IT STARTS HERE. ★

ARMY EDUCATIONAL OUTREACH PROGRAM

2022 Apprenticeships Evaluation Report
Summative Findings

July 2023

U.S. Army Contacts

Travis King, Ph.D.
Director for Basic Research
Office of the Deputy Assistant Secretary of the Army for Research and Technology
travis.l.king36.civ@army.mil

Mike Putnam
Senior Management Analyst
Office of the Deputy Assistant Secretary of the Army for Research and Technology
michael.b.putnam.ctr@army.mil

AEOP Cooperative Agreement Manager

Christina Weber
AEOP Cooperative Agreement Manager
U.S. Army Combat Capabilities Development Command (DEVCOM)
Christina.L.Weber.civ@army.mil

Brian Leftridge
Deputy AEOP Cooperative Agreement Manager
U.S. Army Combat Capabilities Development Command (DEVCOM)
brian.m.leftridge2.civ@army.mil

Battelle AEOP Cooperative Agreement Managers

David Burns
Project Director
burnsd@battelle.org

Augustina Jay
Project Manager
jaya@battelle.org

Stephanie Johnson
Program Manager
johnsonsa@battelle.org

Evaluation Team Contacts – Education Development Center, Inc.

Ginger Fitzhugh (co-PI)
gfitzhugh@edc.org

Alyssa Na'im (co-PI)
anaim@edc.org

Alemayehu Bekele
Cat Buechler
Joshua Cox
Leslie Goodyear
Craig Hoyle
Anne Huntington
Jill Marcus
Tracy McMahon
Sheila Rodriguez
Andresse St. Rose
Elissa West-Frazier

This report has been prepared for the AEOP Cooperative Agreement and the U.S. Army by Education Development Center, Inc. on behalf of Battelle Memorial Institute (Lead Organization) under award W911 SR-15-2-0001.

Contents

Executive Summary i
1 Introduction 4
1.1 AEOP Priorities & Goals 4
1.2 Overview of Participants 4
2 Evaluation Approach 5
2.1 Survey Respondents 5
2.2 Limitations 6
2.3 Report Organization 6
3 Overall Experience 7
3.1 Perceived Value of AEOP Resources 7
3.2 Program Satisfaction 8
3.2.1 Student Program Satisfaction 8
3.2.2 Mentor Program Satisfaction 8
3.3 Suggestions for Improvement 9
3.3.1 Students' Suggestions for Improvements 9
3.3.2 Mentors' Suggestions for Improvement 10
4 Program Activities 11
4.1 STEM Practices 11
5 Development of STEM Skills 13
5.1 STEM Skills 13
5.2 Planning and Carrying out Experiments 14
5.3 Analyzing and Interpreting Data 14
6 Development of 21st Century Skills 16
6.1 Communication and Collaboration 16
6.2 Critical Thinking and Problem Solving 17
6.3 Creativity and Innovation 17
6.4 Initiative, Self-Direction, and Flexibility 18
6.5 Media and Technological Literacy 19
7 Interest in STEM and STEM Careers 20
7.1 Interest in STEM 20

7.2 Interest in Pursuing STEM Education and Careers 21
7.3 Interest in Army/DoD STEM Research and Careers 22
8 Impact of S&E Mentors on Participants 25
8.1 Supporting the Diverse Needs of Students as Learners 27
8.2 Establishing the Relevance of Learning Activities 28
8.3 Supporting Student Development of Collaboration and Interpersonal Skills 28
8.4 Supporting Student STEM Activities and Educational Pathways 29
9 Recommendations 31

Executive Summary

The Army Educational Outreach Program (AEOP) offers students and teachers science, technology, engineering, and mathematics (STEM) programming that is designed to attract, develop, and mentor the next generation of the nation's diverse talent through United States (U.S.) Army educational outreach programs. The Apprenticeships program supports the AEOP mission and goals by providing high school, college, and graduate students with immersive STEM research opportunities in military and university laboratories across the United States and its territories.[1]

Education Development Center, Inc. (EDC), the external evaluation partner for AEOP, conducted a summative evaluation of the 2021-2022 program year. The Apprenticeships evaluation sought to document and assess the benefits of participation, program strengths and challenges, and overall effectiveness in meeting AEOP and program objectives. The primary tools for data collection were student and mentor post-surveys. It is important to recognize that survey results only reflect those individuals who completed surveys and cannot be applied across the Consortium and may not be generalizable within a specific program.

Key findings from the evaluation are presented below.

Overview of Participants

In FY22, Apprenticeships served a total of 468 participants- 76% (354) were students and 24% (114) educators, advisors, mentors, Science & Engineering (S&E) volunteers, or other adults. AEOP has a particular focus on reaching participants who have more limited access to STEM learning opportunities and/or who are from groups that are underrepresented in STEM education and careers. AEOP defines underserved and underrepresented participants as those who possess one or more of the following characteristics: attend a rural, urban, or frontier/tribal school; identify as female; identify as racial/ethnic minority in STEM (i.e., Alaska Native, Native American, Black or African American, Hispanic, Native Hawaiian and other Pacific Islander, other); receive free or reduced meals price at school; speak English as a second language (ELL); first generation college student; students with disabilities; or a dependent of a military service member or veteran.

AEOP has identified a particular interest in reaching students who meet two or more of the underserved and underrepresented criteria described above (referred to hereafter as Underserved). In FY22, 237 (67%) of all Apprenticeships student participants met two or more of the Underserved criteria. An additional 20% (72) of student participants met one of the AEOP Underserved criteria.

[1] AEOP supports high school, undergraduate, and graduate level apprenticeships as well as graduate and post-graduate level fellowships at Army research laboratories. For the purpose of this report, we have deemed all participants as "Apprenticeships."

Participant Experience and Outcomes

Apprenticeships exposed students to an array of STEM- related activities. According to survey results from both students and mentors, the majority of students had experiences working in teams, solving real-world problems, and interacting with STEM researchers; at least 95% of students and mentors reported that students had these opportunities. A relatively smaller majority of students worked with a STEM researcher on a real-world project, used laboratory procedures and tools, and designed and carried out an investigation; between 85% and 98% of students and 95% mentors reported some level of real-life STEM research with STEM professionals.

Students reported improved STEM skills such as: knowledge of STEM topics and STEM research; planning and carrying out an experiment; analyzing and interpreting data. Overall, between 84% and 99% of students and between 87% and 100% of mentors reported improvements in a range of STEM skills for participants.

Students noted gains in 21st Century skills such as: communication and collaboration; critical thinking and problem solving; and creativity and innovation. The majority of students (between 80% and 99%) indicated increased competencies in these areas. Students were less likely to report improvements in their skills related to media and technological literacy. Between 40% and 95% reported gains in this area.

Students' interest in STEM and STEM careers increased, including Army/DoD careers. Most students reported that they were more likely to engage in STEM activities after their participation in AEOP (ranging between 73% and 92%). They, along with their mentors, also indicated that AEOP had a positive influence on students' interest in earning a STEM degree (73% and 77%, respectively) as well as increased appreciation for Army/DoD research (at least 99% of students agreed or strongly agreed with various statements about Army/DoD research).

Mentors used a variety of strategies to engage with students. They reported using strategies to support the diverse needs of students, establish relevant learning activities, support students' development of collaboration and interpersonal skills, and support students' educational pathways. Across an array of items, mentors' responses fell between 53% and 100%.

Overall, both students and mentors reported generally positive experiences with Apprenticeships. Students enjoyed learning new STEM skills, working in teams, networking with STEM researchers. Mentors enjoyed engaging with students with opportunities for hands-on learning experiences, increasing students' interest in STEM, and providing students opportunities to work with others.

Most suggestions for improvement were specific to increased communication in preparation of the program and changes to the stipend, some also noted a desire for presentation opportunities for students.

Recommendations

Programmatic Considerations

- **Continue to offer hands-on, authentic, relevant experiences.** Research shows these kinds of experiences are important to developing and sustaining students' interest in STEM education and career pathways.
- **Consider creating opportunities for students to present their research.** Student and mentor survey responses alike advocated for student participants to have the chance to present their work at the end of the program. Such opportunities could continue to increase students' interest in STEM careers.
- **Facilitate more constant communication between program administrators, mentors, and student participants.** Both student and mentor survey responses indicated a desire for more transparency and timeliness when it came to the logistical aspects of the program- i.e., requirements for participation, deadlines, webinar dates, and email response time.
- **Update how stipends work.** All participants indicated they were satisfied with the stipends. However, participants also suggested improvements to the stipend process both in terms of eligibility and faster payouts. Such improvements can continue to increase the diverse pool of student participants and continue to produce positive outcomes because of participation in Apprenticeships.

Evaluation Considerations

- **Continue to examine ways to increase response rates.** The relatively low survey response rates for students and mentors (23% and 52%, respectively) make it difficult to generalize the findings. The EDC evaluation team is working with IPAs to troubleshoot these issues and develop strategies to improve response rates.

1 Introduction

1.1 AEOP Priorities & Goals

The Army Educational Outreach Program (AEOP) mission is to provide an accessible pathway of science, technology, engineering, and mathematics (STEM) opportunities to attract, develop, and mentor the next generation of our nation's diverse talent through United States (U.S.) Army educational outreach programs. The Apprenticeships program supports the AEOP mission and priorities by providing high school, college, and graduate students with immersive STEM research opportunities in military and university laboratories across the United States and its territories.[2]

AEOP has three priorities:

1. **STEM Literate Citizenry.** Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base (DIB).
2. **STEM Savvy Educators.** Support and empower educators with unique Army research and technology resources.
3. **Sustainable Infrastructure.** Develop and implement a cohesive coordinated, and sustainable STEM education outreach infrastructure across the Army.

1.2 Overview of Participants

In FY22, Apprenticeships served a total of 468 participants – 76% (354) were students and 24% were (114) educators, advisors, mentors, Science & Engineering (S&E) volunteers, or other adults.

In FY22, 67% (237) of all Apprenticeships student participants met two or more of the Underserved criteria. An additional 20% (72) of student participants met one of the AEOP Underserved criteria. AEOP has a particular focus on reaching participants who have more limited access to STEM learning opportunities and/or who are from groups that are underrepresented in STEM education and careers. AEOP has identified an interest in reaching students who meet two or more of the underserved and underrepresented criteria (referred to hereafter as Underserved). AEOP defines Underserved participants as those who possess one or more of the following characteristics: attend a rural, urban, or frontier/tribal school; identify as female[3]; identify as racial/ethnic minority in STEM (i.e., Alaska Native, Native American, Black or African American, Hispanic, Native Hawaiian and other Pacific Islander, other); receive free or reduced meals price at school; speak English as a second language (ELL); first generation college student; students with disabilities; or a dependent of a military service member or veteran.

[2] AEOP supports high school, undergraduate, and graduate level apprenticeships as well as graduate and post-graduate level fellowships at Army research laboratories. For the purpose of this report, we have deemed all participants as "Apprenticeships."
[3] In two AEOP programs—Junior Science and Humanities Symposium (JSHS) and Apprenticeships—only females engaged in certain STEM fields (physical science, computer science, mathematics, or engineering) are considered as underserved. For the purpose of this analysis, we have included all students who identified a female but not based on their STEM discipline, as those data were not available. This likely overestimates numbers for JSHS and Apprenticeships.

2 Evaluation Approach

Education Development Center, Inc. (EDC) became the AEOP's external evaluation partner in fall 2021. The primary tools for data collection were student and mentor post-surveys, which were designed to evaluate the benefits of participation, program strengths and challenges, and overall effectiveness in meeting AEOP and program objectives. Some survey questions were asked of all participants across all AEOP programs, some questions were similar across programs but asked in slightly different ways depending on the program, and some questions were unique to a particular program.

Table 1. Research Questions Addressed in This Report

AEOP Priority	Research Questions Regarding Participants
STEM Literate Citizenry: Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.	*Participant Research Question #1* - To what extent do participants report growth in interest and engagement in STEM?
	Research Question #2a - To what extent do participants report increased STEM competencies, 21st Century/STEM skills, STEM knowledge, STEM abilities, and STEM confidence?
	Research Question #2b – To what extent do participants demonstrate use of and growth in 21st Century skills?
	Participant Research Question #3 - To what extent do participants and mentors report increased participant interest in STEM research and careers?
	Participant Research Question #4 - To what extent do participants and mentors report increased awareness of and interest in Army/DoD STEM research and careers?
	Research Question #5 - To what extent do participants report increased enrollment, achievement, and completion of STEM degree programs?
STEM Savvy Educators: Support and empower educators with unique Army research and technology resources.	*Research Question #6* - What is the impact of scientist and engineer (S&E) mentors on AEOP participants?
	Research Question #7 - To what extent do teacher participants report increased use of new approaches to teaching research concepts within STEM practices, and infusion of careers?
Sustainable Infrastructure: Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.	*Research Question #8* - To what extent do participants report growth in awareness of and/or interest in AEOP opportunities?

2.1 Survey Respondents

This report describes participant data and results from student and mentor surveys. Table 5 shows the number of surveys by program.

Table 2. Participant and Mentor Survey Response Rates

	Participant Surveys		Mentor Surveys	
Program	Count	Response Rate	Count	Response Rate
Apprenticeships	84	23%	59	52%

2.2 Limitations

It is important to recognize that survey results only reflect those individuals who completed surveys and may not be generalizable within Apprenticeships. Due to the relatively low response rates for both participants and mentors (23% and 52%, respectively), it is possible that these responses do not generalize well to the populations that were involved in the Apprenticeships programs.

It is also important to consider the characteristics of survey respondents. For example, some of the respondents had not yet completed high school at the time of the survey, while others are undergraduate students. In this instance, it is important to note that we cannot reasonably expect respondents to report postsecondary outcomes that are long-term goals of the AEOP program.

Finally, while we have presented participant and mentor findings together topically, these results should be interpreted with caution since the proportions of respondents for each group vary considerably by program. In addition, not all questions across the participant and mentor surveys are exactly aligned.

2.3 Report Organization

Evaluation findings presented below are guided by the research questions and organized thematically by topic. Sections include the following:

- Overall Experience
- Program Activities
- Development of STEM Skills
- Development of 21st Century Skills
- Interest in STEM and STEM Careers
- Impact of S&E Mentors on Participants
- Recommendations

3 Overall Experience

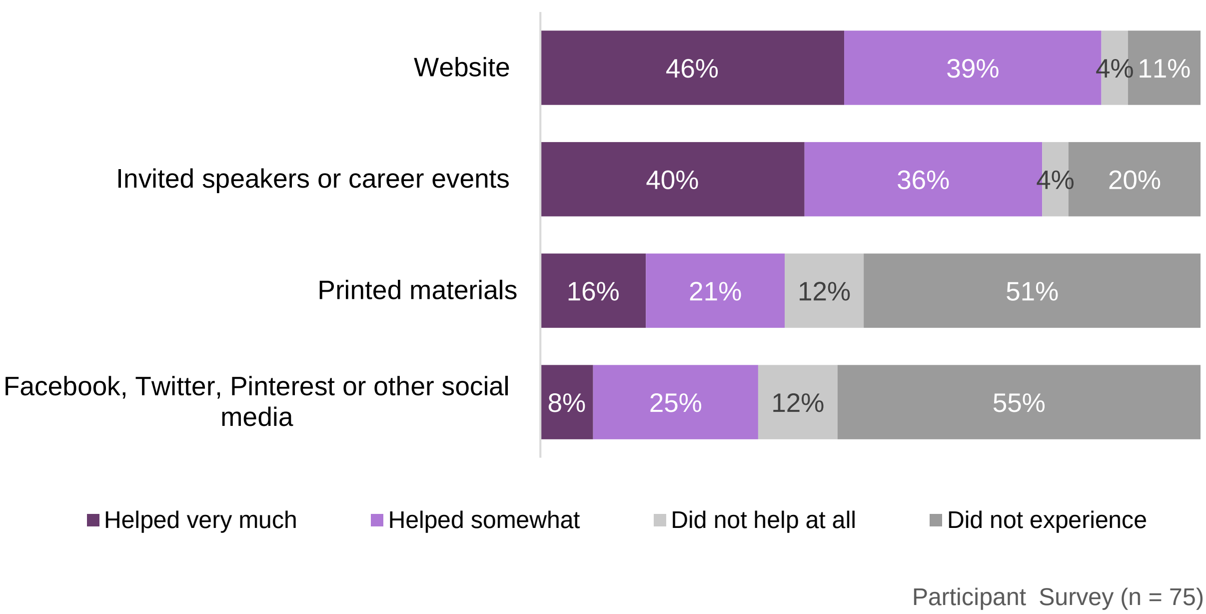
In general, students and mentors reported positive experiences with the Apprenticeships program. Students enjoyed learning new STEM skills, working in teams, and networking with STEM researchers. Mentors enjoyed engaging with students in opportunities for hands-on learning experiences, increasing students' interest in STEM, and providing students opportunities to work with others.

Suggestions for improvement from students were focused on better communication, organization, and planning information (e.g., dates or schedules and participation requirements). Other suggestions for improvements included updates to the way stipends are awarded and affording students the opportunity to present their research at the end of the program.

3.1 Perceived Value of AEOP Resources

Overall, students said that the AEOP website was by far the most helpful resource available to them, while printed and social media were considered less helpful. Students rated the printed materials and social media as relatively less useful than more personal methods such as invited speakers or career events (Figure 1). More than one-half of students said they did not use or were not aware of print or AEOP social media resources, whereas 89% of students reported having used the website (and 75% of students said the website was helpful).

Figure 1. Students reported the AEOP website was the most helpful AEOP resource, while social media was the least effective resource



3.2 Program Satisfaction

To assess overall satisfaction, the surveys asked both students and mentors an open-response question, *please tell us about your overall satisfaction with your Apprenticeships experience*.[4] Although many responses were particular to specific programs, several high-level themes stood out.

3.2.1 Student Program Satisfaction

Roughly 60% of respondents stated that they were very satisfied with the Apprenticeship program. Students believed that they learned valuable skills because of their participation in the Apprenticeships program. Around 70% of the 49 respondents stated that one of the main benefits of Apprenticeships was learning new research and other technical skills. This included skills such as, how to perform or conduct research, learning more about scientific writing, and improving electrical engineering, quantum computing and laboratory skills. About 40% of participants stated that networking, working with others and collaboration was a benefit of the program. For example, this included learning how to collaborate in a laboratory setting. It also exposed them to network or meet other researchers in the field. Approximately 40% of respondents also stated that the program helped them in learning more about careers in the STEM field, such as helping them understand STEM careers and the path they would need to take.

Table 3. Reasons students gave for their satisfaction with AEOP

Theme	Quote
Learned new research and technical skills	*I learned a lot about scientific research in general, as well as the many opportunities available to me, and the power of effective collaboration.*
Had the opportunity to work with others	*The program gave me real insight into an actual laboratory. […] It also let me work with like-minded people on the same project and build my collaboration skills.*
Networked with other STEM researchers	*The Apprenticeship Program expanded my view on scientific research, improved my confidence, and helped me form connections within the scientific community.*
Increased knowledge of STEM career pathways	*[The program] gave me connections and an understanding of the path to a STEM career.*

3.2.2 Mentor Program Satisfaction

Mentors were satisfied with their role in the Apprenticeships program. The majority of mentors (more than 90%) reported that they were very satisfied with the Apprenticeship program. The mentors mentioned that working with the students and the quality of students was

[4] Because of the large number of responses to open-ended questions, the EDC evaluation team selected and analyzed a representative sample of the responses to each open-ended question using a 90% confidence level with a 10% margin of error.

the best part of the program. About 40% of respondents stated that the hands-on experience is one of the strengths of the program. Several respondents stated that interns get to experience real-world projects and were exposed to real STEM research. About one-third of respondents also stated that the mentorship and exposure to scientists and other professionals in the field was a strength of the program.

One-fourth of respondents also mentioned that the program is a mechanism to support students and to keep them on track towards a STEM career. Mentors also mentioned that the pool of students is diverse, they are knowledgeable, and they appreciate that they can select students based on their major and interests. Mentors also indicated satisfaction with stipends, the increases in students' interests in STEM, and the flexibility of topics offered.

Table 4. Reasons mentors gave for their satisfaction with the Apprenticeship program

Theme	Quote
Provides hands-on experiences to students	*I have sponsored four AEOP interns and all of them have been exceptional assets to our office. One former intern is currently working for me and we are keeping this year's intern and encouraging them to apply for the SMART Scholarship Program so they can join our office once they graduate.*
Allows students opportunities to meet and work with other students, scientists, researchers, and other professionals	*Allowing students to interact with peers during the apprenticeship. Providing a strong and diverse pool of applicants to DoD researchers seeking to be mentors*
Stipend enables a pool of diverse students	*Since it pays students, it allows them to do scientific research for the summer, even if they are from low-income households and are expected to get a "summer job." This allows them to earn income for tuition and their family, while they carry out real research.*
Increases students' interest in STEM	*Being a mentor [in the Apprenticeship Program] gave me immense pleasure and satisfaction to help the younger generation cultivate an interest/hunger to learn about the research and development of practical technologies in STEM-related fields. This not only helps DoD but also society.*

3.3 Suggestions for Improvement

In addition to asking students and mentors about their overall satisfaction, the survey also asked participants to identify areas for improvement. Both students and mentors were asked, *what are the three ways Apprenticeships should be improved for future participants?* Mentors were also asked, *what are the three ways Apprenticeships should be improved for mentors/team advisors?* A high-level summary of key themes is included below.

3.3.1 Students' Suggestions for Improvements

Student responses indicated a desire for improved communications. More than one-tenth of the students stated that they wanted better communication, organization, and planning information from program leads. This included clearer communication about program activities, due dates, and the requirements of participants.

About one-tenth of students stated that they wanted an increase in stipend amounts or faster pay out of stipends. Several students also stated that they wanted more opportunities to share their work with peers and present their work at conferences and symposiums. Additionally, some student participants advocated for more individual mentorship opportunities due to the belief that it would enable them to produce more useful results.

3.3.2 Mentors' Suggestions for Improvement

Mentors' suggestions for improvement were largely about programmatic and administrative aspects of the program. About one-fourth of respondents offered suggestions for improving their experience as mentors. For example, they mentioned that the program could provide a program overview, syllabus, or schedule of the initial work; mentors also suggested that the program should provide a checklist of outcomes and topics or a factsheet or summary background information about the apprenticeships. Communications was also mentioned by several respondents. Mentors would appreciated receiving notice early in the summer to allow adequate time to adjust to program schedules.

Some mentors also left remarks on the funding. A few mentors noted that funds should be sent to mentors in a timely manner so that they could prepare for their apprentices. One mentor suggested that students "*should be granted larger stipends based on experience, not just GPA*."

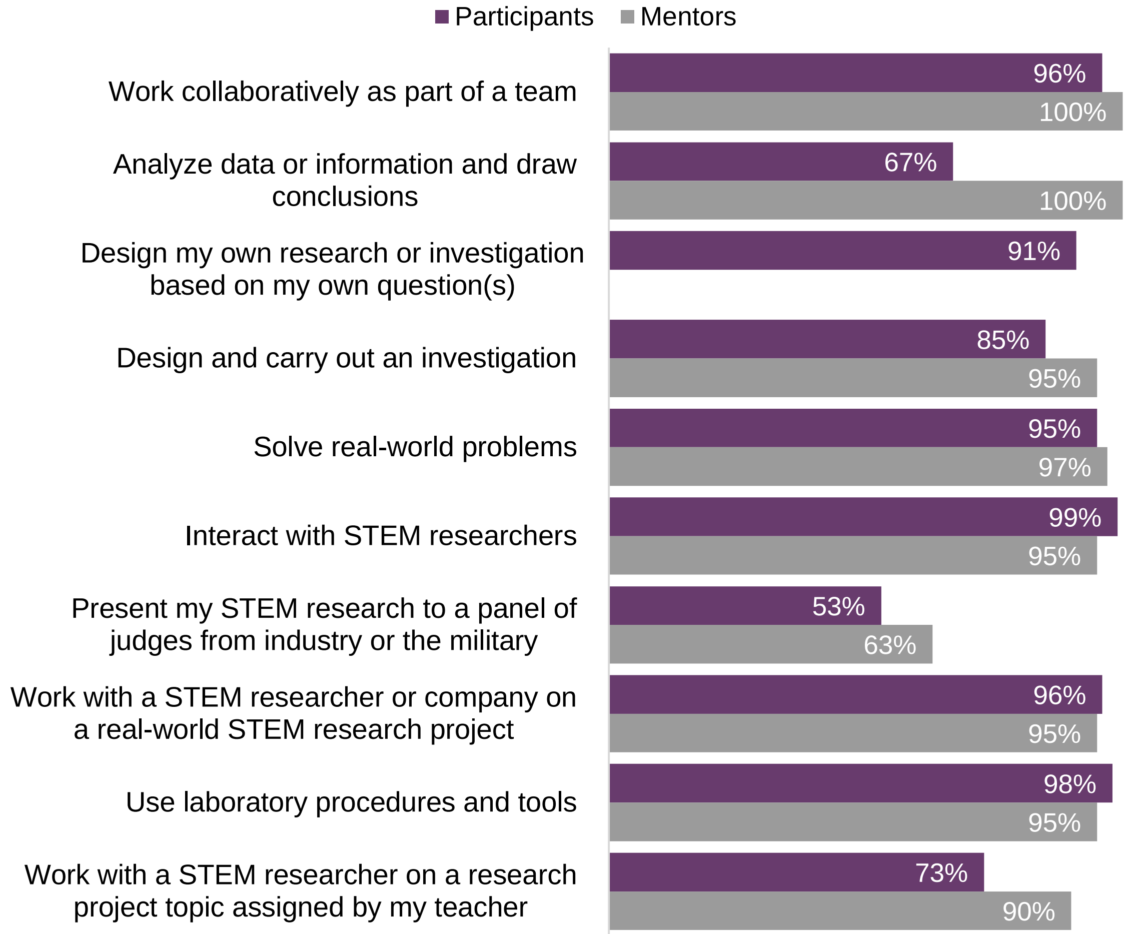
4 Program Activities

Apprenticeships gave high school and undergraduate students the opportunity to engage in a variety of STEM-related activities. According to survey results from both students and mentors, the majority of students had experiences working in teams, solving real-world problems, and interacting with STEM researchers; at least 95% of students and mentors reported that students had these opportunities. A relatively smaller majority of students worked with a STEM researcher on a real-world project, used laboratory procedures and tools, and designed and carried out an investigation; between 85% and 98% of students and 95% mentors reported some level of real-life STEM research with STEM professionals.

4.1 STEM Practices

Apprenticeships participants had opportunities to engage in a variety of STEM activities. Most participants reported interacting with STEM researchers (99%), using laboratory procedures and tools (98%), engaging in collaborative teamwork (96%), and working with a STEM researcher on a project (96%). Results from mentor surveys were similar, with the vast majority of mentors reporting that their students engaged in each of these activities (between 95% and 100%, Figure 2). By comparison, fewer participants reported designing and carrying out an investigation; between 85% and 91% of students reported having this opportunity.

Figure 2. AEOP participants had opportunities to engage in a variety of STEM activities



Participant Survey (n = 84)
Mentor Survey (n = 62)
Participant responses include those who reported, “at least once,” "every day,” and “most days.”
Mentor responses include those who reported, “at least once, “every day,” “a few times,” and “most days.”

5 Development of STEM Skills

Participants reported gains in a number of STEM research skills as a result of their participation in Apprenticeships. Students improved their knowledge of STEM topics and increased their knowledge of how scientists and engineers work on real-world problems, through everyday research within the STEM field. Mentors were only slightly more likely than students to report that they experienced gains as a result of their participation in Apprenticeships.

5.1 STEM Skills

Survey results indicate that the majority of students increased their knowledge of STEM and various aspects of STEM research. Both students and mentors were asked about an array of STEM- and research-related skills. Students were asked to report to what extent they learned about a specific topic (from “did not learn” to “learned a lot”); mentors were asked to indicate to what degree their students had experienced gains in the same areas (from “no gain” to “large gain”). As Table 5 shows, students and mentors consistently reported increases in all areas. Mentors were more likely than students to report gains from their participation in Apprenticeships.

Table 5. Students increased their knowledge of STEM and various aspects of STEM research

Response	*Participant* / *Mentor*	Did not learn / No gain	Learned just a little / Small gain	Learned more than a little / Medium gain	Learned a lot / Large gain	Overall Learning or Gain
In-depth knowledge of a STEM topic(s)	Participant	1%	4%	36%	59%	**99%**
	Mentor	0%	3%	31%	66%	**100%**
Knowledge of research processes, ethics, and rules for conduct in STEM	Participant	1%	5%	23%	71%	**99%**
	Mentor	0%	11%	23%	66%	**100%**
Knowledge of how scientists and engineers work on real problems in STEM	Participant	1%	4%	19%	76%	**99%**
	Mentor	0%	2%	27%	71%	**100%**
Knowledge of what everyday research work is like in STEM	Participant	3%	0%	11%	86%	**97%**
	Mentor	0%	5%	13%	82%	**100%**
Supporting an explanation with STEM knowledge*	Participant	-	-	-	-	**-**
	Mentor	0%	18%	31%	52%	**100%**
Making a model to show how something works*	Participant	-	-	-	-	**-**
	Mentor	13%	37%	21%	29%	**87%**

Participant Survey (n = 80)

Mentor Survey (n = 62)

*This question was not asked of participants

5.2 Planning and Carrying out Experiments

Most students improved skills associated with planning and carrying out investigations. Like the items above, both students and mentors were asked to report to what extent students learned or experienced gains in a number of areas related to conducting experiments. Mentors consistently were more likely than their students to report gains, though percentages were generally high across all areas (see Table 6).

Table 6. Students improved skills related to planning and carrying out investigations

Response	*Participant* / *Mentor*	Did not learn / No gain	Learned just a little / Small gain	Learned more than a little / Medium gain	Learned a lot / Large gain	Overall Learning or Gain
Designing procedures or steps for an experiment or designing a solution that works	Participant	5%	20%	34%	41%	**95%**
	Mentor	2%	15%	39%	45%	**98%**
Creating a hypothesis or explanation that can be tested in an experiment/problem	Participant	9%	24%	39%	28%	**91%**
	Mentor	3%	16%	47%	34%	**97%**
Carrying out an experiment and recording data accurately	Participant	4%	9%	28%	60%	**97%**
	Mentor	5%	10%	23%	63%	**95%**
Defining a problem that can be solved by developing a new or improved product or process	Participant	6%	14%	38%	42%	**94%**
	Mentor	2%	23%	44%	32%	**98%**
Presenting an argument that uses data and/or findings from an experiment or investigation	Participant	11%	10%	33%	46%	**89%**
	Mentor	2%	11%	44%	44%	**98%**

Participant Survey (n = 80)

Mentor Survey (n = 62)

5.3 Analyzing and Interpreting Data

Students developed skills in data analysis and interpretation. Students and mentors were also asked about to what degree students learned or gained experience with analyzing and interpreting data. Table 7 shows the full list of items related to analyzing and interpreting data. Students were least likely to report learning to create charts or graphs to display data; in fact, nearly one-fifth of students said that they "did not learn" this during their participation in Apprenticeships, which maybe be an indication that this was not a major component of the program.

Table 7. Students developed skills in data analysis and interpretation

Response	*Participant* / *Mentor*	Did not learn / No gain	Learned a lot / Large gain	Learned more than a little / Medium gain	Learned just a little / Small gain	Overall Learning or Gain
Considering multiple interpretations of data to decide if something works as intended	Participant	9%	16%	31%	44%	**91%**
	Mentor	0%	19%	45%	36%	**100%**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts	Participant	5%	15%	30%	49%	**94%**
	Mentor	2%	27%	36%	36%	**98%**
Identifying the limitations of the methods and tools used for collecting data	Participant	0%	15%	31%	54%	**100%**
	Mentor	2%	15%	43%	40%	**98%**
Creating charts or graphs to display data and find patterns	Participant	17%	18%	27%	39%	**84%**
	Mentor	3%	13%	27%	57%	**97%**

Participant Survey (n = 80)

Mentor Survey (n = 62)

6 Development of 21st Century Skills

In addition to reporting to what extent they experienced gains in STEM-related skills, students were also asked to indicate gains in 21st Century Skills. Students reported increases in nearly all areas; they were less likely to indicate growth in their media and technological literacy skills, though this may be most likely due to the program not engaging in related activities.

The surveys asked about skills in five main areas:

1. Communication and Collaboration
2. Critical Thinking and Problem Solving
3. Creativity and Innovation
4. Initiative, Self-Direction, and Flexibility
5. Media and Technological Literacy

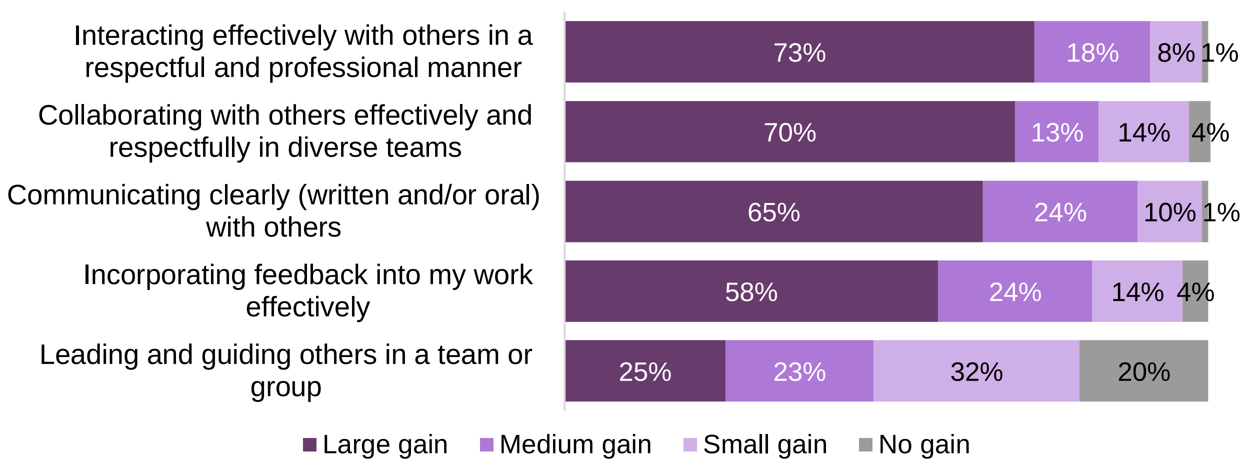
Results from each domain are below.

6.1 Communication and Collaboration

Overall, students overwhelmingly reported gains in their communication and collaboration skills. They reported that they gained skills in communicating clearly (written and/or oral) with others (99%), incorporating feedback into their work (96%), and collaborating with others effectively and respectfully in diverse teams (96%). Students were least likely to report gains in leading and guiding others in a team or group (80%), though this may not have been a central focus of the Apprenticeships program.

Figure 3 below shows responses to these items, including the full range of scaled responses (i.e., from “no gain” to “large gain”).

Figure 3. Students improved their communication and collaboration skills, but were less likely to report improved skills leading within a team

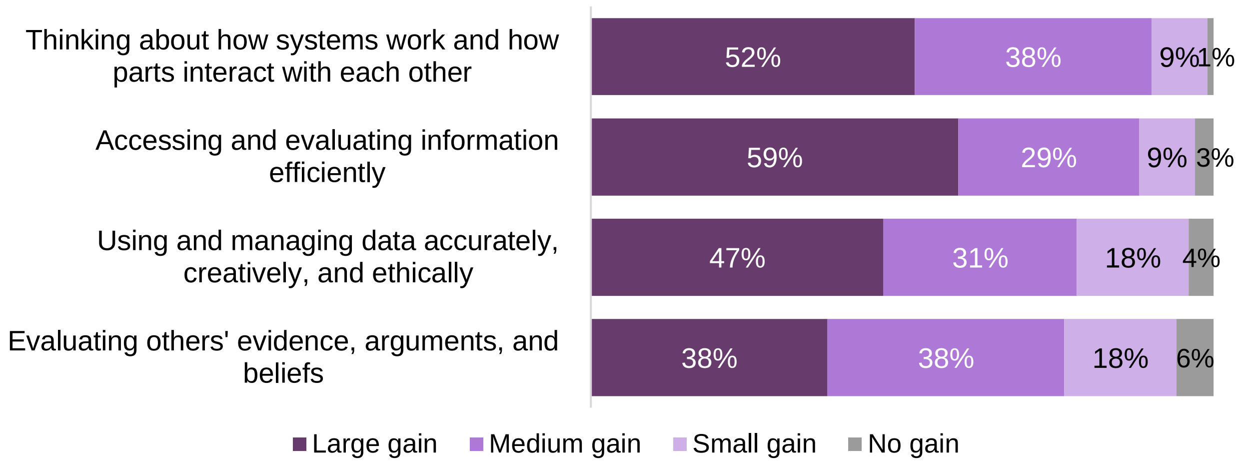


Participant Survey (n = 81)

6.2 Critical Thinking and Problem Solving

Students indicated that they improved various critical thinking and problem-solving skills. The majority of participants reported gains in their ability to think about how systems work and how parts interact with each other (99%); access and evaluate information efficiently (97%); use and manage data accurately, creatively, and ethically (96%); and evaluate others' evidence, arguments, and beliefs (94%). See Figure 4 below for the full range of responses to these items.

Figure 4. Students improved various critical thinking and problem-solving skills

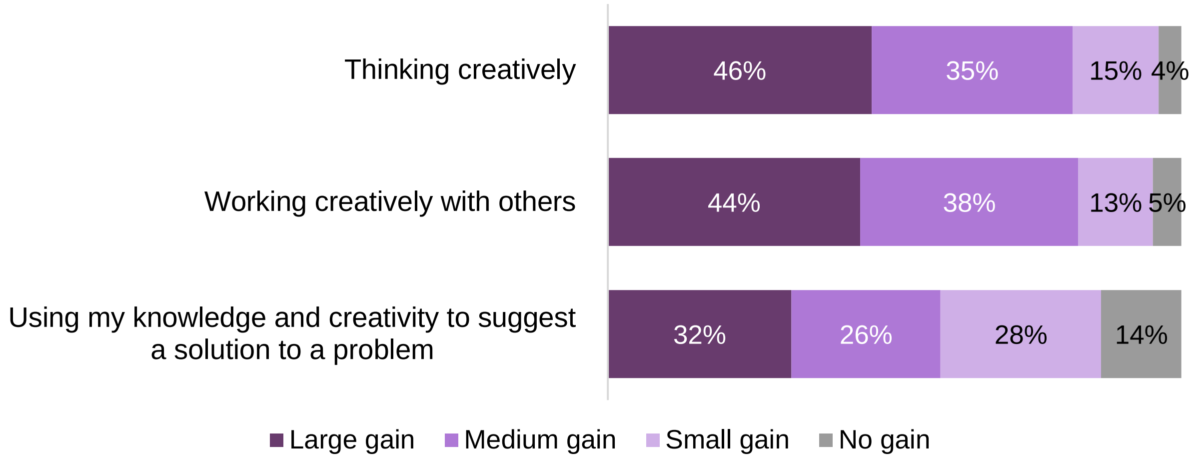


Participant Survey (n = 80)

6.3 Creativity and Innovation

Students increased their innovation skills and ability to use creative approaches to address problems. As Figure 5 shows, most students reported that they increased their skills at thinking creatively (96%), working creatively with others (95%), and using knowledge and creativity to suggest a solution to a problem (86%).

Figure 5. Students increased their ability to work more flexibly and creatively.

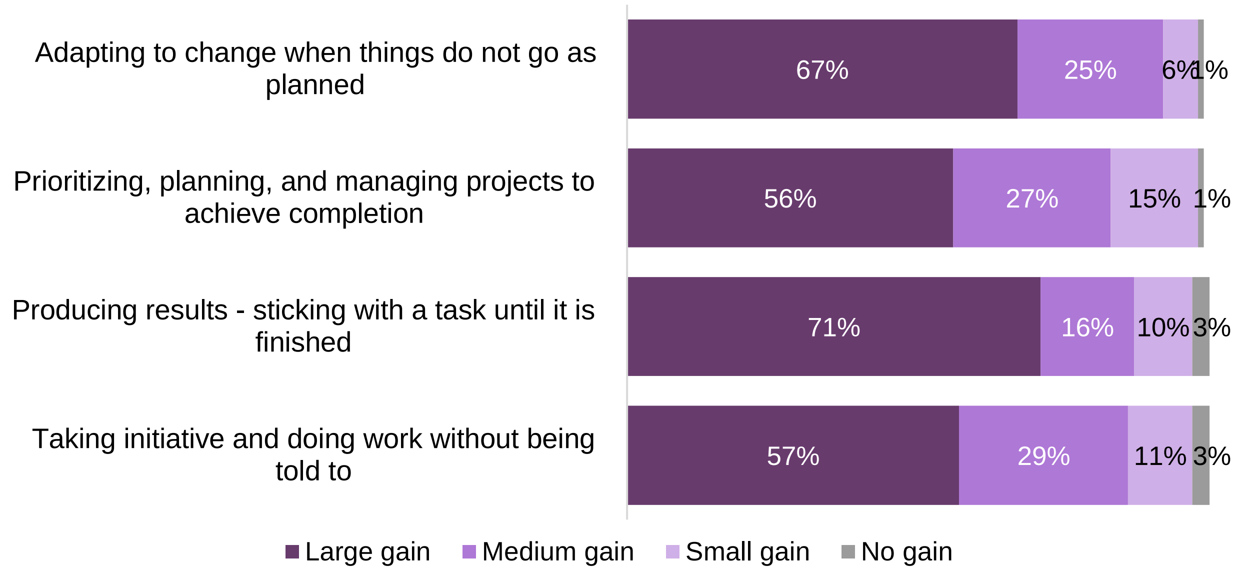


Participant Survey (n = 80)

6.4 Initiative, Self-Direction, and Flexibility

The majority of students reported gains in work habits related to taking initiative, self-direction, and flexibility. On a list of several items, adapting to change when things do not go as planned and prioritizing, planning, and managing projects to achieve completion were at the top of the list, with 99% of all students reporting gains in each area. A slightly smaller, but still high, proportion of students (97%) reported improvement in producing results and taking initiative and doing work without being told to. In addition, these two items had the highest proportion of students who reported “no gain” (3%) or “a small gain” (10% and 11%, respectively). See Figure 6 for the full list of items and range of responses.

Figure 6. Students increased work habits related to taking initiative, self-direction, and flexibility

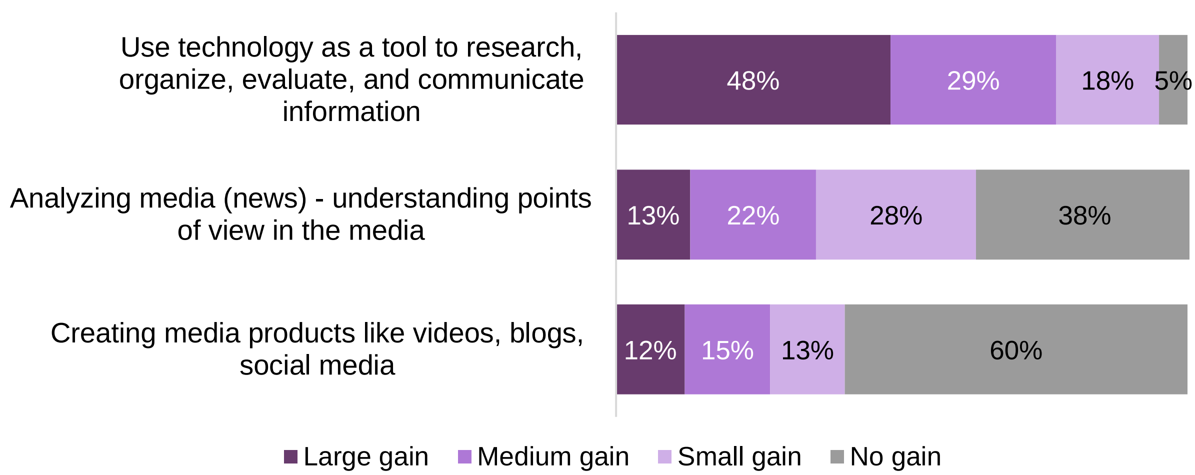


Participant Survey (n = 80)

6.5 Media and Technological Literacy

Among the 21st century skills assessed on the survey, students were least likely to report gains in media and technological literacy. Overall, between 40% and 95% of students reported gains in this area (see Figure 7). Analyzing news media and creating media products were particularly low, with 62% and 40% reporting improvements. These relatively lower percentages are most likely due to Apprenticeships not engaging in related activities.

Figure 7. Students were less likely to report gains in media and technological literacy



Participant Survey (n = 80)

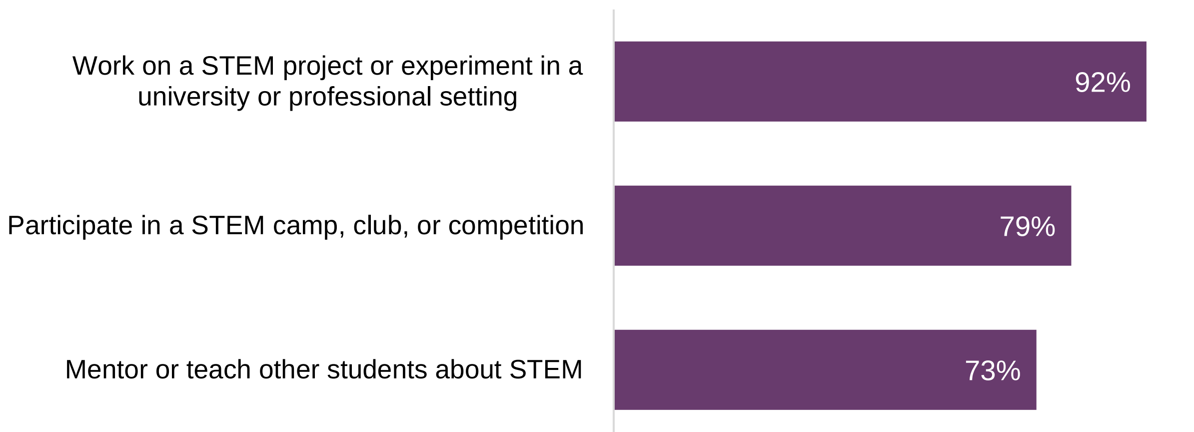
7 Interest in STEM and STEM Careers

The survey results show that participating in Apprenticeships positively influenced students' inclination toward STEM education, interest and exploration, and community service projects, as well as mentoring or teaching other students. The program also increased students' interest in pursuing a STEM career and Army or DoD research, and many students learned about Army, or DoD careers through their participation in Apprenticeships.

7.1 Interest in STEM

Most students reported that they were more likely to engage in other STEM activities after their participation in the Apprenticeships program. As shown in Figure 8, the majority of students reported a higher inclination to engage in STEM education and training opportunities such as working on a STEM project or experiment (92%) or participating in a STEM camp, club, or competition (79%), or mentor or teach other students about STEM (73%).

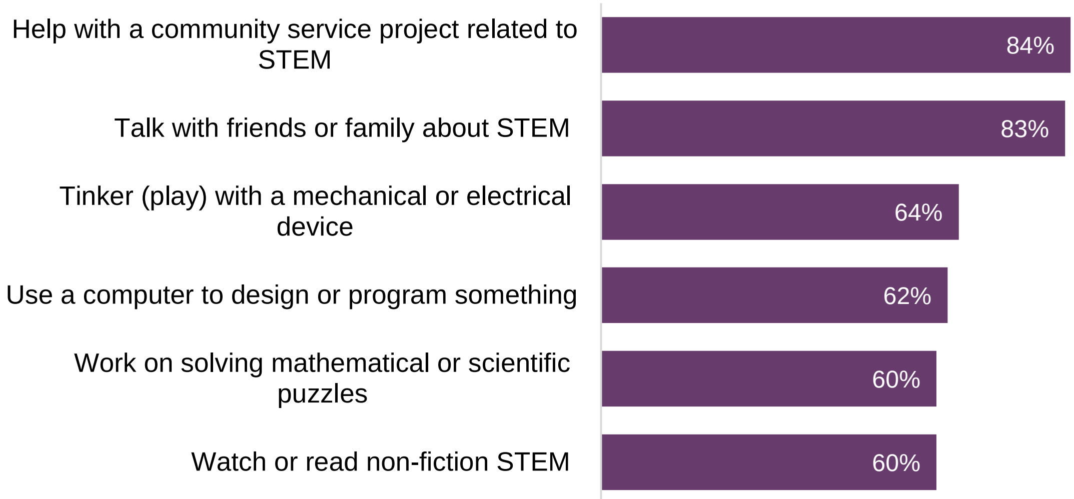
Figure 8. Most students reported an increase in their interest in participating in other kinds of STEM-related activities



Participant Survey (n = 76)
Responses include those who reported, "more likely" and "much more likely."

As Figure 9 shows, a notable proportion of students were also more interested in helping with a community service project related to STEM (84%) and talking with friends and family about STEM (83%).

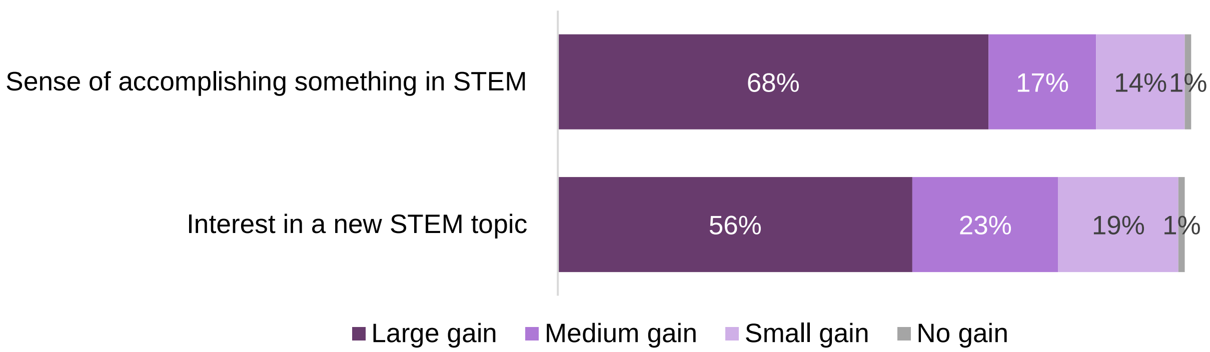
Figure 9. More than half of students reported an increase in their interest in STEM information and exploration



Participant Survey (n = 76)
Responses include those who reported, “more likely” and “much more likely.”

Nearly all students indicated they gained an interest in a new STEM topic (99%) and a sense of accomplishing something in STEM (99%) due to participating in Apprenticeships (Figure 10).

Figure 10. Most students said Apprenticeships increased their STEM Confidence

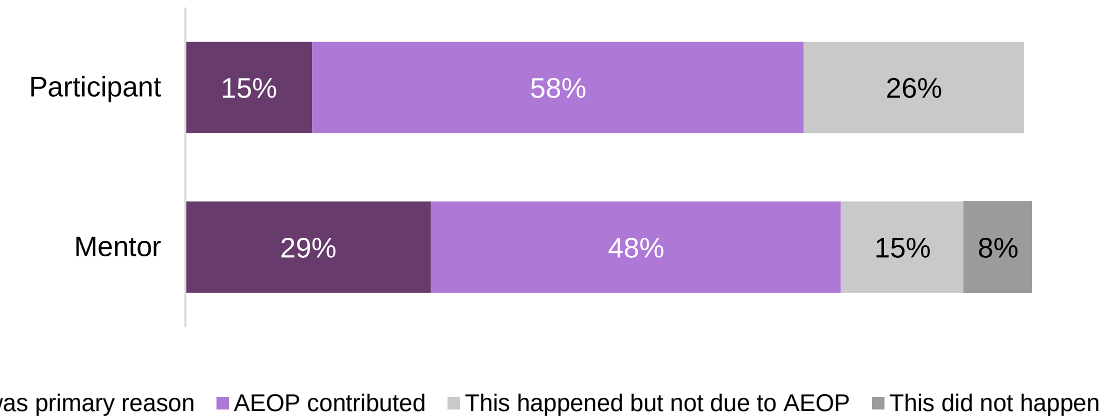


Participant Survey (n = 78)

7.2 Interest in Pursuing STEM Education and Careers

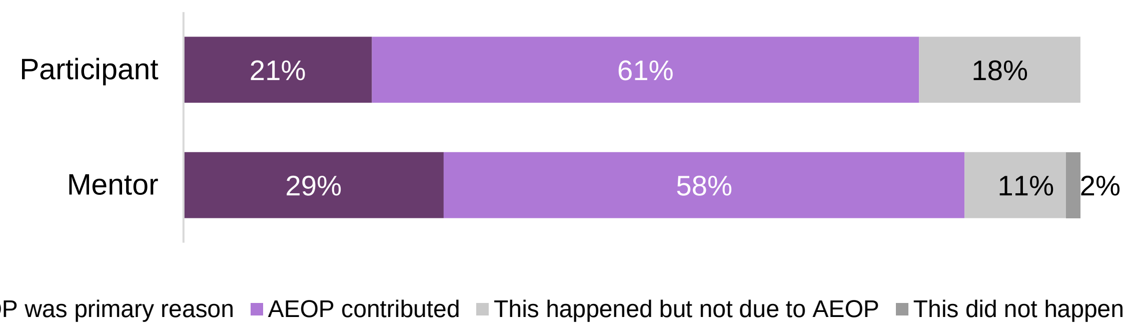
Apprenticeships had a positive influence on students’ interests in STEM education and careers. The surveys asked both students and mentors about students’ interests in earning a STEM degree and pursuing a STEM career (see Figure 11 and Figure 12). Overall, both groups reported students had increased interest, although a higher proportion of mentors than students reported that AEOP contributed to students’ interest. As Figure 11 shows, 73% of students and 77% of mentors reported that the program had influenced students’ interest in *pursuing a STEM* *degree*. When asked about their interest in *pursuing a STEM career*, 82% of students and 87% of mentors indicated that AEOP had an influence (Figure 12).

Figure 11. Apprenticeships had a positive influence on students' interest in earning a STEM degree



Participant Survey (n = 72)
Mentor Survey (62)

Figure 12. Apprenticeships contributed to increasing students' interests in pursuing a STEM career

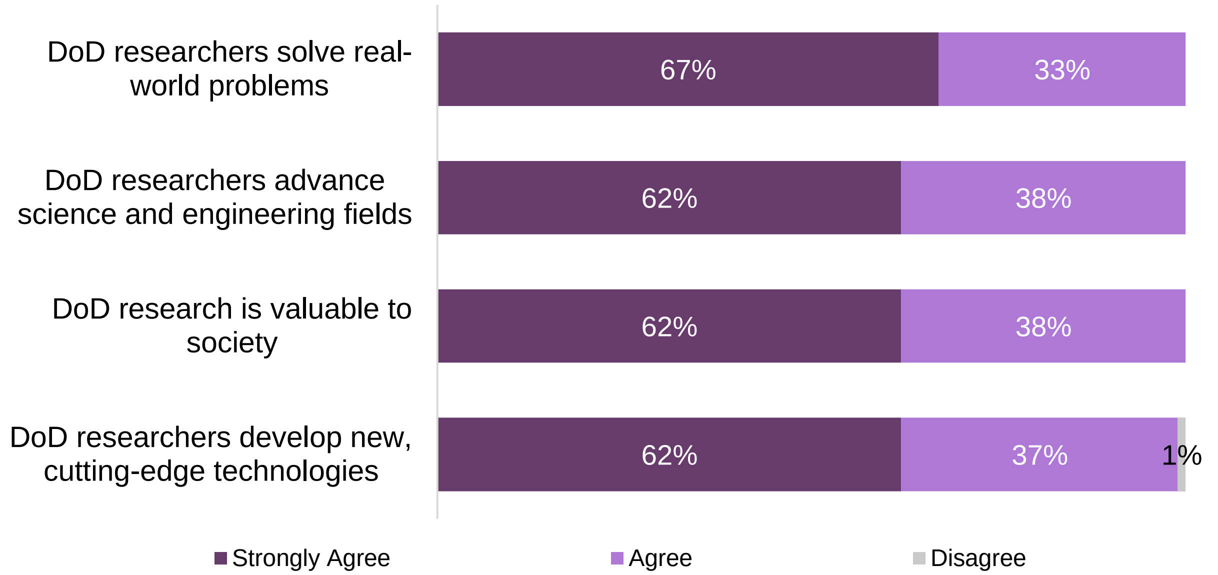


Participant Survey (n = 72)
Mentor Survey (n = 62)

7.3 Interest in Army/DoD STEM Research and Careers

Students gained a greater appreciation of and interest in Army/DoD STEM research and careers through their participation in Apprenticeships. AEOP has an explicit connection to the Army and DoD. Overall, students also agreed that DoD research is important (Figure 13). All or nearly all students (at least 99%) agreed or strongly agreed that DoD researchers advance science and engineering fields; that DoD researchers develop new, cutting-edge technologies; that DoD researchers solve real-world problems; and that DoD research is valuable to society.

Figure 13. Students understand that DoD research is important

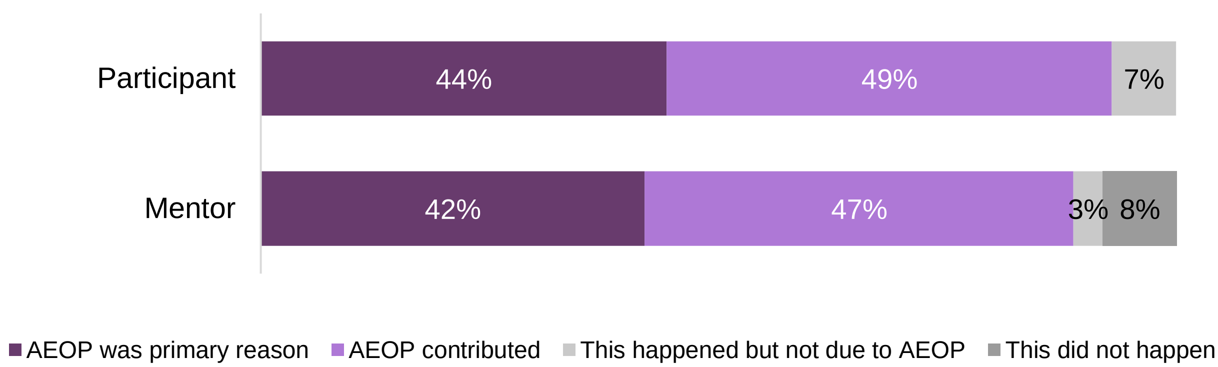


Participant Survey (n = 80)

Note: The survey included a "Strongly Disagree" option, but none of the respondents chose this option.

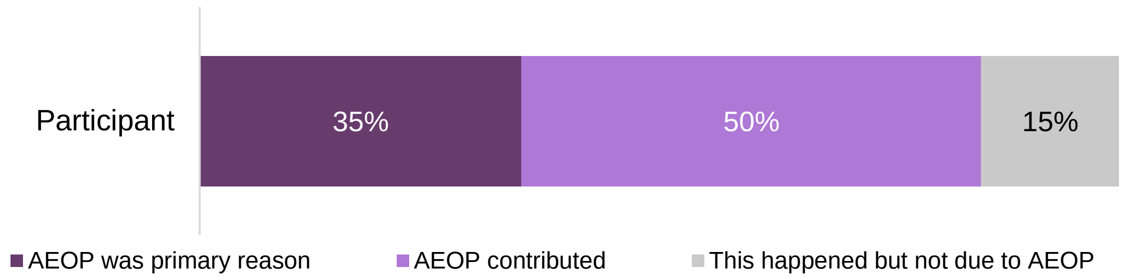
The majority of students (93%) and mentors (89%) agreed that Apprenticeships contributed to students' appreciation of Army/DoD research (Figure 14). In addition, 85% of students reported that their interests in an Army or DoD career increased as result of Apprenticeships (Figure 15).

Figure 14. Apprenticeships contributed to increasing students' appreciation for Army/DoD research



Participant Survey (n = 72)
Mentor Survey (n = 62)

Figure 15. Apprenticeships contributed to increasing students' interest in Army/DoD STEM Careers



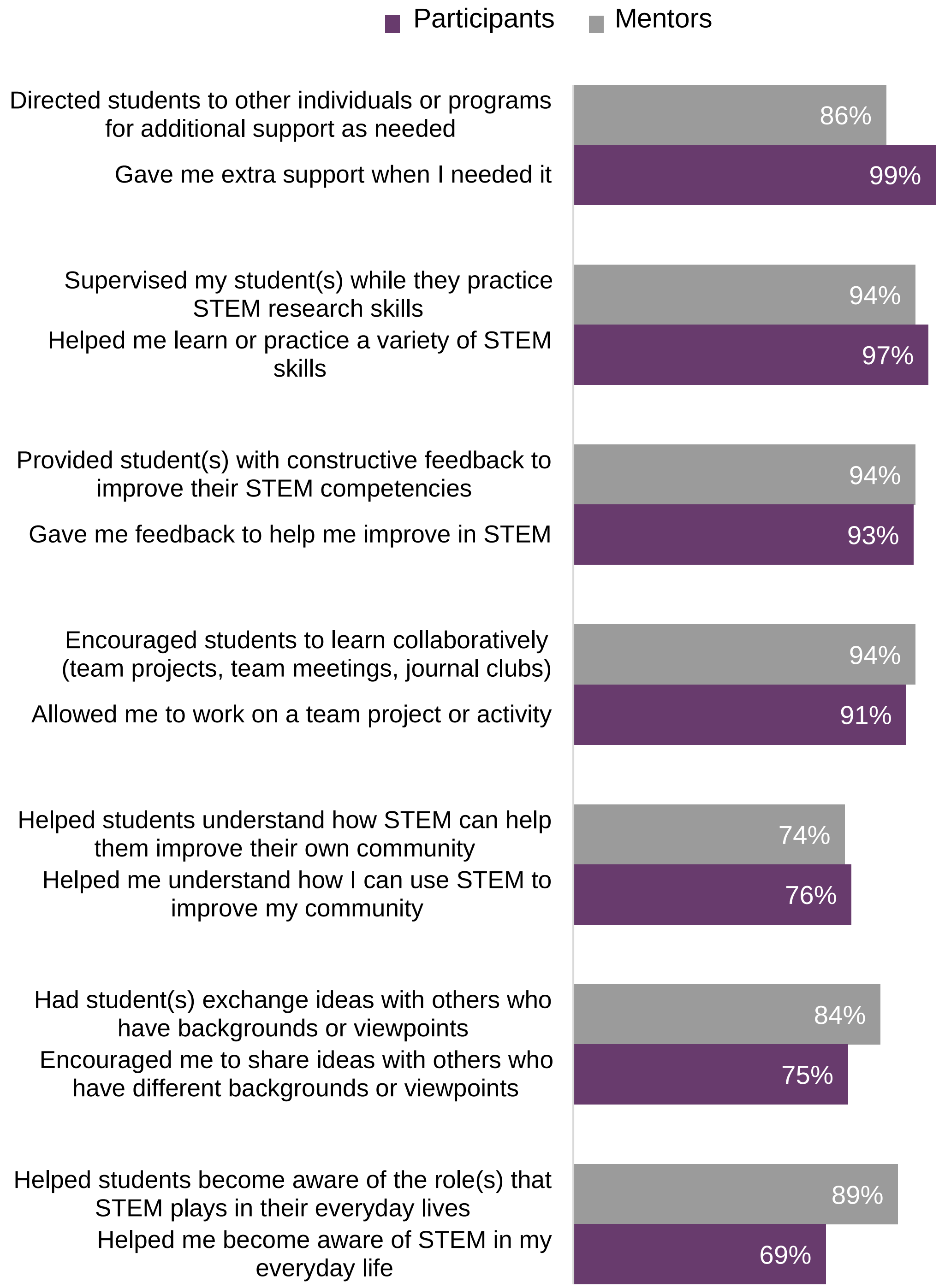
Participant Survey (n = 72)
Note: The survey included a "This did not happen" option, but none of the respondents chose this option.

8 Impact of S&E Mentors on Participants

Mentors play an important role in AEOP. Although their roles may differ, students reported positive experiences working with their mentors and the survey results suggest mentors had a strong impact on Apprenticeships participants.

Students and mentors reported a high use of common strategies across programs to achieve AEOP goals. The survey asked both students and mentors about a range of mentor strategies employed in Apprenticeships (see Figure 16). For example, about two-thirds of students (69%) reported that mentors helped them become aware of STEM in everyday life, while 93% of students indicated that mentors gave them feedback to help them improve in STEM. Mentors' reports on the use of these strategies are largely comparable and similar to those of students. For example, 89% of mentors reported they helped students become aware of the role that STEM plays in their everyday lives, and 94% of mentors said they provided students with constructive feedback to improve their STEM competencies.

Figure 16. Participants and mentors reported common strategies used across AEOP



Participant Survey (n = 75)
Mentor Survey (n = 62)

In addition to the methods mentioned above, the surveys asked about mentor strategies in four main areas:

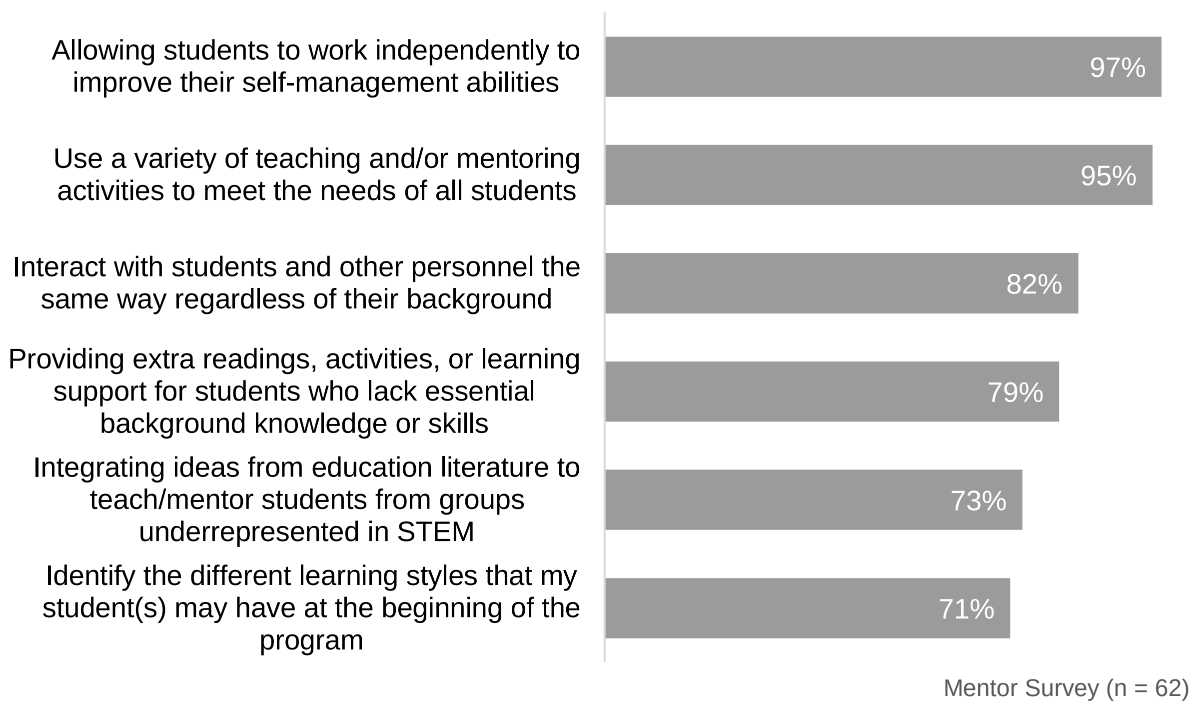
1. Supporting the Diverse Needs of Students as Learners
2. Establishing the Relevance of Learning Activities
3. Supporting Student Development of Collaboration and Interpersonal Skills
4. Supporting Student STEM Activities and Educational Pathways

Findings from each of these core areas are below.

8.1 Supporting the Diverse Needs of Students as Learners

Mentors used multiple strategies to meet students' diverse needs. For example, as shown in Figure 17, mentors most commonly reported that they allowed students to work independently (97%). Mentors also noted that they used a variety of teaching and/or mentoring activities to meet the needs of students (95%) and interacted with students and personnel the same way regardless of their background (82%). Even the lowest reported teaching strategies—providing extra support for students who lack essential background (79%), integrating ideas from education literature to teach students from underrepresented groups (73%), and identifying different learning styles (71%)—were reported as being used by the majority of mentors.

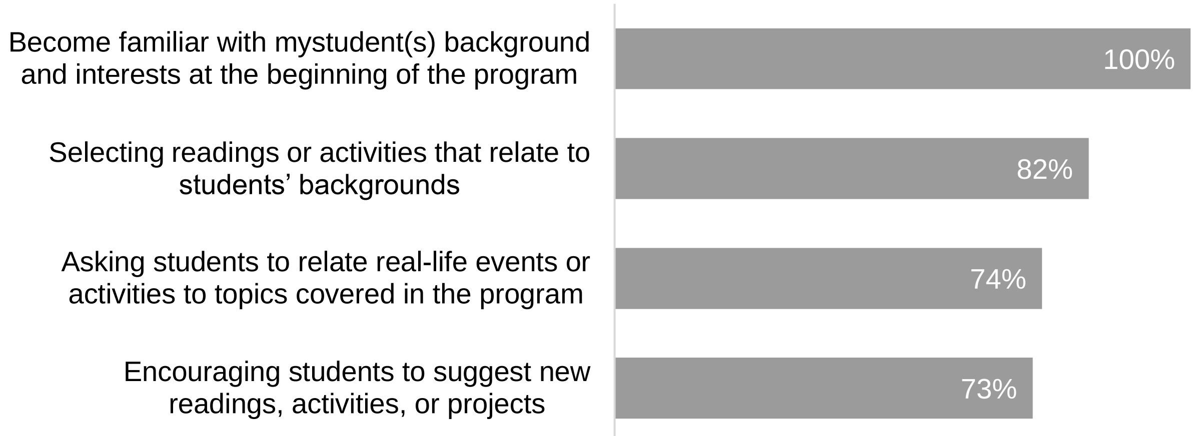
Figure 17. Mentors used multiple strategies to meet students' diverse needs



8.2 Establishing the Relevance of Learning Activities

Mentors used different teaching strategies to enhance the relevance of learning activities. Additional strategies mentors used to positively impact participants included becoming familiar with student background and interests at the beginning of the program (100%); selecting readings or activities that relate to students' backgrounds (82%); asking students to relate real-life events or activities to topics covered in the program (74%); and encouraging students to suggest new readings, activities, or projects (73%, Figure 18).

Figure 18. Mentors used different teaching strategies to enhance the relevance of learning activities

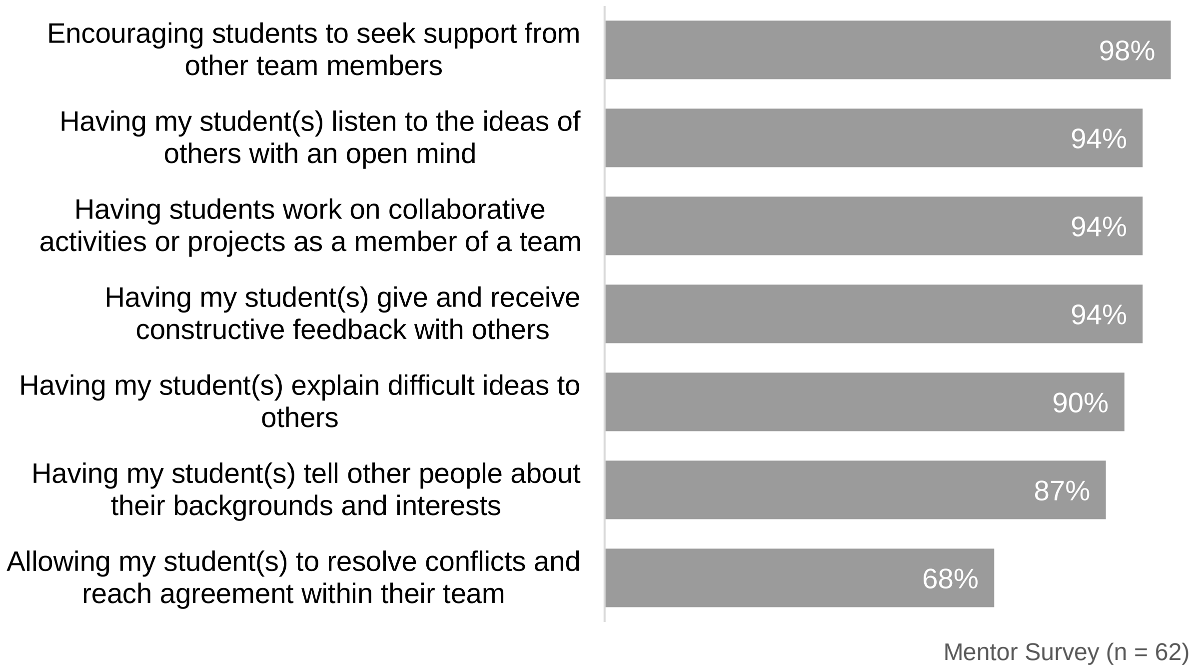


Mentor Survey (n = 62)

8.3 Supporting Student Development of Collaboration and Interpersonal Skills

Mentors frequently fostered communication and interpersonal skills. Almost all mentors reported encouraging students to seek support from other team members (98%), having students listen to the ideas of others with an open mind (94%), and having students give and receive constructive feedback with others (94%). Most reported having students explain difficult ideas to others (90%) and having students tell other people about their backgrounds and interests (87%). The least reported strategy was allowing students to resolve conflicts and reach agreement within their team (68%). See Figure 19 for the full list of responses.

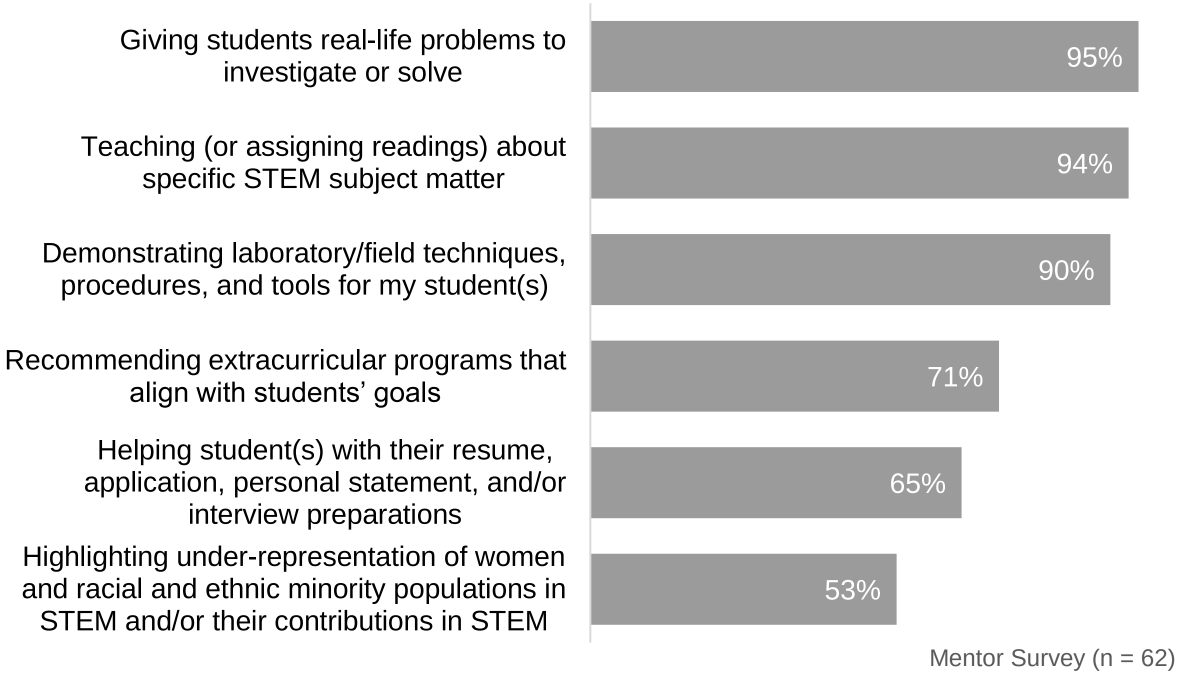
Figure 19. Mentors frequently fostered communication and interpersonal skills



8.4 Supporting Student STEM Activities and Educational Pathways

Mentors reported using different strategies to support student engagement in STEM, with hands-on research approaches being the most common strategy. The majority of mentors (95%) reported giving students real-life problems to investigate or solve; teaching or assigning readings about specific STEM topics (94%); and demonstrating laboratory and field techniques to students (90%). Slightly fewer mentors reported recommending extracurricular programs aligned with student goals (71%). Mentors were least likely to report helping students with their resumes, applications, personal statements, and interview preparation (65%) or highlighting under-representation of women and racial and ethnic minorities contributions in STEM (53%).

Figure 20. Mentors reported using different strategies to support student engagement in STEM, with hands-on research strategies being the most common strategy



9 Recommendations

This report distills findings across the student participant and mentor surveys as they align with AEOP's overarching research questions. As stated in the limitations, data collected for this evaluation are not necessarily representative of the entire Apprenticeships program; however, based on the results presented above, we offer the following recommendations:

Programmatic Considerations

- **Continue to offer hands-on, authentic, relevant experiences.** Research shows these kinds of experiences are important to developing and sustaining students' interest in STEM education and career pathways.
- **Consider creating opportunities for students to present their research.** Student and mentor survey responses alike advocated for student participants to have the chance to present their work at the end of the program. Such opportunities could continue to increase students' interest in STEM careers.
- **Facilitate more constant communication between program administrators, mentors, and student participants.** Both student and mentor survey responses indicated a desire for more transparency and timeliness when it came to the logistical aspects of the program (e.g., requirements for participation, deadlines, webinar dates, email response time).
- **Update how stipends work.** All participants indicated they were satisfied with the stipends. However, there were suggestions for improvements to the stipends process both in terms of eligibility and faster payouts. Such improvements can continue to increase the diverse pool of student participants and continue to produce positive outcomes because of participation in Apprenticeships.

Evaluation Considerations

- **Continue to examine ways to increase response rates.** As noted above, the relatively low response rates for both participants and mentors (23% and 52%, respectively), make it difficult to generalize the findings across the Apprenticeships program. The EDC evaluation team is working with IPAs to troubleshoot these issues and develop strategies to improve response rates.