STUDENT PARTICIPATION AND COMPLETION OF MARKETABLE CREDENTIALS:

An Exploration of Current Systems for and Barriers to Counting Students Served by the Advanced Technological Education Program

EvaluATE

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LIST OF ABBREVIATIONS

ABBREVIATION	EXPLANATION
ATE	Advanced Technological Education
IHE	Institution of Higher Education
NSF	National Science Foundation
PI	Principal Investigator
REU	Research Experience for Undergraduates
SAMPI	Science and Mathematics Program Improvement
STEM	Science, Technology, Engineering, and Mathematics
WBL	Workplace-Based Learning

EXECUTIVE SUMMARY

The current study investigated student participation and completion data for the National Science Foundation's Advanced Technological Education (ATE) program. Inspired by the reporting requirements in Public Law 115-402, the Innovations in Mentoring, Training, and Apprenticeship Act, this study begins to shed light on counts of students served by ATE projects. Acknowledging the limitations of existing data, this study also identifies factors that would need to be considered to improve reporting of student-level data broadly across the ATE program. Data from the ATE Survey, project abstracts, and case studies with currently funded ATE projects were used to assess the participation of students in ATE programming, with a particular focus on applied learning experiences and the completion of marketable credentials. Key findings and recommendations are summarized below.

KEY FINDINGS

Research Question 1

How many students participated in various ATE project activities in 2018 and 2019, as reported on the annual survey of ATE principal investigators?

ATE projects reported direct service to over 60,000 students in 2018 and 70,000 students in 2019. However, due to the structure of the questions on the annual survey of ATE principal investigators, we knew that these might not be unique counts of students. Therefore, case studies of selected ATE projects were conducted to investigate the extent of duplication in student counts.

Research Question 2

How many unique students participated in any ATE project activities in 2019, based on a sample of ATE projects?

The nine ATE projects included in the case study sample reported serving 4,060 unique students in 2019, while these same projects ATE Survey responses for the same year included 4,633 students. The number of unique students served as a percentage of the count reported on the ATE Survey ranged between 40% (indicating the majority of the students were counted more than once on the ATE Survey) to 121% (indicating PIs were able to identify additional students who were not counted on the ATE Survey). In total, 88% of students reported on the ATE Survey were verified as unique counts by the case study participants.

Research Question 3

To what extent and how did the numbers of apprenticeships, internships, and other applied learning opportunities offered by employers in collaboration with ATE projects change across the lifetime of the ATE program?

Given an increased interest in applied learning and workplace-based learning, this report looked closely at the number of projects engaging in these types of activities and at the number of

students such activities served. A review of project abstracts indicates that applied learning experiences were more prevalent in 2018 and 2019 than in previous years of the ATE program, with approximately 40% of funded ATE projects intending to engage in applied learning compared to a prior average of 23% of projects.

Research Question 4

How many students who participated in ATE-funded academic programs successfully completed their educational programs in 2018 and 2019, as reported on the annual survey of ATE principal investigators?

On the ATE Survey, projects reported 710 students who completed ATE-funded academic programs in 2018 and 1,670 students in 2019.

Research Question 5

How many students who began ATE-funded academic programs obtained marketable credentials (e.g., certificate, license, associate degree) from the program or another in a related field in 2019, based on a sample of ATE projects?

Eight of the nine ATE projects included in the case study sample reported a total of 341 unique students who obtained credentials in 2019. The majority of students obtained industry certificates (87%), followed by associate degrees (33%). The nineth case could not track student credentials.

Research Question 6

If the ATE-program wanted to report information on student participation and completion program-wide, what are the barriers they would need to consider or overcome?

Acknowledging the duplication detected in ATE Survey responses, this study closely documented barriers that would need to be considered if the ATE program wanted to collect and report unduplicated counts of student participation and completion program wide. Structural issues within the two-year college environment, along with unclear requirements from NSF, have led to challenges in ATE projects' collection and reporting of information regarding student participation and completion. Compounding this, many PIs interviewed in the case studies reported a lack of data literacy skills, support, or resources to track student counts or completion rates.

In addition to challenges in data collection, defining a suitable measure of success for two-year colleges is important, as degree attainment alone is not an encompassing indicator of ATE project success. In reference to student success, one ATE PI stated, "If I can see a job in the future for [my students], I see that as a success." Additional appropriate metrics might include rates of employment in high-technology fields, along with rates of pay or promotion. However, the ATE Survey cannot adequately capture this information, as the survey is a point-in-time instrument used to monitor activity rather than to track long-term outcomes. Case studies may be able to investigate more indicators of student success; however, to truly capture the full effect, case studies would need to be conducted years after students' involvement with ATE projects.

KEY RECOMMENDATIONS

Recommendations for the NSF ATE program, ATE projects, and EvaluATE based on the findings of this study are summarized below. The recommendations are focused on addressing barriers and challenges associated with collecting accurate and credible student counts across the ATE program. The research team recognizes that system-wide change and support would be needed to systematically collect unduplicated student participation and completion data across the ATE program. This study will help inform planning for future inquiries into the impact of the ATE program as a whole.

Recommendations for the NSF ATE Program

- Be explicit about the metrics ATE projects are expected to track, how indicators are defined/operationalized, and how they should be reported. Standardizing this process will provide a clear process and expectation to projects. To name one example, a project might need to report the number of students obtaining marketable credentials.
- Invest in initiatives that will support project-level data collection and reporting.
- Collaborate with other initiatives that are working to identify alternative success measures. Resources include the American Association of Community Colleges' (AACC, 2012) Voluntary Framework for Accountability and the indicators described by the National Academies of Sciences, Engineering, and Medicine (NAS, 2018). Or fund initiatives to increase discussion in the ATE community about how student success is defined and measured.

Recommendations for ATE Projects

- Engage evaluators during the project planning phase to ensure student tracking is built into project operations.
- Keep detailed digital records.
- Seek out technical support to help meet data collection and evaluation expectations.

Recommendations for EvaluATE about the ATE Survey

- Restructure questions in the ATE Survey to capture unique counts of students where possible.
- Employ strategies to thoroughly inform PIs about the survey requirements regarding student counts.
- Continue to build capacity in the ATE program for data collection, reporting, and literacy.

ABOUT THE AUTHORS

This study was a collaboration between team members from EvaluATE, located at The Evaluation Center at Western Michigan University, and Science and Mathematics Program Improvement (SAMPI), a center within the Mallinson Institute for Science Education, College of Arts and Sciences, also at Western Michigan University. Details about both centers are below.

ABOUT EVALUATE

EvaluATE is the evaluation hub for the National Science Foundation's Advanced Technological Education (NSF's ATE) program. EvaluATE supports the advancement of high-quality evaluation in the ATE program and in STEM education evaluation more broadly through open-access trainings and resources for project staff and evaluators on how to conduct, manage, and use evaluation. EvaluATE also builds community, conducts research on evaluation practice, and manages the annual survey of ATE principal investigators.

EvaluATE's mission is to promote the goals of the ATE program by partnering with ATE projects and centers to strengthen the program's evaluation knowledge base, expand the use of exemplary evaluation practices, and support the continuous improvement of technical education throughout the nation.

EvaluATE's goals are to:

- Ensure that all ATE Principal Investigators (PIs) and evaluators know the essential elements of a credible and useful evaluation.
- Maintain a comprehensive collection of online resources for ATE evaluation.
- Strengthen and expand a network of ATE evaluation stakeholders.
- Gather, synthesize, and disseminate data about ATE program activities to advance knowledge about ATE technician education.

EvaluATE has been funded by the National Science Foundation since 2008 under NSF awards 0802245, 1204683, 1600992, and 1841783.

ABOUT SAMPI

The primary goal of Science and Mathematics Program Improvement (SAMPI) is education improvement through supporting K–12 schools, institutions of higher education, non-profit organizations, funding agencies, and other educational entities to improve their educational programming. With an emphasis on science, technology, engineering, and mathematics (STEM), and general school reform, SAMPI employs a variety of strategies, including evaluation, research, materials development, and consultation, to assist clients with their improvement efforts.

SAMPI's role in this study was to collect, analyze, and report data related to determining: 1) unduplicated counts of students in ATE grant-supported activities, and 2) students receiving

marketable credentials in ATE-related fields. SAMPI identified a sample of ATE projects, conducted interviews with project principal investigators and staff, compiled unduplicated counts of students and credentials, and analyzed qualitative data on barriers and challenges.

INTRODUCTION

Obtaining unique counts of students who have taken part in Advanced Technological Education (ATE) project activities has long been a difficult undertaking. Inspired by the reporting requirements in Public Law 115-402, the Innovations in Mentoring, Training, and Apprenticeship Act, this report uses various data sources to assess and investigate counts of students served by the ATE program. Additionally, it examines challenges (at the project, institution, and ATE program levels) associated with collecting and reporting data related to student participation in and completion of academic programs.

The Innovations in Mentoring, Training, and Apprenticeship Act of 2018 tasked NSF with enhancing associate degree programs and applied learning opportunities in STEM fields for the purpose of remaining competitive in the global economy. In section 5 of the legislation, which covers evaluation and reporting requirements, the act asks for reporting on the following areas:

- "assessment of the effectiveness of the grant programs in expanding apprenticeships, internships, and other applied learning opportunities offered by employers in conjunction with junior or community colleges, or institutions of higher education, as applicable;
- Assess the number of students who participated in the grant programs; and
- Assess the percentage of students participating in the grant programs who successfully complete their education programs."

The importance of reporting accurate and valid data on student participation and success in the ATE program is evident in this request, as it has been throughout years of discussions between EvaluATE and ATE principal investigators, ATE evaluators, and NSF program officers. Therefore, this study begins to address barriers to and solutions for reporting, through an investigation of existing data, supplemented by case studies of nine ATE projects. As a first attempt to shed light on the expectations listed in Public Law 115-402, this study has operationalized student participation and successful completion of education programs to align with existing data sources.

The purpose of this study was to produce a descriptive analysis of available data on the number of students served by ATE project activities (with special attention to participation in applied learning) and on student completion of ATE academic programs. While this aim seems straightforward on the surface, the reality is more complicated. Therefore, this study also documents barriers to collecting and reporting this kind of data and describes challenges that would need to be overcome to report unique counts of students for the entire ATE program.

This report begins by presenting background information on the ATE program and the two-year college context, in addition to definitions of key terms. Following that, the report is organized around six research questions:

1. How many students participated in various ATE project activities in 2018 and 2019, as reported on the annual survey of ATE principal investigators?

2. How many unique students participated in any ATE project activities in 2019, based on a sample of ATE projects?
3. To what extent and how did the number of apprenticeships, internships, and other applied learning opportunities offered by employees in collaboration with ATE projects change across the lifetime of the ATE program?
4. How many students who participated in ATE-funded academic programs successfully completed their education programs in 2018 and 2019, as reported on the annual survey of ATE principal investigators?
5. How many students who began ATE-funded academic programs obtained marketable credentials (e.g., certificate, license, associate degree) from the program or another in a related field in 2019, based on a sample of ATE projects?
6. If the ATE program wanted to report information on student participation and completion program-wide, what are the barriers they would need to consider or overcome?

Under each research question, relevant methods are reported, along with findings and limitations. The report ends with conclusions and recommendations for the NSF ATE program, ATE projects, and EvaluATE. The recommendations focus on addressing barriers and challenges associated with collecting accurate and credible data across the ATE program. Recommendations are made to all three of these groups in recognition that challenges related to student data cannot be solved in isolation but will require improved systems and processes from multiple angles.

BACKGROUND

This section provides relevant context and background information regarding the ATE program, as well as the two-year college setting. The unique factors described here provide context for the interpretation of the findings in this report, as well as situating the recommendations.

ABOUT THE ATE PROGRAM

The NSF ATE program is focused on strengthening the education of technicians in high-technology fields, particularly within two-year institutions of higher education. According to the ATE solicitation,

> The [ATE] program involves partnerships between academic institutions (grades 7–12, IHEs) and industry to promote improvement in the education of science and engineering technicians at the undergraduate and secondary institution school levels. The ATE program supports curriculum development; professional development of college faculty and secondary school teachers; career pathways; and other activities (NSF, 2018).

The ATE program aims to enhance the STEM technical workforce through strengthening education programs, supporting faculty development, and engaging with business and industry. Examples of high-technology fields of interest include advanced manufacturing, biotechnology, energy and environmental technologies, engineering, information technologies, and nanotechnologies.

While all ATE efforts are working towards service of students, not all ATE projects directly interact with students. ATE activities that indirectly serve students may include faculty development, creation of educational materials, or curriculum development for use at institutions other than the grant's host organization. Of the 325 active ATE projects in 2020, approximately 53% engaged in professional development for faculty, 47% developed educational materials, and 35% developed educational courses (Marshall et al., 2020). Other activities directly serve students, for example the development of academic programs, courses, pathways, student support services, and workplace-based learning. Approximately 35% of projects engaged in course development, 33% offered workplace-based learning opportunities, and 28% offered direct support to students obtaining certifications or licensing (Marshall et al., 2020). One ATE project can engage in multiple activities, serving students both indirectly and directly.

ABOUT THE TWO-YEAR COLLEGE CONTEXT

In accordance with the program's emphasis, the majority of ATE projects (77%) are located at two-year colleges. Other project host organizations include four-year colleges (16%), nonprofit organizations (5%), and other types of organizations (2%) (Marshall et al., 2020). Given the prominence of two-year colleges as environments for ATE projects, this section outlines some unique features of a two-year college context to help situate the study's findings.

Two-year colleges, including community colleges and technical colleges, tend to award certificates and associate degrees. There are over 1,000 community colleges in the United States, serving 6.8 million students (AACC, 2021). Two-year colleges constitute a substantial proportion of higher education institutions, with 27% of undergraduate students attending public two-year colleges in fall 2019 (National Student Clearinghouse, 2020).

Two-year college students tend to be transient, with lower persistence rates than those at four-year colleges. In the United States, 62% of students who started at a public two-year college in fall 2018 were still enrolled at any institution in fall 2019, compared with 85% of students who started at a public four-year college. Fifty-four percent (54%) of these two-year college students returned to the same college, compared with 75% of four-year college students (National Student Clearinghouse, 2020). This lower rate of persistence, along with students' tendency at two-year colleges to start and stop their education, has implications for the ability of two-year colleges to systematically track students between academic programs and institutions.

While some students in two-year colleges aim to transfer to four-year colleges, other two-year students enroll with the intention of earning a certificate or associate degree, or solely to take a few courses. The end goal, or "success" metric, for a two-year student can be more complex than simple statistics such as retention, persistence, or even graduation rates can communicate. ATE projects at two-year colleges are expected to be responsive to business and industry needs,

increasing the skills of a twenty-first-century workforce. This dedication to up-skilling can mean aiming for the moving target of industry needs, which may not lead to "success" according to the traditional metrics used by other institutions of higher education.

The American Association of Community Colleges, the Association of Community College Trustees, and the College Board Advocacy and Policy Center, have recognized the need to identify more appropriate indicators for measuring the success of community colleges, and have started an effort called the Voluntary Framework of Accountability. Currently in pilot status, this nationwide system is designed to track metrics that encompass the full breadth of community colleges' missions and goals. These proposed metrics take a broader view of student success beyond certifications or graduation rates (AACC, 2012).

DEFINITION OF KEY TERMS

This section provides definitions for concepts used throughout this report relevant to the ATE program, activities engaged in by ATE projects, credentials awarded by two-year colleges, and the interpretation of findings throughout this study.

Term	Definition
Associate degree	An *associate degree* is an undergraduate degree awarded to a student who has completed two years of study, typically at a two-year or community college. "The associate-level degree usually requires the completion of approximately 60 semester credits" compared to "the bachelor's level degree which usually requires 120 to 130 semester credits" (American Council on Education, 2016, p. 6).
Applied learning experiences	*Applied learning experiences* refers to an educational approach where students engage in direct application of skills, theories, and models. This could refer to classroom activities that involve hands-on activities, engaging in real-world settings, or research experiences.
ATE project	All types of grants awarded by the NSF ATE program will be referred to as *ATE projects* or *projects* throughout this report. For the purpose of this report, ATE projects will encompass awards identified as projects, centers, targeted research projects, or conferences.

ATE Survey	The *ATE Survey* is an annual monitoring survey of all active ATE principal investigators, conducted by EvaluATE since 2000. Questions on the ATE Survey have shifted over the years, but the survey has always focused on collecting insight on the activities and achievements of ATE projects. All reports are available at atesurvey.evalu-ate.org.
ATE-funded academic program	The ATE program supports the development and improvement of academic programs. Supported activities include programmatic curriculum development, development of innovative methods or experiences, and the integration of industry standards and workplace competencies. These academic programs must lead to "an appropriate associate degree or specific occupational competency or certification" (NSF, 2018, p. 5). An academic program that has been developed or modified using ATE funds is referred to as an *ATE-funded academic program.*
ATE-funded course	The ATE program supports the development of course content, including course curricula and learning and laboratory activities. An academic course that has been developed or substantially modified using ATE funds is referred to as an *ATE-funded course.*
Bridge or transition program	A *bridge or transition program* is designed to improve students' preparation for and ease their transition into college. Such programs typically take place between high school and college, but some are offered between two-year and four-year colleges. Activities might include summer programs, college readiness workshops, first-year programs, or support for non-traditional students.
Business and entrepreneurial skills development	ATE projects that engage in *business and entrepreneurial skills development* help students in a systematic way to develop skills in areas such as—but not limited to—business development, marketing, networking, and understanding the global marketplace.
Certificate	A *certificate* is awarded through a non-degree educational program. Certificate programs are relatively short term and offer specialized training in specific skill-sets, usually specific to an industry or field. Certificates are "not typically held to [the] psychometric standards required of certifications" (Lumina Foundation, 2015, p. 10).

Data limitations	*Data limitations* are reported for all findings throughout this report to recognize the underlying assumptions and weaknesses that come with each source of data. Data limitations are discussed in reference to how they constrain the interpretation of a data point, whereas barriers are presented as systemic or structural issues that impede the collection or reporting of data.
Digital badge	A *digital badge* is newer type of credential that uses digital technologies to represent learning achievements. There are few standard definitions, criteria, or requirements for badges. Considered smaller than a certificate, badges can be created by institutions, organizations, groups, or individuals. "Badges can be used in numerous ways to meet a community's needs, to represent granular competencies as well as deeply linked, rich experiences and complex learning" (American Council on Education, 2016, p. 7).
Duplicated and unduplicated counts of students	A major limitation for data sources such as the ATE Survey is *duplicated counts of students*. This refers to data sets in which individual students may have been counted twice and, as a result, the number provided does not represent a number of unique students. An *unduplicated count of students* refers to a count of unique students, where each number stands for one and only one student.
Industry-recognized credential	The Association for Career and Technical Education (2018) defines an *industry-recognized credential* as a credential that "is sought or accepted by employers within the industry or sector involved as a recognized, preferred, or required credential for recruitment, screening, hiring, retention or advancement purposes; and, where appropriate, is endorsed by a nationally recognized trade association or organization representing a significant part of the industry or sector."
Marketable credential	A *credential* is "a documented award by a responsible and authorized body that has determined that an individual has achieved specific learning outcomes relative to a given standard. *Credential* in this context is an umbrella term that includes degrees, diplomas, licenses, certificates, badges, and professional/industry certifications" (Lumina Foundation, 2015, p. 11). The adjective *marketable* is added to *credential* to emphasize these credentials are intended to increase the employability of students who obtain them.

Student mentoring	*Student mentoring* is defined in the ATE Survey (Marshall et al., 2020) as involving "an experienced industry professional, educator, or advanced student providing guidance and advice to help a less experienced student develop the skills and knowledge they need to enhance their academic and professional growth." Data collected through this study shows some confusion from respondents about whether activities such as academic advising would be considered student mentoring. Given the self-reported nature of ATE Survey responses, there will be some variation in the operationalized definitions ATE principal investigators used in providing data from their projects.
Principal investigator	A project's *principal investigator* (PI) is "the individual(s) designated by the proposer, and approved by NSF, who will be responsible for the scientific or technical direction of the project" (NSF, 2020, p. II-53). For the most part, this report draws on direct communication with ATE project PIs or other project staff responsible for collecting or reporting data on students.
Project abstracts	In this report *project abstracts* refers to the short summaries of ATE projects written by project teams and made available via each project's NSF profile.
Self-reported	The description *self-reported* indicates that data was provided by an individual rather than observed by a third party or measured in a more objective manner. This distinction is important for data in this study, as ATE projects self-report information regarding their project activities and the students they serve via the ATE Survey.
Student competitions	*Student competitions* are defined in the ATE Survey (Marshall et al., 2020) as "events at which students compete as individuals or teams using skills related to a STEM discipline or industry."
Student completion	For the purpose of this report, *student completion* is intended to capture the completion of any program or the receipt of any credential awarded by a two-year college. This includes associate degrees, certificates, digital badges, industry credentials, and other marketable credentials.

Student participation	For the purpose of this report, *student participation* is defined as engagement by any student in an activity that has been developed or improved by an ATE project. This may include taking part in academic programs, academic courses, bridge or transition programs, activities that develop business and entrepreneurial skills, mentoring, or workplace-based learning. Student participation in ATE projects does not include indirect or secondary service of students through project activities. For example, student participation does not encompass students who use a textbook created by an ATE project at another institution, or students who receive instruction from faculty who participated in professional development through an ATE project.
Two-year college	A *two-year college* is an institution of higher education that provides a curriculum that can lead to an associate degree or other marketable credentials. While the terms *two-year college* and *community college* can overlap, this study uses the term *two-year college* to reflect language used in the NSF ATE program solicitation.
Workplace-based learning	*Workplace-based learning,* also referred to as *applied learning opportunities*, is defined by the 2020 ATE Survey as "any situation in which a student gains experience at a work site, such as internships, apprenticeships, [and] job shadowing." This report does not consider field trips to industry sites to be workplace-based. WBL is characterized by "sustained interaction with industry or community professionals in real workplace settings...that foster in-depth, firsthand engagement with the tasks required in a given career field, that are aligned to curriculum and institution" (Carl D. Perkins Career and Technical Education Act, 2006, p. 4).

RESEARCH QUESTION 1:

How many students participated in various ATE projects and activities in 2018 and 2019, as reported on the annual survey of ATE principal investigators?

This research question is a first step in understanding the number of students served by the ATE program. Despite the limitations of using the ATE Survey as a data source, it is currently the only program-wide, publicly available authority on ATE projects' activities. Findings in this section begin to describe a landscape that is explored further by the research questions that follow.

METHODS

Annual Survey of ATE Principal Investigators

The research team used data from the 2019 and 2020 ATE Surveys as a measure of students served by ATE activities. EvaluATE has conducted an annual survey of ATE principal investigators since 2000. This survey is referred to as the ATE Survey. To accommodate the time required to assemble each year's data, the ATE Survey asks PIs to report activities that were conducted in the previous calendar year. For example, the 2019 survey asked about activities carried out in 2018, and the 2020 survey asked about activities conducted in 2019. Each year's survey is a census of all ATE awards active as of the opening of the survey in February of that year. The 2019 survey had a response rate of 92%, with 279 grantees responding (out of a total of 304). The 2020 survey had a response rate of 91%, with 294 out of 325 grantees responding.

The ATE Survey is sent via email to the PIs of all active projects on a list shared with EvaluATE by the ATE program lead, Celeste Carter. PIs are asked to confirm their project and contact information prior to the survey opening. PIs are allowed to designate someone other than themselves to receive communication regarding the survey. Once the survey opens, recipients receive weekly reminders until the close of the survey. The 2019 survey opened on March 1, 2019, and closed on April 19, 2019. The 2020 survey opened on February 18, 2020, and closed on May 8, 2020. The time frame of the 2020 survey was extended due to COVID-19.

ATE project activities that directly serve students are categorized and described in Table 1.

Table 1. ATE Activity Descriptions by Category

Activity	Activity Description
Academic programs, courses, and pathways: A specific aim of ATE is to facilitate the development or improvement of programs that lead to "an appropriate associate degree or specific occupational competency or certification" (NSF, 2018, p. 5). These activities may include creating new degree or certificate programs or courses; modifying the content, delivery modes, or instructional strategies of existing programs or courses; or developing educational pathways that facilitate movement of students across educational levels (Marshall et al., 2020, p. 9).	
a. Took at least one course in an academic program developed or modified with ATE funds	Instances wherein students participated in a course within a specified academic program that was created or substantially modified using ATE funding.
b. Completed a course developed or modified with ATE funds	Instances wherein students completed in a course that was created or substantially modified using ATE funding.
c. Used an instrument acquired with ATE funds	Instances where students utilized newly acquired state-of-the-art equipment to further develop technical skills needed for employment.
Student services and support: These activities are designed to enhance student learning and success in STEM programs outside of typical classroom environments (Marshall et al., 2020, p. 17).	
d. Received mentoring	Opportunities wherein students received guidance from an experienced industry professional, educator, or advanced student with the goal of enhancing their academic or professional growth.
e. Participated in a student competition	Events wherein students utilized STEM-related skills to compete as individuals or teams.
f. Received business or entrepreneurial training	Activities that worked with students to develop skills such as business development, marketing, networking, and understanding the global marketplace.
g. Participated in a bridge or transition program	Activities that supported students in transitioning into college, equipping them with necessary skills to navigate college.
Workplace-based learning: Workplace-based learning is defined by the ATE Survey as "any situation in which a student gains experience at a work site, such as internships, apprenticeships, [and] job shadowing" (Marshall et al., 2020, p. 21).	
h. Participated in a workplace-based learning opportunity	Opportunities where students applied academic or technical skills in a real-life work setting, such as through an internship, co-op, or job-shadow.

FINDINGS

In total, according to the ATE Survey, ATE projects served over 60,000 students in 2018 and 70,000 students in 2019. The number of students served by type of ATE activity are summarized in Table 2.

Table 2. Number of Students Reported by ATE PIs on the Annual ATE Survey for 2018 and 2019

Activity	Number of Students by Year*	
	2018	2019
a. Took at least one course in an academic program developed or modified with ATE funds	11,970	10,570
b. Completed a course developed or modified with ATE funds	6,900	9,110
c. Used an instrument acquired with ATE funds	7,110	9,410
d. Received mentoring	9,700	7,540
e. Participated in a student competition	8,570	9,420
f. Received business and entrepreneurial skills development	7,380	13,140
g. Participated in a bridge or transition program	4,990	11,390
h. Participated in a workplace-based learning opportunity	7,290	3,410

Data Source: ATE Survey (2019, 2020)

**Reported number of students are rounded to the nearest ten.*

Limitations of Findings

These counts begin to describe how students engage with activities funded by the ATE program. The following limitations should be considered when interpreting the data.

Student counts are limited to the questions asked on the ATE Survey. Counts reported on the ATE Survey do not encompass all possible ways ATE projects engage with students. For example, the survey does not ask about students who took courses that were previously funded by ATE, students who received a secondary benefit from the ATE program, or students who continue to receive benefits from ATE funding after the grant has ended.

Student counts are self-reported by ATE PIs. The ATE Survey is a self-report tool completed by ATE PIs and therefore not directly observed by the research team. As a result, counts provided in

the ATE Survey are subject to respondent error. Specifically, they are dependent on the interpretation and accuracy of ATE project data collected by PIs and their project staff.

Comparing change in student counts between years is limited. There is little meaning in comparing change in student counts from 2018 to 2019. Not only is this point-in-time comparisons between two years, but the population of ATE projects change from year to year. Each year, some projects begin and others end. As the project population shifts, so does the intended activities and student reach of those projects. Therefore, comparing student counts between years does not give a complete understanding of overall change in the ATE program.

Student counts may be duplicated. Due to challenges related to data collection, storage, and interpretation addressed in this report, duplication of counts may exist within and between activities. For example, students taking courses developed by an ATE project might also receive mentoring by way of that same ATE project. In another example, students may be taking courses in multiple programs that were modified using ATE funds. In these instances, those students would be counted twice, once within each activity. An unduplicated count of students is important in understanding the true reach of the ATE program. Acknowledging this issue of duplication in counts from the ATE Survey led the research team to research question 2.

RESEARCH QUESTION 2

How many unique students participated in any ATE project activities in 2019, based on a sample of ATE projects?

This research question investigates the extent of duplication in counts of students participating in ATE project activities. It also aims to identify barriers to determining the number of unique students as well as the extent to which ATE PIs experience challenges reporting count data.

METHODS

Case Study

The research team conducted case studies with nine currently active ATE projects to determine the following for each of the nine sites:

- An unduplicated count of students who participated in ATE activities in 2019 (research question 2).
- The number of students who participated in an ATE project who obtained a marketable credential from the program or another in a related field since the start of the ATE project (research question 5).

In discussions with NSF about the scope of work, it was determined that only nine projects could be included in the study. Due to this limited sample size, findings from this study cannot generalize to the larger ATE project population. Through this sample, researchers identified what would be needed if such a study were to be done on a larger, program-wide scale. Findings from this sample will provide insights into the feasibility and challenges associated with such a study.

Sample Selection Process

The following outlines the approach used to select the sample and conduct the case studies. Data from the 2020 ATE Survey were used to select nine projects to participate. The process began with cleaning the sampling frame. ATE projects that met the following inclusion criteria were kept in consideration for sample selection:

- *The ATE project was active at the time of the case study.*
- *The ATE project directly served students, according to the project's response on the 2020 ATE Survey (in other words, at least one student was reported on the ATE Survey).*
- *The ATE project was located at a two-year institution, the primary institution type served by the ATE program.*
- *The ATE project identified as a "project" or "small projects for institutions new to ATE," the primary ATE award types*.[1] Other ATE award types (such as "coordination networks," "centers," and "targeted research") tend to be more removed from student services, serving students indirectly or through intermediaries.

This yielded 64 projects in the study's sampling frame, as shown in Figure 1.

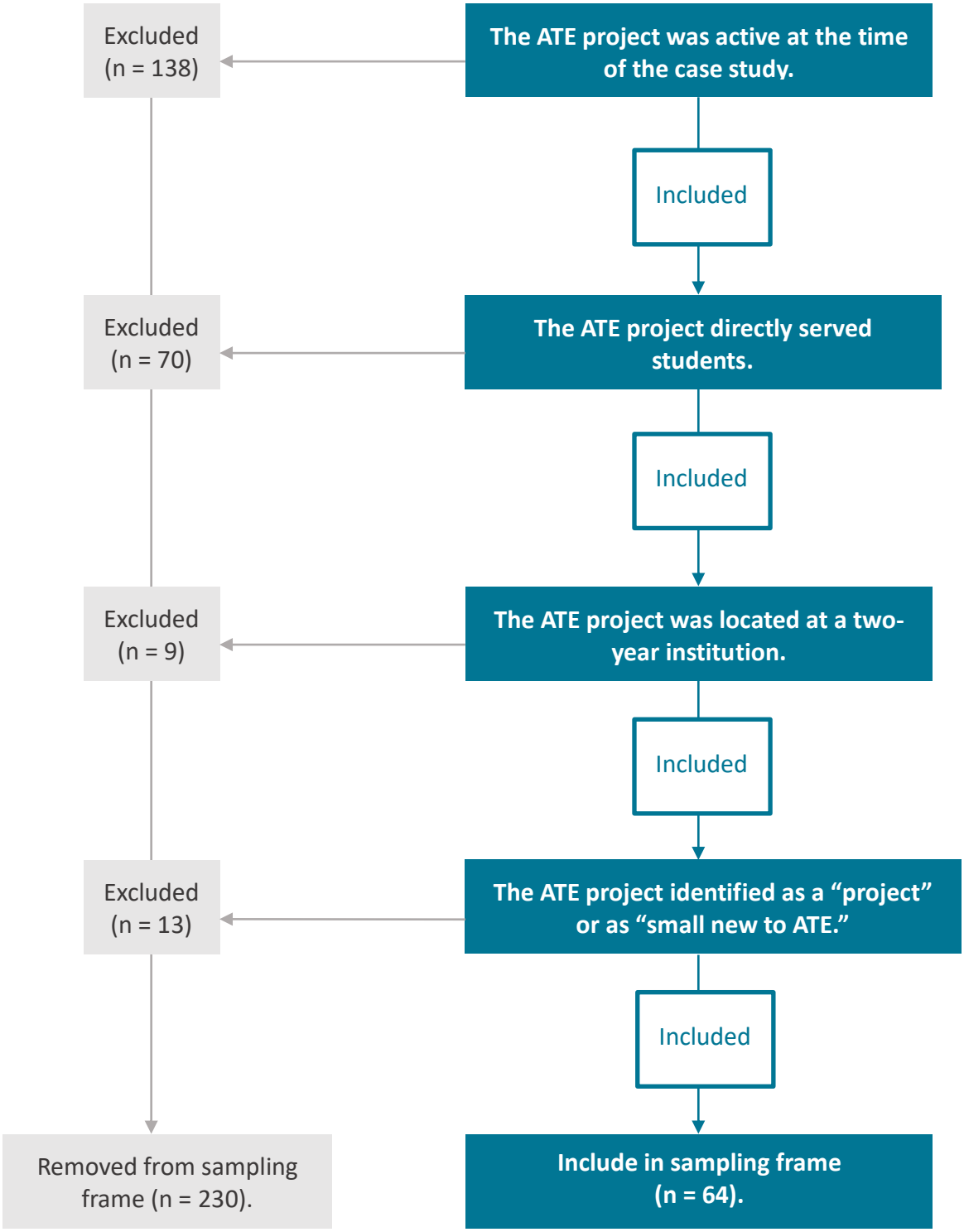
A duplicated count of students served as reported on the ATE Survey was tallied for each of the 64 projects. This was done by adding the counts for each of the following primary activity categories:

- Took at least one course in an academic program developed or modified with ATE funds, or completed at least one course developed or modified with ATE funds
- Participated in workplace-based learning
- Received mentoring

[1] "Projects" are ATE awards ranging between $75,000 and $200,000 per year and are considered the standard ATE funding type. "Small projects for institutions new to ATE" programs are awards up to $300,000 spread over three years and are for institutions that have not received ATE funding in the past seven years. "Coordination networks" are a subset of projects that aim to foster collaboration and partnerships to support technician education. "Centers" are funded up to $7.5 million spread over five years and are expected to support systemic reform, provide models for collaboration with business and industry, and support the overall advancement of technician education within their STEM discipline nationwide. "Targeted research" grants are awards ranging from $150,000 to $800,000 over two to three years that investigate issues related to education and STEM workforce development (NSF, 2018).

- Participated in a student competition
- Used an instrument acquired with ATE funds
- Received business and entrepreneurial skills development
- Participated in a bridge or transition program

Figure 1. Flow Chart of Inclusion Criteria that Led to the Sampling Frame



The final sample selection took into account three selection factors, including number of students served, designation as a minority-serving institution, and belonging to a large community-college system. These factors were chosen to ensure a variety of conditions were included in the study.

The included projects were grouped into four categories based on the total duplicated count of students, as shown in Table 3. The category cut-offs were chosen to ensure that projects of various sizes were included in the study. The research team considered dividing the sample into quartiles (or thirds) based on the total number of students, but this biased the sample toward smaller projects. Two projects were selected from each grouping category. Due to other selection factors, the ninth project was selected from the "100 to 499 students" category.

Table 3. Grouping Categories (Based on the Total Duplicated Count of Students)

Students reported on the ATE Survey	Number of projects Included in the sampling frame	Number of projects selected for the case study
1,000 or more students	2	2
500 – 999 students	3	2
100 – 499 students	24	3
1 – 99 students	35	2

Great care was taken to identify and apply considerations that ensured representation of the diversity of the ATE portfolio and to capture varying contexts that may influence a project's ability to report student data. As such, two other considerations were used to identify final site selection:

- Designation as minority-serving institution. A total of 18 (28%) of the 64 projects were at minority-serving institutions.[2] Projects were therefore selected to ensure that at least two of these were represented in the final study sample.

- Belonging to a large community college system. Fourteen (22%) of the 64 active projects were part of a large community college system in either Texas, California, or Florida. Projects were selected to ensure that at least two such projects were included in the sample.

The above criteria led to the selection of the nine projects shown in Table 4 (code numbers were assigned by the research team).

[2] Of these 18, 13 were Hispanic-serving institutions, 2 were Asian American and Native American Pacific Islander-serving institutions, 1 was an Alaska Native serving institution, 1 was a historically Black college, and 1 was a tribal college. The 3 selected for the sample (Table 4) happened to be Hispanic-serving due to restrictions with the selection criteria.

Table 4. Projects Selected for the Study

Sample selection considerations	Number of projects	Project code								
		1	2	3	4	5	6	7	8	9
Number of students served										
1,000 – 4,999 students	2	✓		✓						
500 – 999 students	2		✓							✓
100 – 499 students	3				✓	✓			✓	
1 – 99 students	2						✓	✓		
Award type										
Projects	7	✓		✓	✓	✓	✓		✓	✓
Small projects for institutions new to ATE	2		✓					✓		
Institution type										
2-year	9	✓	✓	✓	✓	✓	✓	✓	✓	✓
Other selection considerations										
Designation as minority serving institution	3	✓			✓					✓
Association with large state-wide community college system	2	✓								✓

Interviews with the Case Study Sample Grant PIs

The PIs for each of the nine selected projects were contacted through email and invited to participate in an initial interview. The email provided a brief overview of the study and the purposes of the interview. A $1,500 stipend was offered to each institution as an incentive. All nine PIs agreed to participate. A representative from the research team set up a phone call with each PI to answer any questions they had and discuss the process for their institutions to receive the stipend. The questions were emailed to the PIs in advance, and formal interviews were conducted via a videoconferencing service.

The full interview protocol is in Appendix A. Questions were divided into three categories:

- Questions about the project background. Interviewees were asked to describe their project's goals and objectives, their roles in the project, perceptions about the most and least effective aspects of their project, and definitions of project and student success.
- Questions about the unduplicated number of students participating in ATE project activities. Interviewees were presented with the student participant counts they reported in the 2020 ATE Survey for each of the activity categories. Through a series of questions, they worked in collaboration with the interviewer to determine the extent to which the sum of their numbers represented an unduplicated count of students impacted by the project. They were also asked to identify problems and barriers they have encountered in tracking students impacted in their ATE grant, as well as what they would need to improve the process (resources, funding, assistance from others, institutional changes, etc.).
- Questions about the percentage of ATE students who obtained a marketable credential. Interviewees were asked if they tracked the number of ATE students who obtained marketable credentials (certificates, licenses, associate degrees, bachelor's degrees, etc.) related to the program's field of study. If they did, they were asked to provide this information. If they did not, they were asked to identify how this information could be acquired. Interviewees were again asked to identify problems and barriers for tracking marketable credentials, as well as what they would need to improve this process.

Follow-Up Interviews and Interactions

A research team member worked closely with each of the PIs who initially could not provide unduplicated counts and/or identify the number of ATE participating students who obtained marketable credentials. This section focuses on the follow-up to obtain unduplicated counts. Information about the follow-up to obtain marketable credential data is found on pages 37–38.

Six PIs did not initially know how to acquire an unduplicated count of student participants and needed to look more deeply into their records or contact others at their institution for help. In three of these instances, the process required ample support from the research team, including a suggested format in which the information could be provided. The research team acquired unduplicated counts of students for all nine projects. Each PI provided data in one of the following ways:

- By confirming that some student counts reported in the ATE Survey were sub-counts of other categories which were unduplicated (3 projects).
- By confirming that the numbers reported on the ATE Survey were already unduplicated (2 projects).
- By providing detailed digital records of all activities each ATE student engaged in; these were used by researchers to remove the duplicates (2 projects).
- By reviewing participation records and removing the duplicated counts of students, then providing an overall unduplicated count of students (2 projects).

FINDINGS

The research team was successful in determining an unduplicated count of all students who participated in *any* ATE project activity implemented by the nine case study projects in 2019. It was not the intention of the study to determine unduplicated counts for the entire ATE program. The total unduplicated student count for all case study projects combined was 4,060, which was 88% of the total (duplicated) count derived from numbers provided on the 2020 ATE Survey. Table 5 shows these counts, along with the number of students who participated in each of the ATE activity categories within each of the nine projects.

Percentages of duplication varied considerably across the nine projects, suggesting that one should not use the overall percentage as a measure to estimate an unduplicated count for any individual project. Individual projects' unduplicated counts (Table 5) ranged from 40% of the original count reported in the ATE Survey (indicating the majority of the students were counted more than once on the ATE Survey) to 121% (indicating PIs were able to identify additional unique students who were not included in the original ATE Survey count). Two projects had percentages of 100%, indicating that the numbers reported on the survey were an exact count of unique students, and seven projects had percentages under 100%, indicating that some students were counted more than once for the ATE Survey response.

Before producing unduplicated counts, two projects revised their ATE Survey responses, having identified additional students they had not originally reported. Each provided the researchers with a revised count before beginning the effort to un-duplicate it. These PIs acknowledged during the interview that their actual unduplicated count was "higher than I reported" or that their survey response was "probably not complete." The fact that two PIs were able to identify additional students not originally counted on the ATE Survey suggests that some PIs are actually providing *estimates* on the ATE Survey rather than complete counts based on their available records. This was confirmed by one of the PIs who stated during an interview, "I would rather underestimate the counts than overestimate them, so I tended to undercount."

Table 5. Unduplicated Counts by Project

Project code	Total duplicated count of students*		Unduplicated count of students	Percentage of survey count	Number of students who engaged in each ATE project activity							
	ATE Survey[1]	Revised[2]			a	b	c	d	e	f	g	h
1	1,237	1,708	1,112	90%	–	102	569	234	–	–	–	803
2	501	661	606	121%	–	519	120	–	87	27	–	–
3	1,547	–	1,547	100%	–	–	–	–	–	–	–	1,547
4	121	–	102	84%	–	93	14	–	–	–	14	–
5	231	–	144	62%	144	21	45	–	–	21	–	–
6	27	–	15	56%	–	–	–	15	–	–	12	–
7	31	–	31	100%	–	–	–	20	–	11	–	–
8	297	–	244	82%	16	16	120	70	–	–	8	67
9	641	–	259	40%	–	–	101	200	100	40	200	–
Total	**4,633**	**–**	**4,060**	**88%**	**160**	**751**	**969**	**539**	**187**	**99**	**234**	**2,417**

* Counts were revised by the PIs prior to being unduplicated for projects 1 and 2.
[1] ATE Survey refers to the sum total of all counts reported on the ATE Survey.
[2] Revised refers to the sum total after PI reported additional students not counted on the ATE Survey.

Activity category codes are as follows:
a: Took at least one course in an academic program developed or modified with ATE funds
b: Completed a course developed or modified with ATE funds
c: Participated in workplace-based learning
d: Received mentoring
e: Participated in a student competition
f: Used an instrument acquired with ATE funds
g: Received business or entrepreneurial skills development
h: Participated in a bridge or transition program

Limitations of Findings

Varying degrees of information were provided across projects. Some PIs were able to provide detailed digital records that documented each student's participation in each type of activity. Others, however, were only able to provide head counts, paper records (some incomplete), or informal confirmation of unduplicated counts from memory.

Student numbers for some projects could not be verified with formal participation records. Two projects did not maintain digital records. In the first case, the PI stated they had paper records that confirmed the involvement of only *some* of the students. The PI was nonetheless able to confirm an unduplicated count from memory. In the second case, the PI reported that only "head counts" were collected; names were not recorded. The PI also stated, "All I can do is give you numbers because when we put the project together, we did not ask for data, nor were we asked to provide data for success as they came into our relative programs. That was not a part of our collection."

Counts do not necessarily represent the full impact of ATE projects. The reach and influence of an ATE project can be extensive, impacting students well beyond immediate program activities. For example, one of the case study projects focused on refining existing materials for use in wider contexts. This PI described their efforts as being a "scaling" project. Specifically, their goal was to refine their curriculum so that it could be used by other institutions. Thus, the full number of students impacted by their curriculum could not be reported on the ATE Survey. The PI asked during the interview, "[How] do I report [the number of] students who are touched by the curriculum, which would be many times what I could determine?"

RESEARCH QUESTION 3

To what extent and how did the number of apprenticeships, internships, and other applied learning opportunities offered by employers in collaborations with ATE projects change across the lifetime of the ATE program?

The extent of workplace-based and applied learning is a key point of interest in the Innovations in Mentoring, Training, and Apprenticeship Act. Activities such as internships and apprenticeships have also been gaining prominence in ATE discussions. The 2014 ATE solicitation was the first to explicitly mention industry internships for students "that build skills and competencies and introduce students to a real work experience" as a component that submissions might include (NSF, 2014, p. 5). Language in the solicitation regarding workplace-based learning, applied learning, internships, and apprenticeships has remained consistent from 2014 to 2020. This research question looks at the prevalence of workplace-based learning in ATE projects over time, as well as the reported number of students participating in these activities.

METHODS

Lexical Search of ATE Abstracts

The research team conducted a search of the NSF awards database to determine the number of project abstracts that included workplace-based learning activities, such as apprenticeships, internships, or other applied learning opportunities. The NSF awards search tool allows users to download the public profiles of funded NSF grants. A project profile includes information about the grant's funding, timeline, PI leadership team, as well as an abstract. An advanced search was conducted for all grants listed with the program element code for ATE (7412), both active and expired from 1994 to 2020. The search yielded 2,068 results. Of these, 473 had multiple program codes listed, indicating they were funded by the ATE program in addition to other NSF programs. This resulted in a small oversampling of projects that are not considered ATE projects, although they received limited funding from the ATE program. All results were exported and saved as an .xlsx file.

This data file was then uploaded to MAXQDA, a qualitative data analysis software, to examine the presence of workplace-based learning throughout ATE project abstracts. For the purpose of this report, workplace-based is defined as "sustained interaction with industry or community professionals in real workplace settings...that foster in-depth, firsthand engagement with the tasks required in a given career field, that are aligned to curriculum and institution" (Carl D. Perkins Career and Technical Education Act, 2006, p. 4). To conduct a count of how many abstracts mentioned the inclusion of workplace-based learning in its proposed activities, a lexical search was conducted for the following search terms: work-based learning, workplace-based learning, experiential learning, experiential training, job shadowing, mentoring, mentorship, co-opportunity, co-op, internship, externship, apprenticeship, research experience, research experience for undergraduates (or REU), and applied learning.

The searched terms were mentioned in 527 instances across all project abstracts. Instances were reviewed, reconciling any instances wherein a single abstract was counted more than once due to its use of more than one workplace-based learning search term. Out of the 1,958 total ATE funded projects, 445 abstracts mentioned one or more workplace-based learning terms.

In order to shed additional insight on ATE workplace-based learning activities, student participation data obtained from the 2019 and 2020 ATE Survey reports were utilized to capture reported participation in WBL opportunities among ATE projects in 2018 and 2019. Prior years' ATE Surveys did not gather information specific to WBL participation. See research question 1 (p. 19) for full description of the ATE Survey and related methodology.

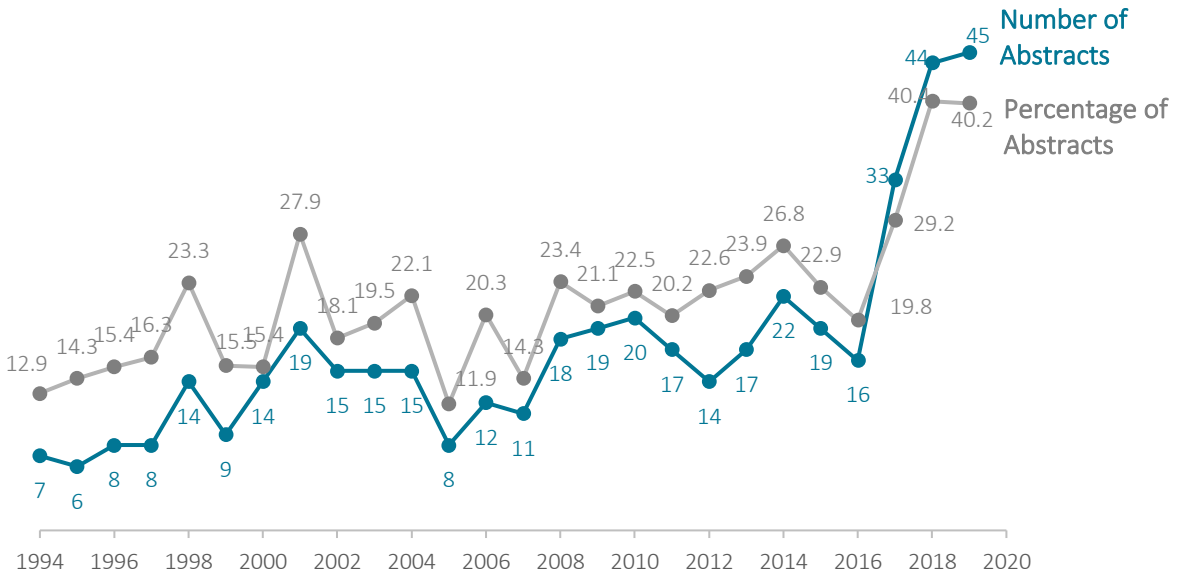
FINDINGS

The search of abstracts from all ATE projects that were funded between 1994 and 2020 (n = 1,958) revealed that just over one-fifth (22.7%) of all abstracts explicitly mentioned one or more workplace-based learning terms. Across all abstracts reviewed, the percentage of each

year's submitted abstracts that explicitly mentioned a workplace-based learning term ranged from 11.9% to 40.4% (Appendix B).

The prevalence of workplace-based learning in ATE abstracts remained relatively consistent from 1994 through 2017 (between 9.5% and 30.1% of abstracts listing WBL). A particularly large increase in workplace-based learning in came in 2018 and 2019. In 2018, 109 ATE projects were funded, and 40.4% of those project abstracts explicitly mentioned workplace-based learning offerings (n = 443). In 2019, 40.2% (n = 45) of the 112 funded ATE projects included workplace-based learning offerings. In comparison to the mean percentage of abstracts that mention workplace-based learning across all years (22.7%), these percentages demonstrate a higher prevalence of workplace-based learning among funded ATE projects than previous years (Figure 2). Results from the 2019 and 2020 ATE Surveys indicated that 7,290 students participated in workplace-based learning in 2018, compared with 3,410 in 2019 (Becho et al., 2019; Marshall et al., 2020).

Figure 2. Percentage of ATE Project Abstracts that Mention Applied Learning, by Year



Data Source: NSF award search database

Limitations of Findings

There are three data limitations to note in the examination of workplace-based learning opportunities among ATE projects.

ATE project abstract data captures project intent, not actual activities. Since project abstracts are written when a project is first funded, abstract data reflect projects' intended activities, rather

than actual or reported project activities. Project activities can sometimes change due to disruptions, unforeseen circumstances, or challenges to implementation. Therefore, it is possible that the true proportion of funded ATE projects that offered workplace-based learning opportunities may differ from what the abstracts reflect.

Data on workplace-based learning activities is not captured by the ATE Survey prior to 2019. The ATE Survey first asked for workplace-based learning data within the ATE community beginning in 2019. Therefore, projects did not report the number of internships, apprenticeships, or other workplace-based learning opportunities, nor number of student who participated in these prior to 2019.

Counts of students who participated in workplace-based learning are self-reported by ATE PIs. Given the self-reported nature of this data, it is possible that duplication exists within student counts across all ATE project activities, including different types of workplace-based learning opportunities (e.g., internship, apprenticeship, co-op learning). Student counts may be inflated due to individual students participating in multiple workplace-based learning opportunities offered by the same ATE project.

RESEARCH QUESTION 4

How many students participated in an ATE-funded academic program successfully completed their education programs in 2018 and 2019, as reported on the ATE Survey?

This question aims to examine academic program completion counts among students who were enrolled in at least one course in an ATE-funded academic program between 2018 and 2019. As noted in earlier sections of this report, academic program completion rates within the ATE context can be difficult to determine. A student who participates in an ATE-funded course may take one or a few courses, transfer to a four-year institution, or achieve the desired skills without pursuing further courses. To better understand program completion within the ATE context, it is important to first determine program completion count data as reported by ATE PIs in the ATE Survey.

METHODS

Annual Survey of ATE Principal Investigators

As was done to answer research question 1, the research team used data from the 2019 and 2020 ATE Surveys as a data source for students served by ATE activities. See page 19 for a more detailed description of the ATE Survey.

FINDINGS

Responding to the 2019 and 2020 ATE Surveys, ATE PIs and project representatives reported a count of students who took at least one course in an ATE-funded or modified academic program and who successfully completed their education programs in 2018 and 2019. In 2018, 710 students successfully completed their education programs, compared to 1,670 in 2019 (Table 6; Becho et al., 2019; Marshall et al., 2020).

Table 6. Program completion among students who took at least one course in an ATE-funded academic program

2018	2019
710	1,670

Data Source: ATE Survey Report (2019, 2020)

Limitations of Findings

Student completion is not representative of full impact. Although student completion is a useful metric in considering impact, it is not representative of the full impact of a program developed or modified with ATE funds. For example, these findings represent participating students who received credentials in 2018 and 2019 alone. Given the time that may elapse between a student's participation in single ATE activity, such as a course, and their completion of a degree program, measuring these in the same year provides a distorted understanding of the impact or influence of ATE projects. Similarly, these findings specifically examine program completion among students who received credentials in ATE-funded programs. It does not look at completion rates of students participating in other ATE project activities (see page 21).

Parallel data are not available prior to 2019. In 2019, the wording of the ATE Survey question about program completion changed. Therefore, a retrospective examination of student completion, as collected in contemporary surveys, is not possible prior to 2019.

RESEARCH QUESTION 5

How many students who began an ATE-funded academic program obtained a marketable credential (e.g., certificate, license, associate degree) from the program or another in a related field in 2019, based on a sample of ATE projects?

The Innovations in Mentoring, Training, and Apprenticeship Act asks about graduation rates; however, it is not feasible to capture a full representation of this information from active ATE projects. It can take several years from the time a student begins involvement with an ATE project to the time they receive a degree. For this study, it was more feasible to focus on the number of students who have obtained any form of marketable credential (certificate, license, or degree) so far.

METHODS

Case Study

As discussed in the methods section for research question 2, the research team conducted case studies with nine currently active ATE projects to determine the following for each of the nine sites:

- An unduplicated count of students who participated in ATE activities in 2019 (research question 2).
- The percentage of students who participated in ATE project who obtained a marketable credential from the program or another in a related field since the start of the ATE project (research question 5).

The case study methods and the criteria used to select the sample are described in detail on pages 22–28 of this report. This section will focus on methods related to the information gathered about students obtaining marketable credentials.

A research team member worked closely with each of the PIs to identify the number of ATE-participating students who obtained marketable credentials. The PIs did not have this information immediately at hand; they accessed it by examining their records or contacting others at their institutions to access the information. In the end, eight of the nine projects were able to provide data about the number of students who obtained marketable credentials. Data were provided in one of the following ways:

- detailed digital project records that documented every marketable credential (certificate, degree, etc.) received by every single ATE student (1 project), or

- an overall count of the total number of ATE students who received any marketable credential, with breakdowns of the counts of those who received each credential type (7 projects).

One PI who was unable to provide data for students obtaining credentials stated that only "head counts" (not names) were collected for student participants, and thus there was no way to track participants' attainment of credentials. Another PI noted their project did not collect marketable-credential data because the current offerings of certificates in their department were not indicative of the focus of their ATE project. They eventually obtained the information via a request to their institution's research office. The delay in obtaining the data was significant due to an already tight workload and office personnel working from home due to COVID.

FINDINGS

The total number of students confirmed to have obtained some sort of marketable credential was 341, which was 14% of the total number of students (unduplicated) who engaged in ATE project activities in 2019 (Table 7) at the eight sites that had access to data for student credentialing. Percentages should not be interpreted as an indication of the total percentage of ATE students who will ultimately receive some sort of marketable credential. Many of the ATE students were still in middle and high school, while others were college students who were working on their degrees and certificates or who were planning to receive degrees at other institutions in the future. The final number who receive some sort of marketable credential will not be realized for several years to come. Further details are in the "Limitations of Findings" section below.

Credentials for the eight case study projects were also broken down into credential types, with 295 students receiving industry credentials, 113 receiving associate degrees, six receiving digital badges, and seven receiving Career Studies Certificates (Table 7). No other credential types (industry licenses, bachelor's degrees, etc.) were reported in the data that were provided.

Table 7. Number of ATE Students Who Have So Far Obtained a Marketable Credential

Project code	Unduplicated count of students	Number who obtained ANY credential	Percentage who obtained credential	Breakdown by credential type*		
				Industry certificate	Associate degree	Other^
1	1,112	179	16%	176	38	–
2	606	52	10%	52	–	–
3	–	*Unable to determine*	*Unable to determine*	*Unable to determine*	*Unable to determine*	*Unable to determine*
4	102	33	32%	13	26	6
5	144	36	25%	36	20	7
6	15	12	80%	–	12	–
7	31	11	36%	–	11	–
8	244	7	3%	7	6	–
9	259	11	8%	11	–	–
Total**	**2,513**	**341**	**14%**	**295**	**113**	**13**

Data Source: Case studies and ATE Survey (2020)

* Some students received more than one type of credential; therefore, the sum of credential type counts may add up to more than the total who received ANY credential.

** Excludes project 3 counts.

^ Project 4: Digital badge, a digital micro-credential certifying competency with a particular skill. Project 5: Career Studies Certificates (CSCs), awarded to students who are halfway through an associate degree.

Limitations of Findings

One project was unable to provide information regarding credentials. For one project, it was impossible to track credentials for individual students because names were not gathered for those who participated in ATE activities. It is possible that students had not actually received any credentials, since at the time they participated they were all high school students engaged in summer program activities. However, there is no way to verify this.

Success, both for a project and for individual students, is not necessarily indicated by the number of credentials counted. During the initial interviews, several of the case study PIs were hesitant to provide credential information because they felt such information would misrepresent their project's true success. One remarked, "I think it's a problem defining success on how many

degrees and certificates students receive." The primary reason for this concern was that some of their students left their programs because they acquired jobs in their field *before* receiving any sort of credential. The PIs consider these students' success to be no less significant than that of those who obtain credentials. One PI explained, "Those students are employed even though they did not receive a marketable credential." Another remarked, "If I can see a job in the future for them, I see that as a success."

The full number students who receive some sort of marketable credential will not be realized for years to come. The credential-to-date count underreports the number of ATE students who ultimately obtain some sort of marketable credential. This is because students are still in the process of working toward credentials (see the next point).

Students are still in the process of obtaining marketable credentials (degrees, certificates, etc.). One PI stated during an interview, "When you ask how many students have received marketable credentials, what you are really asking is, 'What is our completion rate?' But how do I define completion when they are still working on it? When do I say that they are not going to complete? It takes 6 years on average to complete a degree at a community college. That's a long time compared to a 4-year institution.[3]" A second PI stated almost exactly the same thing: "In order to get an accurate picture of the percentages of ATE students who ultimately receive some sort of marketable credential, we need to look at credentials received six years later." Another PI reported that 23 students were "on track" to receive certificates and associate degrees but were not included in the count provided.

There is a lack of data-sharing agreements across institutions. All of the ATE projects that were sampled for this study took place at two-year institutions. Many of the students who attend these institutions will eventually transfer to another institution to complete their degrees. Overall, there are not sufficient resources or agreements in place to track students long-term across these institutions. One PI stated, "We have no articulation agreement statewide with the [state universities] or the [private universities] to [track] community college students [along] pathways that lead to credentialing, so we've got a data problem." Another remarked, "Backtracking throughout [our] state is not being done."

Credential completions may not be the result, or entirely the result, of participation in ATE activities. The majority of the credentials reported in Table 7 were certificates, which can be difficult to document accurately due to the factors listed above. It is also possible that what was credited to ATE may have been due to other activities that were conducted in parallel with, but were not part of, the ATE program. For example, a PI may give ATE credit for a certification simply because the student who received the certificate enrolled in one or more ATE-funded courses.

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3 Data from the National Center for Education Statistics (Shapiro, et a., 2016) shows the national average time enrolled for associate degree earners is 3.3 years, while the average elapsed time was 5.5 years for associate degree earners. Enrolled time represents the cumulative amount of time a student has been enrolled in courses, regardless of gaps in enrollment; whereas elapsed time is the total time a student takes from beginning an academic program to completion.

RESEARCH QUESTION 6

If the ATE program wanted to collect information on student participation and completion program-wide, what are the barriers they would need to consider or overcome?

From the start of this study, the research team recognized that existing data from the ATE Survey could not provide an unduplicated count of students who were served by ATE projects or completed academic programs. Therefore, one of the motivations behind this study is to more fully understand the barriers and challenges ATE projects experience when collecting and reporting data on students, particularly unduplicated student counts and counts of credentials obtained. Findings related to this research question summarize the barriers illuminated throughout the study. These findings provide insight into the kinds of challenges that would be encountered if a similar study were to be conducted on a larger, program-wide scale.

METHODS

Case Study

Findings from this section primarily came from the case studies described in research question 2. The following interview questions provide the basis for most of the barriers identified in this section:

- What are some of the problems and barriers you have encountered in tracking students impacted by your ATE grant? What are some of the problems and barriers you have encountered in tracking ATE students who obtain a marketable credential?
- What could be done to improve this process? What would be needed in terms of: (a) resources, (b) funding (c) assistance from others, (d) institutional changes, and (e) other areas?

FINDINGS

Several barriers were identified through the case study interviews, but two stood out as being the most prominent: lack of a consistent approach to collecting appropriate data and a lack of time or support for doing so. Some who struggled with these issues expressed willingness to gather more detailed data if given enhanced guidance from NSF about what to collect. Others felt different measures of success to be more important (and more worth the use of scarce time and resources) than these specific numbers. The following section provides further details.

Barriers to Collecting Student Participation and Completion Data

Lack of time and help. Several PIs expressed willingness to more thoroughly document participation and credential completions but felt they did not have enough time and help from others. As one remarked, "It takes so much time." One PI asserted this even more strongly: "I am only one person. I need help so badly. I can't work any more than *all the time*. It is hard to find the time to do this." Financial constraints at the institutional level were a contributing factor.

Financial considerations. For some PIs, lack of time was enhanced by frustrations over a lack of institutional support resulting from budget constraints. Financial instability at an institutional level reduces the resources and personnel that are available to assist PIs with data collection at the project level. One described the financial environment of many community colleges as being "dire," adding that "data is not going to be a priority when you are in survival mode." Challenges related to COVID are major factors contributing to this. As one PI stated, "It has all gotten muddled with the pandemic."

Lack of a consistent approach or system. Another barrier was the perceived lack of a standard system for tracking students after they move to another institution. Persistence rates are often lower at community colleges because students transfer to other institutions. Data sharing is therefore essential for tracking the progress of students. However, as one PI stated, "Few people are advocating for [this]." PIs reported that the same system for tracking students is not used by everyone. As one remarked, "Everyone tracks differently and does it their own way." Another compared it to a competition: "We don't have a good way to track credentials. We have a count that is like a contest among all the community colleges about who can get the students with the most credentials." This is further complicated by the different types of ATE activities and audiences served. For example, tracking the progress of high school students after they complete a bridge program can require a different approach than tracking the progress of college students after they complete a course. Each has unique challenges.

Guidance from NSF was perceived as being unclear. PIs who struggled with documenting student participation and credentials expressed willingness to gather more complete data given more explicit guidance about what was required. One explained, "I love NSF, and I'm willing to collect anything. I only need to know what…to collect." Some noted that it can be difficult to know what information is needed to determine a project's true impact. For example, if a project is developing materials for others to use, PIs need clarification on whether to count how many students are being impacted at every institution that uses those materials. One asked, "If the original scope of the grant was to create curriculum, do I also report [the number of] students who are touched by the curriculum, which would be many times what I can determine?"

Counts were perceived as being not fully representative of a project's impact. Some felt that ATE (and NSF) should more strongly emphasize measures of success beyond counts. For example, some students who begin an ATE program will acquire a job in their field *without* completing a degree or credential. Focusing on credential counts fails to acknowledge that there are other ways projects define success. Particularly in the context of smaller projects, counts may have less

meaning. One interviewee stated, “Not…everything that can be counted is important. If you are dealing with small programs like [ours], then counts don’t make a lot of sense.”

Lack of awareness of existing databases. PIs seemed unaware of existing databases such as the National Student Clearinghouse that may be able to provide them with some information related to student credentials. There is also likely a capacity issue, as PIs and their staff may lack the knowledge of how to make use of such a resource.

Limitations of Findings

Most of the barriers that were identified in this section were based on comments made by a subsample of ATE PIs. It is possible that additional barriers that were not identified in these case studies would be encountered in a large-scale study. It is also possible that some barriers may not be as widespread as reported in these case studies.

CONCLUSION

Those who have never engaged in data collection at the project level may assume it is a straightforward process to count students and track their progress towards obtaining credentials. It may seem like simply a matter of documenting who has taken part in which ATE activities and what marketable credentials have been obtained along the way. This study has demonstrated, however, that reality is more complicated.

The ATE Survey provides useful point-in-time data on project-level participation in various activities. It also provides a limited view of the number of students who complete their academic programs in a given year. These measures allow for tracking of general trends at the program level. This being said, they do not allow for tracking individual student-level outcomes (e.g. credentials, job attainment, transfer to another institution). The case studies conducted for this study allowed for more in-depth analysis of data gathered through the ATE Survey and a better understanding of barriers and challenges involved in tracking student-level data in the ATE program.

SUMMARY OF FINDINGS

Student Participation

ATE PIs reported serving over 60,000 students in 2018 and 70,000 students in 2019. In 2018, most students were served through academic programs developed or modified with ATE funds (11,970), receiving mentoring (9,700), and participating in a student competition (8,570). In 2019, most students were served through activities that developed business and entrepreneurial skills (13,140 students), followed by bridge or transition programs (11,390), and in an academic program (10,570). (See Table 2 on page 21 for more details.) Students served by ATE activities vary by year, depending on the focus of active projects within that year.

In recognition that student counts reported on the ATE Survey had a possibility for duplicating counts of individual students, this study worked with nine ATE projects to better understand the extent of that duplication. Table 8 summarizes the percent of duplication for each project, comparing the number of students reported on the 2020 ATE Survey to an unduplicated count collected by this study. In total, 88% of the counts reported on the ATE Survey were verified as unique counts by the case study participants. Percentages ranged from 40% (indicating the majority of the students were counted more than once on the ATE Survey) to 121% (indicating PIs were able to identify additional students who were not counted on the ATE Survey. Given the considerable variability in percentages of unique counts across the nine projects, the overall percentage should not be used to estimate an unduplicated count for any individual project.

Table 5. Unduplicated Counts by Project

Project code	Total duplicated count of students from ATE Survey[1]	Unduplicated count of students	Percentage of survey count
1	1,237	1,112	90%
2	501	606	121%
3	1,547	1,547	100%
4	121	102	84%
5	231	144	62%
6	27	15	56%
7	31	31	100%
8	297	244	82%
9	641	259	40%
Total	**4,633**	**4,060**	**88%**

[1] ATE Survey refers to the sum total of all counts reported on the ATE Survey.

Applied Learning in ATE

Twenty-three percent of ATE project abstracts mentioned one or more workplace-based learning or applied learning terms. The lowest funding year for projects intending to conduct applied learning was 2005, with only 12% of ATE project abstracts mentioning applied learning, compared to the highest year in 2020 with 40% of project abstracts mentioning applied learning. There was a higher prevalence of workplace-based learning among ATE projects funded in 2018 and 2019 than in previous years. ATE PIs reported 7,290 students participating in workplace-based learning in 2018 and 3,410 students in 2019.

Student Completion

According to the ATE Survey, 710 students completed ATE-funded academic programs in 2018, compared to 1,670 students in 2019. From the nine ATE projects included in the case study, 341 students served obtained a marketable credential, approximately 14%. Most students received industry certificates, followed by associate degrees. These data are point-in-time snapshots from a small sample of ATE projects and therefore cannot be generalized to the ATE program.

Barriers to Data Collection

ATE project PIs and staff experience many barriers to collecting these types of data. The processes can be surprisingly challenging. For example, community college faculty often lack the time, help, and resources that are needed to collect student information completely and accurately. Current strains on institutional budgets create further challenges. A lack of PI or project staff experience in systematically collecting data about students is also a barrier, as some grantees simply do not know what information they need to collect and how they need to collect it. Comments made by case study participants, however, indicate that grantees are open to collecting data, given sufficient guidance.

Other barriers may prove to be more difficult to overcome, such as the limitations of student activity and credential completion counts as measures of student success at community colleges (the primary institution type served by ATE grants). Many students transfer to other institutions to complete their education, and it can be challenging to track their progress after they move on. In addition, some students receive employment in the field without completing a college degree, indicating that there are aspects of student success that are not captured by completion and credential data. Additional measures of success should be considered, including student and faculty demographics, transfer rates to other programs/institutions, and student first-year program of study selection (NAS, 2018; Spaulding et al., 2020). The ATE program also has other areas of focus for which student counts are inappropriate measures, including faculty development, curriculum development, and business and industry engagement.

Nevertheless, this report serves as a framework for improving the process moving forward. While not completely capturing all aspects of success, the recommendations below provide insights for how NSF ATE, ATE projects, and EvaluATE can work together to acquire more accurate and credible data. The recommendations will also help inform planning for future inquiries into the impact of the ATE program as a whole.

RECOMMENDATIONS

The following is a list of recommendations based on the information that has been gathered for this report, with emphasis on the case study interviews, to support future efforts that aim to track unduplicated counts of students served by ATE programs and measure ATE successes. While many of these recommendations are based on findings from a subsample of nine projects, they provide insights about improving the process for ATE programs in general. The shared perspectives of case study PIs suggest common challenges and concerns that could be addressed program-wide. Recommendations are divided into three groups: (1) recommendations for the NSF ATE program, (2) recommendations for ATE projects, and (3) recommendations for EvaluATE about the ATE Survey.

The recommendations for NSF provide insights into the barriers PIs and their project staff face in documenting participation and tracking data, and what NSF might do to assist them with improving this process. These recommendations may also be helpful in determining how to address various barriers and challenges if a study similar to this one were to be conducted on a larger, program-wide scale.

The recommendations for ATE projects provide insights to PIs and their project staff about their role in prioritizing tracking, maintaining detailed digital records, and bringing their evaluators into the data collection process.

The recommendations for EvaluATE provide insights into how the ATE Survey, or the process of informing PIs about what is expected with the survey, could be improved to gather complete and accurate unduplicated counts program-wide. While it may seem unusual that we are making recommendations to ourselves, the ATE Survey is an important part of the process and must be addressed.

RECOMMENDATIONS FOR NSF ATE PROGRAM

ATE should be explicit in the data they ask projects to collect. This includes how these indicators are being defined and operationalized, and how they should be reported. Standardizing these elements will provide project staff with a clear process and set of expectations. The number of students obtaining marketable credentials is one example of data that projects would need to collect. None of the case study PIs were initially able to provide tracking information on students who obtained marketable credentials. Many had to search to acquire it. Explicitly defined metrics could help PIs become able to provide such data more readily. PIs understand that it is important to document and track student data. However, many lack the experience to know exactly how to do it. One remarked during an interview, “Those running these sorts of programs just don’t have experience with how to [acquire] unduplicated counts.” One drawback is that PIs may need to increase their budgets for the relevant staff, such as institutional research personnel and evaluators, to assist them with the data collection, which could potentially reduce the amount of funding for other aspects of their projects, as there are budget caps to consider.

Invest in grant- or contract-funded initiatives to support project-level data collection and reporting. These initiatives should help PIs and their project staff to become more aware of existing data sharing services. At least one PI was already aware that such resources existed and was using one of them: "We're using a software product called Handshake that if anybody puts [our college] within their bio, it automatically [generates] some sort of a connection of information to be able to collect data as to where the student is, what they are doing, and how they are doing it years after they leave our institution." Initiatives should also involve targeted trainings and virtual Q&A sessions about how to access and use existing resources and services, and how to develop templates or standard formats for data collection. Support people could be assigned as points of contact to assist PIs and their staff with completing these templates or standard formats.

Collaborate with other initiatives that are working to identify alternative measures of success for two-year schools (e.g., AACC's (2012) Voluntary Framework of Accountability or NAS's (2018) indicators), or fund initiatives that intend to increase discussion in the ATE community about how student success is defined and measured. PIs recognize that some success indicators cannot be measured with credentials. They noted that several students had acquired jobs in the field without completing a certificate or a degree. These students were regarded as successful because they attained the end goal: employment. NSF should support discussions that explore the value of this and similar kinds of success, along with how these successes can be measured and reported.

RECOMMENDATIONS FOR ATE PROJECTS

Build student tracking into project operations during the planning phase. This should be viewed by ATE project PIs as essential. It cannot be emphasized enough that plans for project tracking should be outlined at the beginning of the project's development stage. Having this clearly articulated and carried out from the start will save PIs from the stress of trying to gather information after the fact (as the PIs in the case study had to do). There may simply not be enough time to backtrack data once the project is underway.

Engage project evaluators to assist with tracking students. PIs should bring their external evaluators into the process as early as possible. Those who feel overwhelmed by a lack of time may be able to alleviate some of their stress through discussions about what responsibilities the evaluator can take on. Evaluators will likely already be collecting participation records through surveys and other means for the various ATE activities. PIs should also have discussions about what additional ideas evaluators have for tracking credential data.

Keep detailed digital records. Paper records can be quite time-consuming to find and sort through them when information is needed at a later date. As such, detailed participation and completion records should be recorded using standard software applications. A checkmark system is recommended, in which students are identified in rows and activities and credentials are listed in columns. This would simplify the process of identifying every activity that an ATE student has engaged in, as well as credentials that have been obtained.

PIs should seek out technical support to help meet data collection and evaluation expectations. While PIs expressed willingness to collect any information requested, they were not always inclined to do so without being explicitly asked. PIs should draw on resources other than NSF for guidance about how to collect student participation/tracking data and better meet evaluation expectations. In addition to engaging the skills of their evaluator as early as possible (as described above), they should seek out technical staff or others within their institutions who have experience and skill with data tracking and reporting. This may involve requesting assistance from an institutional research office, the registrar's office, or others.

RECOMMENDATIONS FOR EVALUATE AND THE ATE SURVEY

Restructure questions in the ATE Survey to capture unique counts of students where possible. The simplest way to facilitate an unduplicated count of students from each ATE project would be to directly ask for that number on the ATE Survey. This idea was reflected by a PI during their interview: "I'm surprised one of the questions was not, 'How many unique students participated in ATE activities?' That would have been an unduplicated answer." However, this would not necessarily guarantee exact counts that are free from estimates. The probability remains that some ATE projects will not be able to identify unique students across different activities. This would be particularly difficult for projects that only collect head counts. Restructuring and re-wording questions on the ATE Survey could provide a better estimate of the total number of unique students who are actually served directly by ATE projects.

Employ strategies to thoroughly inform PIs about the survey requirements regarding student counts. Even though the ATE Survey is mentioned in the grant solicitation, some PIs may not be aware, prior to receiving the survey, of the level of effort required to complete it. One PI stated during an interview, "I spent three weeks trying to fill out the survey. That's a lot. I'm willing to do [it], but I got caught unaware." It is unclear, however, how representative this perception was, as this sentiment was not expressed by any other interviewee. EvaluATE does reach out to all active PIs via direct email, share ATE Survey questions online prior to the survey opening, notify new grantees of survey requirements at the ATE PI Getting Started workshop, include information about the survey in their monthly newsletters, and provide as-needed technical assistance regarding the survey throughout the year. Nevertheless, EvaluATE should explore additional ways to ensure that PIs are well aware of the survey, and of what it will take to complete it, long before it is actually administered.

Continue to build capacity in the ATE program for data collection, reporting, and literacy. EvaluATE currently infuses its webinars, workshops, and resources with guidance and support on high-quality data collection. However, more targeted trainings could be offered that are focused on refining and improving the data literacy skills of PIs and their project staff. This could include specific resources about requesting data from an institutional research office, guidance on setting up data tracking spreadsheets, or advice on coordinating the collection of student counts between the registrar's office, their project records, and their evaluation efforts. Greater

availability of targeted support has the potential to aid the quality of data reported on the ATE Survey as well as increase the quality of ATE evaluations.

FUTURE RESEARCH QUESTIONS

This study begins to shed light on how many students are served, and in what ways, by the ATE program. While the report offers recommendations to enhance capacity for collecting accurate and reliable student counts, the findings presented also bring up opportunities for future research.

Fruitful areas for future research include:

- Further investigation into what led to the increase in workplace-based learning starting in 2018.
- Discussion of and agreement on the operational definitions of student success metrics such as attendance and program completion.
- Identification of more holistic metrics for measuring student success within a two-year college context.
- Investigation into the causal connection between student participation in an ATE project and program completion or other success metrics.
- Further research into the best ways ATE PIs' data gathering and reporting can be supported, both within and beyond their institutions.

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APPENDIX A
Detailed Interview Protocol for Case Study

Interview Preamble

Science and Mathematics Program Improvement (SAMPI) at Western Michigan University is conducting a study to bring clarity to the ATE survey, as well as to identify potential challenges and barriers to collecting and reporting unduplicated student counts. A limitation of existing ATE survey data is that student counts are *not* unduplicated. Projects report the number of students who participated in different activities, but the same students often participate in multiple activities within the same year, as well as across years. The purpose of our study is to determine the number of unique students who participate in ATE project activities in a given year across the ATE program, and to determine what resources would be needed to properly monitor/evaluate this program. We are contacting you because you have agreed to participate in an interview to help us gather the information we need.

The interview will be recorded so that I can transcribe it. I will delete the interview immediately after it is transcribed. Your responses will be kept confidential. Your name will never be linked to what you tell us. You have been assigned a code number and your responses will be associated with that number. Do you have any questions before we begin?

Part I: Questions about the Project Background

1. Can you give me a general overview of what your ATE project does?
2. What is the purpose of the project? What are you trying to accomplish?
3. What is your role in this project? Who else plays a significant role in implementing the project?
4. How effective would you say your project is in terms of impacting and serving students? What aspects have been most effective and why? What aspects have been least effective and why?
5. How do you define success for this program? How does the program determine whether a student has successfully completed it?

Part 2. Questions related to answering the question, "How many unduplicated students participated in ATE project activities?"

According to the survey responses we received from you/your site, ***[insert number]*** students participated in various ATE program activities including…" ***[Fill in the information below based on the site]***

___ who participated in workplace-based learning activities

___ who received mentoring

___ who participated in student competitions

___ who used an instrument acquired with ATE funds

___ who received business and entrepreneurial skills development

___ who participated in a bridge or transition program

___ who took at least one course in [insert degree or certificate program modified by ATE]

___ who took at least one course modified by ATE ***[list courses identified in survey]***

6. What do you know about whether these counts are unduplicated? Can you think of any students that were missed in these counts?
7. What sorts of participation records for each of these activities do you have? (Prompts: Paper records? Digital files such as Excel?) Are you able to provide this information to us?
8. **[If concerns are expressed about providing identifiable information or names]** Who at your institution could help us get de-identified data? Who are the best people to be talking to about this?
9. Are detailed demographic data available for each program? Are you able to provide us with this information?
10. ***[If PI does not have any or all of the needed information]*** Who would we need to contact to acquire this information? (Prompts: Other faculty? Individual at Institutional Research Office? Others?)
11. What are some of the problems and barriers you have encountered in tracking students impacted by your ATE grant?
12. What could be done to improve this process? What would be needed in terms of: (a) resources, (b) funding (c) assistance from others, (d) institutional changes, and (e) other areas?

[Questions related to acquiring the data to answer the question, "What percentage of students who begin an ATE program obtain a marketable credential (certificate, license, associate degree, bachelor degree) from the program field?"]

13. Do you track the number of ATE students who obtain the following marketable credentials? (a) certificate, (b) license, (c) associate degree, (d) bachelor degree, (e) others? What information do you have?
14. Who might we contact at your institution to acquire this information? (Prompts: Contacts at registrar's office? Contacts at institutional research office? Other contacts?]

15. Does it makes sense for us to go through you to get this information, or for us to contact them?
16. What are some of the problems and barriers you have encountered in tracking ATE students who obtain a marketable credential?
17. What could be done to improve this process? What would be needed in terms of: (a) resources, (b) funding, (c) assistance from others, (d) institutional changes, and (e) other areas?

APPENDIX B
Detailed Data on Workplace-Based Learning

This table reports the number of ATE projects that mentioned workplace-based learning in their project abstract. These counts are a result of a lexical search for the following search terms: work-based learning, workplace-based learning, experiential learning, experiential training, job shadowing, mentoring, mentorship, co-opportunity, co-op, internship, externship, apprenticeship, research experience, research experience for undergraduates (or REU), and applied learning.

Year funded	Total number of projects	Frequency of WBL mentioned in abstract	
	n	n	%
1994	54	7	12.9
1995	42	6	14.3
1996	52	8	15.4
1997	49	8	16.3
1998	60	14	23.3
1999	58	9	15.5
2000	91	14	15.4
2001	68	19	27.9
2002	83	15	18.1
2003	77	15	19.5
2004	68	15	22.1
2005	67	8	11.9
2006	59	12	20.3
2007	77	11	14.3
2008	77	18	23.4

Year funded	Total number of projects	Frequency of WBL mentioned in abstract	
	n	n	%
2009	90	19	21.1
2010	89	20	22.5
2011	84	17	20.2
2012	62	14	22.6
2013	71	17	23.9
2014	82	22	26.8
2015	83	19	22.9
2016	81	16	19.8
2017	113	33	29.2
2018	109	44	40.4
2019	112	45	40.2
Total	**1958**	**445**	**22.7**

APPENDIX C
Relevant Questions from the ATE Survey

This appendix includes relevant questions from the 2020 and 2019 ATE Survey. To see all questions asked on the ATE Survey, visit atesurvey.evalu-ate.org

Program Development

Program Development is the creation or substantial modification of a specific degree or certificate program for implementation at specific colleges or high schools.

Do not use this section of the survey to report on:

- Curricula developed only for use by other institutions
- Workshops to build capacity around program development or implementation

In 2019, did your ATE project create or substantially modify an academic degree or certificate program?

- ○ Yes
- ○ No (skip this section)
- ○ Planning to in the future (skip this section)

2.1. **How many degree or certificate programs were created or modified by your ATE project in 2019?**

_____ [text box]

2.3. **How many students took at least one course in each certificate or degree program? Count each student only once.**

Program	Total number of students
[name of program, piped text from 2.2]*	_____
[name of program, piped text from 2.2]*	_____

[*The number of rows will automate to match the respondent's answer to 2.1. For example, if 6 was reported in 2.1, then 6 rows will appear.]

2.6. **Did any students complete the following program(s) in 2019?**

	Yes	No
[name of program, piped text from Q2.2]*	○	○
[name of program, piped text from Q2.2]	○	○

[*The number of rows will automate to match the respondent's answer to Q2.1]

2.6.1. (If yes to Q2.9) **How many students completed each of the following program(s) in 2019?**

	Total number of students who completed program
[name of program, piped text from Q2.2]*	_____
[name of program, piped text from Q2.2]	_____

[*The number of rows will automate to match the respondent's answer to Q2.1.]

Course Development

In 2019, did your ATE project create or substantially modify an academic course?

- ○ Yes
- ○ No (skip this section)
- ○ Planning to in the future (skip this section)

2.9. **How many courses were created or modified by your ATE project in 2019?**

_____ [text box]

2.11. (If yes to Q2.10.c, course was offered in 2019) **How many students completed this course in 2019?**

_____ [text box]

[*The number of rows will automate to match the respondent's answer to Q2.10.]

Acquisition of Instruments, Equipment, and Tools

Instruments, equipment, and tools are physical items used in instruction in technical courses to help students learn processes, understand concepts, or how to perform tasks.

In 2019, did your ATE project acquire instrumentation, equipment, or tools for use in instruction?

- ○ Yes
- ○ No (skip this section)
- ○ Planning to in the future (skip this section)

2.19. **How many courses, students, and educators used this instrumentation equipment, or instrumentation in 2019?**

Courses _____

Students _____

Educators _____

Business and Entrepreneurial Skills Development

Business and entrepreneurial skills development is helping students in a systematic way to develop their skills in areas such as—but not limited to—business development, marketing, networking, and understanding the global marketplace.

Do not use this section of the survey to report on:

- Activities with a primary focus other than business or entrepreneurial skills development (such as courses or workshops on other topics that might also have an indirect effect on these skills)
- Activities that did not involve working with students directly

In 2019, did your ATE project work with students specifically to develop their business and entrepreneurial skills?

- ○ Yes
- ○ No (skip this section)
- ○ Planning to in the future (skip this section)

3.2. **How many students participated in business and entrepreneurial skills development provided by your project in 2019?**

Total students _____

Workplace-Based Learning

Workplace-based learning includes any situation in which a student gains experience at a work site, such as internships, apprenticeships, job shadowing, and field trips to industry sites.

Do not use this section of the survey to report on:

- Activities that took place in a school setting

In 2019, did your ATE project offer workplace-based learning to students?

- ○ Yes
- ○ No (skip this section)
- ○ Planning to in the future (skip this section)

3.5. **How many students participated in each type of workplace-based learning provided by your project in 2019?**

Field trips to business/industry sites	_____ students
Job shadowing	_____ students
Apprenticeships	_____ students
Externships	_____ students
Internships	_____ students
Co-op Learning	_____ students
Other types of workplace-based learning	_____ students

Student Mentoring

Student mentoring involves an experienced industry professional, educator, or advanced student providing guidance and advice to help a less experienced student develop the skills and knowledge they need to enhance their academic and professional growth.

Do not use this section of the survey to report on:

- Mentoring or coaching intended for educators or other professionals
- Mentoring provided to students on an informal or ad hoc basis

In 2019, did your ATE project offer formal mentoring or coaching to students?

○ Yes
○ No (skip this section)
○ Planning to in the future (skip this section)

3.8. **How many students received mentoring or coaching through your ATE project in 2019?**

_____ High school students

_____ 2-year college students

_____ 4-year college students

_____ Other (describe) _____

Student Competitions

Student competitions are events at which students compete as individuals or teams using skills related to a STEM discipline or industry.

Do not use this section to report on:

- Student involvement in competitions not directly hosted or organized by your project

In 2019, did your ATE project host or organize a student competition?

○ Yes
○ No (skip this section)
○ Planning to in the future (skip this section)

3.10. **How many students participated in the competitions hosted or organized by your ATE project in 2019?**

_____ [text box]

Programs to Support Transition into College

Programs to support transition into college are systematic efforts to equip students with the skills they need to successfully navigate college. Examples include—but are not limited to—summer bridge programs, college readiness workshops or classes, first-year programs, support for non-traditional students, or other activities.

Do not use this section of the survey to report on:

- Support provided to transitioning students on an ad hoc or informal basis
- Indirect support (such as guidance for faculty or staff on how to support transitioning students)

In 2019, did your project offer formal programs to help students transition into college?

- ○ Yes
- ○ No (skip this section)
- ○ Planning to in the future (skip this section)

3.12. **List the transition programs supported by your ATE project in 2019.**

What is the name of the program?	**Who is the primary audience?**	**How many students participated?**
_____ [text box]*	[drop-down box with the following options] - High school students - Recent high school graduates (e.g., summer programs) - First-year college students - Non-traditional students - Other	_____ [text box]

[*The number of rows will automate to match the respondent's answer to Q3.12.]

APPENDIX D
ATE Survey Reports

Reports from the 2020 and 2019 ATE Survey are included in this appendix. For more information about the ATE Survey and additional reports, visit atesurvey.evalu-ate.org.

ATE Survey 2020

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

EvaluATE

www.evalu-ate.org/annual_survey

CONTENTS

Click any topic to jump to that section.

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 2020 survey of ATE program grantees. EvaluATE, the learning and evaluation hub for the ATE program locate 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 2019 calendar year (and 2019 fiscal year for budget-related questions).

The 2020 survey was a census of ATE principal investigators (PIs) with active grants (N=325). Ninety-one percent (n=294) of PIs 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 2020 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 evalu-ate.org/annual_survey/reports. Custom reports may be developed upon request. For more information, contact valerie.marshall@wmich.edu.

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 gain insight on the types of data projects are already requested 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-four percent of ATE grants were for projects (including a variety of subcategories of project types).** Among the 247 project grants, 62 were designated for institutions new to the ATE program, and 5 were coordination network grants. Of the 32 centers, 12 identified as support or resource centers, 11 as regional centers, and 9 as national centers.

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

Figure 1. Types of ATE grants awarded (n=294)

Figure 2. Percentage of ATE grant recipients at institution types (n=294)

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 225 grants awarded to two-year colleges supported 201 projects, 22 centers, and 2 targeted research studies. Most of the 11 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 engineering technologies.

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.

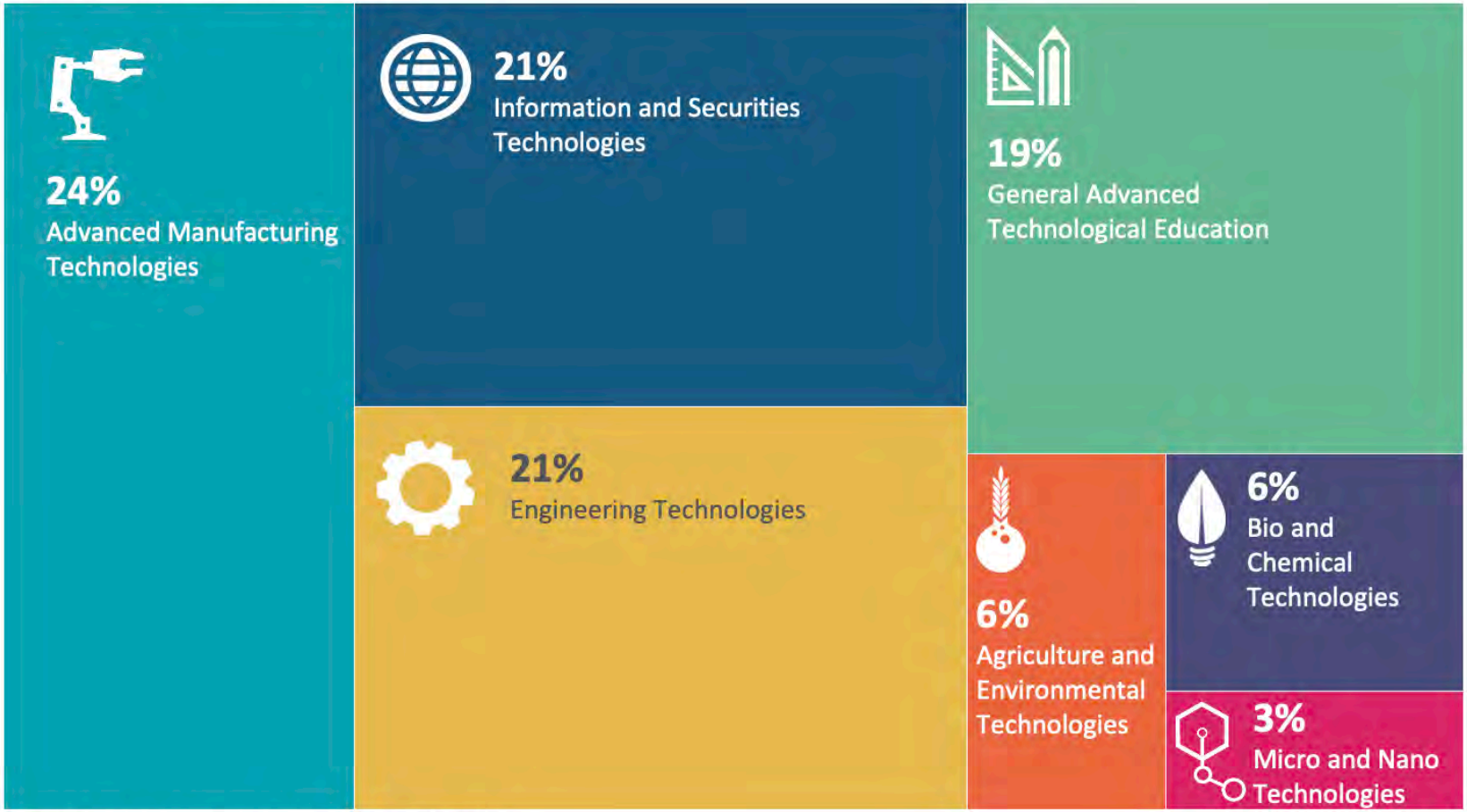


Figure 3. Disciplinary areas of ATE projects (n=294)

ATE PROJECT ACTIVITIES

ATE projects engaged in a variety of activities in 2019 to improve the education of science and engineering technicians.

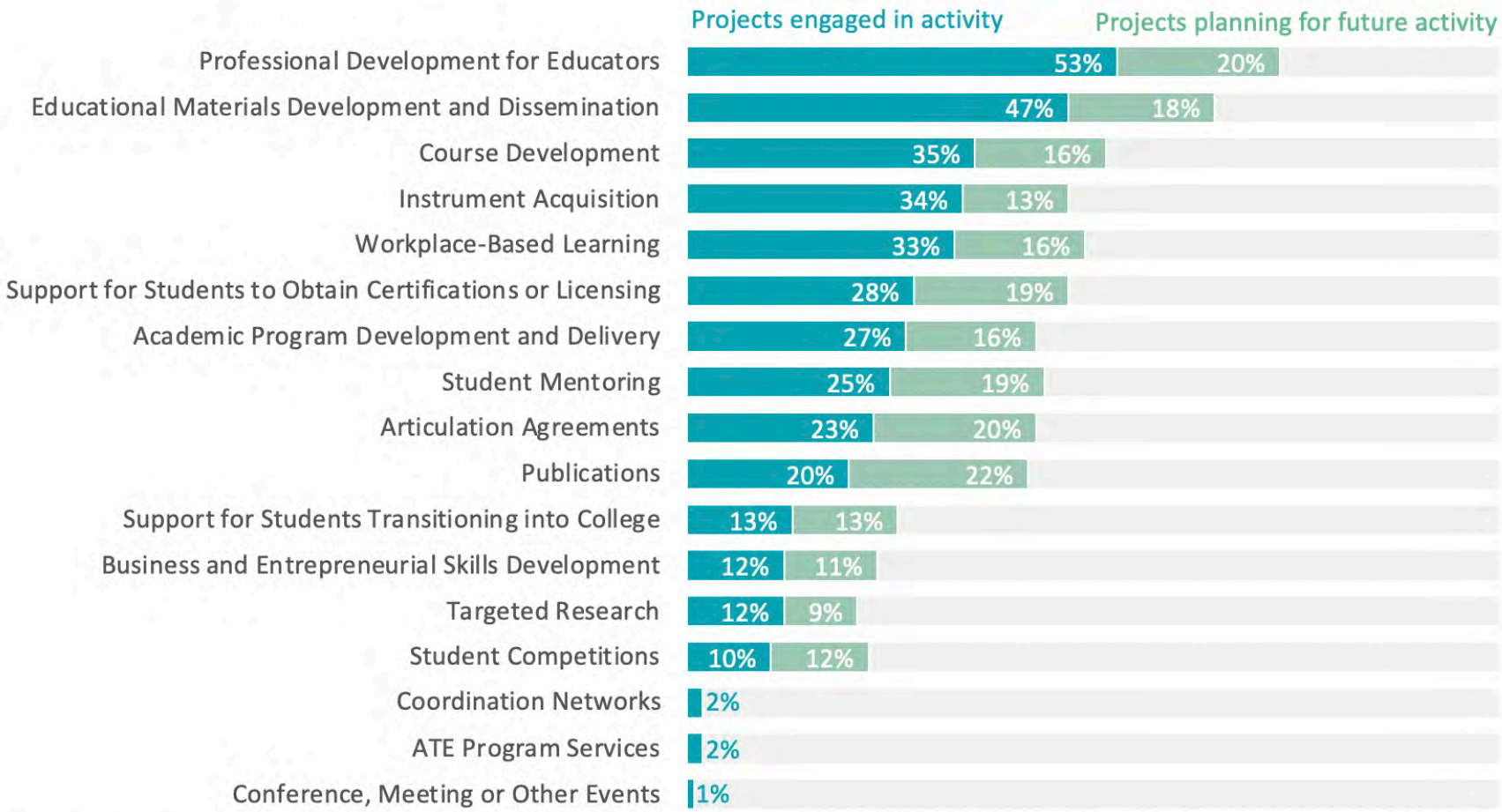


Figure 4. Percentage of projects that reported engaging in activities in 2019 and planning activities for the future (n=294)

ATE PROJECTS AT MINORITY-SERVING INSTITUTIONS

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

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

Forty-eight 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. Designation is based on the percentage of minority students enrolled in the school. **Of the 263 projects at IHEs, 24% are at minority-serving institutions.** The majority of these IHEs (77%) are Hispanic-serving. Predominantly Black or historically Black colleges and universities and Asian American and Native American Pacific Islander-serving institutions each make up 7% of the minority-serving IHEs that host ATE projects. Three ATE projects are located at Native Hawaiian-serving IHEs, one is located at a tribal college, and one is located at an Alaska Native-serving IHE.

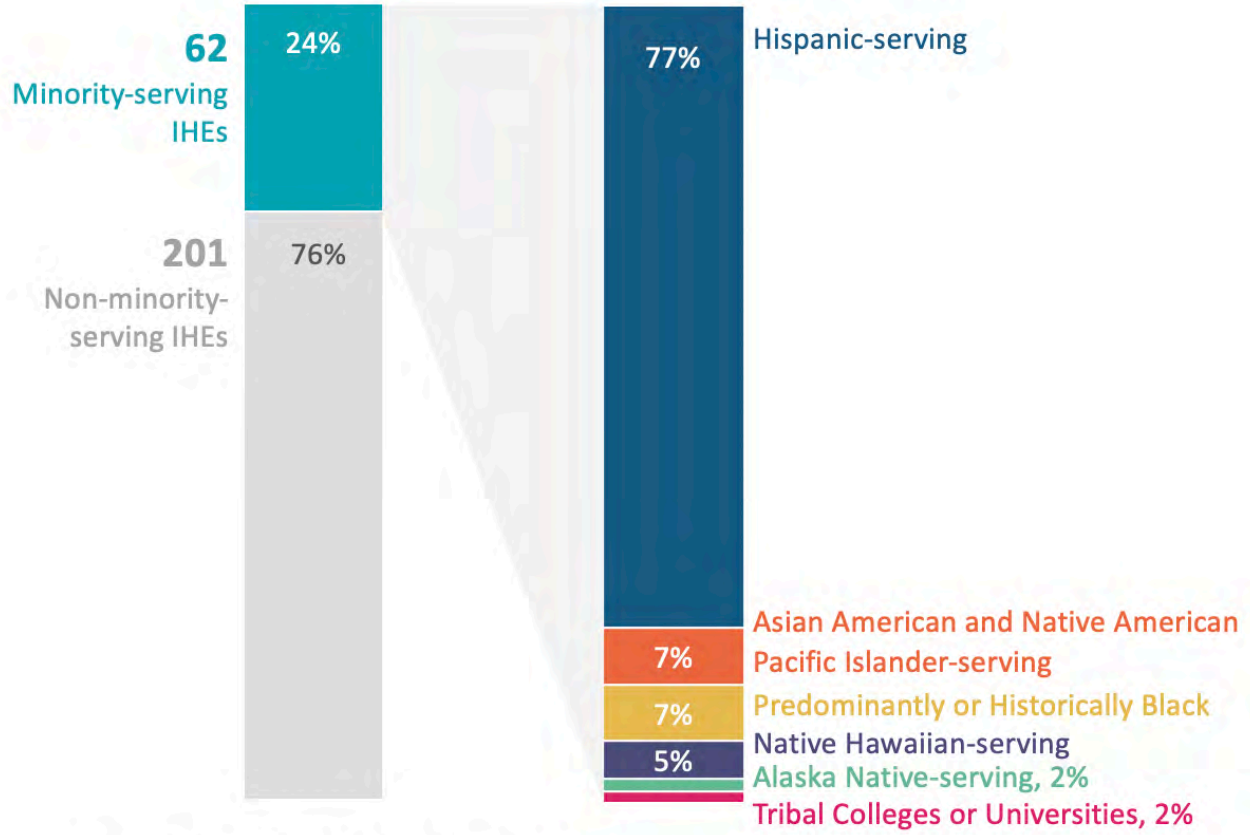


Figure 5. ATE projects at minority-serving institutions (n=62)

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.

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

Figure 6. Gender identities of ATE PIs (n=294). Each icon represents 1%.

Fourteen percent of ATE projects have PIs who are over the age of 65, while 37% are between the ages of 55 and 64, 28% are 45–54, 18% are 35–44, and 3% are 25–34.

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.

Seventy-nine percent of ATE projects have a PI who identifies as white.

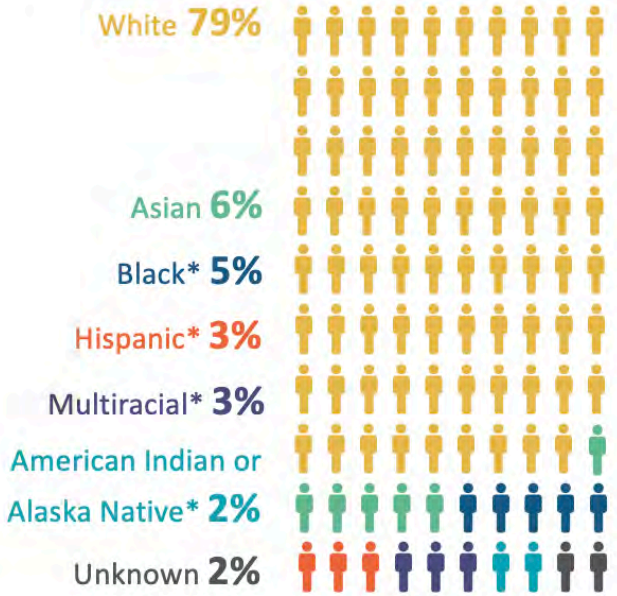


Figure 7. Racial and ethnic identities of ATE PIs (n=294). Each icon represents 1%. *Historically underrepresented racial and ethnic groups.

ACADEMIC PROGRAMS, COURSES, AND PATHWAYS

The ATE program supports the creation and improvement of 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-seven 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 153 academic degree programs were developed or substantially modified by 78 ATE projects in 2019. **Most of these programs award certificates (49%) or associate degrees (45%).** Three programs award bachelor's degrees, and six programs provide other types of credentials. **Nearly 10,570 students attended at least one course in these academic programs**, with a total of 1,672 completing a program in 2019; 550 students completed an associate degree program, while 891 students completed a certificate program. Programs with students completing certifications or degrees in 2019 graduated an average of 28 students.

75 Certificate programs served
3,760 students

68 Associate degree programs served
5,790 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.

Over 65 percent of the ATE projects that developed or modified academic programs emphasized recruitment of **women** or **underrepresented racial or ethnic minority students**.

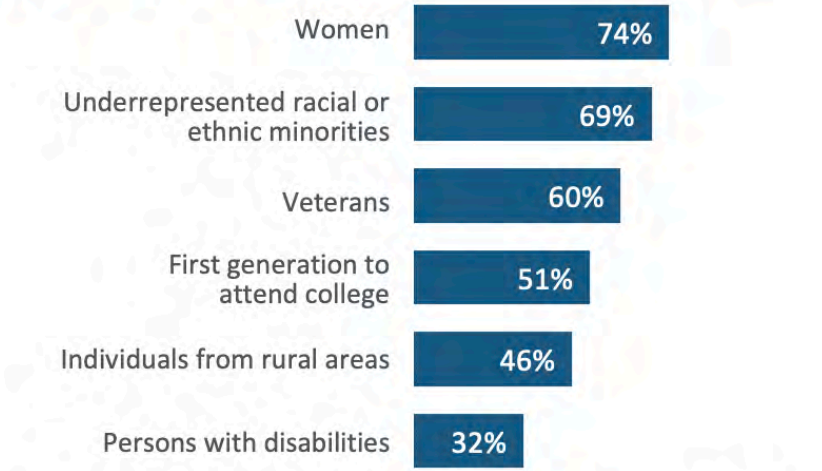


Figure 8. Percentage of projects that emphasized recruitment of students from specific demographic groups (n=65)

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 153 academic programs that were developed or modified by ATE projects in 2019, 97 programs (63%) reported student characteristics. Due to this low response rate and changes in the survey questions, the numbers reported here do not represent the entire ATE program and should not be compared with previous years' data.[i]

The percentage of women in ATE-supported programs is similar to national participation rates. **Overall, 21% 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.

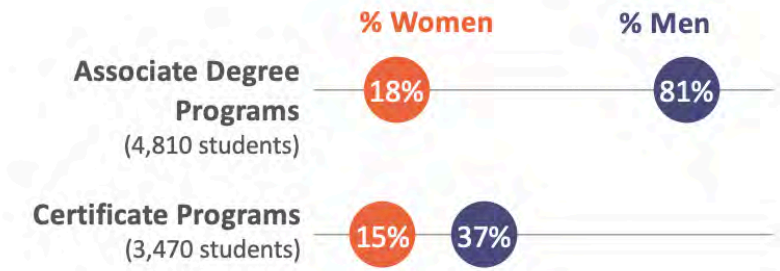


Figure 9. Percentage of women and men in ATE-supported academic programs by degree level (n=91)

Students who identify as Black/African American, Hispanic/Latino or Latina have slightly higher representation in ATE-supported programs than they do in the general population of students across types of 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.

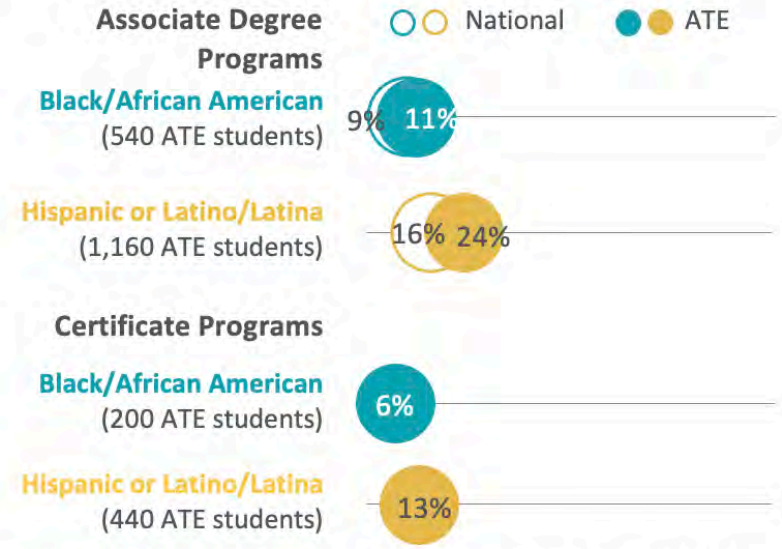


Figure 10. Percentage of students from underrepresented racial and ethnic minority groups in ATE-supported academic programs in associate degree programs, compared with national rates (n=91)

COURSE DEVELOPMENT

Thirty-five 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 454 courses were developed by 104 projects in 2019. The majority of these courses (84%) were for two-year college students.

26
High school courses were developed by **10** ATE projects

381
Two-year college courses were developed by **93** ATE projects

13
Four-year college courses were developed by **5** ATE projects

Sixty-three percent of these 454 courses were offered in 2019.

9,110 students
completed an ATE-developed or -modified course in 2019

ATE PIs were asked about the primary delivery modes for each of the courses they developed or modified. **Compared to 2018, more ATE courses are being developed for an online format.**

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

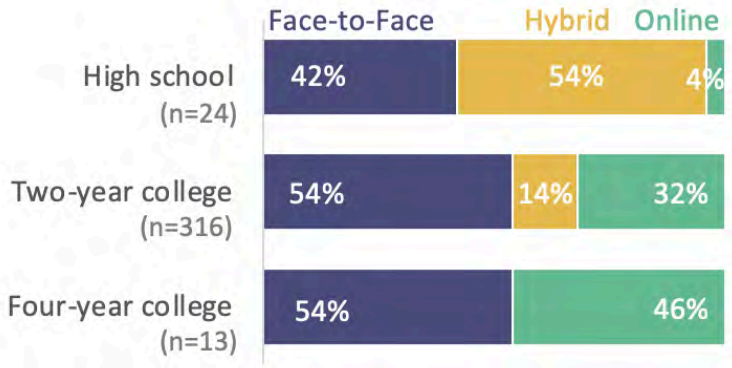


Figure 11. Percent of courses designed by differing delivery mode, by education level

INSTRUMENT ACQUISITION

Thirty-two 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.

Ninety-five ATE projects acquired instrumentation or equipment in 2019. Examples of instruments purchased and utilized by projects include 3D printers, computers, drones, virtual reality viewers, laser engravers, and laboratory equipment. Eighty projects reported the amounts they spent on instrumentation or equipment. **Projects spent between $160 and $375,000 on instrument acquisition in 2019.**

A majority of projects spent less than 25% of their grant funds on instrumentation in 2019.

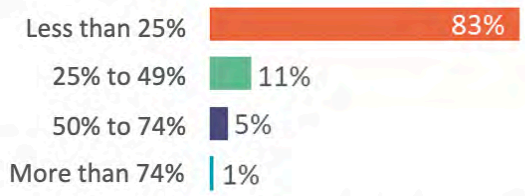


Figure 12. Percentage of total grant amount spent on instrumentation or equipment in 2019 (n=80)

Projects that used 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 2019, over 9,000 students used instruments and equipment, with one project making up over 25% of the total number of students.

A median of 30 students used the equipment or instrumentation acquired by each ATE project.

Eighty-one projects reported acquiring instrumentation, equipment, or tools to give students hands-on experience with instruments used in the field. Six projects reported acquiring instruments to allow students to perform technical tasks in a simulated environment, and four projects noted other reasons, such as enabling students with disabilities to perform certain technical tasks and allowing remote students to participate in a live session or demonstration.

ARTICULATION AGREEMENTS

Twenty-one percent of ATE projects created or maintained articulation agreements.

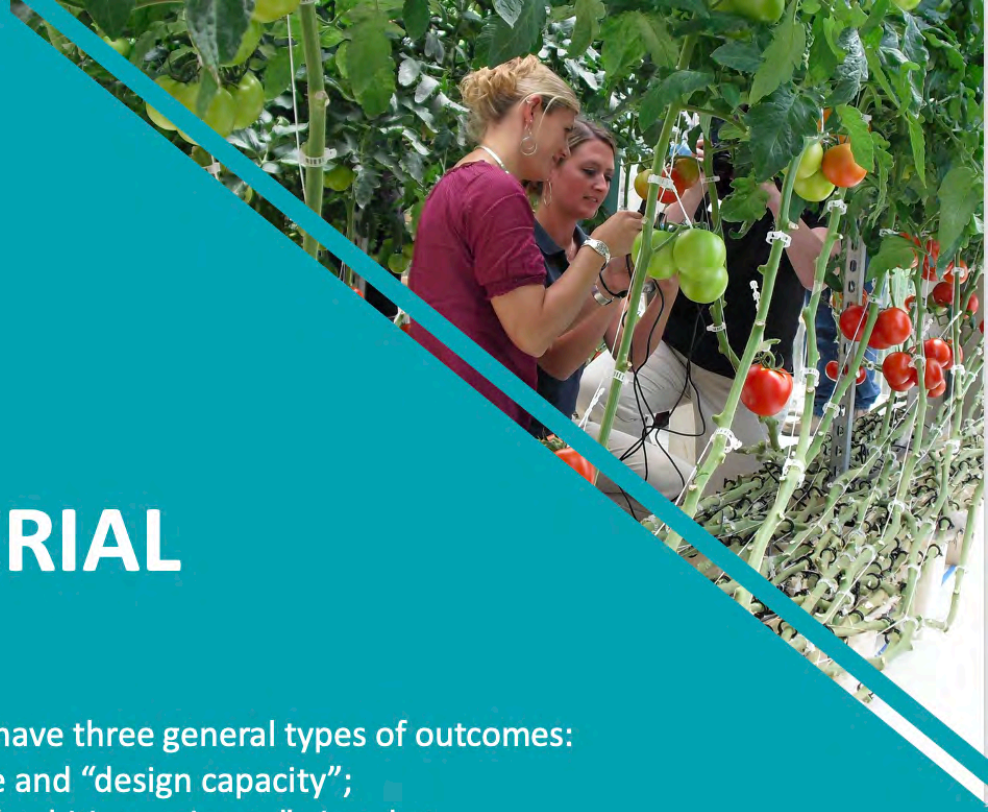
Articulation agreements are formal agreements between educational institutions that provide students from secondary schools with pathways and education access to two-year colleges and four-year colleges. These agreements contribute to increasing the number and diversity of scientists, engineers, and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

Sixty-three projects developed or maintained articulation agreements in 2019. Note that one project was responsible for 10,621 out of 11,166 articulation agreements in place between high school to two-year colleges.

Most articulation agreements in created in 2019 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=63)



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 material 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.

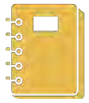
130 ATE projects developed or modified over 7,080 educational materials in 2019.

3,210
Assessment activities or tests

890
Modules or instructional units

930
Lessons or lesson plans

650
Lab experiments



460
Course curricula

240
Interactive simulations

Other materials developed include 220 case studies or problem sets, 170 program curricula, 150 instructor guides, and 40 textbooks.

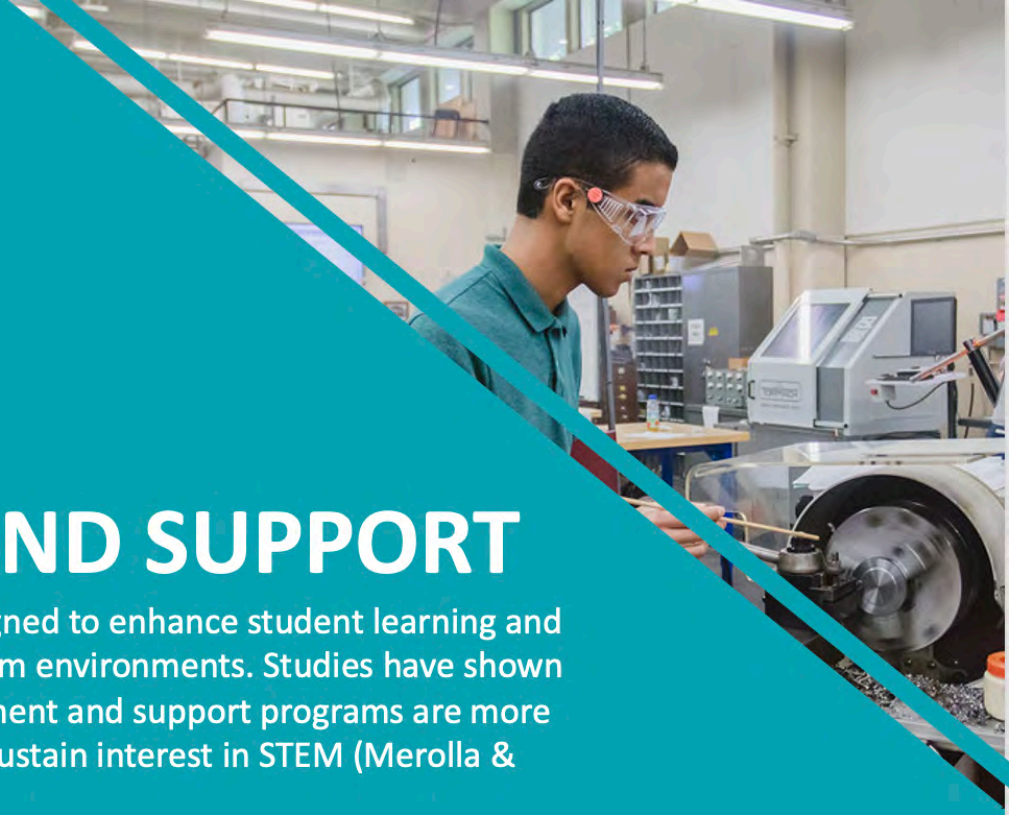
Educational materials created in 2019 by ATE projects were primarily disseminated through the projects' websites (62%) and workshops (62%), followed by ATE Central (the ATE program's archiving platform, 52%). Fewer than 15% disseminated their materials at conferences (14%) or through a clearinghouse or repository (11%). Twenty-seven projects indicated "other" modes of dissemination, with 12 projects noting they disseminated materials through commercial publications. Additional avenues of dissemination included sharing via academic and industry partnerships.

One-hundred twenty-two ATE projects disseminated educational materials that were created prior to 2019. These materials were primarily course curricula (59%), modules or instructional units (47%), and lesson plans (42%). ATE projects also reported continued dissemination of lab experiments (37%), assessment activities or tests (30%), and case studies or problem sets (18%) created in previous years.

Conferences were the most prominent avenue (71%) for disseminating materials that were created in previous years. Sixty-two percent of projects that developed educational materials in previous years posted materials to their websites, and 61% distributed materials at workshops.

Thirty-eight of the 130 projects that developed educational materials kept track of what other institutions are using their program and/or course curricula.

2,090 institutions
Used program and/or course curricula created by 38 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

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

149 projects provided at least one type of direct student service or support.

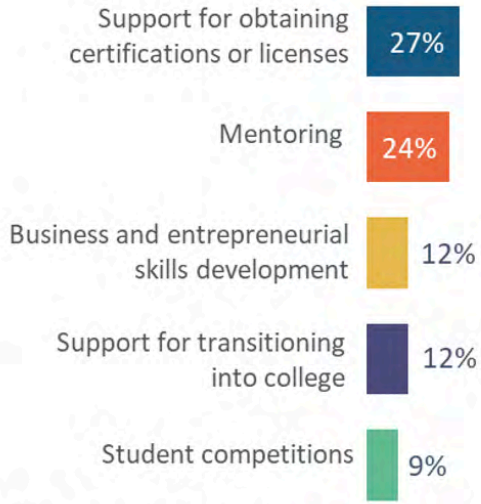


Figure 14. Percentage of projects that provided student services and support (n=294)

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 13,140 students received business and entrepreneurial skills development from 34 ATE projects in 2019.

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 local industry professionals (20%) and incubator programs (6%).

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

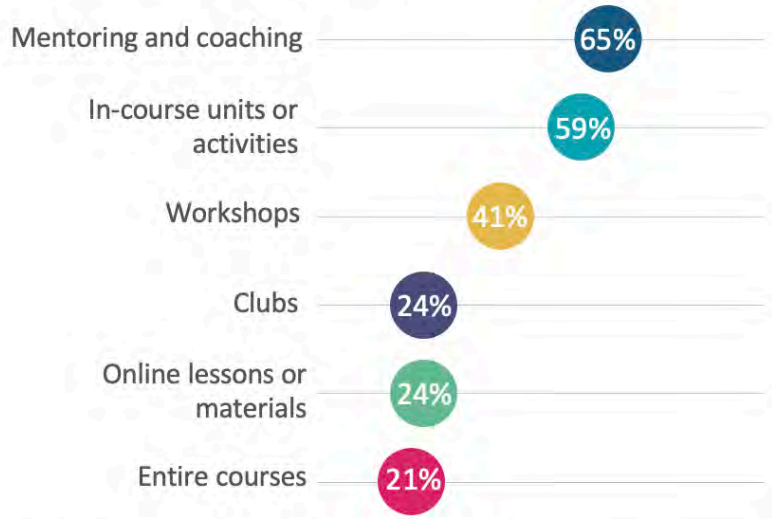


Figure 15. Percentage of skills development opportunities offered to students by ATE projects (n=34)

STUDENT SERVICE AND SUPPORT (continued)

Twenty-four percent of ATE projects provided students with mentoring or coaching, and 9% hosted or organized a student competition.

STUDENT 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).

Nearly **7,540** students received mentoring through ATE projects.

2,760
High school students

4,560
Two-year college students

220
Four-year college students

Mentoring was most often provided by educational faculty or staff (79%), followed by business and industry professionals (50%) and students or peers (49%). Thirty-one percent of projects that offered mentoring or coaching provided training to the mentors.

STUDENT 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., 2017).

9,420 students participated in one of the 117 ATE-hosted student competitions. The most common areas for competitions included:

50
information securities competitions engaged
3,210
students

37
engineering technologies competitions engaged
5,080
students

22
advanced manufacturing technologies competitions engaged
675
students

Eight other competitions engaged 460 additional students in ATE disciplines including micro and nanotechnologies, agricultural and environmental technologies, and bio and chemical technologies.

STUDENT SERVICE AND SUPPORT (continued)

Twelve 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=57)

Over **11,000** 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).

Seventy-nine ATE projects provided students with support for obtaining certifications or licenses in 2019. Eighty-seven percent of ATE projects reported supporting students through aligning existing courses with licensing or certification requirements. ATE projects also provided test preparation workshops or learning modules (62%) and served as testing centers (41%). 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 (42), followed by for-profit companies (36) and government agencies (22).

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 2019.

WORKPLACE-BASED LEARNING

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

In 2019, 3,410 students participated in workplace-based learning opportunities offered by 76 ATE projects. An additional 16 ATE projects reported offering field trips to business and industry sites.

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

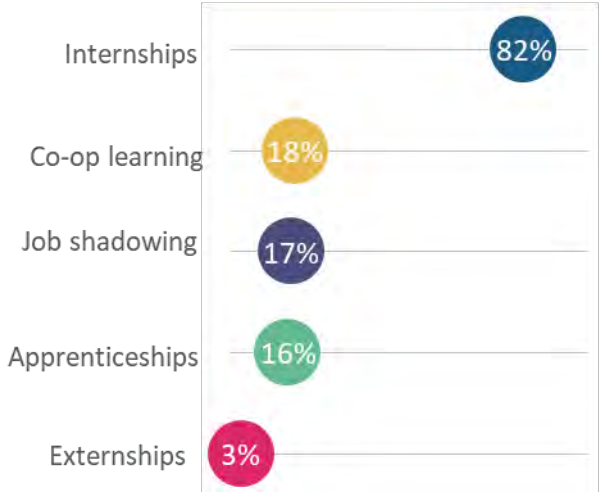


Figure 17. Percentage of ATE projects that offered each type of workplace-based learning (n=76)

The median number of weekly hours that students spent in a workplace-based learning activity ranged from 6 to 20 hours, and the median number of weeks spent in an activity ranged from 6 weeks (job shadowing) to 42 weeks (apprenticeships).

Respondents discussed a variety of benefits to both students and employers as a result of offering workplace-based learning. As one respondent noted, these opportunities:

> **"build avenues for students to connect with relevant real-world experiences ranging from specific case studies explored in class to internships, apprenticeships, and ultimately employment in the field."**

Survey respondents were asked to report on a series of characteristics about the workplace-based learning opportunity that was offered. Table 1 shows these characteristics for the three most frequently reported characteristics. As shown in the table, variation was seen both within and across different workplace-based learning activities.

	Internships (n=62)	Co-op learning (n=14)	Job shadowing (n=13)
Received Payment	65%	50%	15%
Academic Credit	66%	71%	23%
Coupled with a course	55%	57%	23
Required by program	53%	64%	38

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 expects 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

Fifty percent of ATE projects provided training or professional development to current or future educators.

One-hundred forty-seven ATE projects provided 1,070 training or professional development activities for educators in 2019. Most of these activities were a day or less in length (56%), including webinars and one-day workshops. Almost a quarter lasted more than one day but less than a week (22%) including in-person multi-day workshops and online modules. The remaining 22% of activities lasted one week or longer, including courses, summer institutes, internships, and peer coaching.

Figure 18. Number of professional development activities for educators by length of time (n=145)

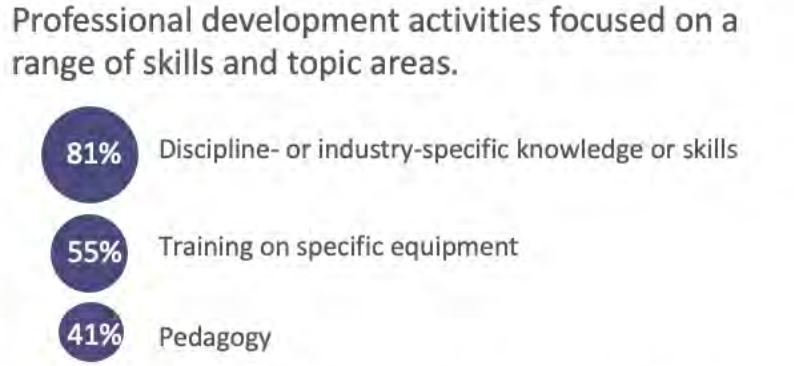


Figure 19. Top three professional development activities (n=143)

Additional professional development activities reported by ATE projects included recruitment or retention of students (23%) and other professional skills, such as communication (20%).

Fifty-five percent of educators served by professional development activities were two-year college faculty, followed by high school teachers (24%) and pre-service teachers (8%). Four-year college faculty made up 6% of professional development participants, and other types of educators made up 7%.

7,820 educators
participated in ATE-sponsored professional development in 2019 (n=108)

30,360 students
were taught by educators who participated in ATE-sponsored professional development (n=43)

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 AND CONFERENCES

Only a few ATE projects are funded specifically to organize coordination networks and conferences, but many projects are actively engaged in professional exchange.

COORDINATION NETWORKS

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

- **Consortium for Advanced Manufacturing of Cell and Tissue-Based Products** aims to unify and scale the progress in workforce preparation for all levels of career tracks in biomanufacturing.
- **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 Internet of Things Coordination Network** is designed to study the emergence of smart device technologies, including products, technologies, standards, and applications.
- **The Necessary Skills Now Network** facilitates collaboration between educators and employers to improve the employability skills of entry-level technicians in STEM fields.

CONFERENCES AND MEETINGS

Four ATE projects were explicitly funded to coordinate conferences or meetings in 2019. Nine additional projects indicated that hosting a conference was a main purpose of their grant. These 13 projects held a total of 16 conferences and meetings. Attendance at these meetings ranged from 15 to 600. ATE PIs identified the purpose of these events as networking and professional development, disseminating best practices, and bringing together stakeholders from industry and education.

16 conferences and meetings
were organized by ATE projects

1,450 people
attended conferences and meetings organized by ATE projects

Fifty-seven other ATE projects indicated that they organized 290 conferences, meetings, or similar events in 2019. The average attendance at these meetings was 150 participants, with a maximum of 3,760 at one event.

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

Twelve percent of ATE projects conducted some type of research, and 19% developed materials intended for publication.

TARGETED RESEARCH

Eleven ATE projects were specifically funded to conduct targeted research in 2019. At the time of the 2020 survey, 22% were collecting data, while 33% were analyzing data, 33% were writing up results, and 12% had findings published or submitted for publication.

Additionally, 34 ATE projects indicated they conducted some sort of research in 2019. Examples included conducting descriptive research (94%), document reviews (33%), correlational research (15%), experimental or quasi-experimental research (12%), meta-analysis (3%), and other research (3%).

Research findings were most frequently disseminated via conference presentations or posted online.

Figure 20. Percentage of projects that share their research via various dissemination channels (n=34)

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-five ATE projects prepared a total of 163 publications.

PIs reported 10,069 other publications of various types. According to their write-in responses, these included 69 other publication types, such as blogs, online news articles, and videos. Additionally, the ATE Collaborative Outreach and Engagement Project distributed 10,000 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

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

Six ATE projects are funded to provide services and support specifically for ATE grantseekers, 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 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.
- **Mentor-Connect** is a mentoring and leadership development program for two-year institutions of higher education new to the ATE program.

Collectively, these six projects reported the following achievements:

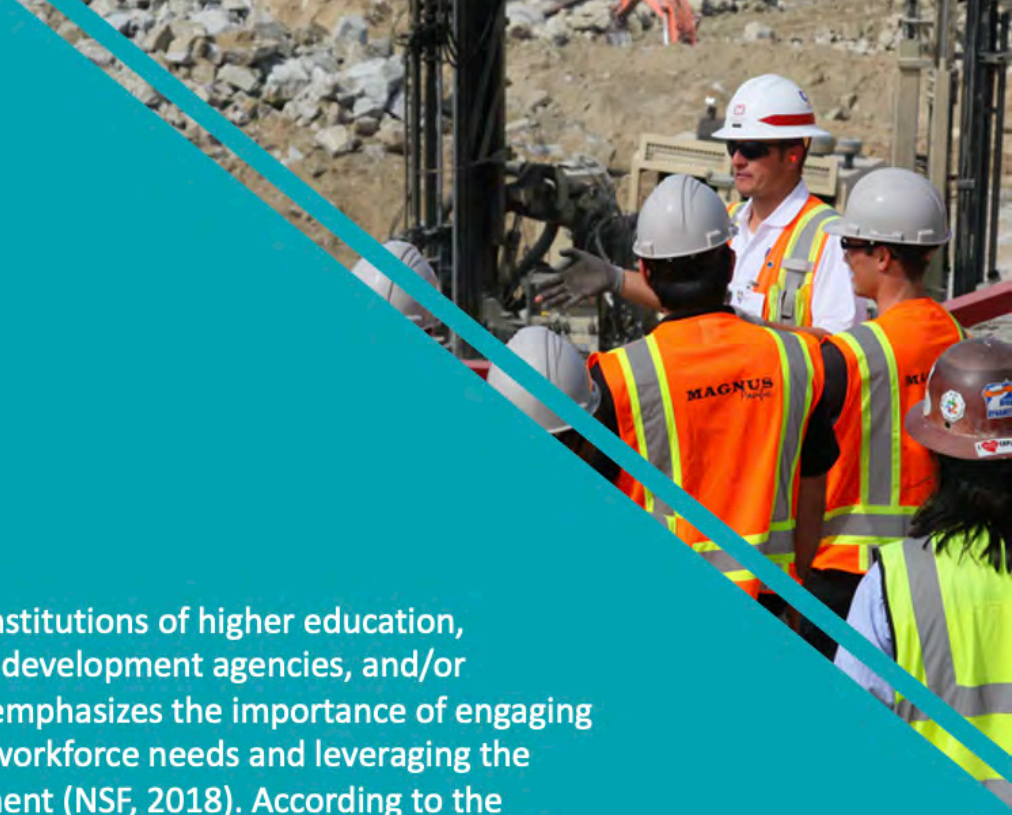
All survey respondents were invited to report on the ways in which their projects served and supported the ATE program, even if that was not the main focus of their work. Thirty-five additional projects identified ways that their projects served the ATE community.

23 projects developed and disseminated resource materials

21 projects held in-person workshops

12 projects offered webinars

21 projects provided technical assistance to individuals



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 8,500 other organizations and institutions.

In 2019, ATE projects collaborated with 2,710 business and industry partners, 2,370 K–12 schools, 2,030 colleges, 470 entities within their host institutions, 340 public agencies, and 100 other types of partners. ATE projects collaborated with a median of five business and industry groups, four K–12 schools, two colleges, and two other ATE projects.

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

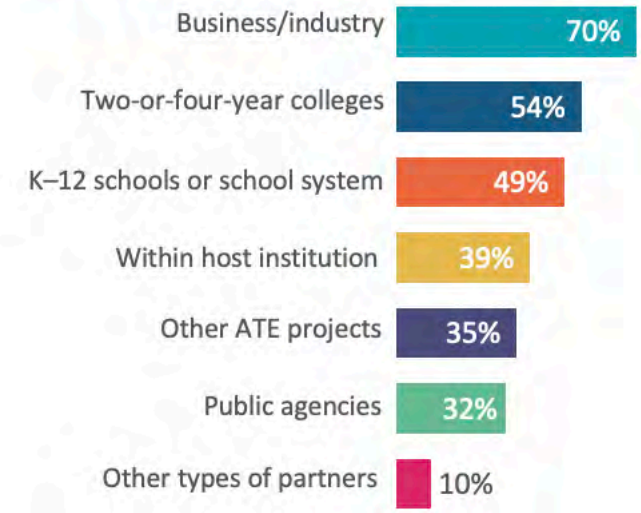


Figure 21. Percentage of ATE projects that collaborated with other groups, by type (n=294)

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

Collaborators provided over $16 million in monetary and in-kind support to 123 ATE projects.

Nineteen percent of projects reported receiving monetary support from collaborators, while 33% reported receiving in-kind support. The median contributions for monetary support and in-kind support across projects were $29,000 and $10,000, respectively. A few projects accounted for a large proportion of the monetary and in-kind support received from external collaborators. Specifically, two projects reported 59% of the total monetary support, while four other projects reported 46% of the total in-kind support received by ATE projects in 2019. Projects reported that in-kind support primarily consisted of staff time (24%) and equipment (21%). Other types of in-kind support included access to facilities, materials, and software.

COLLABORATION WITH BUSINESS AND INDUSTRY

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

A total of 187 projects reported collaborating with business and industry groups. Most used these partners to identify workforce needs, review and advise on curriculum, or assist with instruction.

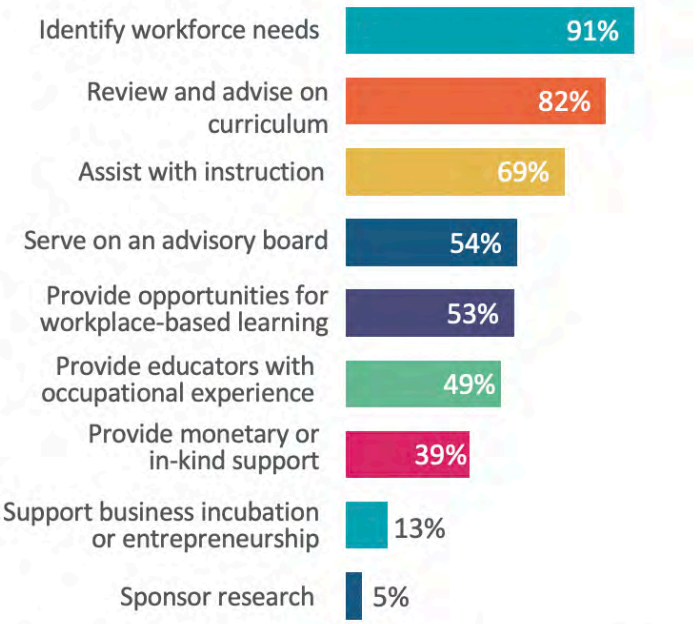


Figure 22. Percentage of projects reporting contributions from business and industry partners (n=187)

Business and industry representatives serve on advisory boards for 159 projects. Most of these projects (60%) 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, such as advisory boards, PIs frequently pointed to the utility of the information that they received from them. For example, as one PI noted, they provide:

> **"an exchange of information that has ultimately made the project more successful. Shared information led to improvements in quality, speed, and overall project productivity."**

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

> **build avenues for students to connect with relevant real-world experiences ranging from specific case studies explored in class to internships, apprenticeships, and ultimately employment in the field."**

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

Eighty-nine percent of ATE projects engaged an evaluator.

Two-hundred sixty-two ATE projects (89%) had an evaluator in 2019. Of the 32 PIs who said they did not have an evaluator, 16 were in their first year of funding. **Of the 262 projects with an evaluator, 87% reported having an external evaluator, with 10% having both an internal and external evaluator and 3% having only an internal evaluator.**

Thirty-two 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 42% interacted with their evaluators occasionally (more often than quarterly) and 26% did so infrequently or rarely (once a quarter or less).

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

Figure 23. Types of evaluation report received by ATE projects (n=262)

Of the 231 PIs who received evaluation reports, 71% indicated their project's evaluation caused them to make a change in implementing their project, and 51% indicated 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, executive administrators, and their project advisory committee.

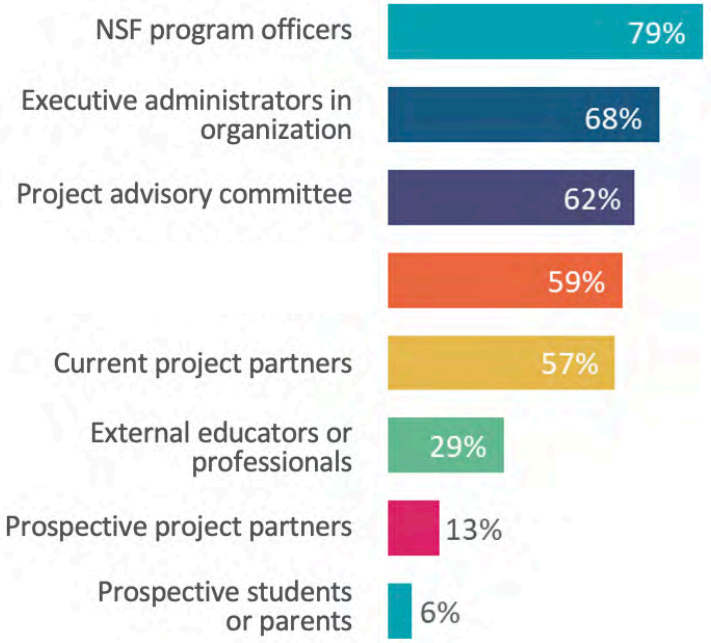


Figure 24. Percentage of projects that shared their evaluation results with various audiences (n=216)

ATE ANNUAL SURVEY
2020 HIGHLIGHTS

This summary of activities and achievements of the Advanced Technology Education (ATE) program is based on the 2020 ATE survey. Principal investigators for 91% (n=294) of ATE grants completed the survey, out of a total of 325 ATE grants. This included 247 projects, 32 centers, 4 conference grants, and 11 targeted research projects.

153 DEGREE PROGRAMS AND 454 COURSES
were developed by 125 ATE projects.

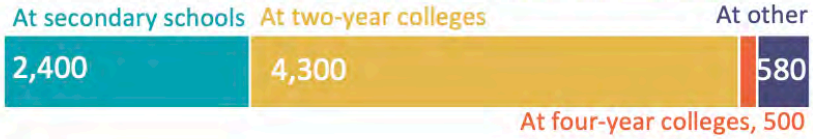
Almost half (49%) of all academic degree programs developed were certificate programs, and a majority (84%) of courses developed were at the associate degree level.

68
Associate degree programs served 5,790 students

75
Certificate programs served 3,760 students

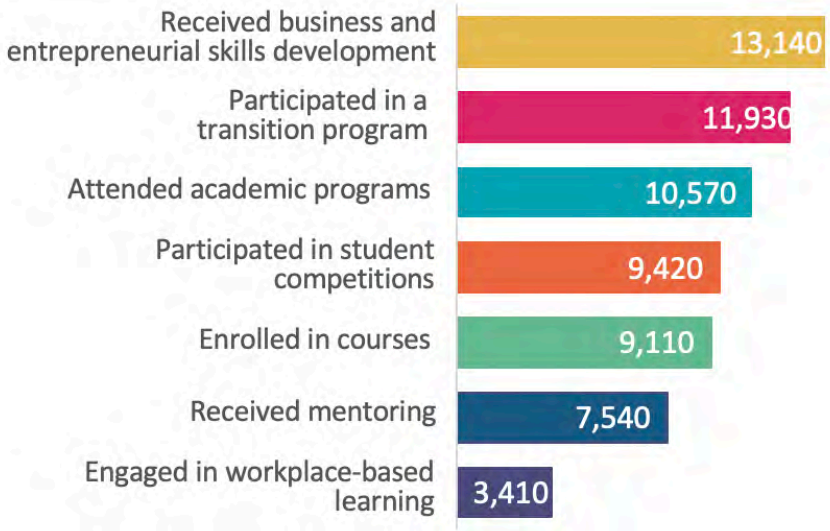
7,820 EDUCATORS
participated in 1,070 professional development activities.[1]

The main audiences for ATE professional development activities were educators at **secondary schools** and **two-year colleges**.



65,000+ STUDENTS
were served by ATE projects.

ATE projects served over 65,000 students through a variety of activities.[1]



[1] Due to the structure of the survey questions, educator and student counts cannot be combined because of the the high probability of double-counting individual students.

ATE ANNUAL SURVEY
2020 HIGHLIGHTS (continued)

7,110 EDUCATIONAL MATERIALS
were developed by 126 ATE projects.

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

3,310 Assessment activities or tests

1,160 Modules or instructional units

1,010 Lessons or lesson plans

11,651 ARTICULATION AGREEMENTS
were developed or maintained by 62 ATE projects.

4,300 students matriculated to a higher-level education institution with the aid of an ATE-supported articulation agreement.

8,500 COLLABORATORS
were engaged by ATE projects.

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

70% collaborated with **business and industry groups**

54% collaborated with **other two- and four-year colleges**

OTHER ACTIVITIES were conducted by ATE projects in 2019 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 **5 coordination networks**

conducted **11 research studies**

hosted **16 conferences**

developed **163 publications**

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.

TECHNICAL NOTES

[i] The 2020 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 student 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 report.

[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

2020 Report

December 2020

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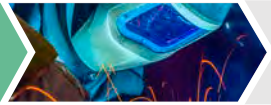

ATE Survey 2019

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

EvaluATE

www.evalu-ate.org/annual_survey

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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 2019 survey of ATE program grantees. Conducted by EvaluATE (the evaluation hub for the ATE program, located at The Evaluation Center at Western Michigan University), this annual ATE survey was the 20th. Included in this report are findings about ATE projects and their activities and achievements during the 2018 calendar year (and 2018 fiscal year for budget-related questions).

The 2019 survey was a census of ATE principal investigators (PIs) with active grants (N=304). Ninety-two percent (n=279) of PIs 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 2019 survey with those of previous years. 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 never before addressed in the ATE survey's history, 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 evalu-ate.org/annual_survey/reports. Custom reports may be developed upon request. For more information, contact lyssa.becho@wmich.edu.

ATE GRANTEE AND CHARACTERISTICS

As context for the remainder of this report, this se
the individuals and institutions that received ATE
the funded work, such as types of awards, disciplinary focus, 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-two percent of ATE grants were for projects (which includes a variety of subcategories of project types). Among the 229 project grants, 50 were designated for institutions new to the ATE program and three were planning grants. Of the 32 centers, 11 identified as national centers, 13 as regional centers, and eight as support or resource centers.

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

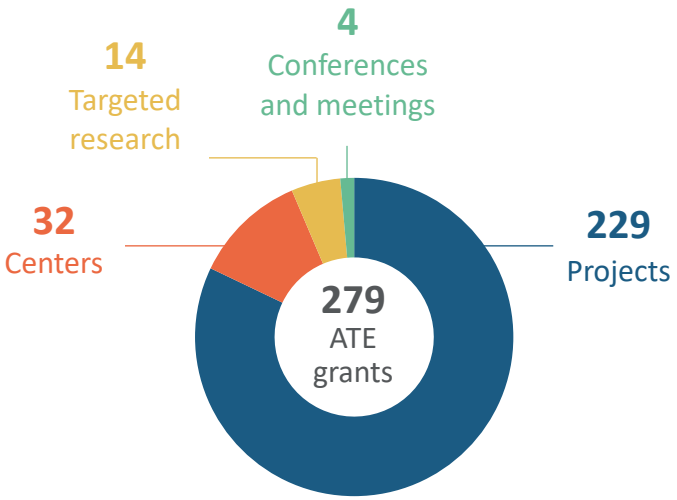


Figure 1. Types of ATE grants awarded (n=279)

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

Figure 2. Percentage of ATE grant recipients at institution types (n=279)

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 203 grants awarded to two-year colleges supported 175 projects, 23 centers, and five targeted research studies. Most of the 14 targeted research projects (57%) are located at four-year colleges, while conference grant recipients are mainly located at nonprofit organizations (75%).

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.

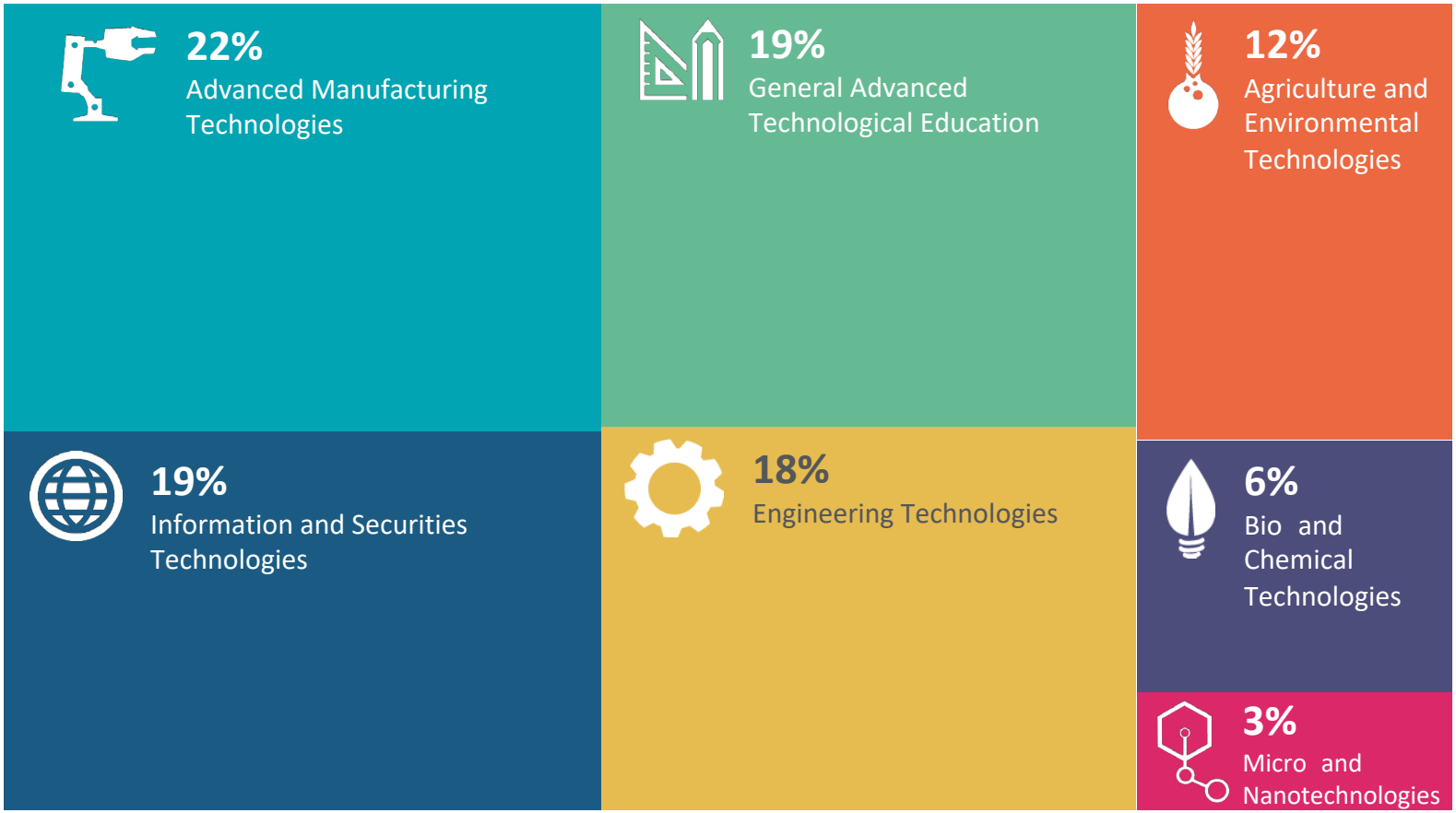


Figure 3. Disciplinary areas of ATE projects (n=279)

ATE PROJECT ACTIVITIES

ATE projects engaged in a variety of activities in 2018 to improve the education of science and engineering technicians.

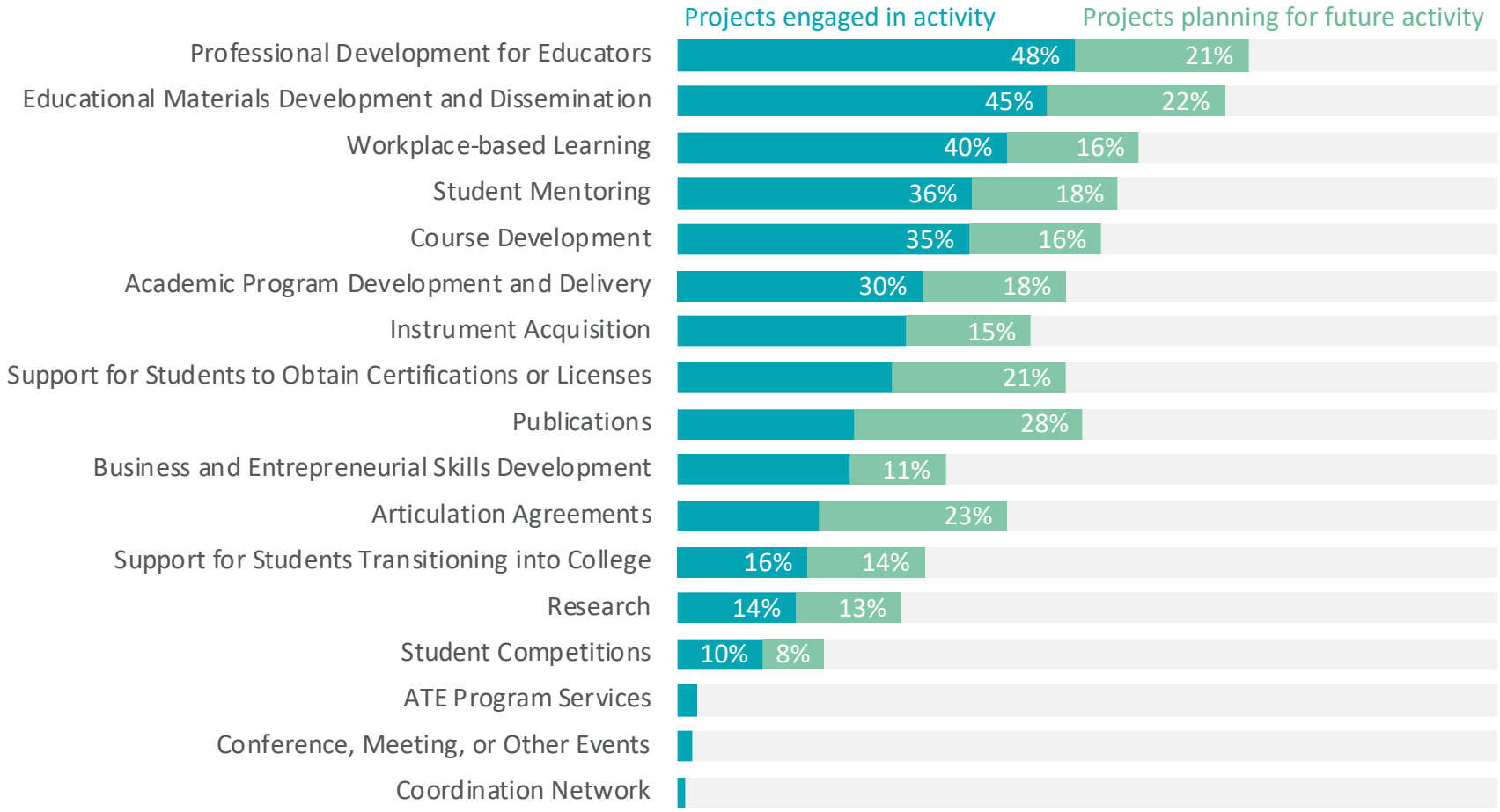


Figure 4. Percent of projects that reported engaging in activities in 2018 and planning activities for the future (n=279)

ATE PROJECTS AT MINORITY-SERVING INSTITUTIONS

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

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

Forty-nine 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. Designation is based on the percentage of minority students enrolled in the school. Of the 253 projects at IHEs, 26% are at IHEs that are designated as minority-serving. The majority of these IHEs (75%) are Hispanic-serving. Predominantly Black or historically Black colleges and universities make up 8% of the minority-serving IHEs that host ATE projects. Three ATE projects are located at Native Hawaiian-serving IHEs, one is located at a tribal college, and one is located at an Alaska Native-serving IHE.

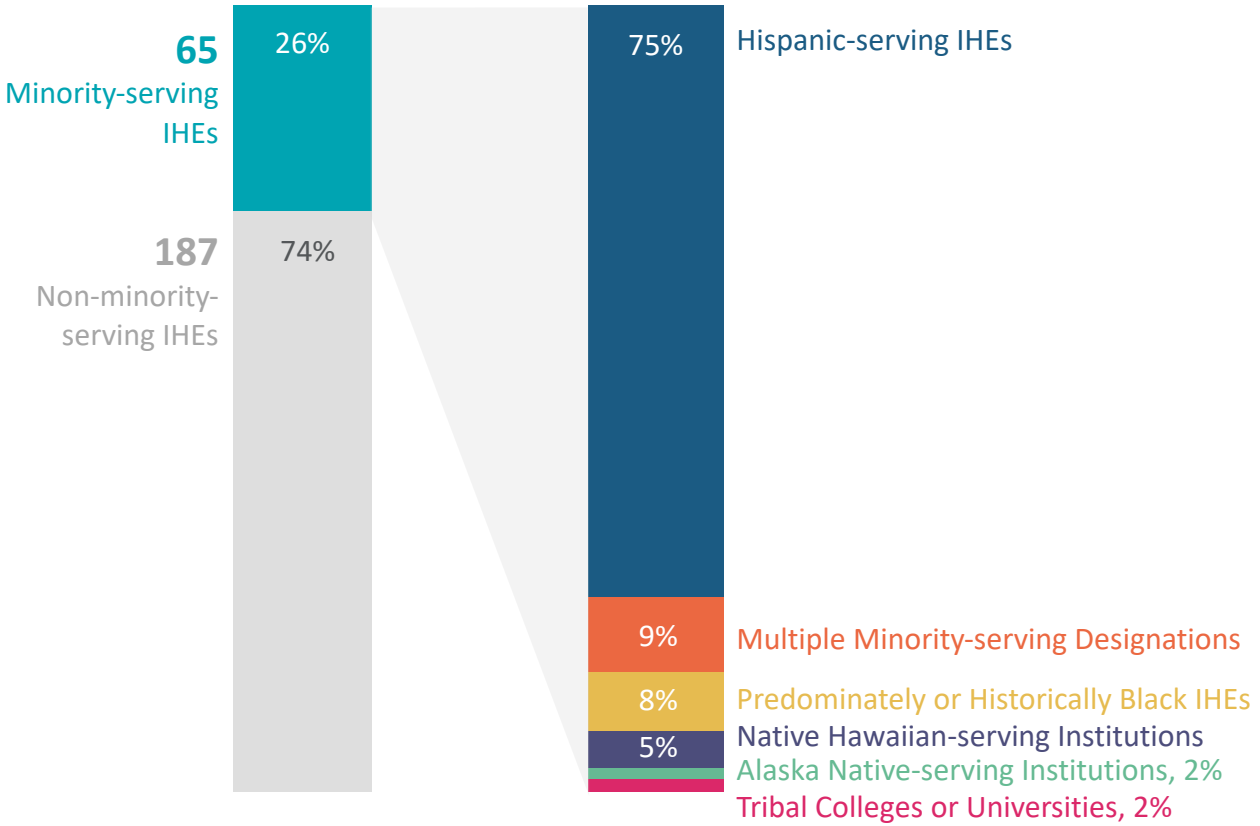


Figure 5. ATE projects at minority-serving institutions (n=65)

ATE PRINCIPAL INVESTIGATORS

Twelve percent of ATE projects have PIs from historically underrepresented racial and ethnic groups.

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.

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

Figure 6. Gender identity of ATE PIs (n=273). Each icon represents 1%.

Thirteen percent of ATE PIs are over the age of 65, while 33% are between the ages of 55 and 64, 29% are 45–54, 21% are 35–44, and 3% are 25–34.

Twelve 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-one percent of ATE projects have a PI who identifies as white.

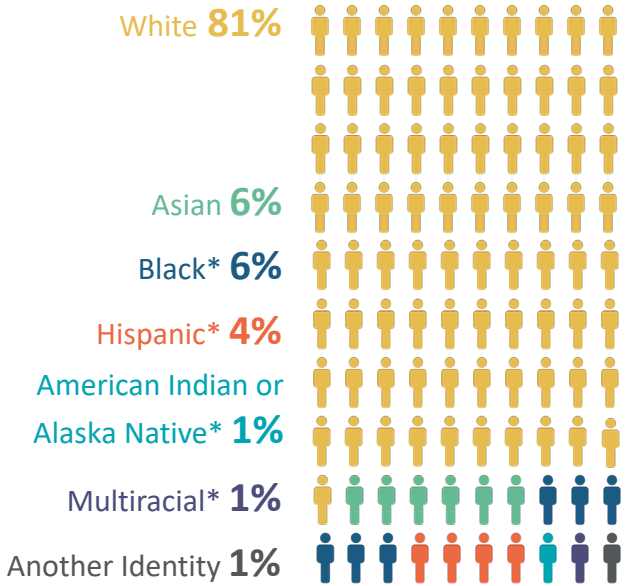


Figure 7. Racial and ethnic identity of ATE PIs (n=272). Each icon represents 1%. *Historically underrepresented racial and ethnic groups.

ACADEMIC PROGRAMS, COURSES, AND PATHWAYS

The ATE program supports the creation and improvement of 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

Thirty 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).

ATE PIs were asked to identify the degree or certificate programs that their projects created or improved with ATE funding, the demographic characteristics of students served by those programs, and how many students enrolled in and completed the programs.

A total of 160 academic degree programs were developed or substantially modified by 83 ATE projects in 2018. Most of these programs award associate degrees (51%), followed by certificates (40%). Four programs award bachelor's degrees and nine programs provide other types of credentials. Nearly 12,000 students attended at least one course in these academic programs, with a total of 710 completing the program in 2018; 410 students completed an associate degree program, while 300 students completed a certificate program. Programs with students completing academic programs graduated an average of 11 students in 2018.

82 Associate degree programs served
6,810 students

64 Certificate programs served
4,870 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.

Over half of the ATE projects that developed or modified academic programs emphasized recruitment of **women** or **underrepresented racial or ethnic minority students**.

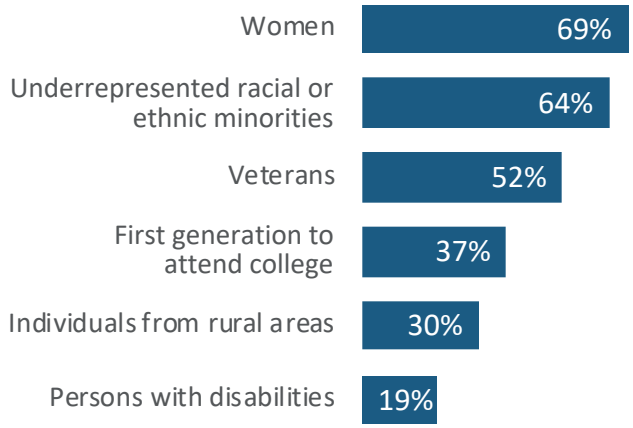


Figure 8. Percentage of projects that emphasized recruitment of students from specific demographic groups (n=70)

STUDENTS SERVED BY ATE ACADEMIC PROGRAMS

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

Of the 160 academic programs that were developed or modified by ATE projects in 2018, only 49 of them reported student characteristics. Due to this low response rate, and changes in the survey questions, the numbers reported here do not presume to represent the entire ATE program and should not be compared with previous years' data.[i]

The percentage of women in ATE-supported programs is similar to national participation rates. Overall, 28% of ATE students are women, although the proportion of women varies by education level and discipline. According to the U.S. Department of Education, 25% 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.

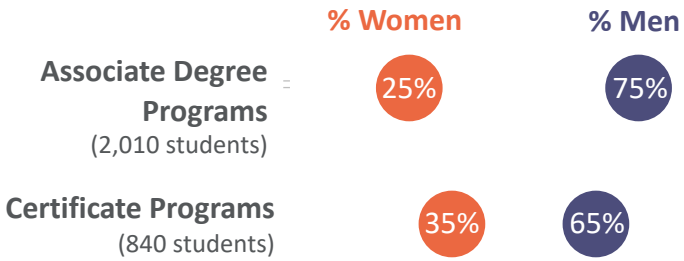


Figure 9. Percentage of women and men in ATE-supported academic programs by degree level (n=49)

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

Students who identify as Black/African American and Hispanic/Latino or Latina are generally well-represented in the ATE program.

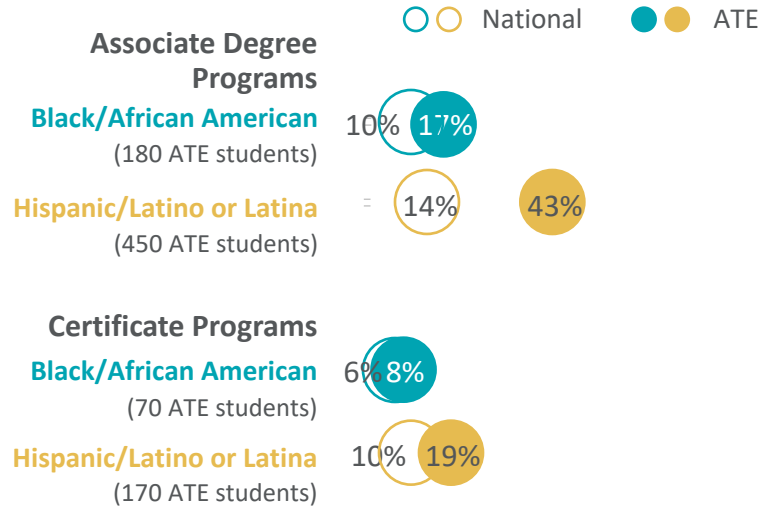


Figure 10. Percentage of students from underrepresented racial and ethnic minority groups in ATE-supported academic programs by degree level, compared with national rates (n=49)

COURSE DEVELOPMENT

Thirty-five 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 level of these courses, their primary delivery mode, and how many students enrolled in the courses. ATE projects that engaged in course development may have done so as part of a larger initiative to develop or modify an entire degree or certificate program, or as a stand-alone effort.

A total of 423 courses were developed by 99 projects in 2018. The majority of these courses were for two-year college students (90%).

21
High school courses were developed by
10
ATE projects

380
Two-year college courses were developed by
89
ATE projects

15
Four-year college courses were developed by
6
ATE projects

Fifty-two percent of these 423 courses were offered in 2018.

6,900 students
were enrolled in an ATE-developed or -modified course in 2018

ATE PIs were asked about the primary delivery modes for each of the courses they developed or modified. While there is increasing demand for online courses, ATE courses are still primarily developed for face-to-face classroom instruction.

Most courses developed or modified are **face-to-face**, not **online** or a **hybrid** of both.

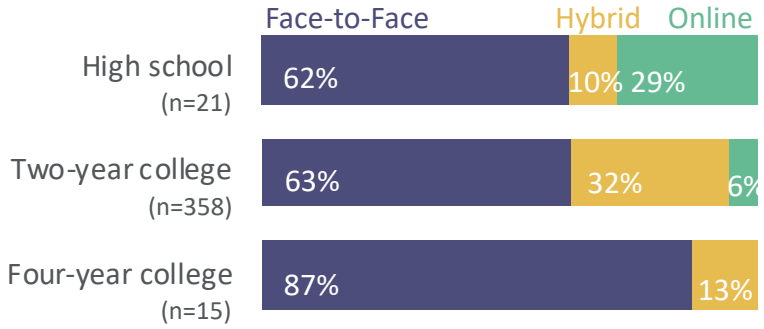


Figure 11. Percentage of course delivery mode by education level.

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.

Seventy-eight ATE projects acquired instrumentation or equipment in 2018. The PIs for these projects were asked to identify what they purchased (due to the diversity of responses to this open-ended question, their answers could not be readily classified).

ATE projects obtained a wide array of technical devices in 2018 to support instruction:

3-D printers

Virtual reality viewers

Computers

Drones

Laser engravers

Laboratory equipment

Projects that used ATE funding to purchase instruments or equipment are expected to revise their academic programming to maximize the value of the items to enhance student learning.

A median of 50 students used the equipment or instrumentation acquired by each ATE project.

3,450 students
benefited from purchased equipment

300 educators
used the purchased equipment

230 courses
used the purchased equipment

ARTICULATION AGREEMENTS

Seventeen 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).

Forty-eight projects developed or maintained articulation agreements in 2018.

ATE-supported articulation agreements involved almost 1,000 institutions and were used by 4,000 students in 2018.

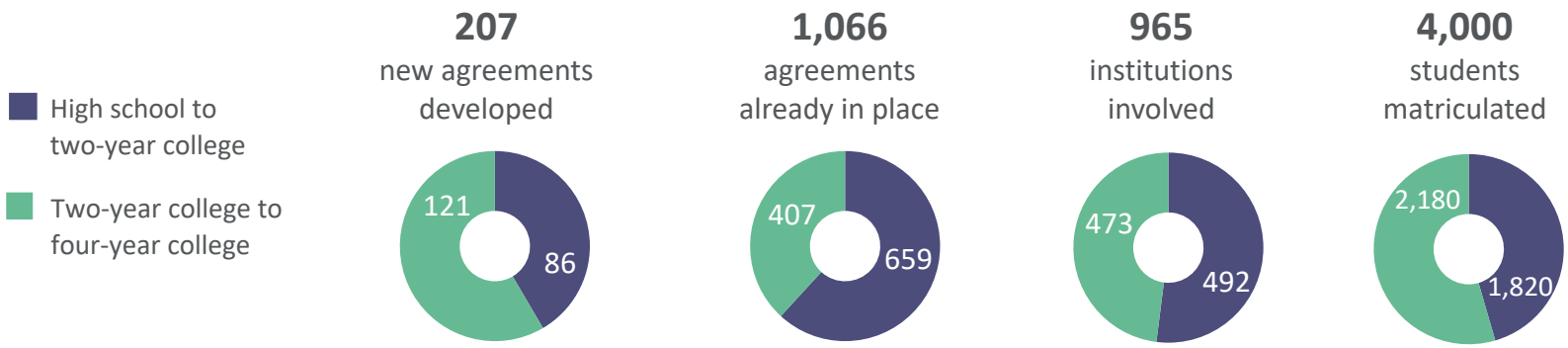


Figure 12. Number of articulation agreements, institutions, and students who matriculated in 2018 (n=48)

EDUCATIONAL MATE
DEVELOPMENT

Instructors' use of curriculum materials is believed to
(1) improvement of educators' pedagogical knowledg
(2) increased opportunities for students to engage in "ambitious science," aimed at developing their skills in both the 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 material 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-five percent of ATE projects created or substantially modified educational materials.

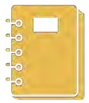
126 ATE projects developed or modified over 7,110 educational materials in 2018.

3,310
Assessment activities or tests

1,160
Modules or instructional units

1,010
Lessons or lesson plans

550
Lab experiments



340
Course curricula

330
Case studies or problem sets

Other materials developed include 130 instructor guides, 120 program curricula, 80 interactive simulations, and 50 textbooks.

The educational materials created by ATE projects were primarily disseminated through the projects' websites (66%), followed by clearinghouses or repositories maintained by other organizations (21%). Less than 10% pursued commercial publication as a way to disseminate their educational materials (8%). Fifty-two projects indicated "other" ways of dissemination, with 20 projects noting they disseminated materials at conferences and workshops. Additional avenues of dissemination included sharing via academic and industry partnerships.

Ninety-two ATE projects continued to disseminate educational materials that were created prior to 2018. These materials were primarily course curricula (53%), modules or instructional units (49%), and program curricula (45%). ATE projects also reported continued dissemination of instructor guides (39%), lab experiments (39%), and lesson plans (37%) created in previous years.

The most prominent avenues for continued dissemination mirror those for newly created materials. Sixty-seven percent of projects that developed educational materials in previous years posted materials on their websites, 28% disseminated materials at conferences or workshops, and 17% posted materials to clearinghouses or repositories maintained by other organizations.

Twenty-six of the 126 projects that developed educational materials kept track of what other institutions are using their program and/or course curricula.

540 institutions
Used program and/or course curricula created by 22 ATE projects

STUDENT SERVICES 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

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

169 projects provided at least one type of direct student service or support.

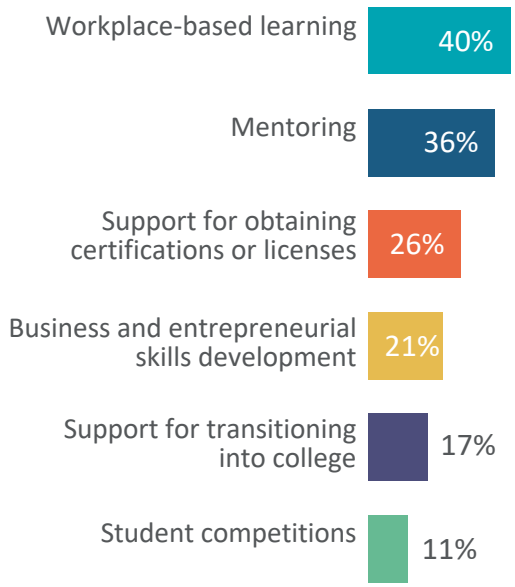


Figure 13. Percentage of projects that provided student services and support (n=279)

BUSINESS AND ENTREPRENEURIAL SKILLS

Business and entrepreneurial skills development involves working with students to develop their skills in areas such as — but not limited to — business development, marketing, networking, and understanding the global marketplace. While research on the impact of entrepreneurial education is mixed, it is generally agreed that it is an important component of STEM education and part of a national strategy to "accelerate innovation" (Winkler, et al., 2015). Twenty-one percent of ATE projects engaged students in building their business and entrepreneurial skills.

A total of 7,380 students received business and entrepreneurial skills development from 59 ATE projects in 2018.

The three most frequently used strategies for this skill development were in-course units or activities (56%), mentoring or coaching (53%), and workshops (36%). Projects also reported developing students' business and entrepreneurship skills through clubs (25%), entire courses (17%), and incubator programs (5%).

STUDENT SERVICE AND SUPPORT (continued)

Thirty-six percent of ATE projects provided students with mentoring or coaching, and 10% hosted or organized a student competition.

STUDENT 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).

Nearly **9,700** students received mentoring through ATE projects.

4,700
High school students

4,390
Two-year college students

600
Four-year college students

Mentoring was most often provided by educational faculty or staff (88%), followed by business and industry professionals (51%) and students or peers (39%). Twenty-six percent of projects that offered mentoring or coaching provided training to the mentors.

STUDENT 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., 2017).

8,570 students participated in one of the 84 student competitions hosted or organized by ATE projects. The most common areas for competitions included:

47
robotic competitions engaged
7,780
students

13
cybersecurity competitions engaged
150
students

6
bio- and chemical-tech competitions engaged
370
students

Eighteen other competitions engaged 270 additional students. Topics ranged across ATE disciplinary areas, including cyberdefense, welding, manufacturing, and vegetable crop judging.

STUDENT SERVICE AND SUPPORT (continued)

Sixteen percent of ATE projects provided extra support for students transitioning into college, and 26% 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 aimed at **high school students**.

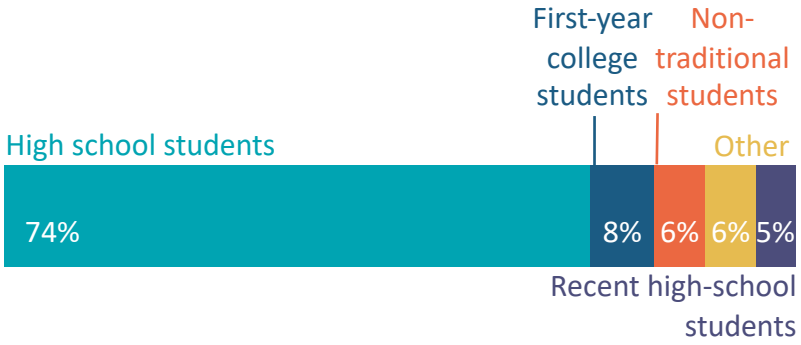


Figure 14. Primary audience for transition programs supported by ATE projects (n=62)

Over **5,000** students transitioning into college received support from ATE projects.

4,730
High school students

120
First-year college students

140
Non-traditional students

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 student 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).

Seventy-three ATE projects provided students with support for obtaining certifications or licenses in 2018. Open-ended survey responses indicate that the ATE projects that supported students in obtaining certifications or licenses did so primarily by embedding certification requirements within courses, offering preparatory courses, paying students' testing fees, or serving as a testing center.

WORKPLACE-BASE

Workplace-based learning includes any situation i
work site, such as through internships, apprentice
industry sites. Research indicates that such experi
in their abilities and enhance employability skills,
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 2018.

WORKPLACE-BASED LEARNING

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

A total of 7,290 students participated in workplace-based learning offered by 112 ATE projects in 2018. Internships, apprenticeships, and co-op learning were the most time-intensive opportunities. Participating students committed a median of 20 hours per week over 12 weeks per year to internships, 24 hours per week over 42 weeks per year to apprenticeships, and 16 hours per week over 13 weeks per year to co-op learning.

Students were paid and/or received academic credit for most internships, apprenticeships, or externships offered by ATE projects.

71%
of workplace-based learning opportunities **paid students**
(n=72)

61%
of workplace-based learning opportunities included **academic credit**
(n=72)

ATE PIs were asked to identify the types of workplace-based learning their projects offered. Definitions of the types of learning opportunities listed on the survey were not provided since there is substantial variation in the literature in terms of how these activities are conceptualized and implemented.

Internships made up almost half of workplace-based learning opportunities offered by ATE projects.

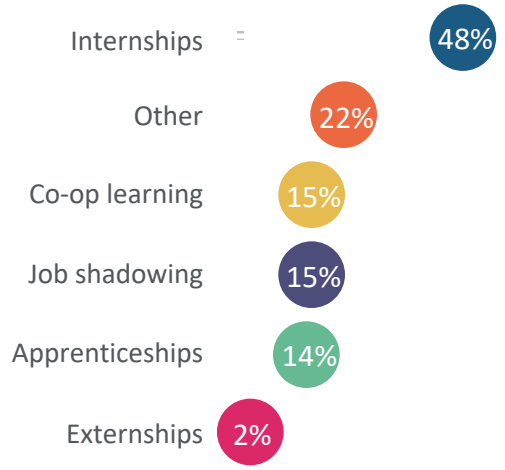


Figure 15. Percentage of ATE projects that offered each type of workplace-based learning (n=112)

Additionally, 60% of ATE PIs whose projects offered workplace-based learning identified field trips to business or industry sites as one of their opportunities. The 22% of respondents who selected *other* explained that they offered employment placement, industry/college partnership project, service learning, laboratory exercises, and work study experiences. (These examples may or may not meet a strict definition of workplace-based learning.)

PROFESSIONAL DEV
FOR EDUCATORS

Community college faculty have diverse responsib
courses, but also are often charged with responsib
institutional administration. Incoming faculty are t
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

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

One-hundred and thirty-five ATE projects provided a total of 1,080 training or professional development activities for educators in 2018. Most of these activities were a day or less in length (58%), including webinars and one-day workshops. Almost a third lasted more than one day but less than a week (30%) including in-person multi-day workshops and online modules. The remaining 12% of activities lasted one week or longer, including courses, summer institutes, internships, and peer coaching.

ATE projects offered 1,080 professional development activities for educators in 2018.

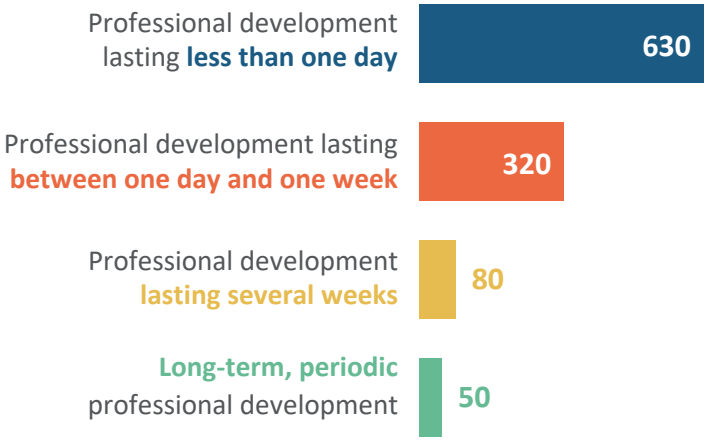


Figure 16. Number of professional development activities for educators by length of time (n=132)

Professional development activities primarily focused on discipline- or industry-specific knowledge or skills (77%), followed by training on specific equipment (37%) and teaching pedagogy (31%). A smaller percentage focused on recruitment or retention of students (23%) and other professional skills (17%), such as problem-solving, communication, project development and management, and inclusion practices.

19,330 educators
participated in ATE-sponsored professional development (n=132)

Forty-four percent of educators served by professional development activities were two-year college faculty, followed by high school teachers (33%) and other types of educators (19%). Four-year college faculty made up 3% of professional development participants, and preservice teachers made up 1%.

Thirty-nine projects reported tracking the number of students who were taught by the educators who participated in ATE-supported professional development. According to those projects:

44,050 students
were taught by educators who participated in ATE-sponsored professional development (n=39)

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 name and purpose of the events and number of attendees. Those engaged in network coordination were simply asked to identify the purpose of their networks.

COORDINATION NETWORKS AND CONFERENCES

Only a few ATE projects are funded specifically to organize coordination networks and conferences, but many projects are actively engaged in professional exchange.

COORDINATION NETWORKS

Three ATE projects indicated that they were specifically funded to develop and facilitate coordination networks.

- **Consortium for Advanced Manufacturing of Cell and Tissue-Based Products** is focused on workforce development in manufacturing that constructs biological systems in combination with natural or synthetic materials using robotics, microfluidics, 3-D printing, computational modeling, and novel types of engineering.
- **Technician Education in Additive Manufacturing and Materials** is a coordination network focused on identifying the ways in which the convergence of materials science and additive manufacturing can be addressed in technician education resources.
- **Virtual Reality Coordination Network** brings together innovators in education, industry, and virtual and augmented reality development to create an end-to-end collaborative innovation ecosystem that will enhance learning through virtual and augmented reality-based technologies.

PIs for 58 other projects also said that coordinating a network was part of their funded activities. Their open-ended responses suggest that some of this work may not align exactly with NSF's definition of a coordination network. However, it is clear that several projects actively bring together diverse stakeholders to problem solve, advance common goals, and share knowledge.

CONFERENCES AND MEETINGS

Organizing conferences and meetings was the primary purpose of five ATE projects in 2018. These projects held a total of 10 conferences and meetings. Attendance at these meetings ranged from 20 to 900. ATE PIs identified the purpose of these events as networking and professional development, disseminating best practices, and bringing together stakeholders from industry and education.

10 conferences and meetings
were organized by ATE projects

2,310 people
attended conferences and meetings organized by ATE projects

One-hundred seventy-five other ATE projects indicated that they organized some type of conference, meeting, or similar event in 2018. However, the open-ended responses about the purposes and audiences of these events revealed that many PIs were reporting on conferences and meetings in which project personnel participated, rather than events organized by their projects. Many others reported on meetings that were held for the purpose of their projects' management and oversight. For these reasons, it is difficult to make conclusions about the nature, extent, and reach of professional exchange organized by ATE projects. However, whether organizing or attending, it is apparent that ATE project personnel are actively engaged within their professional communities.

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 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 events).

ATE TARGETED RESEARCH AND PUBLICATIONS

Fourteen percent of ATE projects conducted some type of research, and 22% developed materials intended for publication.

TARGETED RESEARCH

Fourteen ATE projects were specifically funded to conduct targeted research in 2018. At the time of the 2019 survey, 11% of these projects were in the planning phase, while 22% were collecting data, 33% were analyzing data, and 34% were writing up results.

Forty ATE projects indicated they conducted some sort of research in 2018. Examples included reviews of existing literature, informal research on best practices, and surveys of industry partners or participants for program improvement.

Research findings are most frequently disseminated via conference presentations or are posted online.

Figure 17. Dissemination channels for research findings (n=40)

PUBLICATIONS

While publication is an expectation for all projects engaged in targeted research, many ATE projects 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).

Sixty ATE projects prepared a total of 228 publications.

32 Manuscripts for academic journals

14 Manuscripts for practitioner journals

26 Reports

59 Magazine articles

PIs reported 97 other types of publications. According to their write-in responses, these included white papers, book chapters, blogs, online news articles, and video media.

ATE PROGRAM SERVICES

The primary purpose of a few ATE projects 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 a narrower area 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.

Seven ATE projects are funded to provide services and support specifically for ATE grantseekers, grantees, and their affiliates. The projects with a specific focus on serving the ATE community include the following:

- **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 and dissemination.
- **ATE Collaborative Outreach and Engagement Project** 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 evaluation capacity for those involved with ATE projects through training, networking opportunities, and research, including administration of the ATE Annual Survey.
- **Mentor-Connect** is a mentoring and leadership development program for two-year institutions of higher education new to the ATE program.
- **Promoting STEM Education at Two-Year Colleges** and **ATE Two-Year Colleges** provide proposal writing workshops and a mentoring program for two-year college STEM faculty.

Collectively, these seven projects report the following achievements:

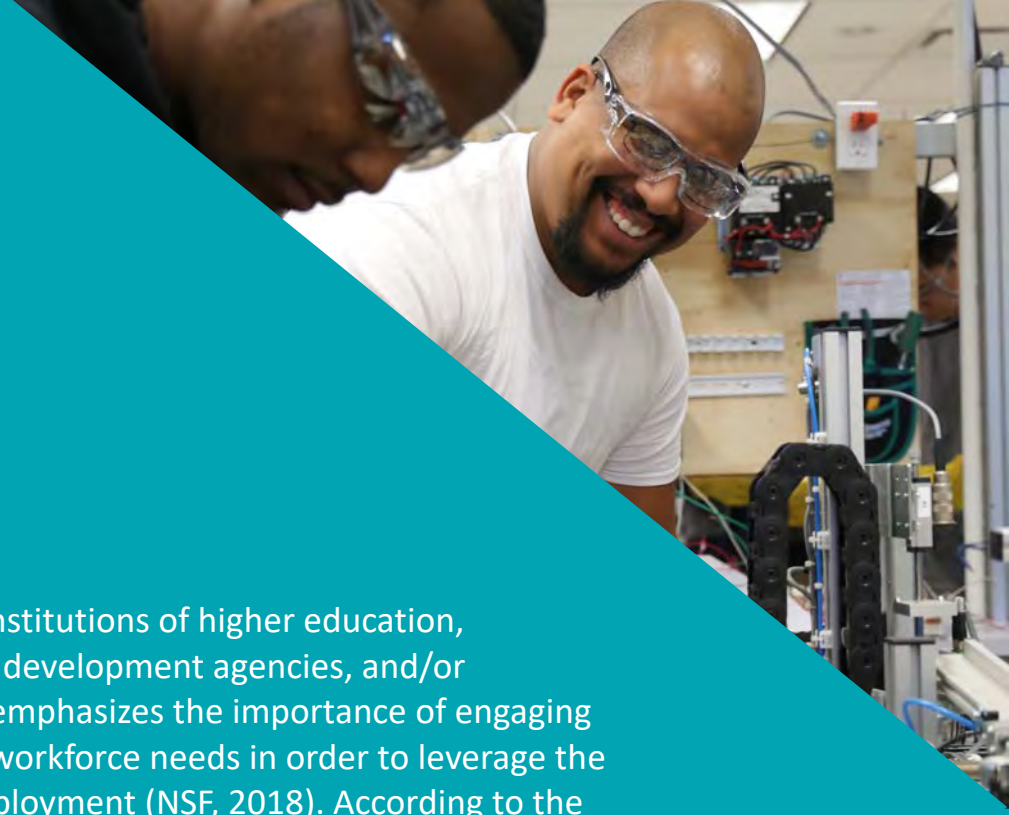
Delivered 5 workshops
that engaged an average of
50 people per workshop

Delivered 18 webinars
that engaged an average of
100 people per webinar

Provided over 290 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-seven additional projects identified ways that their projects served the ATE community.

23 projects developed and disseminated resource materials
17 projects held in-person workshops
10 projects offered webinars
6 projects provided technical assistance to individuals



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 in order to leverage the assets of industry in preparing students for their 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 almost 10,000 other organizations and institutions.

In total, ATE projects collaborated with 3,810 business and industry partners, 2,510 K-12 schools, 2,260 colleges, 550 entities within their host institution, 490 public agencies, and 90 other types of partners. ATE projects collaborated with a median of five business and industry partners, four K-12 schools, two colleges, and one other ATE project.

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

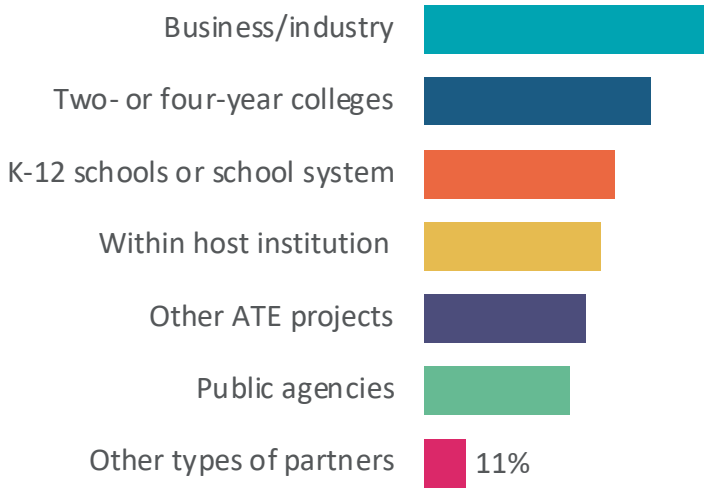


Figure 18. Percentage of ATE projects that collaborated with other groups, by type (n=279)

Projects that indicated they worked with other types of partners identified these collaborators as mostly nonprofit institutions and professional associations.

Collaborators provided over $15 million in monetary and in-kind support to 117 ATE projects.

$7,545,200 monetary support

$7,645,450 in-kind support

Eighteen percent of projects reported receiving monetary support from collaborators, while 35% reported receiving in-kind support. The median contributions for monetary support and in-kind support across projects were $29,000 and $10,000, respectively. Just a few projects accounted for a large proportion of the monetary and in-kind supported received from external collaborators. Specifically, three projects reported 43% of the total monetary support, while four other projects reported 42% of the total in-kind support received by ATE projects in 2018. Projects reported that in-kind support primarily consisted of staff time (35%) and equipment (17%). Other types of in-kind support included access to facilities, materials, supplies, and software.

COLLABORATION WITH BUSINESS AND INDUSTRY

Seventy-four percent of ATE projects collaborated with business and industry partners.

A total of 207 projects reported collaborating with business and industry partners. Most used these partners to identify workforce needs, serve on advisory boards, or review and advise on curriculum.

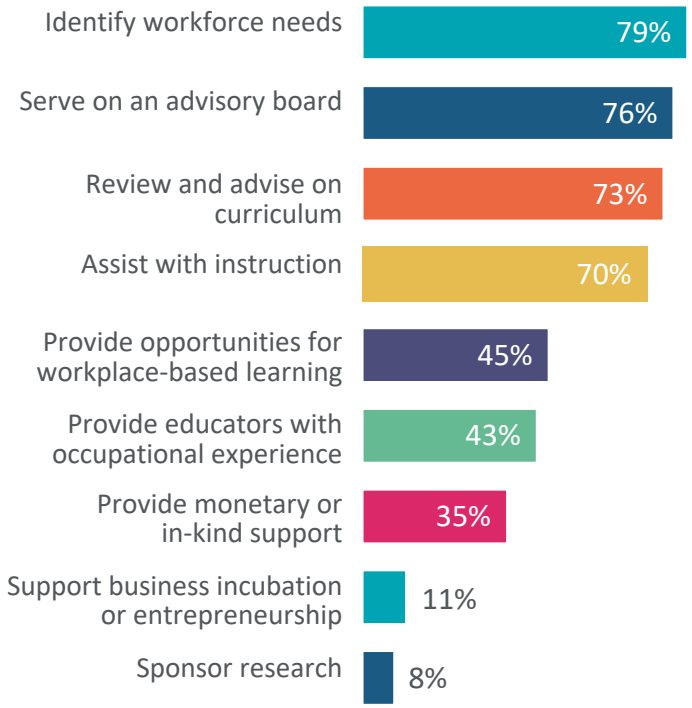


Figure 19. Percentage of projects reporting contributions from business and industry collaborators (n=207)

For the 157 projects that engaged business and industry partners to serve on their advisory boards, 13% reported partners committed one hour or less, 56% committed two to five hours, 25% committed one to two days, and 6% committed more than three days.

PIs whose projects collaborated with business and industry were asked to identify the most important benefits they derived from those collaborations. For example, one PI noted that engaging business and industry partners gave them

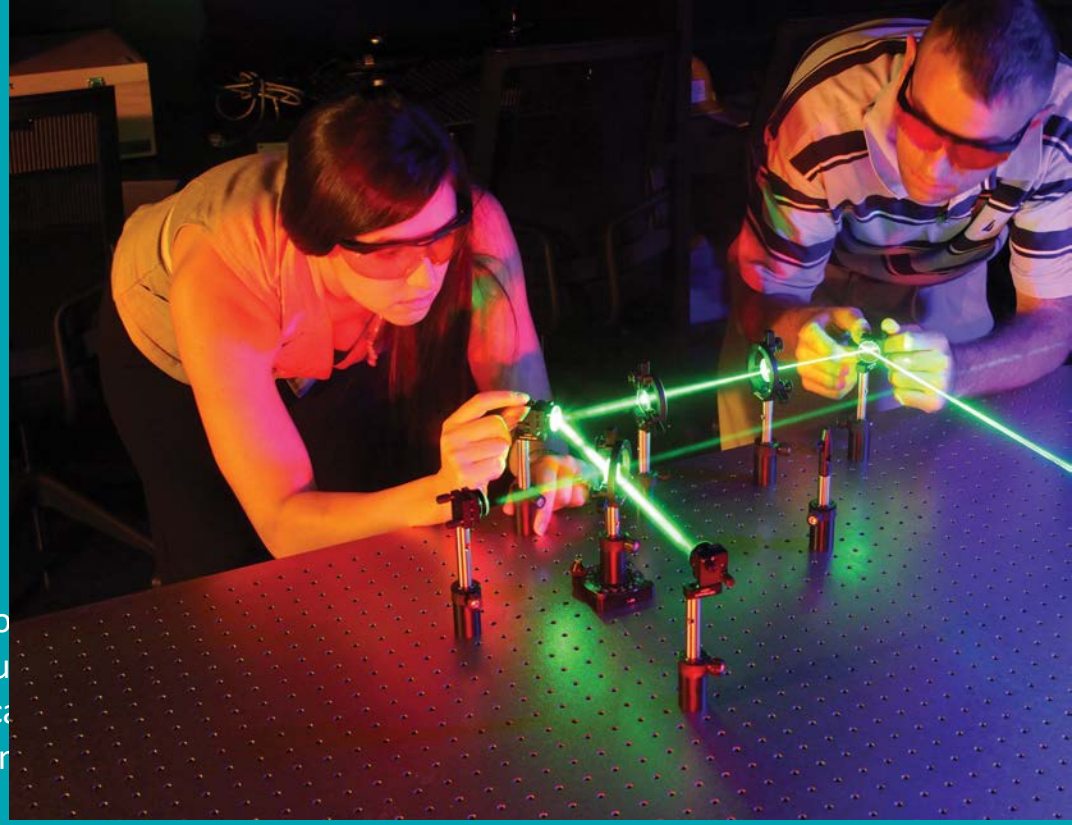
> **"a greater understanding of industry needs and what needs to be taught in the classroom to ensure graduates are prepared for entry level positions."**

Collaborating with industry allowed projects to "maintain relevant instructional material" and provided "insight into course and curriculum development." Partnerships with industry also benefited students, creating a "sustainable network of work study employers" and "student internships."

One respondent noted that their project was

> **able to offer our students more opportunities for work experience, including internships, and also provide students an opportunity to develop their confidence and presentation skills in sharing information about their career path with others."**

EVALUATION



All ATE projects are required to have an evaluatio
effectiveness. Evaluation of ATE and other NSF-fu
distinct purposes: (1) Produce information that ca
being implemented and (2) Determine and docur
(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 percent of ATE projects engaged an evaluator.

Most ATE projects (90%) had an evaluator in 2018. Of the 27 PIs who responded they did not have an evaluator, 16 were in their first year of funding. Most projects with an evaluator identified having an external evaluator (88%), with 9% having both an internal and external evaluator and 3% having only an internal evaluator.

Thirty 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 42% interacted with their evaluators occasionally (more often than quarterly) and 29% did so infrequently or rarely (once a quarter or less).

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

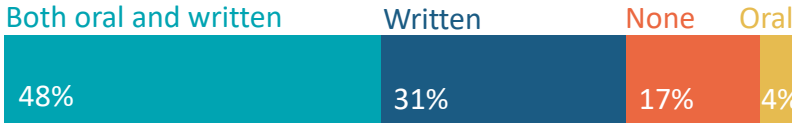


Figure 20. Percentages of projects that received oral and/or written reports (n=249)

Of the 207 PIs who received an evaluation report, 46% indicated their project's evaluation caused them to make a change in implementing their project and 10% indicated 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 and executive administrators, faculty, or staff at their host institutions.

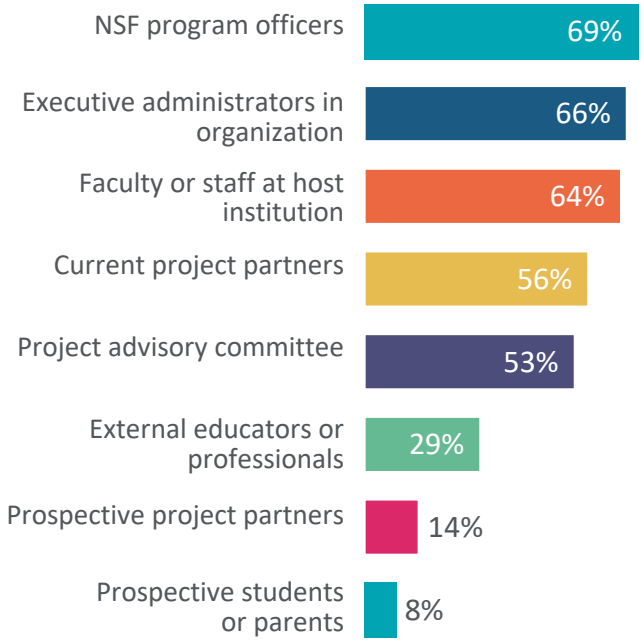


Figure 21. Percentage of projects that shared their evaluation results with various audiences (n=207)

ATE ANNUAL SURVEY
2019 HIGHLIGHTS

This summary of activities and achievements of the Advanced Technology Education (ATE) program is based on the 2019 ATE Annual Survey. Principal investigators for 92% (n=279) of ATE grants completed the survey, out of a total of 304 ATE grants. This included 229 projects, 32 centers, 4 conference grants, and 14 targeted research studies.

160 DEGREE PROGRAMS AND 423 COURSES
were developed by 99 ATE projects.

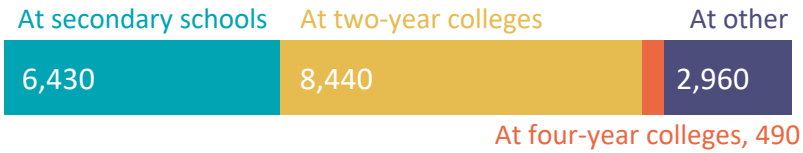
The majority of academic degree programs (51%) and courses (90%) developed were at the associate's degree level.

82
Associate's degree programs served 6,810 students

64
Certificate programs served 4,870 students

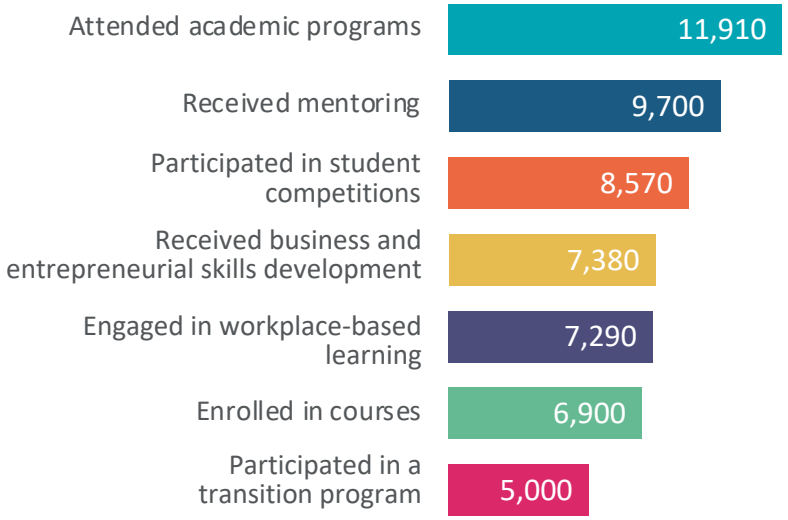
19,330 EDUCATORS
participated in 1,080 professional development activities.

The main audiences for ATE professional development activities were educators at **secondary schools** and **two-year colleges**.



50,000+ STUDENTS
were served by ATE projects.

ATE projects served over 50,000 students through a variety of activities.[1]



[1] Due to the structure of the survey questions, student counts cannot be combined because of the the high probability of double counting individual students.

ATE ANNUAL SURVEY

2019 HIGHLIGHTS continued

7,110 EDUCATIONAL MATERIALS

were developed by 126 ATE projects.

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

3,310
Assessment activities or tests

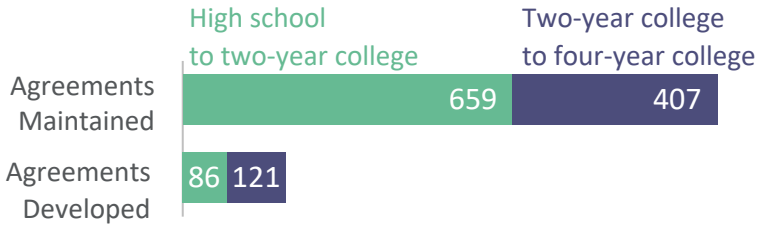
1,160
Modules or instructional units

1,010
Lessons or lesson plans

1,273 ARTICULATION AGREEMENTS

were developed or maintained by 48 ATE projects.

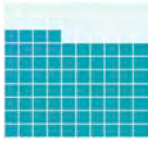
4,000 students matriculated to a higher-level education institution with the aid of an ATE-supported articulation agreement.



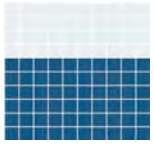
10,000 COLLABORATORS

were engaged by ATE projects.

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



74% collaborated with **business and industry partners**



60% collaborated with **other two- and four-year colleges**

OTHER ACTIVITIES were conducted by ATE projects in 2018 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 **3 coordination networks**

conducted **14 research studies**

hosted **10 conferences**

developed **228 publications**

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.

TECHNICAL NOTES

[i] The 2019 ATE Annual 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 for student characteristics by race, ethnicity, and gender in a single question. This approach differs from previous years, 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 2018. In previous years, projects reported student 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 2019 report.

[ii] National data for two-year STEM programs are from the 2015-16 National Center for Education Statistics Digest of Education Statistics *Table 321.50.* (Retrieved from https://nces.ed.gov/programs/digest/2014menu_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 (NCES). 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 secondary school level reflects enrollment in public schools in 2017 and is from *Table 203.60.* The national percentage of underrepresented minority students at the two-year and four-year levels reflects STEM degrees conferred in 2016, derived from *Table 321.30* for two-year institutions and *Table 322.30* for four-year institutions. Selected fields of study are the same as those listed in note ii.

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ATE Annual Survey

2019 Report

January 2020

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