Equity Promotion for Underrepresented Community College Students Nationwide: A Case Study of the Micro Nano Technology Collaborative Undergraduate Research Network

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Abstract

There are many individuals from groups traditionally underrepresented in higher education— first-generation, low-income, and Black and Hispanic students — where community college serves as a bridge to entering the technical workforce or pursuing higher education. Most of these students attend community college part-time to accommodate their familial obligations, demanding work schedules, and the budget afforded to their education. Numerous studies indicate that increased financial support, engagement in external experiences, and strong faculty mentorship can promote these students' academic and future professional success. The Micro Nano Technology Education Center aims to increase educational equity and diversity by addressing this need by offering community college students nationwide the opportunity to work with and learn from faculty mentors, baccalaureate research universities, and industry partners from across the nation remotely or in person through the Micro Nano Technology Collaborative Undergraduate Research Network. This network works to prepare underserved students for entering the technical workforce or transferring into higher education through funded academic-year and summer capstone experiences along with faculty mentorship, peer mentorship, and weekly networking opportunities. Our results found no statistically significant difference in student-perceived retention, accessibility, or in students' belief that they belong in laboratories where they may not see representation before and after participating in the MNT-CURN program. However, these results indicate positive trends in these areas, and students self-reported that participating in MNT-CURN increased their confidence that they will complete a STEM-based degree.

Keywords: diversity, equity, inclusion, community college, research, education

Introduction

The current state of the science, technology, engineering, and mathematics (STEM) fields demonstrates disproportionately low African American, Hispanic, Native American & Alaskan Native representation in the workforce and the achievement of bachelor's degrees in STEM [1,2]. In the case of women, underrepresentation in STEM is especially demonstrated in engineering, physics, mathematics, earth science, and computer science [3]. Community colleges serve a vital role in providing opportunities for individuals who are underrepresented and disadvantaged to enter the realm of postsecondary education [4]. Currently, community colleges educate 38% of all U.S. undergraduate students, 52% of Native American students, 48% of Hispanic students, and 39% of African American students. Of students in community college, 30% are first-generation students, 16% are single parents, and 21% are students with disabilities [5]. Open enrollment makes community college more accessible to students with broader variation in academic achievement and preparation [6]. The significantly reduced cost of community college, compared to 4-year schools, makes them accessible to students from low-income backgrounds

[7]. However, despite the increased accessibility of community colleges, community colleges in general, still show low STEM degree achievement rates [8,9].

Undergraduate research experiences have been demonstrated to help in increasing STEM excitement and retention rates in underrepresented students [10,11]. Various studies in undergraduate research experiences have shown increased STEM degree achievement rates among undergraduate research students [12,13]. Undergraduate research has also been shown to strengthen positive scientific identities, persistence in pursuing a scientific career, and integral skills in STEM, such as critical thinking, problem-solving, and understanding scientific topics, and persistence in pursuing a scientific career [14,15].

Community college students face a key challenge in the pursuit of undergraduate research, many community colleges have very limited research opportunities, if any at all. These reduced opportunities result in a deficit in undergraduate research culture at community colleges [16,17]. As a result, community college students are at a disadvantage compared to their peers in 4-year research institutions and often miss out on the benefits associated with participation in undergraduate research.

The primary goal of the Micro Nano Technology Collaborative Undergraduate Research Network (MNT-CURN) is to increase educational equity and STEM degree achievement by providing community college students nationwide with research opportunities that are accessible and offer the chance to build valuable STEM workforce skills. Created in 2021, MNT-CURN is a National Science Foundation-funded program based at Pasadena City College in Pasadena, California. Community college students nationwide participate in virtual research-based meeting sessions with experts in various micro-nanotechnology fields throughout the academic year. Ultimately, they gain hands-on research experience at a participating university. This is accomplished by relying on high-impact practices (HIPs) to retain, train, and prepare students for the technical workforce or transfer to a higher education institution. HIPs require students to devote significant time and effort while fostering extensive interaction and feedback among peers and faculty.
Furthermore, students are placed in diverse environments and encouraged to apply their education in different settings [18]. HIPs include academic learning communities, collaborative assignments and projects, common intellectual experiences, undergraduate research, ePortfolios, and internships [18, 19]. They have been shown to increase the likelihood of students completing college within six years [20]. These HIPs have also improved critical thinking skills, more in-depth learning opportunities, and positive attitudes toward interacting with classmates and staff [21]. However, recent research has shown that HIPs, while useful, are often least accessible to historically underserved students. As a result, HIPs have increased inequity rather than decreased it [22]. MNT-CURN strives to address this inequity by utilizing a framework that makes HIPs easily accessible to historically underserved students.

Methods

Evaluation Setup

MNT-CURN's commitment to providing research opportunities to community college students has been evaluated in many ways to observe the program's efficacy. Educators who are not internally affiliated with the program were selected as external evaluators to ensure the goal was met. They were selected due to prior experience evaluating similar scientific programs and equity research. This group of evaluators included Terryl Bailey, the President of The Allison Group, Dr. Jalil Bishop, the co-founder of Equity Research Cooperative (EqRC), and Dr. Antar Tichavakunda, a professor of Race and Higher Education at the University of California at Santa Barbara. Together these expert evaluators used multiple tools to determine the effectiveness of MNT-CURN. These tools included surveys, focus groups, staff interviews, and observations.

Surveys

Surveys that the Allison Group created were administered before, during, and after MNT-CURN to get consistent feedback from the students about their experiences and perceptions of the program. Since the surveys allowed students to answer organically and in a way that can be quantified, they will be the focus of the results in this study. The surveys encouraged students to think about their experiences within STEM, both within the MNT-CURN program and at their home institution. The optional surveys given pre- and post-academic year focused on the student's goals and ideals in STEM fields and whether they planned to continue pursuing STEM-related career paths. In contrast, the bimonthly surveys focused on diversity and inclusion within the program. These surveys aimed to capture a quantified view of how the participants perceived themselves as part of MNT-CURN and STEM as a whole.

Figures 1-5 display the types of questions asked during the surveys. **Figures 1 and 2** show the answers to questions regarding race/ethnicity, gender, and childhood household income. **Figures 3-5** show the answers in pre and post-cohort of Year Two. These particular questions were chosen as they reflected whether students were likely to continue studying STEM and/or how vital MNT-CURN benefits like stipends and mentorship were to the students.

Results

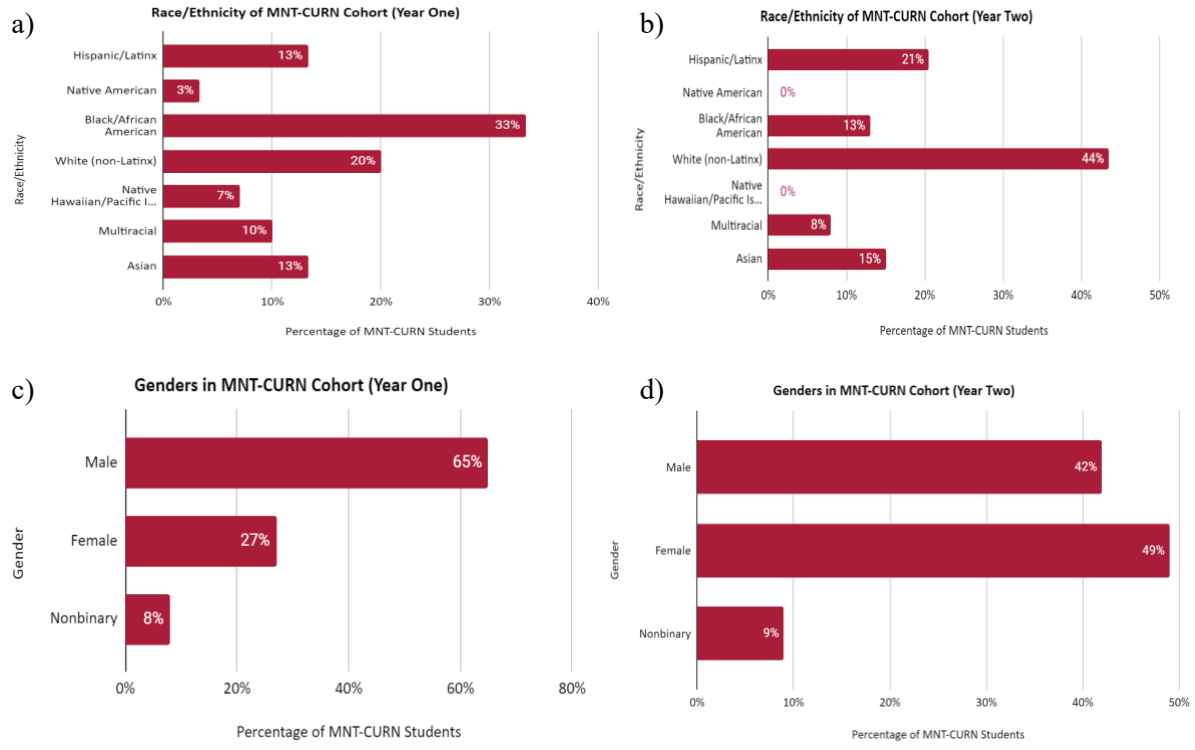

Fig. 1. Race and ethnicity statistics of the MNT-CURN student cohort over the first two years of the MNT-CURN program. (a) Year one N=30, 3 participants skipped (b) Year two N=33, 2 participants skipped. Gender statistics of the MNT-CURN student cohort over the first two years of the MNT-CURN program. (c) Year one N = 30. (d) Year two N=33, 2 participants skipped this question in the survey and the questionnaire.

Figure 1 provides data from the first two years of MNT-CURN cohorts. This portion of the data focused on compiling the racial (a and b) and gender (c and d) distributions from the beginning to the present. This data was used to evaluate the program's equity and inclusion of underrepresented groups.

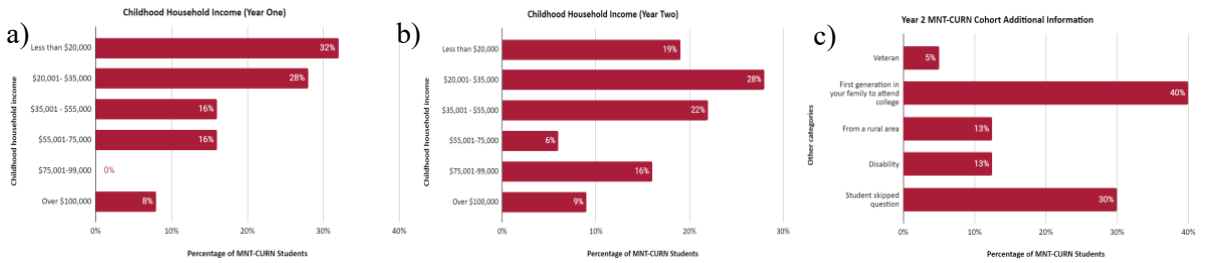

Fig. 2. Childhood household income statistics of MNT-CURN student cohort of the MNT-CURN program, Year One, N= 36(a) Year Two, N=40 (b). Veteran, first generation, rural area, and disability statistics of the MNT-CURN student cohort were collected in Year Two, N=40 (c).

Income data over the two years was also compiled to further evaluate equity and inclusion trends. The statistics of childhood household income allowed analysis of the amount of low-income students that comprised MNT-CURN's student population (a and b). The additional information included aspects of sub-populations amongst students that allowed for the display of diversity among the students (c).

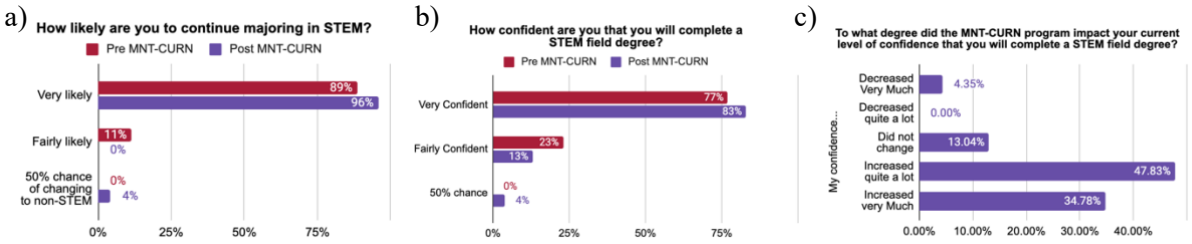

Fig. 3. Percent likelihood of Year Two MNT-CURN cohort students to continue majoring in STEM before and after the MNT-CURN experience (Pre MNT-CURN N=35, Post MNT-CURN N=24) (a). Percent confidence of Year 2 MNT-CURN cohort students to graduate with a degree in STEM before and after the MNT-CURN experience (Pre MNT-CURN N=35, Post MNT-CURN N=23) (b). Students self-declared the impact MNT-CURN had on their level of confidence that they will complete their STEM degree (N=23) (c). Figures a and b showed non-significant results.

To evaluate MNT-CURN's goal of student retention and personal growth, paired T-Test analyses of the questions "How likely are you to continue majoring in STEM?" (a) and "How confident are you that you will complete a STEM field degree?" (b) was completed to see if there were statistical significance between the pre-and post- cohort surveys. For the "How likely are you to continue majoring in STEM?" question, the responses were found to be insignificant, with a *p*-value of 0.294. Similarly, the "How confident are you that you will complete a STEM field degree?" question had a *p*-value of 0.270. Despite the non-significant results, the self-report of MNT-CURN's impact on the confidence of students to complete STEM-related degrees displayed that the majority of students had an increase in confidence post-cohort (c). Figure 3c was excluded from paired T-Test analysis because this question only pertains to and is being asked in the post-cohort survey.

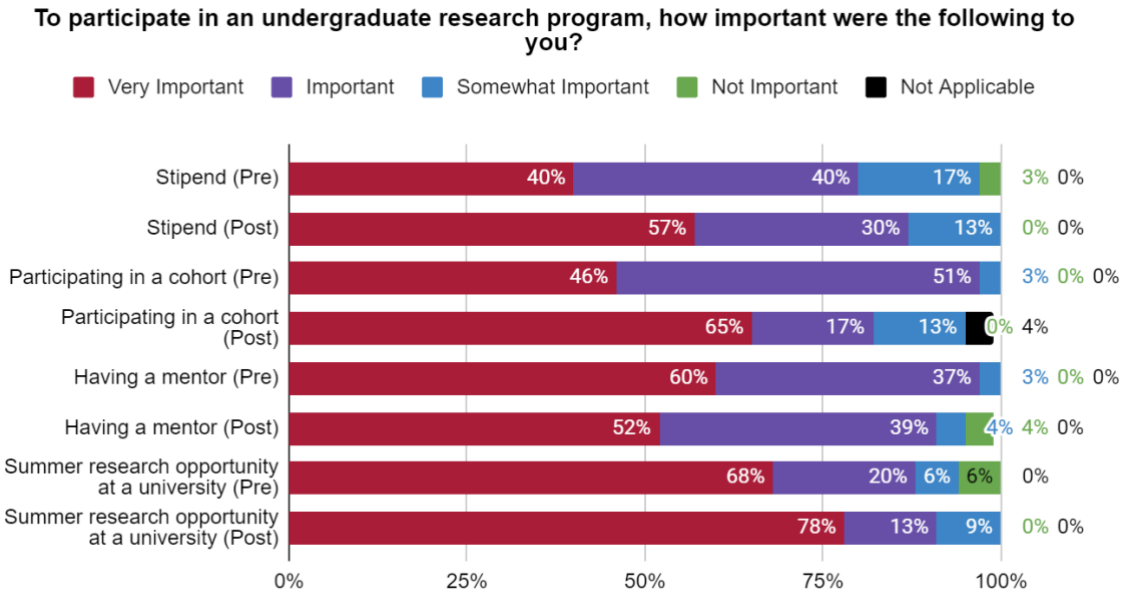

Fig. 4. Student self-declared the importance of various aspects of the MNT-CURN program before and after MNT-CURN program completion. All comparisons were non-significant. Pre MNT-CURN N=35; Post MNT-CURN N=23.

Due to the noted inaccessibility of programs similar to MNT-CURN that provide research experience and STEM mentorship and the complexity of how each portion may intersect, each aspect of this question was evaluated separately for pre- and post-MNT-CURN cohort response via paired T-Test analyses. All aspects were found to have insignificant differences. The respective *p* values are: Stipend: 0.127, Participating in a cohort: 0.461, Having a mentor: 0.266, Summer research opportunity at a university: 0.109.

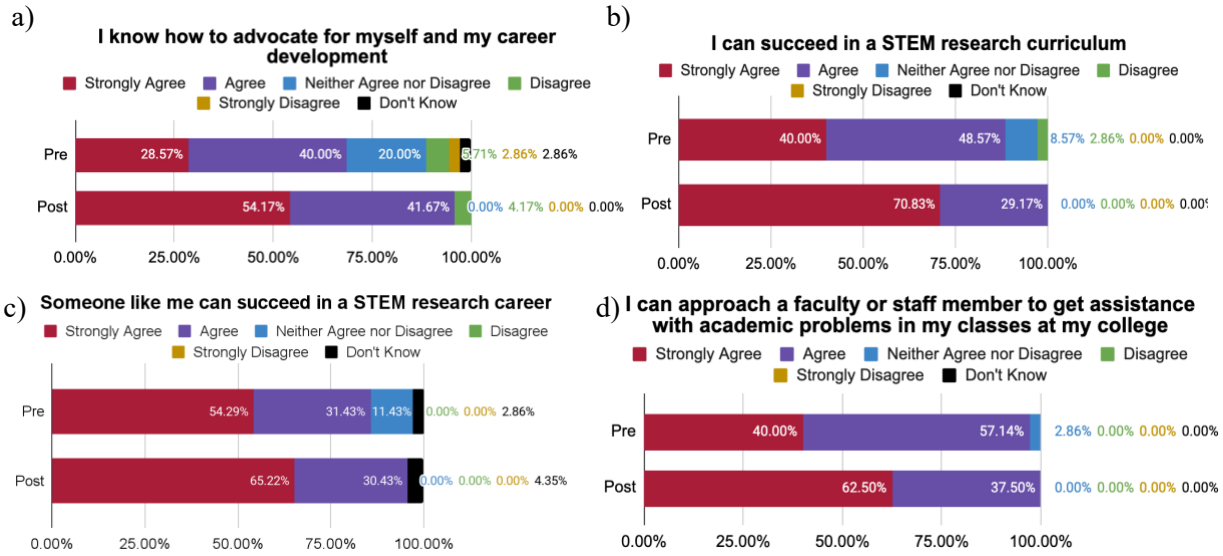

Fig. 5. Student beliefs on various aspects of entering STEM academia and workforce spheres before and after MNT-CURN program completion. Student beliefs regarding their ability to

advocate for themselves (a). Student beliefs on their ability to succeed in STEM (b). Student beliefs that someone like them can succeed in STEM (c). Student beliefs that they can approach faculty or staff for help with academic problems (d). All comparisons were non-significant. Pre MNT-CURN N=35; Post MNT-CUTN N=24.

In order to observe MNT-CURN's impact on the student beliefs within the STEM field, paired T-Test analyses were completed to compare the pre-and post-cohort responses. All the aspects resulted in insignificant data. The *p* values for the separate elements are as follows: Self-Advocacy: 0.240, Succeeding in STEM research curriculum: 0.359, Being able to succeed in STEM research career: 0.076, Approaching Faculty/Staff: 0.368.

Discussion

Equity in STEM

In an effort to execute the goal of promoting equity amongst underrepresented student populations, MNT-CURN invites students from traditionally underrepresented groups to apply. Since its inception, MNT-CURN evaluators surveyed the demographic makeup of the 2022 and 2023 cohorts to observe these efforts. In **Figure 1**, the data shows a shift in racial makeup in the Year One and Year Two cohorts. According to the American Association of Community Colleges (AACC), the reported average racial demographics of community college students enrolled for credit are as follows: Caucasian students - 45%, Hispanic students - 27%, Native American students - 1%, African American students -12% [12]. In our data, we see a shift from Year One to Year Two in terms of the racial makeup of the cohort. In Year One (**Figure 1a**), the majority of the cohort is from an underrepresented group within STEM, though in Year Two (**Figure 1b)**, the percentages mirror the AACC data.
Further evaluation would be necessary to uncover how the cohort's racial data shifted to the statistical norm. Further, **Figure 1c-d** displays the data on gender from Year One and Two. A shift from male to female majority can be seen along with increased nonbinary participants in the cohorts. As the goal of MNT-CURN is to promote equity, this trend of racial and gender makeup should be observed for more years for further evaluation.

As the accessibility of community college allows students from impoverished backgrounds a chance to have an education, socioeconomic trends observed show that students from low-income backgrounds will still struggle to attain their associate degree [23]. As represented in **Figure 2a-b**, more than half of the students from both years come from households where the below $55,000. As that would be considered low income, the goal of equity among class is being met as the cohort consistently allows the opportunity of research to lower-income students.

Additionally, of the students in MNT-CURN's year two cohort that answered or skipped the additional information questions in **Figure 2c**, 5% were veterans, 40% were first-generation college students, 12.50% were from a rural area, and 12.50% were disabled. Compared to the representation of first-generation college students in community college as described by the AACC (30%), the MNT-CURN program demonstrated a 33.33% representation of first-generation college students within their program.

Use of HIPs and Their Access:

As previously addressed, research shows that while community colleges create a way for low-income students to gain an education, their financial status and responsibilities will statistically make obtaining degrees harder [23]. While HIPs, like undergraduate research, have been shown to benefit students and bolster STEM retention rates, accessibility for community college students remains limited [10, 11, 22]. MNT-CURN addresses this issue by creating cohorts geared toward community college STEM students and providing resources such as stipends and remote research engagement [24]. As there is a higher

prevalence for community college students to experience a lack of basic needs such as food security and housing, the chance to participate in a HIP that provides payment and remote opportunities opens doors for students who would not be able to sacrifice the time or resources to experience undergraduate research [23, 25, 26]. According to our data, **Figure 4** shows that most students pre- and post-cohort considered the stipend payment as "very important" or "important" in participating in an undergraduate research program. The difference between the pre and post surveys were determined to be non-significant; however, the consistency of the majority considering the HIPs available in the program to be of importance, shows the goal of MNT-CURN's accessibility is being met.

Addressing the Student Retention of STEM Majors for Careers

MNT-CURN also has goals to improve STEM student retention and prepare students for technical careers or higher education. According to research, while the majority of community college students aspire to transfer to 4-year universities, only a fraction do so [27]. In the evaluation surveys given at the beginning and end of the academic cohort, students were asked about their plans to major in STEM and their confidence levels for completing a STEM field degree. In **Figure 3a**, the data shows that while 89% of students were most likely planning on continuing STEM-based majors before the cohort, the percentage jumped to 96%. Similarly, the data collected on students' confidence in finishing a STEM degree increased from 77% to 83% (**Figure 3b**). These observations are supported by **Figure 3c,** where students were asked directly about MNT-CURN's impact on their confidence levels. Figure 3c displays that 82.61% of students in the cohorts felt that their confidence in completing a STEM degree was increased due to MNT-CURN. In **Figure 5**, the data shows that students typically displayed a more positive outlook on aspects of belonging and succeeding within STEM after their participation in MNT-CURN. These upward trends in planning to engage with and complete STEM degrees showcase that MNT-CURN's goal of student retention and preparing for future STEM-related endeavors positively influenced the cohort, despite the data being statistically insignificant.

Conclusion

Overall, MNT-CURN's goals for increasing STEM engagement for students statistically underrepresented in STEM fields and undergraduate research will need further evaluation. While the cohorts bridge a gap for students that may benefit from high-impact practices or mentoring, they would otherwise have no accessibility to such until and if they attended a four-year university; our data at this time shows no statistical significance. According to the studies cited in this paper, it is concluded that MNT-CURN's program may see positive trends in the areas of efficacy in student retention, accessibility, and reinforcing the belief in students that they belong in laboratories where they may not see representation, but the data shows no significant increase in these measures and will require more cohorts to see greater impact.

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Disclosures

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