

ATE Survey 2021

Findings from the Annual Survey of Principal
Investigators in the National Science Foundation's
Advanced Technological Education Program



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INTRODUCTION

The Scientific and Advanced-Technology Act (1992) called for establishing “a national advanced technician training program utilizing the resources of the nation’s two-year associate-degree-granting colleges.” In response, the National Science Foundation (NSF) created the Advanced Technological Education (ATE) program. The ATE program makes awards ranging from \$70,000 to \$7.5 million to support an array of initiatives to improve the education of technicians at undergraduate institutions and secondary schools, with an emphasis on two-year colleges. Examples of high-technology fields of interest include advanced manufacturing, biotechnology, energy and environmental technologies, engineering, information technologies, and nanotechnologies.

This report summarizes data gathered in the 2021 survey of ATE program grantees. EvaluATE, the evaluation hub for the ATE program, located at The Evaluation Center at Western Michigan University, has conducted this survey annually since 2000. Included in this report are findings about ATE projects and their activities and achievements during the 2020 calendar year (and, for budget-related questions, the 2020 fiscal year).

The 2021 survey was a census of ATE principal investigators (PIs) with active grants (N=344). Ninety-one percent of PIs (n=313) responded to the survey. The survey included sections about grantee characteristics and practices, evaluation, collaboration, academic program or course development, educational materials development, instrument

acquisition, student services and support, professional development for educators or future educators, professional exchange, research and publications, and ATE program services. Grantees were asked to complete sections that pertained to their work.

Survey questions were substantially revised in 2018, resulting in the modification of existing questions and addition of several new questions to capture a wider range of activities supported by ATE grants. Readers are cautioned against comparing results of the 2021 survey with those prior to 2019. In some cases, changes in the survey questions and structure led to fewer respondents reporting in some areas. In a tradeoff, this report includes data on several types of activities not addressed by the ATE survey prior to 2019, such as workplace-based learning experiences for students, support for students transitioning into college, and acquisition of equipment for use in instruction.

Reported numbers of participants, products, and activities throughout this report are rounded to the nearest ten. The *n* that appears with tables and figures indicates the number of respondents for a given item.

Additional reports based on annual ATE survey data dating back to 2000 are available at atesurvey.evalu-ate.org/survey-resources/. Custom reports may be developed upon request. For more information, contact atesurvey@evalu-ate.org.

HOW TO USE THIS REPORT

This report is intended for a broad audience, including ATE project staff, evaluators of ATE projects, those interested in submitting to the ATE program, NSF program officers, and others interested in learning more about advanced technological education. To encourage use of this report and translate findings into action, we have outlined how each of these audiences can use this report.

ATE project staff. ATE project staff, including PIs, co-PIs, and others who work on ATE-funded projects, can benefit from this report through an increased awareness of how their project fits into the larger ATE program portfolio. Reading about the activities and achievements of other projects can provide insights about the similarities and differences between their project and others'. Project staff can use this report to better understand how their project fits amidst the larger framework of ATE projects across the country. Additionally, the survey report can be used to identify potential practices to add to their current project or inspire ideas for future projects.

ATE evaluators. ATE evaluators can benefit from understanding standard practices for evaluations of ATE projects, including types of reports produced and use of those reports. Additionally, ATE evaluators new to projects may gain insight about the types of data projects are already asked to collect in order to respond to this survey.

ATE program grantseekers. For those interested in submitting a proposal to the ATE program, this report provides a sense of what funded projects are already doing. A detailed understanding of ATE activities can benefit proposers in the planning stages, as well as in their final submissions to NSF. Grantseekers might use data from this report either to support the continuation of a common activity or to justify an alternative activity to fill a need or gap in ATE activities. The findings in this report may also inspire ideas for targeted research projects.

NSF program officers. The survey report provides a comprehensive overview of the ATE program, allowing NSF program officers to identify larger trends or needs in the ATE program. Additionally, this report can be shared with Congress as evidence of the program's achievements.

Others interested in advanced technological education. This survey report is freely available from the EvaluATE website, open to anyone who has interest in advanced technological education. Efforts to increase courses and programs in career and technical education are not limited to the ATE program. Other academic programs or projects intended to advance career and technical education can benefit from understanding ATE project activities.

ATE GRANTEE AND PROJECT CHARACTERISTICS

As context for the remainder of this report, this section provides basic information about the individuals and institutions that received ATE awards, as well as key characteristics of the funded work, such as types of awards, disciplinary emphases, and nature of activities.



ATE GRANT TYPES AND INSTITUTIONS

Most ATE grants support projects, and most PIs are located at two-year colleges.

ATE awards fit into four main categories: projects, centers, targeted research, and conferences and meetings. The ATE program has special funding tracks for institutions new to the program and for organizations developing plans for national centers. **Eighty-six percent of ATE grants were for projects (including a variety of subcategories of project types).** Among the 270 project grants, 65 were designated for institutions new to the ATE program, and six were coordination network grants. Of the 27 centers, 12 identified as support or resource centers, 8 as regional centers, and 7 as national centers.

The majority of ATE grants support **projects**.



Figure 1. Types of ATE grants awarded (n=313)

Most ATE grantees are located at **two-year colleges**, followed by **four-year colleges and universities** and **nonprofits**.



Figure 2. ATE grant recipient institutions (n=313)

The ATE program solicitation states that the “program focuses on two-year colleges and expects two-year colleges to have a leadership role in all projects” (NSF, 2018, p. 4). Accordingly, most ATE grants are located at two-year colleges. The 234 grants awarded to two-year colleges supported 209 projects, 21 centers, and, and 2 targeted research studies; 2 were conference and meeting grants. Most of the 10 targeted research projects (64%) are located at four-year colleges.

Unless specified, all types of grants—projects, centers, targeted research, and conferences—are referred to as *projects* in the remainder of this report.

ATE PROJECT DISCIPLINES

The majority of ATE projects are in the areas of advanced manufacturing technologies, information and securities technologies, and general advanced technological education.

In alignment with the broad aim of the ATE program to improve the education of science and engineering technicians, the disciplinary emphases of ATE grantees are diverse.

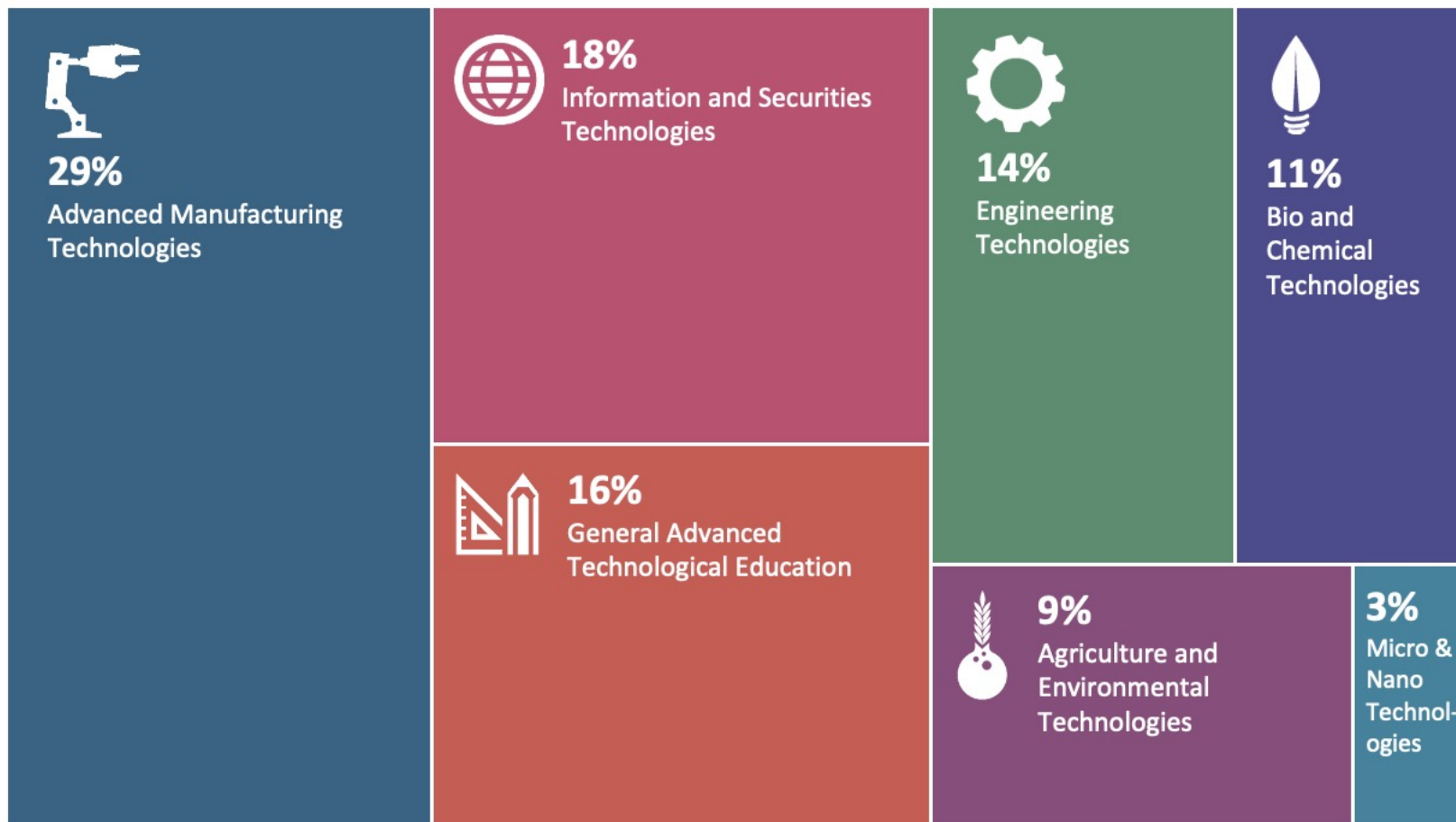


Figure 3. Disciplinary areas of ATE projects (n=313)

ATE PROJECT ACTIVITIES

ATE projects engaged in a variety of activities in 2020 to improve the education of science and engineering technicians.

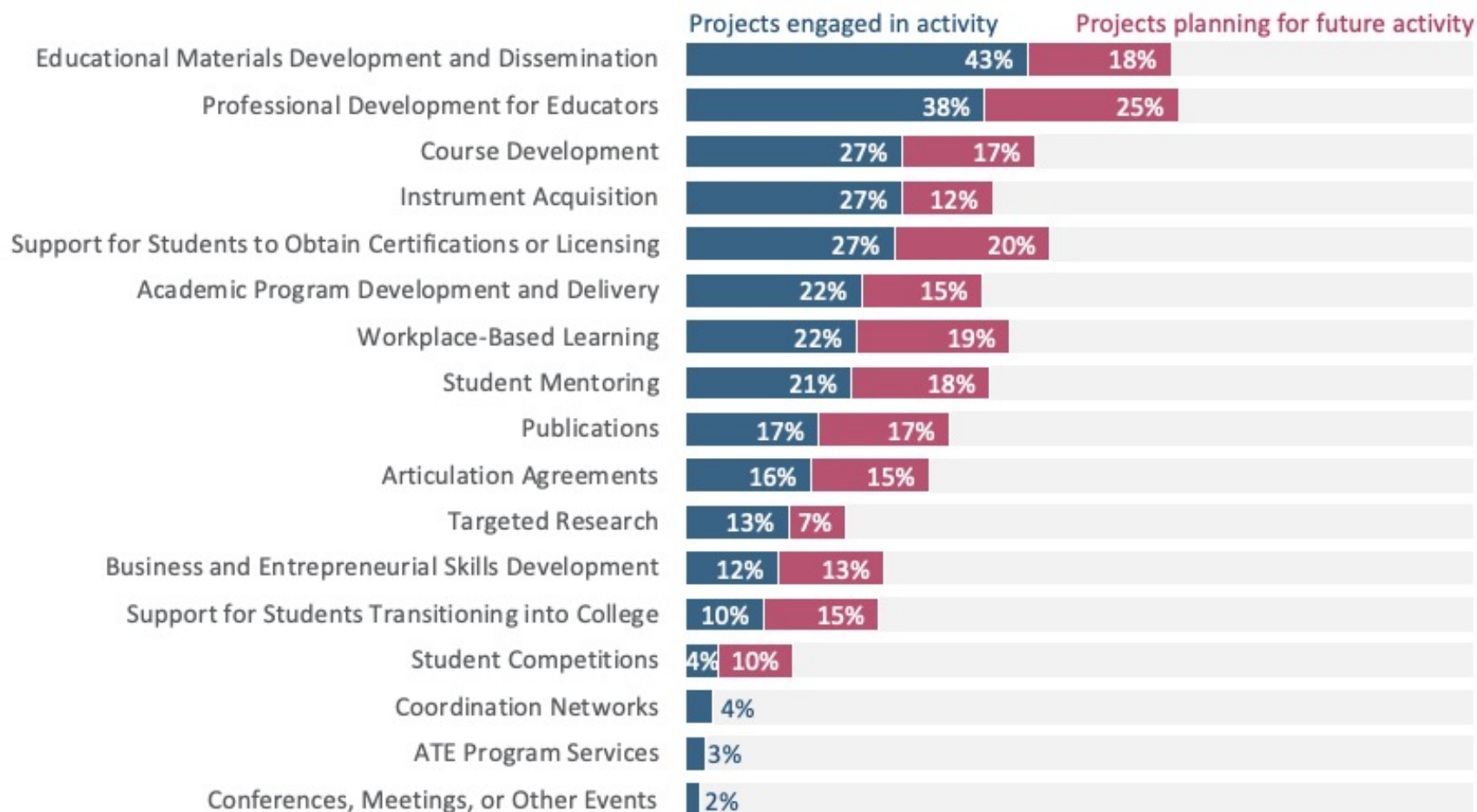


Figure 4. Percentage of projects that reported engaging in activities in 2020 and planning activities for the future (n=313)

ATE PROJECTS AT MINORITY-SERVING INSTITUTIONS

Twenty-two percent of ATE projects are located at minority-serving institutions.

Sixty-nine ATE projects are located at **minority-serving** institutions of higher education (IHEs).

Fifty-four ATE projects are located at **Hispanic-serving** institutions of higher education.

Minority-serving institutions are defined in U.S. law under Title III of the Higher Education Act of 1965. The designation is based on the percentage of minority students enrolled in the school.

Of the 294 projects at IHEs, 23% are at minority-serving institutions. The majority of these IHEs (78%) are Hispanic-serving. Alaska Native-serving institutions made up 9% of IHEs, followed by 6% of IHEs located at Native Hawaiian-serving institutions and 6% at predominantly Black or historically Black colleges and universities, and 1% at Tribal Colleges or Universities.

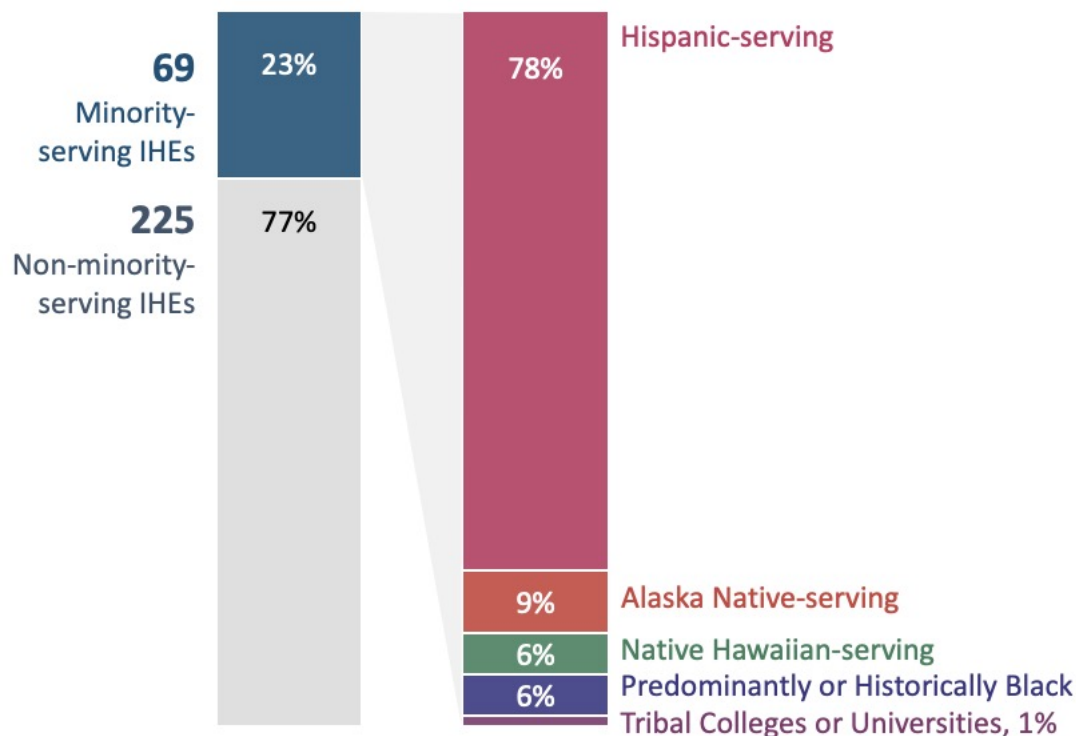


Figure 5. ATE projects at minority-serving institutions (n=69)

ATE PRINCIPAL INVESTIGATORS

Thirteen percent of ATE projects have PIs from racial and ethnic groups historically underrepresented in STEM.

The ATE community is still working towards increasing diversity among PIs. The typical ATE PI is male, white, and between the ages of 55 and 64. Fourteen percent of ATE projects have PIs who are over the age of 65, while 37% are between the ages of 55 and 64, 27% are 45–54, 19% are 35–44, and 3% are 25–34.

The majority of ATE projects have a PI who identifies as **male**.

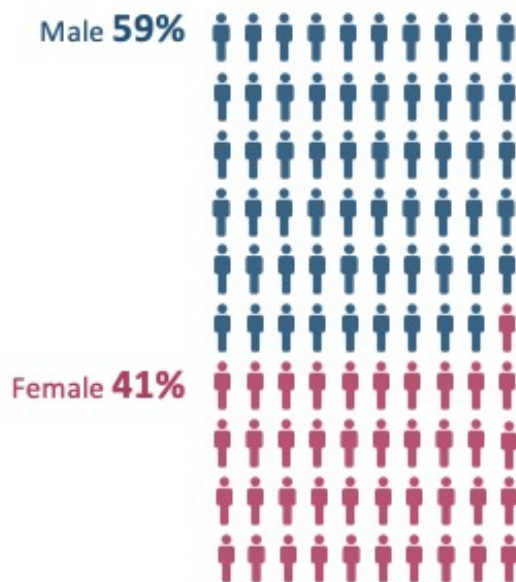


Figure 6. Gender identities of ATE PIs (n=313). Each icon represents 1%.

Thirteen percent of ATE projects have PIs from historically underrepresented racial and ethnic groups, which includes Black, Hispanic, American Indian or Alaska Native, and multiracial.

Eighty-two percent of ATE projects have a PI who identifies as **white**.

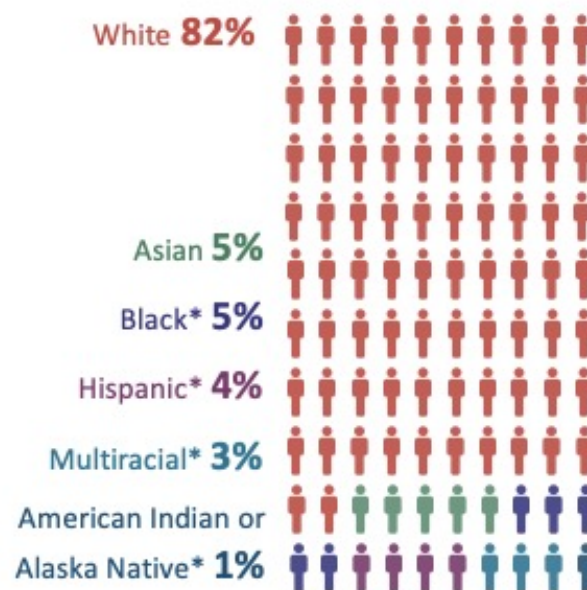


Figure 7. Racial and ethnic identities of ATE PIs (n=313). Each icon represents 1%. *Historically underrepresented racial and ethnic groups.

A photograph of two construction workers in a hard hat and safety glasses, looking at plans on a construction site. The worker on the left is wearing a blue shirt and a hard hat with 'PETE' and '3196' written on it. The worker on the right is wearing a green shirt and a hard hat with '1702' written on it. They are standing in front of a large steel structure, possibly a bridge or a large building under construction.

ACADEMIC PROGRAMS, COURSES, AND PATHWAYS

The ATE program supports the creation and improvement of academic programs that lead to “an appropriate associate degree or specific occupational competency or certification” (NSF, 2018, p. 5). Examples of funded activities include creating new degree or certificate programs or courses; modifying the content, instructional strategies, or delivery modes of existing programs and courses; enhancing programs through the acquisition of instruments or equipment for use in instruction; and developing educational pathways (including articulation agreements) that facilitate students’ movement across education levels.

ACADEMIC PROGRAM DEVELOPMENT

Twenty-two percent of ATE projects created or substantially modified an academic program.

The Committee on Science, Technology, Engineering, and Math Education's 2013 strategic plan called for graduating "one million additional students with degrees in STEM fields over the next 10 years" (p. 10) and increasing the number of two-year colleges with "effective STEM programs" (p. 30). One of the ways that ATE responds to this call is through the development of new STEM academic programs. ATE PIs were asked to identify the degree or certificate programs that their projects created or improved with ATE funding, and characteristics of students served by those programs.

A total of 130 academic degree programs were developed or substantially modified by 70 ATE projects in 2020. **Most of these programs awarded certificates (49%) or associate degrees (41%).** Four programs awarded bachelor's degrees, and seven programs provided other types of credentials. **Over 10,470 students attended at least one course in these academic programs**, with a total of 910 completing a program in 2020; 400 students completed an associate degree program, while 365 students completed a certificate program. Programs with students completing certifications or degrees in 2020 graduated an average of 20 students.



60 certificate programs served
3,000 students



50 associate degree programs served
6,630 students

The Committee on STEM Education's 2018 report noted the persistence of labor shortages in STEM fields and underscored the importance of increasing diversity, equity, and inclusion in STEM. NSF (2019) has determined that women, persons with disabilities, and three racial and ethnic groups—Blacks, Hispanics, and American Indians or Alaskan Natives—are underrepresented in science and engineering.

Fifty-five ATE projects out of the 70 that developed academic degree programs emphasized recruitment of at least one of the following types of students.

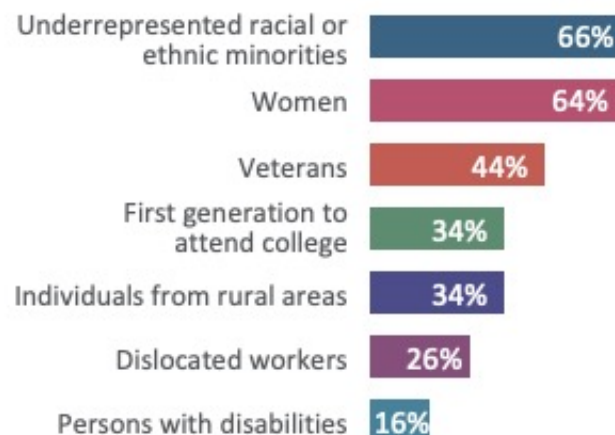


Figure 8. Percentage of projects that emphasized recruitment of students from specific demographic groups (n=70)

STUDENTS SERVED BY ATE ACADEMIC PROGRAMS

Students from groups that have been historically underrepresented in STEM have similar rates of participation in the ATE program.

Of the 130 academic programs that were developed or modified by ATE projects in 2020, 80 programs (62%) reported student characteristics. Due to this low response rate, the numbers reported here do not represent the entire ATE program, nor all 70 ATE projects that created or substantially modified academic programs in 2020.ⁱ

The gender breakdown in ATE-supported programs is similar to what is observed in STEM programs nationally. **Overall, 25% of ATE students are women, although the proportion of women varies by education level and discipline.** According to the U.S. Department of Education, 21% of students in technical programs at two-year colleges in the U.S. are women.ⁱⁱ

Like other STEM programs, ATE projects still face a challenge in attracting **women** to the field.

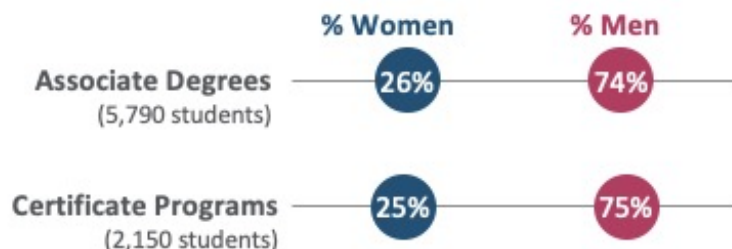


Figure 9. Percentage of women and men in ATE-supported academic programs by degree level (n=69)

Students who identify as Black / African American or Hispanic / Latino or Latina have slightly higher representation in ATE-supported programs than they do in the general population of students across educational degrees. (See the technical notes for a full explanation of comparison sources for national data.ⁱⁱⁱ)

The percentage of students who identify as **Black / African American** and **Hispanic / Latino or Latina** in the ATE program mimics national trends.

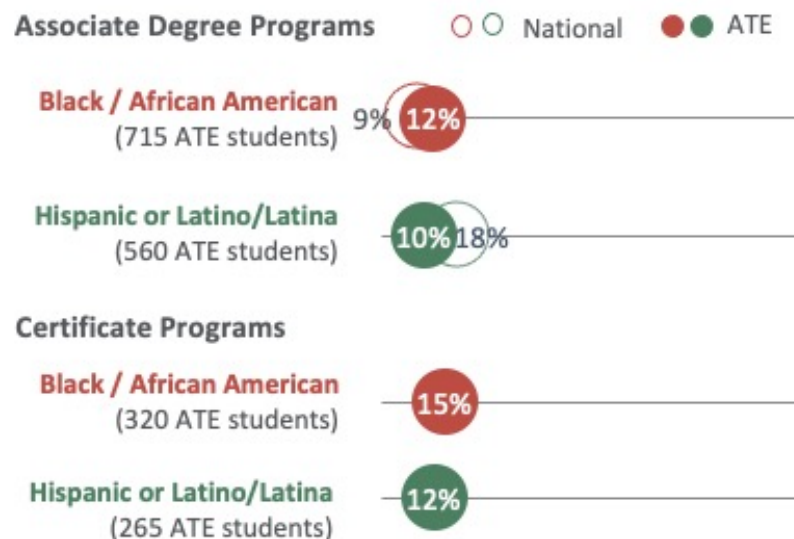


Figure 10. Percentage of students from underrepresented racial and ethnic minority groups in ATE-supported academic programs, compared with national rates (n=69).

COURSE DEVELOPMENT

Twenty-eight percent of ATE projects created or modified at least one academic course.

ATE PIs whose projects engaged in creating or substantially modifying academic courses were asked to identify the number and types of courses they created or modified, the academic levels of these courses, their primary delivery modes, and how many students enrolled in the courses. Some ATE projects engaged in course development as part of a larger initiative to develop or modify an entire degree or certificate program; others did so as a stand-alone effort.

A total of 370 courses were developed by 88 projects in 2020. The majority of these courses (88%) were for **two-year college students**.



25

High school
courses were
developed by
9
ATE projects



320

Two-year college
courses were
developed by
75
ATE projects



10

Four-year college
courses were
developed by
4
ATE projects

Sixty-eight percent of these 370 courses were offered in 2020.



8,710 students

completed an ATE-developed or modified
course in 2020

ATE PIs were asked about the primary delivery modes for each of the courses they developed or modified. **Compared to 2019, more ATE courses are being developed for a hybrid format.**

Most ATE courses were designed for a **hybrid** of online and face-to-face delivery, as compared with exclusively **online** or **face-to-face**.

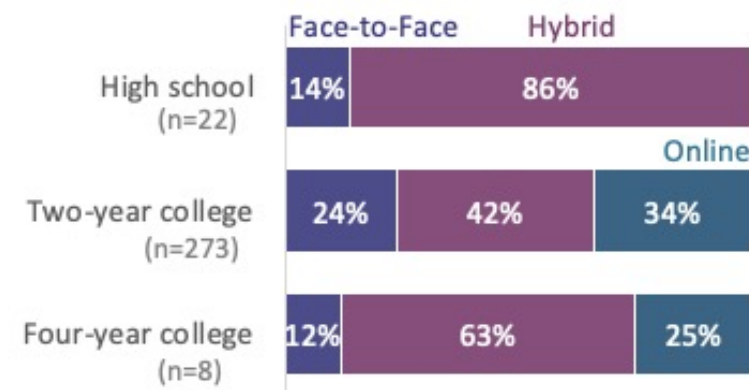


Figure 11. Percent of courses designed by differing delivery mode, by education level

INSTRUMENT ACQUISITION

Twenty-eight percent of ATE projects acquired instruments or equipment to prepare students for work in business and industry.

Using state-of-the-art equipment contributes to the development of technical skills students will need for employment. Hands-on experience with such equipment has also been shown to contribute to students' self-efficacy and positively impact their longer-term career and educational goals (Amelink et al., 2015). The ATE program includes a funding stream to help grantees obtain instruments or equipment that can be used in instruction to prepare students for employment in business and industry.

Eighty-six ATE projects acquired instrumentation or equipment in 2020. Examples of instruments purchased and utilized by projects include 3D printers, computers, drones, virtual reality viewers, laser engravers, and laboratory equipment. Seventy-six projects reported the amounts they spent on instrumentation or equipment. **Projects spent between \$115 and \$330,770 on instrument acquisition in 2020.**

A majority of projects spent less than 25% of their grant funds on instrumentation in 2020.

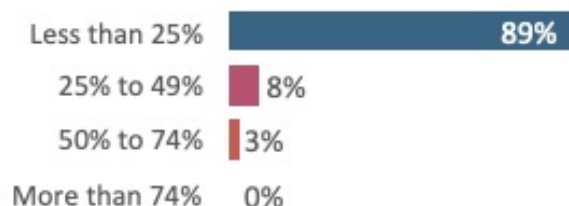


Figure 12. Percentage of total grant amount spent on instrumentation or equipment in 2020 (n=76)

Projects that use ATE funding to purchase instruments or equipment are expected to revise their academic programming to maximize the value of the items for student learning. In 2020, 2,800 students used instruments and equipment.

A median of 12 students used the equipment or instrumentation acquired by each ATE project.



2,800 students
benefited from purchased equipment



290 educators
used the purchased equipment



260 courses
used the purchased equipment

Seventy-three projects reported acquiring instrumentation, equipment, or tools to give students hands-on experience with instruments used in the field. Seven projects reported acquiring instruments to allow students to perform technical tasks in a simulated environment, and six projects noted other reasons, such as enabling students with disabilities to perform certain technical tasks and allowing remote students to participate in a virtual summer camp or mobile lab.

ARTICULATION AGREEMENTS

Sixteen percent of ATE projects created or maintained articulation agreements.

Articulation agreements are formal agreements between educational institutions that provide students from secondary schools with pathways and education access to two-year colleges and four-year colleges. These agreements contribute to increasing the number and diversity of scientists, engineers, and technicians (National Academy of Engineering & National Research Council, 2012).

In 1992, Congress saw the importance of these agreements and required their use in NSF's ATE program. The current ATE solicitation calls for "developing life-long career and educational pathways for technicians to support the changing workplace" (NSF, 2018, p. 5).

Fifty projects developed or maintained articulation agreements in 2020. Note that one project was responsible for a 95-percent drop in the number of articulation agreements in place between 2019 (11,532) and 2020 (517).

Most articulation agreements created in 2020 were between **high schools and two-year colleges**, but more students matriculated between **two-year and four-year colleges**.

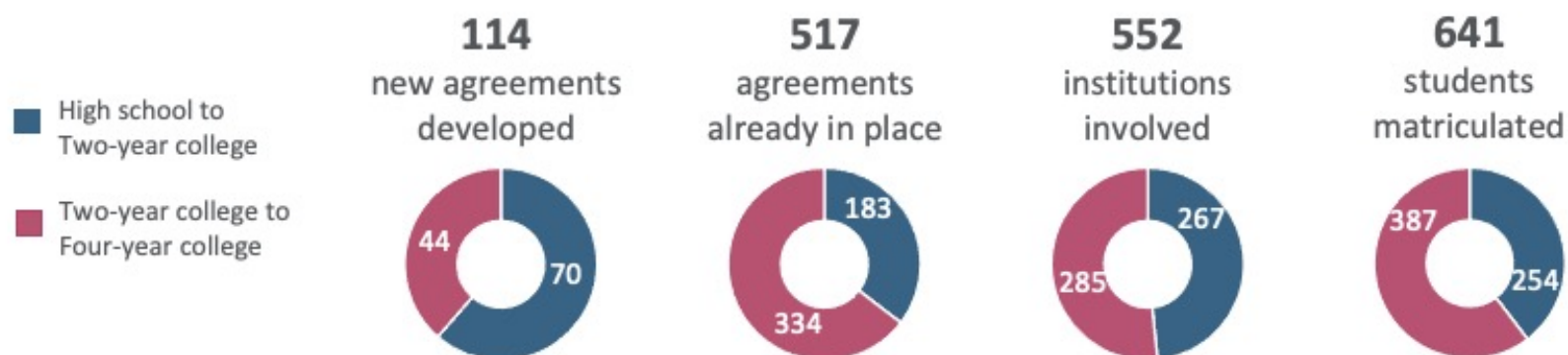


Figure 13. Number of articulation agreements, institutions, and students (n=50)

A young woman with curly hair is looking through a microscope. The image is partially obscured by a blue diagonal overlay that contains the text.

EDUCATIONAL MATERIAL DEVELOPMENT

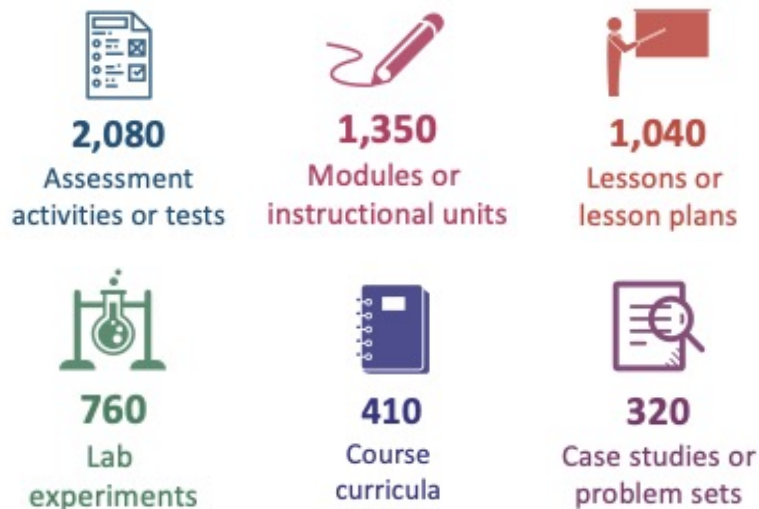
Instructors' use of curriculum materials is believed to have three general types of outcomes: (1) improvement of educators' pedagogical knowledge and "design capacity"; (2) increased opportunities for students to engage in "ambitious science," aimed at developing their skills in both generation and use of scientific knowledge; and (3) improved student learning outcomes (Davis et al., 2016). The ATE program supports the creation, validation, and dissemination of educational materials in print or digital formats to be used for instructional or assessment purposes. Such materials include—but are not limited to—tests, lab experiments, instructional modules, and textbooks.

The PIs whose projects developed educational materials were asked to report the type and number of materials they developed or adapted and how those materials were disseminated beyond their institutions.

EDUCATIONAL MATERIAL DEVELOPMENT

Forty-four percent of ATE projects created or substantially modified educational materials.

136 ATE projects developed or modified over 6,830 educational materials in 2020.



Additional materials developed include 320 instructor guides, 210 interactive simulations, 200 program curricula, and 20 textbooks.

Educational materials created in 2020 by ATE projects were primarily disseminated through the projects' websites (65%) and workshops (54%), followed by ATE Central (the ATE program's archiving platform, 47%). Fewer than 15% disseminated their materials through a clearinghouse or repository (11%). Forty-two projects indicated "other" modes of dissemination, with 10 projects noting they disseminated materials through a conference

presentation or booth. Additional avenues of dissemination included sharing via internal and external academic and industry partnerships, webinars, and newsletters.

One hundred five ATE projects disseminated educational materials that were created prior to 2020. These materials were primarily course curricula (56%), modules or instructional units (43%), and lab experiments (38%). ATE projects also reported continued dissemination of program curricula (37%), instructor guides and manuals (32%), and lesson plans (26%) created in previous years.

Posting materials developed on their website (59%) was the most prominent avenue for disseminating materials that were created in previous years. Fifty-two percent of projects distributed materials that were developed in a previous year at a workshop, and 49% distributed materials at a conference.

Thirty-one of the 136 projects that developed educational materials kept track of which other institutions are using their program and/or course curricula.



1,220 institutions

Used program and/or course curricula created by 31 ATE projects



STUDENT SERVICE AND SUPPORT

The ATE program supports an array of activities designed to enhance student learning and success in STEM programs outside of typical classroom environments. Studies have shown that students who experience these types of enrichment and support programs are more likely to have positive attitudes toward science and sustain interest in STEM (Merolla & Serpe, 2014).

ATE PIs were asked if their projects provided any of the following student-focused services: support for students transitioning into college, opportunities to participate in STEM competitions, mentoring, entrepreneurial skills development, or support for obtaining industry-recognized certifications or licenses. Respondents who answered affirmatively were asked additional questions about the nature of these activities and the number of students served.

STUDENT SERVICE AND SUPPORT

Forty-four percent of projects provided at least one type of student service or support.

138 ATE projects provided at least one type of student service or support.

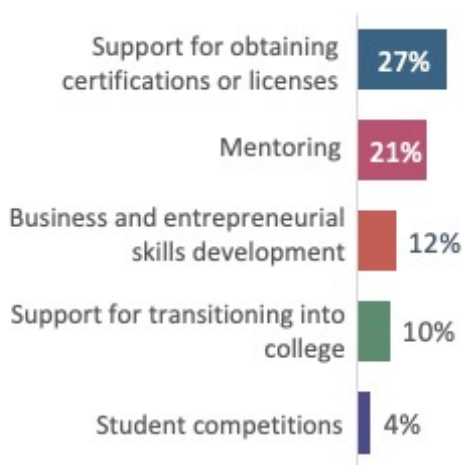


Figure 14. Percentage of projects that provided student services and support (n=313)

BUSINESS AND ENTREPRENEURIAL SKILLS

Business and entrepreneurial skills development involves working with students to develop their skills in areas such as business development, marketing, networking, and understanding the global marketplace. **Twelve percent of ATE projects engaged students in building their business and entrepreneurial skills.**

A total of 4,980 students received business and entrepreneurial skills development from 37 ATE projects in 2020.

ATE projects used a variety of strategies to develop students' business and entrepreneurial skills. Other strategies not reported in the graph below included engaging with industry professionals (30%) and incubator programs (3%).

Mentoring and coaching, and **in-course units or activities** are the dominant ways of helping students develop business and entrepreneurial skills in the ATE program.

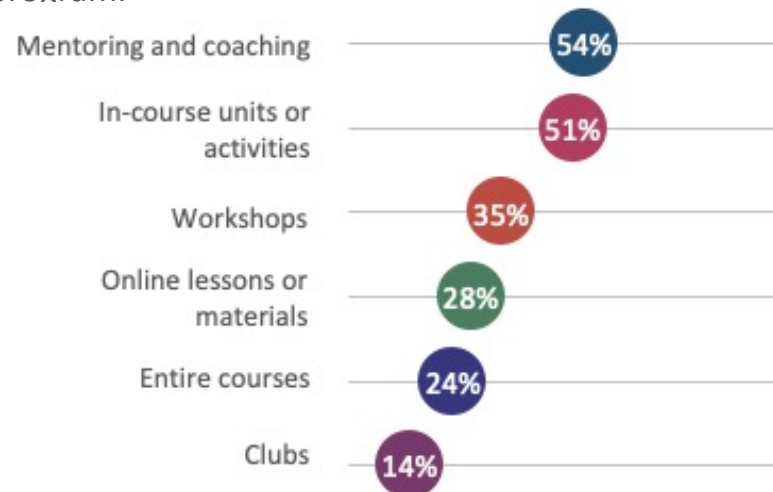


Figure 15. Percentage of skills development opportunities offered to students by ATE projects (n=37)

STUDENT SERVICE AND SUPPORT (continued)

Twenty-one percent of ATE projects provided students with mentoring or coaching, and 4% hosted or organized a student competition.

MENTORING

Student mentoring involves an experienced industry professional, educator, or advanced student providing guidance and advice to help less-experienced students develop the skills and knowledge they need to enhance their academic and professional growth. Mentoring is a source of both psychosocial support and career advancement (Anderson et al., 2015). This type of support is especially important for students at two-year colleges, who typically face more barriers to degree completion than those at four-year institutions (Crisp, 2010).

Approximately **4,000** students received mentoring through ATE projects.

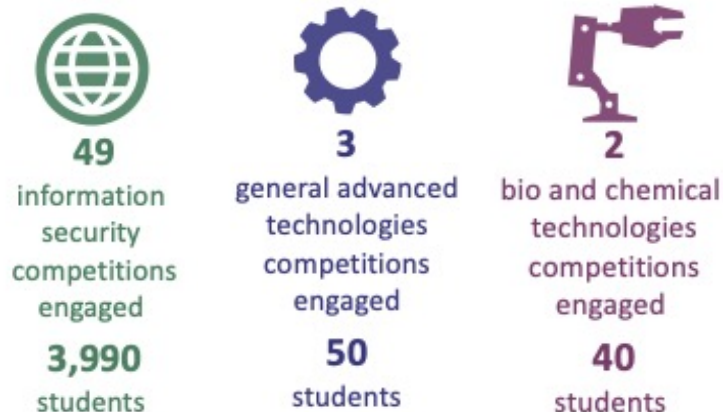


Mentoring was most often provided by educational faculty or staff (80%), followed by business and industry professionals (55%) and students or peers (38%). Thirty-one percent of projects that offered mentoring or coaching provided training to the mentors.

COMPETITIONS

In student competitions, students compete as individuals or teams using skills related to a STEM discipline or industry, such as robotics, information technology, or engineering. Research shows that participation in STEM competitions has a positive impact on students' interest in pursuing STEM careers, even when controlling for prior interest and ability (Miller et al., 2018).

4,110 students participated in one of the 56 ATE-hosted student competitions. The most common areas for competitions included:



Two other competitions engaged 30 additional students in ATE disciplines including engineering technologies and advanced manufacturing technologies.

STUDENT SERVICE AND SUPPORT (continued)

Ten percent of ATE projects provided extra support for students transitioning into college, and 27% helped students prepare for certification or licensure.

TRANSITION PROGRAMS

Community colleges enroll disproportionate numbers of students who are economically disadvantaged and from underrepresented minority groups (Edgecombe, 2019). Programs that support students as they transition into college are an important means for enhancing academic persistence and completion among these and other students (Baber, 2018). **The ATE program supports efforts to facilitate students’ transition into college and equip them with the skills they need to successfully navigate college.** Such programs include—but are not limited to—summer bridge programs, college readiness workshops or classes, first-year programs, and support for nontraditional students.

The majority of transition programs are for **high school students**.

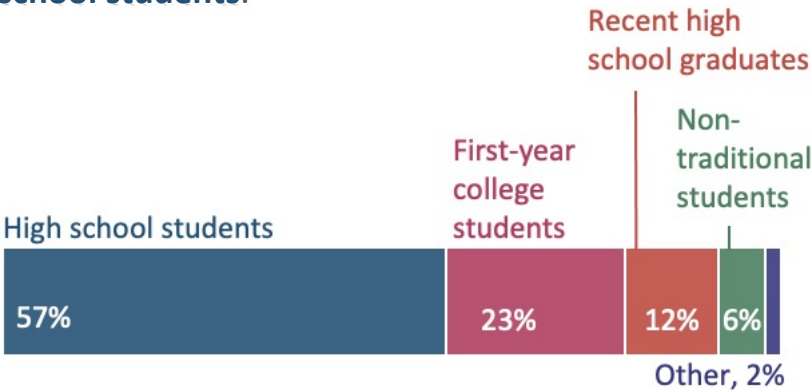


Figure 16. Primary audience for transition programs supported by ATE projects (n=49)

Over **5,500** students transitioning into college received support from ATE projects.



SUPPORT FOR CERTIFICATIONS OR LICENSURE

Professional certifications, typically awarded by industry groups or professional organizations, serve as verification that an individual has the knowledge and skills required for certain jobs. Many community colleges offer students assistance in obtaining these credentials. These efforts may involve aligning academic programming with certification exams, offering exam preparation support, or operating testing centers on campus (NAS, 2017).

Eighty-three ATE projects provided students with support for obtaining certifications or licenses in 2020. Eighty-nine percent of those ATE projects reported supporting students through aligning existing courses with licensing or certification requirements. ATE projects also provided test preparation workshops or learning modules (58%) and served as testing centers (33%). ATE projects involved in this activity were asked to identify the type of entity that awards the licenses or certifications they help students obtain. The most common response was non-governmental organizations (56), followed by for-profit companies (29) and government agencies (17).

A photograph showing two individuals in full-body yellow protective suits, including hoods and respirators, standing outdoors. They are positioned next to a large white metal storage container. One person is holding a black bucket. In the foreground, there is a yellow wheeled trash bin. A 'No Parking' sign is visible on the side of the container. The scene appears to be a hazardous waste management or environmental remediation site.

WORKPLACE-BASED LEARNING

Workplace-based learning includes any situation in which a student gains experience at a work site, such as through internships, apprenticeships, co-op learning, and job shadowing. Research indicates that such experiences contribute to students' confidence in their abilities and enhance employability skills, such as problem-solving, communication, and professionalism (Jackson, 2014).

ATE PIs whose projects offered workplace-based learning were asked about key characteristics of the workplace-based learning opportunities they offered and about the number of students who participated in these activities in 2020.

WORKPLACE-BASED LEARNING

Twenty-two percent of ATE projects provided workplace-based learning opportunities for students.

In 2020, 1,610 students participated in workplace-based learning opportunities offered by 68 ATE projects. An additional 3 ATE projects reported offering field trips to business and industry sites. The 22% of projects that provided workplace-based learning in 2020 excludes the 3 projects that only reported offering field trips.

Most ATE projects offered workplace-based learning through **internships** and **apprenticeships**.

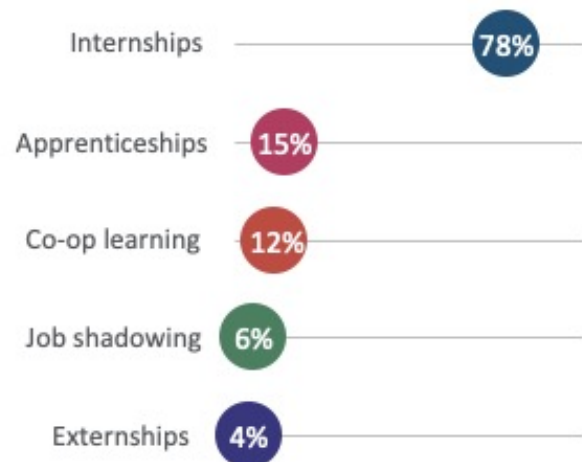


Figure 17. Percentage of ATE projects that offered each type of workplace-based learning (n=68)

The median number of weekly hours that students spent in a workplace-based learning activity ranged from 4 to 16, and the median number of weeks spent in an activity ranged from 5 (job shadowing) to 42 (apprenticeships).

Respondents discussed a variety of benefits to both students and employers. As one respondent noted, these opportunities allow student experiences in:

“Relating academic studies with practical work experience, building industry partnerships, ... customized learning for students, building student resume and exposure to industry options, soft-skills development, filling tangible needs for local industry and creating partnerships that lead to jobs for students after graduation.”

Survey respondents reported on the characteristics of the workplace-based learning their projects offered. The table shows variation both within and across activities.

	Internships (n=53)	Apprenticeships (n=10)	Co-op learning (n=8)
Required by program	51%	50%	50%
Academic credit	68%	50%	88%
Coupled with a course	59%	70%	63%
Received payment	72%	60%	50%

Table 1. Characteristics of the three most frequently reported workplace-based learning activities

PROFESSIONAL DEVELOPMENT FOR EDUCATORS

Community college faculty have diverse responsibilities. They design and deliver courses and are often charged with responsibilities related to student retention or institutional administration. Incoming faculty are typically subject matter experts with minimal training in pedagogy (Strickland-Davis et al., 2019). Furthermore, instructors in advanced technological fields must keep pace with rapidly changing technology and workforce needs. Increasingly, secondary school teachers are being called up to play a part in building students' STEM knowledge and skills and instilling interest in STEM careers.

The ATE program provides support for projects to develop and deliver professional development for educators, with a focus on enhancing their “disciplinary capabilities, teaching skills, understanding of current technologies and practices, and employability skills” (NSF, 2018, p. 5). ATE PIs were asked to report on the focus, number, and length of professional development activities provided by their projects, as well as the number and type of participants and number of students subsequently impacted by those participants.



PROFESSIONAL DEVELOPMENT FOR EDUCATORS

Thirty-eight percent of ATE projects provided training or professional development to current or future educators.

One-hundred nineteen ATE projects provided 860 training or professional development activities for educators in 2020.

Almost half of these activities were a day or less in length (46%), including webinars and one-day workshops. Almost one-third lasted more than one day but less than a week (30%), including in-person multi-day workshops and online modules. The remaining 24% of activities lasted one week or longer, including courses, summer institutes, internships, and peer coaching.

ATE projects offered 860 professional development activities for educators in 2020.



Figure 18. Number of professional development activities for educators by length of time (n=116)

Professional development activities focused on a range of skills and topic areas. Eighty-one percent focused on discipline- or industry-specific knowledge or skills, 42% on pedagogy, and 41% on training on specific equipment. Additional professional development topics reported by ATE projects included recruitment or retention of students (19%) and other professional skills, such as leadership (13%).

Sixty-two percent of educators served by professional development activities were two-year college faculty, followed by four-year college faculty (18%) and high school teachers (12%). Pre-service teachers made up less than 1% of professional development participants, and other types of educators made up 8%.



8,630 educators

participated in ATE-sponsored professional development in 2020 (n=88)



720 pre-service teachers and others

participated in ATE-sponsored professional development in 2020 (n=19)



35,310 students

were taught by educators who participated in ATE-sponsored professional development (n=31)

A photograph showing two male technicians in a workshop. They are wearing dark blue short-sleeved shirts and caps. One technician is leaning over the open hood of a red sports car, working on the engine. The other technician stands next to the car, looking at a small device or manual. The background shows a typical garage environment with various tools and equipment.

PROFESSIONAL EXCHANGE

Bringing together professionals from different organizations and geographical locations facilitates knowledge diffusion, collaboration, and professional interaction (Chai & Freeman, 2019). Research has shown that “diverse collaborative networks” enhance innovation and complex problem-solving (Biancani et al., 2014).

The ATE program has two funding tracks that support activities to catalyze professional exchange. One such track supports **coordination networks**, which facilitate collaboration and communication about research, training, and education across disciplines, organizations, and geographical boundaries. The other track provides funding for **conferences, meetings, and events** to improve understanding of advanced technological education issues (NSF, 2018, p. 9).

ATE PIs whose projects hosted conferences or similar events were asked to identify the names and purposes of the events and the number of attendees. Those engaged in network coordination were asked to identify the purpose of their networks.

COORDINATION NETWORKS

Four percent of ATE projects indicated coordination networks as a primary purpose of their grant.

11 ATE projects indicated that developing and facilitating coordination networks was the primary purpose of their grant.

- **A Regional Approach to College and Career Readiness Pathways in Career and Technical Education** focuses on developing career and technical education pathways in southwest Missouri for automotive, construction, and welding technology.
- **A Sustainable ATE Coordination Network for Enhancing Personalized Learning Using Virtual and Augmented Reality-based Technology** enhances the advanced automotive and aviation manufacturing workforce pipeline, via the use of virtual reality and augmented reality technologies.
- **Advanced Technological Education Coordination Network for Knowledge Sharing in Robotics/Automation and Cybersecurity** intends to facilitate the sharing of best practices about how to develop community college students' knowledge and skills in robotics/automation and cybersecurity.
- **Center for Systems Security and Information Assurance (CSSIA)** supported the development of successful cybersecurity certificate and degree programs across the country.
- **Enhancing the Independent Mechatronics Technical Curriculum and Creating a New Pathway from Rural High Schools into Mechatronics Careers** aims enhance and expand high-quality/low-cost distance education models and create a new pathway to mechatronics programs in partnership with dedicated rural high schools.
- **Impact of System-Wide Contextualization of Math in Rural Arizona Colleges on Producing More Qualified Technicians (SFAz+8 CXM)** encourages the integration of mathematics into technical education courses to encourage student completion.
- **Manufacturing Alliance Keeping Education Relevant to Technical Employee Competence (MakerTEC)** seeks to find solutions for the advanced manufacturing sector that result in meeting their skilled worker needs and reducing costs.
- **Technician Education in Additive Manufacturing and Materials (TEAMM)** is focused on identifying the ways in which the convergence of materials science and additive manufacturing can be addressed in technician education resources.
- **The Necessary Skills Now Network** facilitates collaboration between educators and employers to improve the employability skills of entry-level technicians in STEM fields.
- **Unmanned Aircraft Systems (UAS) and Geospatial Information Technology Integration (GIT) into Technician Education** aims to develop curriculum, establish collaborative educational pathways, and expand UAS and GIT professional development opportunities.
- **Using High-Resolution Mass Spectrometry to Develop Advanced Laboratory Skills in Collaboration with Industry** provides workshops that help high school STEM educators increase their understanding of high-resolution mass spectrometry.

CONFERENCES AND MEETINGS

Only a few ATE projects are funded specifically to organize conferences, but other projects also actively engaged in professional exchange.

Six ATE projects were explicitly funded to coordinate conferences or meetings in 2020. Two additional projects indicated that hosting a conference was a main purpose of their grant. Of these eight projects, four were able to host conferences in 2020. These four projects hosted a total of six conferences or meetings, with attendance that ranged from 6 to 900 people. ATE PIs identified the purposes of these events as networking and professional development, disseminating best practices, and bringing together stakeholders from industry and education.



6 conferences and meetings
were organized by ATE projects



1,080 people
attended conferences and meetings
organized by ATE projects

Projects that organized conference or meeting events in 2020 included:

- **Conference to Explore the Impact of Future of Work Issues on Technician Education in Florida** hosted a National Science Foundation Future of Work caucus.
- **Smart Manufacturing for America's Revolutionizing Technological Transformation** held (virtually) a third smart manufacturing workshop.
- **Strengthening and Supporting the Community College Leadership Role in Advancing STEM Technician Education** hosted the 2020 virtual ATE conference, as well as a 2020 MentorLinks Project meeting.
- **Workshop to Improve the Assessment of Professional Development in Teacher Education** held meetings with ATE projects to advance their development of formative assessment tools.



RESEARCH AND PUBLICATIONS

All NSF-funded projects are expected to advance the frontiers of knowledge (NSF, 2019). The ATE program's **targeted research track** funds studies to generate knowledge and build an evidence base for technician education and the development of a skilled technical workforce. ATE PIs whose projects engaged in research were asked about the purpose and status of their research, their methods and findings, and their dissemination strategies.

Publications are a vehicle not only for disseminating research findings, but also for sharing promising practices, lessons learned, and information about project developments and materials. Survey respondents were asked about the number and types of publications produced by their projects, such as articles, reports, white papers, and other documents of publishable quality (not including projects' annual reports to NSF, evaluation reports, or conference materials).

ATE TARGETED RESEARCH AND PUBLICATIONS

Thirteen percent of ATE projects conducted some type of research, and 17% developed materials intended for publication.

TARGETED RESEARCH

Ten ATE projects were specifically funded to conduct targeted research in 2020. At the time of the 2020 survey, 22% were in the planning phase, 34% were collecting data, 22% were analyzing data, and 22% were writing up results.

Additionally, 32 ATE projects indicated they conducted some sort of research in 2020. Examples included conducting descriptive research (66%), experimental or quasi-experimental research (25%), correlational research (16%), document reviews (13%), meta-analysis (3%), and other research (9%).

Research findings are frequently disseminated through **conference presentations** or **articles in peer-reviewed journals**.



Figure 19. Percentage of projects that share their research via various dissemination channels (n=41)

PUBLICATIONS

While publication is an expectation for all projects engaged in targeted research, many other ATE projects also prepare publications of various types. Therefore, all ATE PIs were asked if their projects developed publications (excluding annual reports prepared for NSF, evaluation reports, and conference proceedings).

Fifty-one ATE projects prepared a total of **170 publications**.



PIs reported 10 other publication types, such as a textbook chapter and news articles. Additionally, the ATE Collaborative Outreach and Engagement Project distributed 5,500 copies of the *ATE Impacts* book.



ATE PROGRAM SERVICES

For a few ATE projects, the primary purpose is to provide activities, materials, or services to enhance the capacity of ATE grantseekers, grantees, and affiliated stakeholders to plan and conduct successful ATE projects. In some other programs within NSF's Education and Human Resources directorate, these types of program-oriented services are consolidated and provided by a single organization. The ATE program is configured differently; ATE program-specific support, technical assistance, and other services are delivered by multiple grant-funded entities that focus on narrower areas of expertise, with an array of other projects contributing to program capacity in various ways. The ATE program also has a culture of sharing and support to advance the shared interests of program stakeholders.

ATE PIs were asked to identify the ways in which their projects supported the ATE community and the number of people served through their service activities.

ATE PROGRAM SERVICES

Three percent of projects were funded specifically to serve the ATE program.

Eight ATE projects are funded to provide services and support specifically for ATE grantseekers and grantees and their affiliates. These projects include the following:

- **AccessATE** supports ATE projects in understanding and complying with accessibility requirements to make their materials and activities more accessible to all students and faculty, including those with disabilities.
- **ATE Central** is the ATE program's information hub, dedicated to highlighting the work of ATE projects and supporting projects in various aspects of their work, such as archiving, outreach, and connecting with others in the ATE community.
- **ATE for 2 Year Colleges (ATE-2YC)** provided proposal writing workshops and a mentoring program for two-year college STEM faculty. This work will continue under the **Mentor Up** project.
- **ATE Collaborative Outreach and Engagement** raises awareness of the ATE program, primarily through the publication of the *ATE Impacts* book.
- **Broadening the Impact of STEM Education** encourages collaboration between community colleges and ATE programs through the dissemination of resources and provision of technical assistance, including the MentorLinks program.
- **EvaluATE** strengthens the evaluation capacity of those involved with ATE projects through training, networking opportunities, and research, including administration of the ATE annual survey.

- **Formative Assessment Systems for ATE (FAS4ATE)** develops and tests toolkits for assessing professional development activities.
- **Mentor-Connect** is a mentoring and leadership development program for two-year institutions of higher education new to the ATE program.

Collectively, these eight projects reported the following achievements:



Delivered 21 webinars
that engaged an average of
106 people per webinar



Provided over 268 people
with one-on-one technical assistance

All survey respondents were invited to report on the ways in which their projects served and supported the ATE program, even if that was not the main focus of their work. Forty-four additional projects identified ways that their projects served the ATE community. Thirty projects developed and disseminated resource materials. Six projects held in-person workshops. Twenty-three projects offered webinars. And 20 projects provided technical assistance to individuals.

A photograph showing three individuals in a workshop or industrial setting. They are all wearing safety glasses. A woman on the left is looking towards the center. A man in the middle is looking towards the right. A young man on the right is looking directly at the camera. They appear to be working together on a task. The background shows industrial equipment and a bright light source.

COLLABORATION

NSF encourages ATE projects to partner with other institutions of higher education, secondary schools, businesses, industries, economic development agencies, and/or government agencies. The ATE program solicitation emphasizes the importance of engaging with industry to ensure programs are responsive to workforce needs and leveraging the assets of industry in preparing students for employment (NSF, 2018). According to the Brookings Institution, hallmarks of successful community college based workforce training programs include employer involvement in curriculum development and workplace experiences for students (Soliz, 2016).

ATE PIs were asked about the types of entities with which they collaborated and the benefits of those collaborations, including monetary and in-kind support. Projects that collaborated with business and industry were asked to identify the specific ways in which they worked with these groups.

COLLABORATION

ATE projects collaborated with over 7,500 other organizations and institutions.

In 2020, ATE projects collaborated with 2,660 business and industry partners, 1,900 K–12 schools, 1,610 colleges, 560 other ATE projects, 390 entities within their host institutions, 360 public agencies, and 70 other types of partners. ATE projects collaborated with a median of five business and industry groups, two K–12 schools, two colleges, and one other ATE project.

ATE projects most frequently collaborated with **business and industry** groups, followed by **other two- or four-year colleges**.

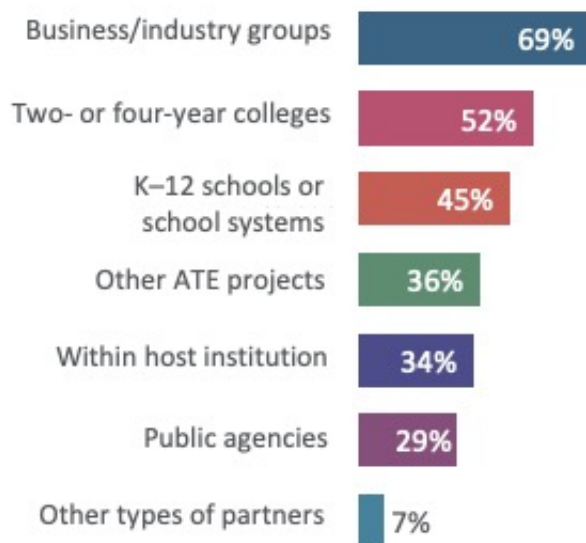


Figure 20. Percentage of ATE projects that collaborated with other groups, by type (n=313)

Most projects that indicated they worked with other types of partners identified these collaborators as community organizations and professional associations.

Collaborators provided over \$7 million in monetary and in-kind support to 108 ATE projects.



Thirteen percent of projects reported receiving monetary support from collaborators, while 28% reported receiving in-kind support. The median contributions for monetary support and in-kind support across projects were \$20,000 and \$12,250, respectively. Projects reported that in-kind support primarily consisted of staff time (65%) and equipment (38%). Other types of in-kind support included access to facilities, materials, and supplies.

COLLABORATION WITH BUSINESS AND INDUSTRY

Sixty-nine percent of ATE projects collaborated with business and industry partners.

A total of 215 projects reported collaborating with business and industry groups. Most used these partners to **identify workforce needs**, **serve on an advisory board**, or **review and advise on curriculum**.

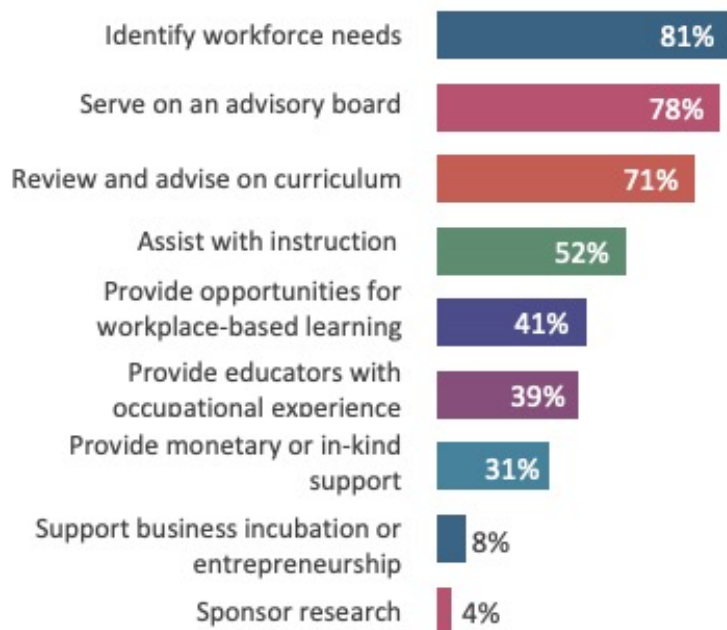


Figure 21. Percentage of projects reporting contributions from business and industry partners (n=215)

Business and industry representatives serve on advisory boards for 168 projects. Most of these projects (62%) reported that their advisors from business and industry committed two to five hours per year to their ATE projects.

When asked to identify benefits of collaborating with different organizations and groups, PIs frequently pointed to the utility of the information that they received from them. For example, as one PI noted, they provide

“vision and leadership so our activities are aligned with the skills and competencies needed for successful careers. This in turn bolsters our academic programming and professional development.”

Collaborations with industry groups were also noted by PIs as important to project innovation and growth, allowing PIs' work to “reach a larger audience” and “understand industry needs.”

Industry partnerships also benefited students by helping to

“share resources such as curriculum and instruction [for faculty]. We work with business and industry on internships for our students. K–12 schools work with potential students by offering summer camps.”



EVALUATION

Each ATE project is required to have an evaluation component to assess its quality and effectiveness. Evaluation of ATE and other NSF-funded projects is intended to serve two distinct purposes: (1) Produce information that can be used to improve a project as it is being implemented and (2) Determine and document a project's achievements (Frechtling, 2010).

ATE PIs were asked about their evaluators and interactions with them, as well as their projects' use and dissemination of evaluation results.

EVALUATION

Ninety-one percent of ATE projects engaged an evaluator.

Two-hundred eighty-six ATE projects had evaluators in 2020. Of the 27 PIs who said they did not have evaluators, 12 were in their first year of funding. **Of the 286 projects with evaluators, 86% reported having an external evaluator, with 9% having both an internal and external evaluator and 5% having only an internal evaluator.**

Thirty-seven percent of PIs reported that they interacted with their evaluators *continually* (at least once a week) or *often* (two or three times a month), while 40% interacted with their evaluators *occasionally* (more often than quarterly) and 23% did so *infrequently* or *rarely* (once a quarter or less).

Almost half of ATE projects received **both oral and written** evaluation reports.



Figure 22. Types of evaluation report received by ATE projects (n=285)

Of the 243 PIs who received evaluation reports, 72% indicated their project's evaluation caused them to make a change in implementing their project, and 40% indicated that the evaluation caused them to make a change in their project's goals, objectives, or target audience.

Most projects shared their evaluation results with **NSF program officers**, their **project advisory committee**, and **faculty or staff at their host institution**.



Figure 23. Percentage of projects that shared their evaluation results with various audiences (n=232)

ATE SURVEY

2021 HIGHLIGHTS

This summary of activities and achievements of the Advanced Technology Education (ATE) program is based on the 2021 ATE Survey. Principal investigators for 91% of ATE grants (n=313, out of a total of 344 active ATE grants) completed the survey. Respondents represented grants supporting 270 projects, 27 centers, 6 conferences, and 10 targeted research projects.

130 DEGREE PROGRAMS AND 370 COURSES

were developed by 112 ATE projects.

Almost half (49%) of all academic degree programs developed were certificate programs, and a majority (88%) of courses developed were at the associate degree level.



50 associate degree
programs served
6,630 students



60 certificate
programs served
3,000 students

8,630 EDUCATORS

participated in 860 professional development activities.

Over 5,750 educators who received professional development were located at **two-year colleges** followed by 1,720 educators at **four-year colleges**.

At two-year colleges

5,750

At four-year colleges

1,720

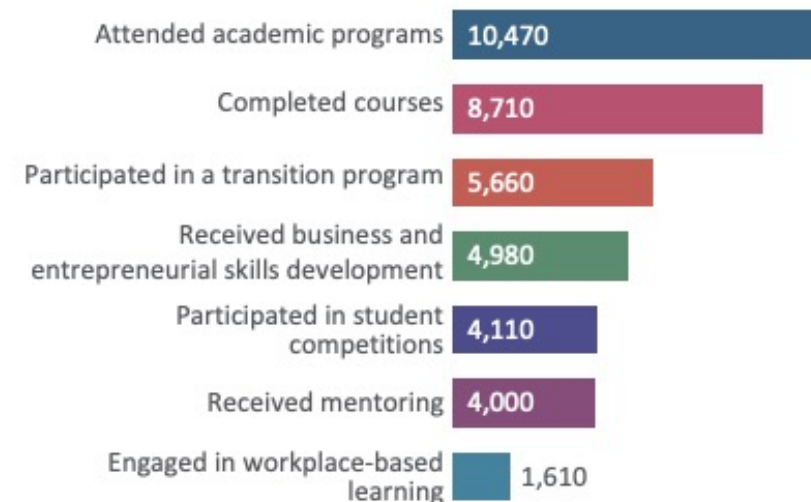
1,150

At secondary schools

39,500+ STUDENTS

were served by ATE projects.

ATE projects served over 39,500 students through a variety of activities in 2020.* ATE projects served the most students through developing or modifying academic programs, followed by courses.



* Due to the structure of the survey questions, the total number of students served may not represent a count of unique students.

ATE SURVEY

2021 HIGHLIGHTS (continued)

6,830 EDUCATIONAL MATERIALS

were developed by 136 ATE projects.

Educational materials developed included assessment activities, modules or instructional units, lessons, lab experiments, curricula, case studies, instructor guides, and textbooks.



2,080

Assessment
activities or tests



1,350

Modules or
instructional units



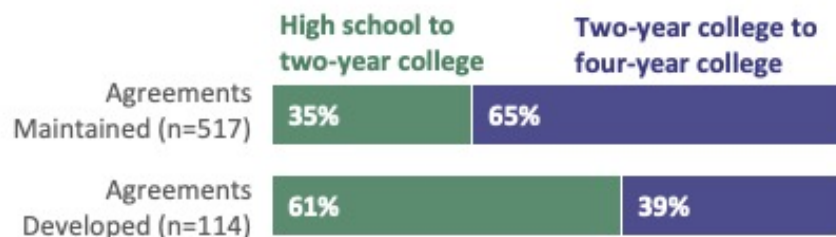
1,040

Lessons or
lesson plans

630 ARTICULATION AGREEMENTS

were developed or maintained by 50 ATE projects.

640 students matriculated to a higher-level education institution with the aid of an ATE-supported articulation agreement.

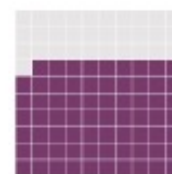


This material is based upon work supported by the National Science Foundation under grant number 1600992. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

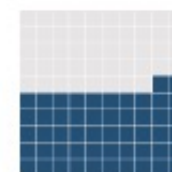
7,560 COLLABORATORS

were engaged by ATE projects.

ATE projects most frequently collaborated with business and industry groups and other colleges and universities.



69%
collaborated with
business and
industry groups



52%
collaborated with
other two- and
four-year colleges

OTHER ACTIVITIES were conducted by ATE projects in 2020 in support of advanced technological education.

ATE projects engaged in a wide range of activities. More information about those listed below and others can be found in the full report.



operated
**11 coordination
networks**



conducted
**10 research
studies**



hosted
6 conferences



developed
170 publications

TECHNICAL NOTES

ⁱ The 2021 ATE survey asked about the racial, ethnic, and gender identities of students in alignment with how the National Center for Education Statistics requests student demographic data from colleges. This involves asking students' race, ethnicity, and gender in a single question. This approach differs from years prior to 2019, when PIs were asked to report on the race, ethnicity, and gender identities of their students in separate questions. Additionally, ATE PIs were asked to report demographics for only students who had attended at least one course in an academic program that was developed or substantially modified in 2019. Prior to 2019, projects reported demographic information on students who attended at least one course in an ATE-supported academic program. This, in addition to a lower than usual response rate, resulted in a decrease in student demographic data for the 2020 and 2021 reports.

ⁱⁱ National data for two-year STEM programs are from the 2017–18 National Center for Education Statistics Digest of Education Statistics *Table 321.40* and *Table 321.50*. (Retrieved from https://nces.ed.gov/programs/digest/current_tables.asp.) Selected fields of study include agriculture and natural resources, biological and biomedical sciences, communications technologies, computer and information sciences, construction, engineering and engineering technologies, mechanic and repair technologies/technicians, physical sciences and science technologies, precision production, and transportation and materials moving. While these are not exact comparison groups, they are as close as available data allow.

ⁱⁱⁱ Comparison data for student demographics are from the National Center for Education Statistics. The referenced NCES tables were retrieved from https://nces.ed.gov/programs/digest/current_tables.asp. The national percentage of underrepresented minority students at the two-year level reflects STEM degrees conferred in the 2017–18 school year, derived from *Table 321.30*. Selected fields of study are the same as those listed in note ii. National rates for certificate programs are not presented because they are not reported by race and STEM field.

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ATE Annual Survey

2021 Report

December 2021

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Suggested citation:

Marshall, V. A., Sturgis, E., Becho, L. W., Wingate, L. A., & Gullickson, A. (2021). *ATE Survey: 2021 report*. Kalamazoo, MI: The Evaluation Center, Western Michigan University. Retrieved from <https://atesurvey.evalu.ate.org/>



This material is based upon work supported by the National Science Foundation under grant number 1841783. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.