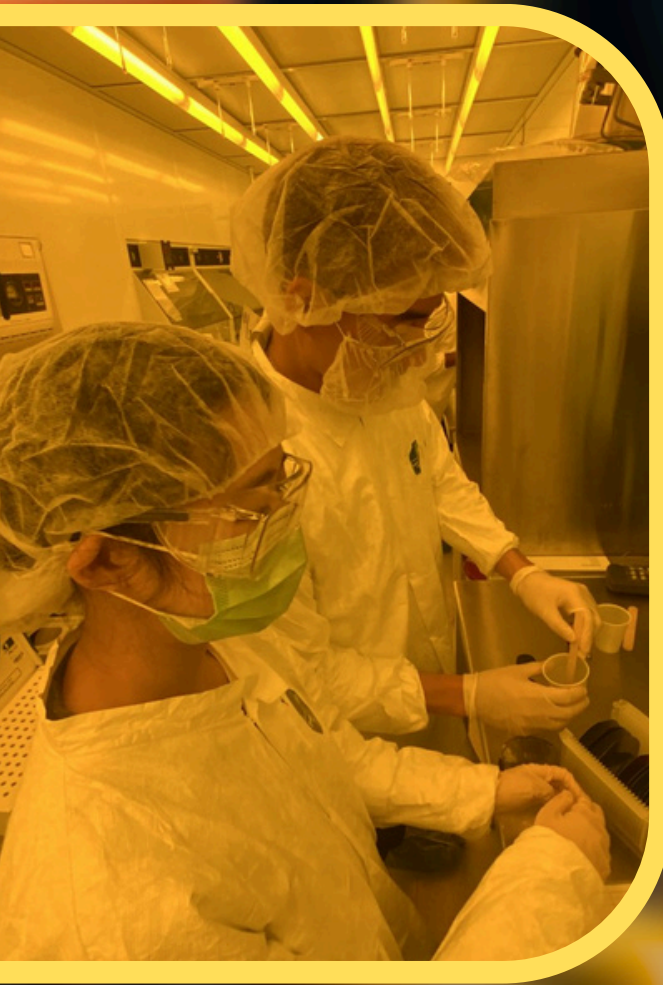




MNT-CURN & START

SUMMARY & OUTCOMES



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Micro Nano Technology Education Center (MNT-EC)



MNT-EC

Pasadena, CA

Pasadena City College administers the Micro Nano Technology Education Center (MNT-EC) through a grant from the National Science Foundation's Advanced Technological Education (ATE) Program. MNT-EC is a consortium of community colleges, universities, and industry partners that serves as a national hub for information-sharing and education in micro and nanotechnology (MNT).

The Center's mission is to expand the MNT technician workforce by fostering collaboration and mentorship. By providing resources for students in nanotechnology, photonics, nanobiotechnology, materials science, and semiconductor fabrication, **MNT-EC guides the next generation of professionals.** The Center collaborates with industry leaders such as the SEMI Foundation and the National Institute for Industry and Career Advancement (NIICA), forging partnerships that shape education and workforce strategies to ensure students are prepared for the technical workforce. Through these alliances, the Center integrates industry insights into curricula, ensuring students gain hands-on experience with cutting-edge technologies. These efforts bridge the gap between academic training and industry demands, **creating a skilled workforce that adapts to technologies.**

To address the nation's growing demand for MNT technicians, **MNT-EC is spearheading innovative approaches to workforce training.** A key focus of the Center includes undergraduate research, aimed at enhancing students' critical thinking, technical skills, and problem-solving capabilities. Through MNT-EC programs like the Micro Nano Technology Collaborative Undergraduate Research Network (MNT-CURN) and the Skills Training in Advanced Research and Technology (START) programs, students gain **invaluable hands-on experience** and engage in **immersive workforce opportunities.** By collaborating with industry experts, academic institutions, and government agencies, these initiatives are not just building the next generation of MNT technicians—they are shaping the future of an industry that will define the technological landscape for years to come.

VISION

MNT-EC's Vision for the Future of the Workforce

The micro- and nanotechnology (MNT) workforce is on the cusp of significant transformation. Federal investments, including funding from initiatives like the CHIPS and Science Act, signal a nationwide commitment to bolstering domestic technology capabilities.

However, as the industry expands, a robust and well-prepared workforce is essential to sustaining this national progress. Data from the Bureau of Labor Statistics suggests that a substantial workforce gap will emerge over the next few years, calling for a large-scale investment in workforce development. Without a strong pipeline of skilled technicians, these advancements risk stalling.

MNT-EC is not just responding to this challenge—it is driving the solution. Through expanded research opportunities, internships, and workforce training programs, the Center is preparing the next generation of MNT technicians. This effort is not merely about filling workforce gaps; it is about ensuring that the nation's technological advancements are matched by a skilled, prepared workforce—one that can sustain innovation and secure the country's leadership.

MNT-EC has already demonstrated remarkable success in preparing students for the workforce. Through flagship programs like MNT-CURN, START, and AT3, the Center has gathered extensive outcomes data, proving the direct link between student engagement and successful workforce participation. These initiatives have not only helped students secure high-demand careers but have also **reinforced MNT-EC's role as a national leader in workforce development.**

Now, MNT-EC's focus shifts to scaling these successes and ensuring long-term, sustainable programming. With strategic investment, the Center can expand its reach, providing more students—particularly those from community colleges—with transformative training opportunities that will strengthen the broader MNT industry.

MNT-EC is working to secure lasting resources, including funding for a **Community College and Technical Education Incentive Endowment**, which will provide critical support for students pursuing careers in this high-growth sector.

By securing long-term funding, MNT-EC can ensure its workforce development programs evolve alongside the industry, equipping students with the skills necessary to meet emerging technological demands. This investment will not only strengthen the technician workforce but also drive innovation, economic growth, and the long-term resilience of the MNT sector. Additionally, it will expand access to cutting-edge training opportunities, enabling more students from diverse backgrounds to enter and thrive in the field, fostering inclusivity, bridging gaps, and supporting workforce

FOCUS ON UNDERGRADUATE RESEARCH & INTERNSHIPS

MNT-EC's mission is grounded in pedagogical research that demonstrates how hands-on experience through research and internships is a critical factor in student success. These opportunities equip STEM undergraduates with essential technical skills, expand their professional networks, and improve career readiness—key factors that influence long-term workforce participation.

By funding these experiences, MNT-EC ensures that students from all backgrounds can access career-building opportunities without financial hardship. Without paid research and internships, many students must choose between immediate financial need and career advancement.

By reducing financial barriers and exposing students to high-paying, high-demand fields, MNT-EC strengthens national workforce development efforts. In doing so, **the Center not only prepares students for the workforce but also helps build a national pipeline of skilled technicians.**



RESEARCH

Literature emphasizes that undergraduate research opportunities enhance communication skills, spark interest in graduate school, and improve enrollment and retention rates. Additionally, studies have demonstrated that providing research opportunities to traditionally underrepresented students in STEM can broaden participation and build self-confidence. [1]



INTERNSHIP

Literature also illustrates the impacts of internships on career decision making, emphasizing undergraduate internships as a key pathway towards STEM careers. These experiences also play a crucial role in fostering a sense of belonging, connecting students with quality mentors, and facilitating smoother transitions to four-year institutions. [2]



1. Mastronardi, Marialice, Maura Borrego, Nathan Choe, and Risa Hartman. "The Impact of Undergraduate Research Experiences on Participants' Career Decisions." *Journal of STEM Education: Innovations and Research* 22, no. 2 (2021): 75-82.
2. Patel, Anushka, et. al. "Summer Research Internships Prepare High School Students for 21st Century Biomedical Careers." *Journal of STEM Outreach* 4, no. 1 (2021).

MNT-CURN

SUMMARY



To expand research and internship opportunities for students, MNT-EC launched its flagship undergraduate research program, the Micro Nano Technology Collaborative Undergraduate Research Network (MNT-CURN), in 2021 with funding from the National Science Foundation (NSF). Designed to advance educational equity, the program provided community college students with hands-on research experiences, strengthening pathways to STEM degree attainment.

MNT-CURN offered students immersive opportunities throughout the academic year, from conducting lab simulations and coding to participating in peer mentorship programs. Faculty mentors provided continuous guidance, while subject-matter experts introduced students to high-impact career pathways in the MNT workforce.

These academic-year efforts culminated in internships at university partner sites, providing students with valuable hands-on experience. In efforts to reduce barriers to participation, MNT-CURN offered remote research alongside in-person opportunities, ensuring broader accessibility for students with geographic or financial constraints.

- ✦ At the University of North Texas, students synthesized nano-based therapeutic agents.
- ✦ At the University of North Texas, students synthesized nano-based therapeutic agents.
- ✦ Through remote experiences at Purdue University, the University of Florida, Indiana University, and University of Illinois, students worked with stimulations and machine learning techniques.

To develop this programming, MNT-CURN forged strong partnerships between industry, community colleges, and universities. **By 2024, the program supported 151 interns, placing 132 into summer research programs, and cultivated relationships with 41 industry and university partners through outreach.** These efforts have significantly advanced student success and helped address critical workforce gaps, ensuring students gain the hands-on experience necessary to excel in high-demand technical fields. Through collaboration, MNT-CURN is strengthening the pipeline of skilled professionals ready to meet industry needs.



MEETINGS

Weekly remote meetings featuring presentations by peer mentors, faculty, and subject-matter experts.



MENTORSHIP

On-site mentorship with faculty at students' home institutions, as well as industry, community college, university, and peer mentorship.



INTERNSHIPS

Summer internships at university partner institutions, such as Caltech, Princeton, University of New Mexico, University of North Texas, and Purdue.



EVALUATION

Student participation surveys and feedback to evaluate program success and objectives.

MNT-EC's Vision for the Future of the Workforce

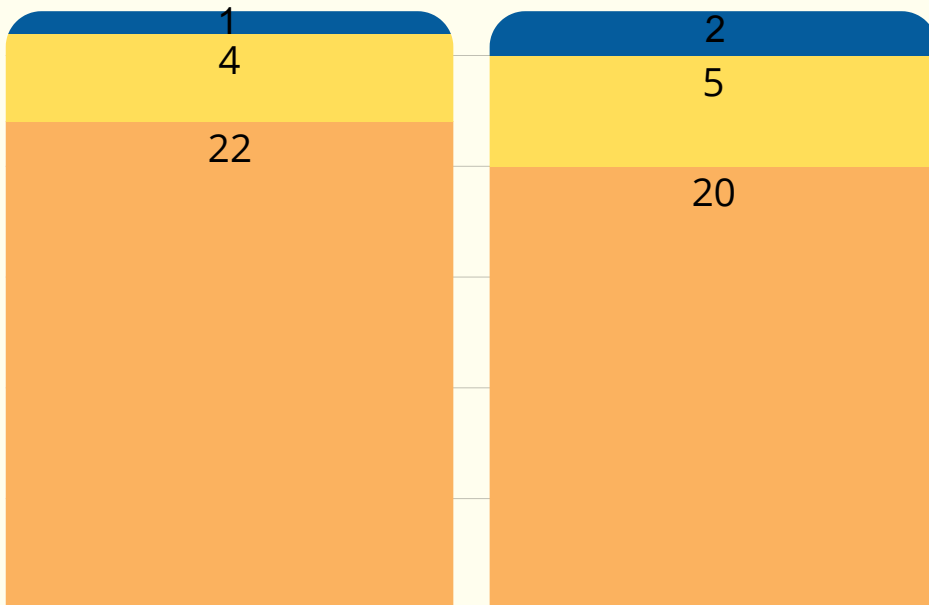
MNT-CURN graduated **150 students from community college partners across seven states:** California, Washington, Texas, New York, Louisiana, Utah, and Pennsylvania. These graduates have successfully transferred to prestigious universities, such as UCLA, MIT, UC Berkeley, and Arizona State. Others have secured employment with organizations like the Philadelphia Water Department and companies including Lockheed Martin.

When surveyed, graduates of the 2023-2024 program reported the following career and skill development outcomes:

- ★ **100%** said it was “very likely” that they would pursue a STEM major.
- ★ **81%** “strongly agreed” or “agreed” that “someone like me can succeed in a STEM research career.”
- ★ **74%** now saw their “background as a strength in STEM classrooms, research, and work environments.”
- ★ **89%** ranked MNT-CURN as “excellent” or “very good” for providing opportunities to learn about real-world applications and research.

STUDENTS REFLECTED ON PERSONAL AND PROFESSIONAL GROWTH IN A POST-PROGRAM SURVEY: *

Agree Neutral Disagree



In the last year, I've leveraged a connection I've made with someone to advance my career.

My confidence increased that I will complete a STEM field degree.

"If it weren't for MNT-CURN I wouldn't have had the opportunity to attend the research program that I will be attending this summer. MNT-CURN has significantly increased my confidence in my career."

"I think I was always good at school, but the professional development resources provided by the program definitely taught me a lot about what I needed to do if I wanted to find success in my field."

"I wasn't entirely sure what occupation or field I would go into after graduating with my mechanical engineering technology degree, but with this research opportunity, I have become excited to enter into the semiconductor and nanotechnologies field."

* Based on survey results from 27 students in the post-program survey

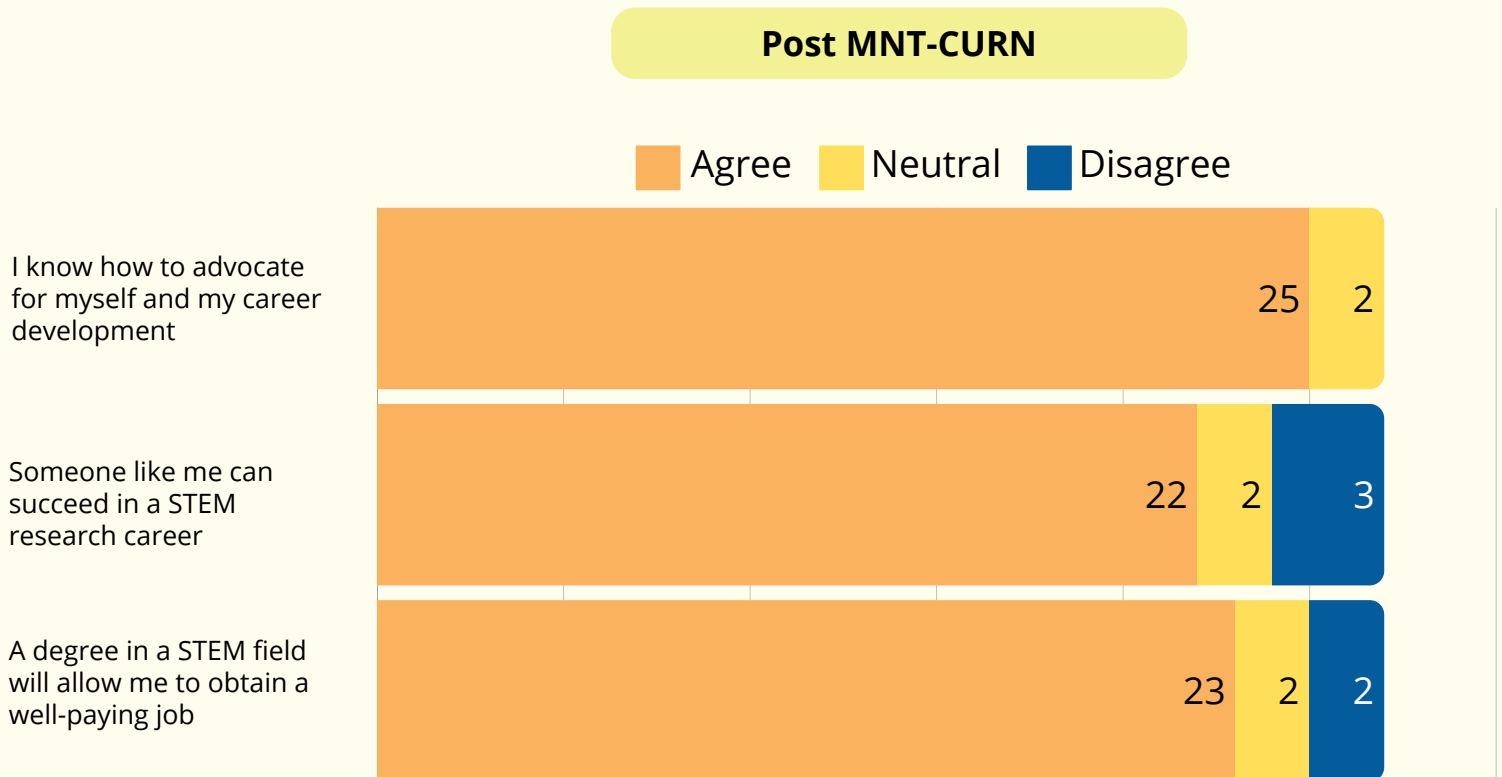
MNT-CURN Evaluation

To evaluate the impact of its first MNT-CURN cohort, MNT-EC contracted The MUME Collective in May 2022 to conduct surveys and facilitate two student focus groups.

The results were striking: students reported increased confidence and a stronger sense of capability in STEM. Compared to their pre-program responses, a higher percentage of participants “strongly agreed” that they felt confident in their ability to “succeed in a STEM research career” and “advocate for their career development.” Additionally, students highlighted the value of mentorship and hands-on research experiences, emphasizing how these opportunities deepened their technical skills and broadened their career aspirations. Many also expressed that the program fostered a sense of belonging in STEM, reinforcing their commitment to pursuing long-term careers in the field.

Student testimonials reinforced these findings. One participant noted, “I feel much more confident reaching out to people I don’t know and asking for help,” while another shared, “I’ve gained confidence and believe I can excel in my major.” Others emphasized how MNT-CURN expanded their career horizons: “Since joining the program, I’ve considered working in multiple research departments.”

Many students also credited the program with helping them build essential networking skills, allowing them to form meaningful connections with industry professionals. Several participants expressed that the experience not only clarified their career goals but also provided them with a sense of direction and motivation to pursue advanced studies. Ultimately, MNT-CURN proved transformative—empowering students to take decisive steps toward their academic and professional futures.



* Based on survey results from 27 students in the post survey.



START PROGRAM

SUMMARY

MNT-EC didn't stop with MNT-CURN. To further expand research opportunities, the Center launched the Skills Training in Advanced Research & Technology (START) Program, designed to enhance student awareness of STEM careers while equipping them with critical technical and professional skills. Through START, community college students engaged in research projects at four-year institutions, gaining direct experience in advanced research environments.

A key pillar of START was its multi-tiered mentorship model, ensuring comprehensive student support. This approach included one-on-one, group, peer-to-peer, faculty research, and industry mentorship. To promote accessibility, mentoring relationships were offered to students in both in-person and online formats, ensuring that students could receive support in a way that best suited their needs.

Through this framework, Pasadena City College students secured prestigious START internships at regional universities and industry partners. Among START participants, three students interned at the California Institute of Technology in 2022, while another three participated in research at Keck Medicine at the University of Southern California, and five at Rice University and Stonehill College gaining invaluable hands-on experience.

As a regional training hub, START provided students with hands-on research experience while addressing workforce gaps and strengthening pathways between two-year and four-year institutions. Participant surveys confirmed its impact—**students reported significant growth in research, communication, leadership, and technical skills,** demonstrating the program's value as a meaningful investment in students' future success and career readiness.



WORK-BASED LEARNING

Attract students into MNT technical employment by providing worked-based learning.



SKILLS

Teach soft and technical skills needed for the successful completion of academic programs.



OPPORTUNITIES

Connect students to opportunities that better prepare them for MNT jobs.





START PROGRAM

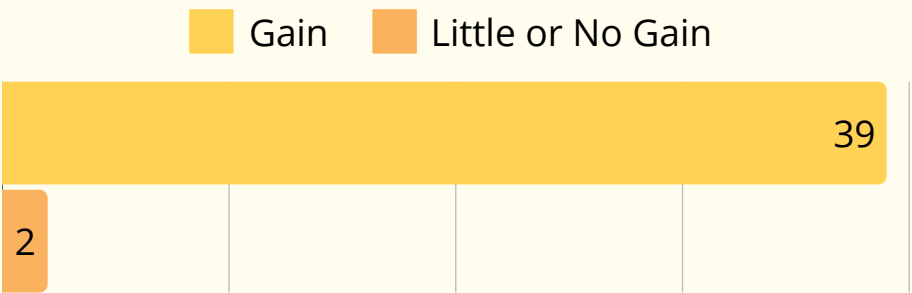
EVALUATION

A core goal of the START program was to strengthen students' research skills—essential for success in STEM careers.

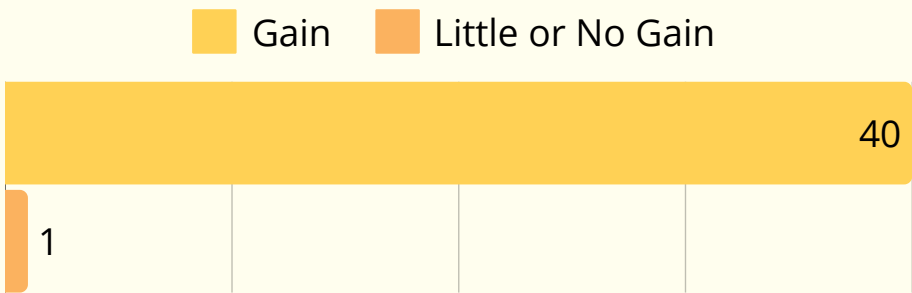
To measure growth, MNT-CURN surveyed students before and after the program, revealing a powerful transformation. The results showed a clear impact: the number of students who felt their research skills “needed development” plummeted from **13 to just 2**. This striking improvement highlights the program’s role in **building both confidence, proficiency, critical thinking, problem-solving, and hands-on experience in scientific research**.

This progress reflects the START program’s effectiveness in bridging the gap between classroom learning and real-world STEM applications. By equipping students with hands-on experience, practical skills, problem-solving abilities, industry connections, and mentorship, the program not only bolstered their technical capabilities but also empowered them to approach future challenges with confidence and skill. Additionally, START fostered a sense of belonging in STEM fields, encouraging students from diverse backgrounds to pursue long-term careers in research, innovation, leadership, entrepreneurship, and technology.

DID PARTICIPATING IN START HELP YOU GAIN UNDERSTANDING OF THE RESEARCH PROCESS?



DID PARTICIPATING IN START HELP YOU BUILD SKILL IN THE INTERPRETATION OF RESEARCH RESULTS?



** Based on post-program surveys answered by START participants*

START Program Student Learning Gains

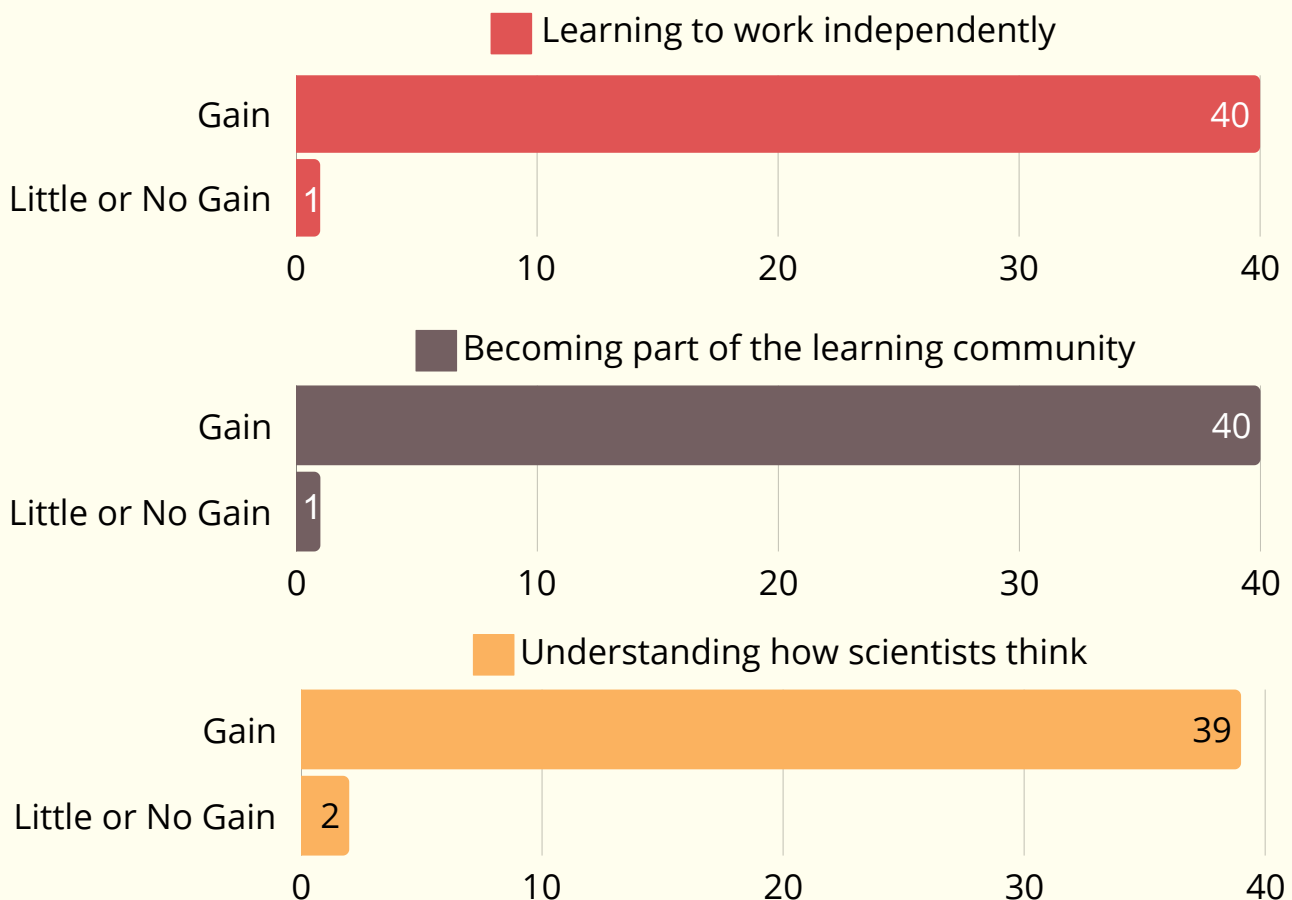
Surveys measured students' confidence in scientific, technical, and professional skills, such as analyzing scientific data and participating in interdisciplinary research.

Post-START, **not a single student** rated themselves as “not at all prepared” in any scientific skill. Even more striking, the number of students who felt **“prepared” or “very prepared” surged** across every measured skill, underscoring the program’s powerful impact.

Additionally, as shown in the below graphs, **97%** of students reported gaining a deeper understanding of research and soft skills, reinforcing the program’s strong impact.

The results indicated that the **START Program played a key role in enhancing student preparedness in these areas**, with a noticeable increase in their confidence, problem-solving abilities, industry awareness, and technical capabilities across the board.

IN A POST-PROGRAM SURVEY, STUDENTS ALSO RATED HOW MUCH THEY GAINED FROM PARTICIPATING IN THE START PROGRAM IN THE FOLLOWING AREAS:



START Program Student Voices



What is the primary benefit you received from participating in the START Program? *



I obtained knowledge regarding industry standards of the field I am studying. I also improved my independent learning skills.



I learned to be professional and deliver the work in a timely manner. This program also help me bring the significant of the research on the real world scenario and inspires me to go a graduate program.

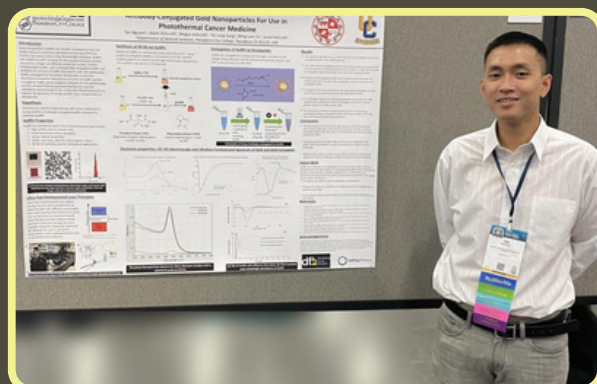


I demystified what it means to apply to and attend graduate school and conduct research. Established a mentor-mentee relationships that I can look to for advice and support beyond the duration of the program.



I got out of one's comfort zone and was in a position to learn from great minds. Our mentors have walked where we are trying to get to, and it does not get better than that.

* Answers provided in survey from START participants



CONFERENCES

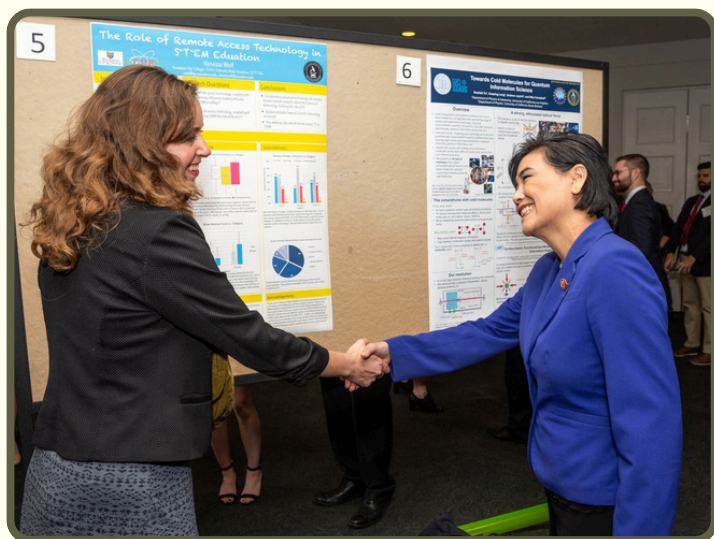
& STUDENT ENGAGEMENT

MNT-EC is not just shaping the future of workforce development—it is ensuring students have a voice in it. As part of its commitment to outreach and engagement, the Center funds student participation in conferences and policy discussions, creating direct pathways to industry and government leaders.

In June 2024, **MNT-EC brought 151 students and faculty to the TechConnect World Conference** in Washington, D.C., where students joined career panels, networking events, and a dedicated student poster session. At the 'TechConnect CHIPS Workforce Development Sessions,' students learned how to translate their skills into semiconductor careers and connected with key industry leaders. In 2025, MNT-EC will expand its efforts, funding another cohort of students to attend TechConnect and other critical workforce development conferences. MNT-EC's ongoing initiatives reinforce its dedication to empower students with opportunities that bridge education, industry, and policy.

Beyond conferences, MNT-EC secured an unprecedented opportunity for **20 community college students to meet with the White House Office of Science and Technology Policy (OSTP)** and representatives from federal agencies. In a candid roundtable, students shared experiences, emphasizing the need for paid internships and funding. One student reflected, "I really enjoyed the D.C. trip—it felt like my opinion was valuable. I had a voice. They cared about what I had to say."

Through these high-impact engagements, MNT-EC is doing more than exposing students to career opportunities—it is empowering them to shape the policies that will define their futures. These experiences provide students with critical industry insights, build confidence, and open doors to networks that will support them for years to come. By facilitating dialogue, MNT-EC ensures the next generation of STEM professionals is heard and represented in workforce discussions.



VIRTUAL REALITY (VR) ENGAGEMENT

TRANSFORMING SEMICONDUCTOR EDUCATION AT MNT-EC

500+

People trained annually

1288

Learning activities completed

44%

Average skill improvement

Training All People (TAP)'s immersive, Risk-Free Training for Tomorrow's Workforce

MNT-EC also joined with Training for All People (TAP) to offer virtual reality training for MNT-EC students. This training enables students to experience a semiconductor manufacturing environment without real-world safety risks. Through hands-on virtual simulations, students engage in complex processes that would otherwise be inaccessible.

Key Benefits

- ★ **Full Cleanroom Experience:** From gowning to etching and lithography, students navigate an entire semiconductor fab.
- ★ **Hands-On Learning with HMI & MES Systems:** Students interact with virtual Manufacturing Execution Systems (MES) and analyze metrology reports, preparing them for real-world operations.
- ★ **Unparalleled Access to Advanced Equipment :** TAP's VR allows students to observe semiconductor processes like Physical Vapor Deposition (PVD) in action—something impossible in a live factory setting.
- ★ **Real-Time Feedback & Skill Tracking:** Students receive direct instruction, with performance metrics recorded to track improvement.



Tailored to High-Tech Careers

TAP's VR training bridges the gap between theoretical learning and hands-on expertise, ensuring students gain the technical skills needed for high-tech careers.

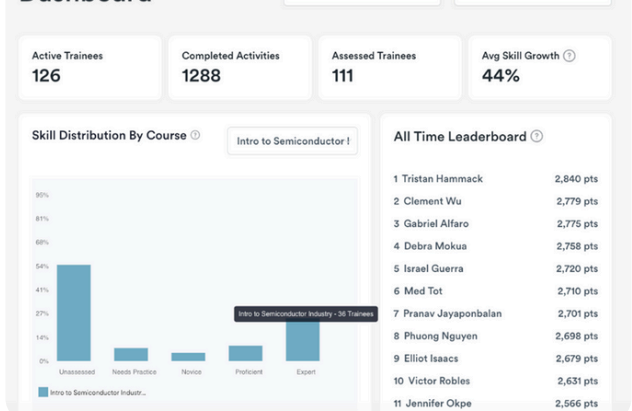


Trusted by Experts

Training utilized by Northrop Grumman's Advanced Technology Labs



Dashboard





2025 & BEYOND

AT3

Building on the success of both MNT-CURN and START, MNT-EC launched the Advanced Technology Technician Training Program (AT3). While preserving the core objectives of its predecessors—such as promoting hands-on learning and offering undergraduate research opportunities to develop a skilled technical workforce—**AT3 enhances these efforts by providing a more expansive and comprehensive training experience.** This includes direct placement of students into industry technician internships and job opportunities, further bridging the gap between education and career readiness.

AT3 will create a nationwide network of community colleges and regional hubs, each featuring a local site coordinator, nearby industries, and four-year universities, ensuring the program is responsive to local workforce needs. Current industry partners include Micron (Idaho, New York), Texas Instruments (Texas, Utah), Wolfspeed (North Carolina, New York), Attollo Engineering (California), GlobalFoundries (New York), Synopsys (Indiana), Intel (Ohio, Arizona, Oregon, New Mexico), Hewlett Packard (California), Cirrus Logic (Arizona), and ARM (California).



Additionally, AT3 offers short cleanroom experiences through university partners such as the University of New Mexico, UCLA, USC, Caltech, University of North Texas, Carnegie Mellon, Stanford, University of Washington, University of North Dakota, Princeton, UC Santa Barbara, and SUNY Polytechnic Institute in Albany, New York. These hands-on experiences provide students with **valuable exposure to cutting-edge fabrication techniques** and **state-of-the-art research facilities**, enhancing their technical proficiency and career readiness.



***With nearly 100 community college partners,
AT3 will train over 500 students annually,
providing the most extensive workforce
pipeline for a MNT industry partner.***



2025 & BEYOND

AT3

PROGRAM GOALS

- **Workforce Preparation:** Equip students with the skills needed for careers in the MNT sector, including roles as process and equipment technicians in semiconductor manufacturing.
- **Flexibility and Accessibility:** Provide both in-person and remote learning options to meet the diverse needs of students, including those facing geographical limitations.
- **Cross-Disciplinary Opportunities:** Offer students the chance to develop research projects across a wide range of MNT disciplines, including micro-electro-mechanical systems (MEMS), photonics, nanobiotechnology, and nanomanufacturing.
- **Industry Pathways:** Create clear pathways for community college students to gain access to industry-supported internships or registered apprenticeships, ensuring a seamless transition into the workforce.

PROGRAM TIMELINE

- **Academic Year:** During the academic year, students are offered local industry and research experiences. The goal is for community college sites to gain access to equipment and industry-validated curricula. Students will also be offered a variety of mentorship opportunities.
- **Summer Term:** After the academic year, students will participate in industry-supported internships or registered apprenticeships, with programs tailored to regional industry needs. Industry partners will also commit to interviewing AT3 students for employment. Remote summer opportunities will be available for greater accessibility.
- **Industry Collaboration:** AT3 will collaborate with the SEMI Foundation and NIICA to validate curriculum content, support internships and apprenticeship, and to provide access to industry validated certifications and assessments.

ANNUAL RECRUITMENT TARGETS

- **Year 1:** For the 2024-2025 academic year, AT3 is supporting **437 community college students**, with 75% actively applying for industry or university summer internships and job opportunities.
- **Year 2:** For the 2025-2026 academic year, AT3 plans to support up to **500 community college students**, with the goal of placing at least 75% into industry or academic internships.



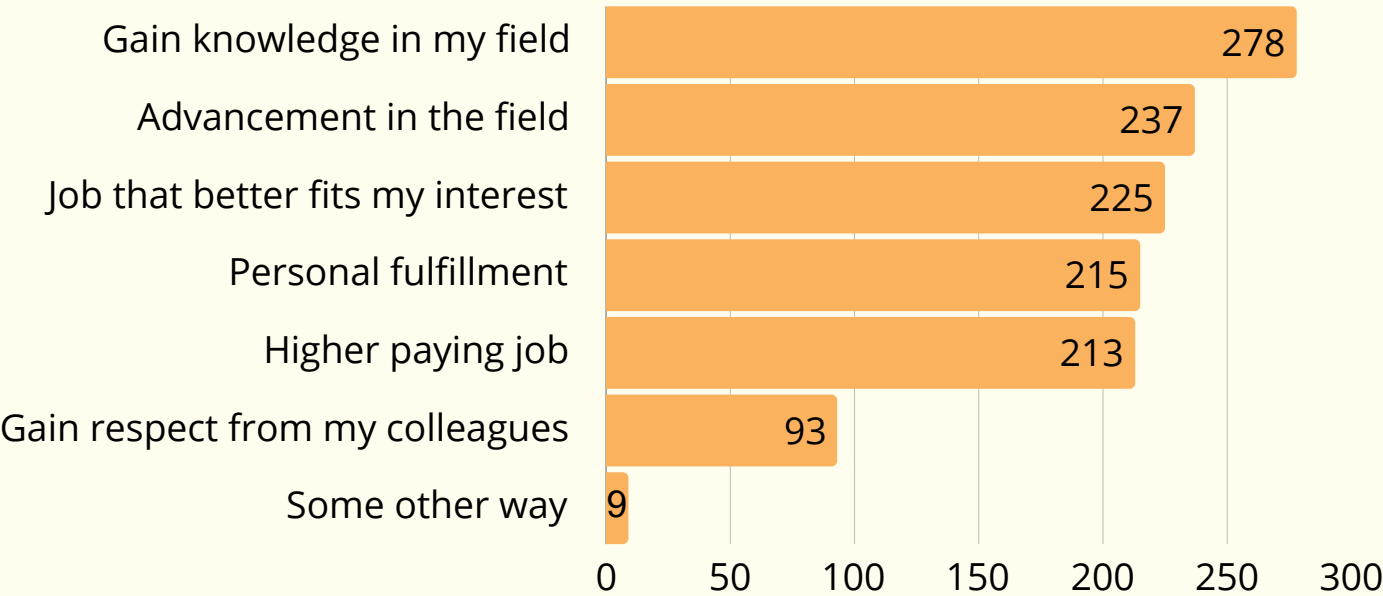
AT3: PRE-PROGRAM SURVEY

At the launch of AT3, baseline surveys were launched with strong engagement from participants, with 319 students responding—an impressive 73% response rate. Of these, 241 were full-time students and 78 were part-time. Engineering dominated the cohort, with 130 students specializing in fields from Mechanical Engineering to Semiconductor Manufacturing, while others pursued STEM disciplines like Computer Science, Chemistry, Physics, and Biological Sciences.

The results underscored a deep commitment to STEM careers: **243 students expressed confidence in earning a STEM degree, and over 200 voiced strong intent to pursue technician careers.** From the outset, AT3 participants demonstrated not only enthusiasm but a clear drive to gain the skills and experience needed to propel their futures forward. This data highlights the program’s success in fostering a skilled, motivated workforce ready to meet industry demands.

Students also reflected on how community college would shape their future, their answers emphasizing the critical role of community college programs and opportunities in supporting their STEM aspirations.

HOW COMMUNITY COLLEGE WILL CONTRIBUTE TO MY FUTURE:





AT3: VISION FOR THE FUTURE

AT3 has the potential to transform the technical workforce pipeline, but its long-term success is at risk. Currently reliant on government funding, the program remains vulnerable to shifting political priorities, economic downturns, and administrative changes. Yet, the demand for a highly skilled, adaptable workforce has never been more urgent—economic growth and technological competitiveness depend on it.

To secure AT3's future, a resilient funding model is critical. This proposal introduces the **Community College and Technical Education Incentive Endowment**—a long-term financial solution designed to sustain AT3 and similar programs for years to come. By establishing a stable funding source, the endowment will ensure continuous access to cutting-edge training, hands-on experiences, and industry partnerships for future generations of students.



THE VISION

The Community College and Technical Education Incentive Endowment aims to provide **long-term, sustainable investment** in technical education. By ensuring that students are effectively trained and equipped for the workforce, the endowment would strengthen the skilled technical workforce pipeline and secure AT3's critical mission for years to come.

The Community College and Technical Education Incentive Endowment

☀ Partnership Building

Alongside initial government funding, the AT3 program would actively engage with industry leaders and philanthropic organizations to form strategic partnerships that ensure long-term support.

☀ Endowment Creation

A dedicated endowment fund will be established through philanthropic efforts, specifically designed to support community college and technical education initiatives. The interest generated by this fund will support student-focused programs, including AT3, with 80% of the funds allocated directly to student incentive programs.

☀ Industry Contribution

Industry partners will play a key role in the endowment's initial funding, recognizing the long-term value of investing in a skilled technical workforce pipeline.

☀ Outcome-Based Evaluation

The endowment will operate on a five-year trial period, with data collected to assess the impact of student incentive programs on workforce development and employment outcomes.

ACKNOWLEDGEMENTS

MNT-CURN, START, and AT3 would not be possible without the invaluable support of industry and partner networks.

We extend our deepest gratitude to the ME Commons Midwestern Microelectronics Consortium (MMEC) for their generous funding, which ensured that every student who applied to AT3 for the 2024-2025 program was accepted. Their commitment helps advance AT3's mission: to ensure that no community college student is ever turned away from participation.

We also want to thank Texas Instruments (TI) for their insights and collaboration, which played a pivotal role in shaping the AT3 program. Their guidance was instrumental in bringing this initiative to life. Another thank you is extended to the SEMI Foundation and NIIICA for their thought leadership and support throughout the development of these programs.

Finally, successful education and workforce programs thrive when all partners prioritize student success over individual gain. This shared commitment defines MNT-EC's partner network. We appreciate everyone who has contributed to building this program, centered on the goal of strengthening the U.S. microelectronics industry through a well-prepared and skilled workforce.



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