (e.g. calibrating equipment, writing). Interestingly, the strongest scores (4.6/5.0) were in personal gain and critical thinking, broadly applicable abilities consistent with the goals of our REU. Importantly, 88% also reported their academic or career goals changed after participating in the REU.

Figure 3. *NSF SALG Scores (5-excellent, 1-poor), n=25, 2021-2023*



We also solicited open-ended comments about their experiences and value for their academic and career development, organizing them into two groups: “Impact on academic plans” and “Impact on career plans” (Table 1). While almost uniformly positive, many revealed that the REU experience had a transformational impact on their academic and career plans, which was a central goal of our program.

Table 1. *Student comments on the value of the REU program, divided into two areas.*

Impact on academic plans	**Impact on career plans**
Before this summer program I intended to apply to nursing school. However, now after completing bench research, I plan to pursue a more research focused degree and later a Masters.	*The research opportunity allowed me to see and understand what the field was actually like versus my idealized version of it. It tempered my expectations but also allowed me to create achievable goals for my future.*
*Before I wasn’t sure what I wanted. Now I know I want to work towards a PhD and pursue research!***	*It made me realize I do not want to be a biologist and it made the transition to another field of science easier.*
This research experience influenced my thinking about future school and career plans by exposing me to a field that I have never seen, worked in, or known about in detail. Conducting bench research and actively working on the scientific process with my mentor shifted my complete understanding of STEM and my future as a nurse and researcher.	*…. I'm at Amherst College now, studying mathematics …. I'm interested in computational biology, specifically genomics. During the REU, I worked on a computational biochemistry project, which sparked my interest in similar work and led me to this field.*
Got another research position and am head of research for a VCU organization. (REU) Skills have seamlessly transferred over into other labs	*My research experience has broaden my perspective about my future school and career plans. I am now more invested in my education and eager to acquire new information so I can further expand my knowledge on science.*
It helped me commit to coming to William & Mary, which was probably the best choice I could have made, so I am very thankful for that guidance!	*Was unsure when I attended, now I am certain that I want to pursue a career in microbiology and dietetics*
Before doing REU I wanted to major in astronomy and minor in biology so that I can become an astrobiologist. I am fully planning to go into a graduate program now.	*Helped me to become a better public speaker and presenter (in regards to PowerPoint flow and vocal projection). Opened a door for further research opportunities*
I go on hikes a lot more, and collect insects regularly now. I have gotten really into microscopy to where I have a collection of different microscopes and take photos on them regularly. I also participate and sometimes lead programs that let students explore various STEM fields and serve as an advocate and resource for helping students find and apply for REU's.	*During the REU, I worked on a computational biochemistry project, which sparked my interest in similar work and led me to this field. The summers after the REU, I've worked at the Broad Institute of MIT & Harvard doing cancer research. Though, the REU at JMU was my most favorite experience of all time, I could never forget it :)*
I’m attending George Mason University and have started applying to Master’s and Ph.D. programs for after I graduate this spring. Since participating in the NSF REU, I’ve been fortunate to have some amazing opportunities that have helped me explore which research path I’d like to pursue. Without a doubt, I wouldn’t be where I am today without that (REU) experience, and I’m so grateful for it.	*Once I graduate I am planning on going into industry and I want to start working in a laboratory somewhere, preferably in the research and development department. I have worked hard to build my skills in the lab in the last two years and I do not know if I would have made the switch without the opportunity to do field research during the summer of 2022.*

** Many participants (>5) stated that attending the REU program either reinforced or made them want to go to graduate school and complete a masters or doctorate program

Conclusions

Community college students face several challenges transferring to biology programs at four-year institutions, including difficulties in obtaining research experience. To provide authentic research experiences for young community college students, we developed an NSF funded residential REU program in Biology and Data Science at James Madison University limited to community college students between their first and second year.

The unique focus of our narrow recruitment led to challenges different from other REU programs serving students from four-year institutions. First, since students applied after one community college semester, they had a limited community college academic record and struggled obtaining letters of recommendation. Consequently, we considered high school transcripts, only required one letter and were willing to accept that letter from a high school teacher. Second, students often arrived with limited biology and data science background; consequently, we developed a boot camp targeted at basic skills needed to conduct research. Third, community college students are typically not aware of summer research opportunities, consequently it was necessary for us to reach out to them, which we did through established partnerships with local community colleges and creating a national database of contacts at community colleges. Fourth, we found that students were highly diverse in their background, expectations and needs; consequently, we focused on individual mentoring over group training.

Overall, we broadly met our goals. Each year, our applicant pool approximately doubled through expanded national recruitment. Of the participants, 38% were from under-represented minorities and 34% were first generation. SALG scores were positive and, most importantly, student comments reflected a transformational change in their academic and career plans, often tied to their experience in research and data science.

In summary, we believe that summer research programs can be effectively developed for community college students as early as between their first and second year, as long as the unique challenges and opportunities of this group are recognized and addressed.

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