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ARMY EDUCATIONAL OUTREACH PROGRAM

2022 GEMS Evaluation Report
Summative Findings

July 2023

aeop
ARMY EDUCATIONAL OUTREACH PROGRAM

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Contents

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. GEMS is an Army-sponsored summer STEM enrichment program for students in grades 5–12 held in the summer at participating Army Research Laboratories.

Education Development Center, Inc. (EDC), the external evaluation partner for AEOP, conducted an evaluation of the Gains in the Education of Mathematics and Science (GEMS) during the 2021-2022 program year. The GEMS 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 as well as data from a site visit conducted by the EDC team. It is important to recognize that survey results only reflect those individuals who completed surveys and may not be generalizable within a specific program. Additionally, the site visit data may not be generalizable to all the programmatic locations, because it was a snapshot view of the program.

Key findings from the evaluation are presented below.

Overview of Participants

In FY22, GEMS served a total of 2,871 participants: 94% (2,698) were students and 6% (173) were near-peer mentors.

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, 2,113 (78%) of all GEMS student participants met two or more of the Underserved criteria. An additional 20% of student participants met just one of the AEOP Underserved criteria.**

Participant Experience and Outcomes

GEMS gave students the opportunity to engage in various STEM-related activities. According to survey results from both participants and mentors, most students had experiences working collaboratively as a team, analyzing data and information, and interacting with STEM

researchers. At least 93% of participants and 86% of mentors reported that students had these opportunities. The majority of participants and mentors also reported that participants gained experience solving real world problems (86% of participants and 95% of mentors).

Students reported improved STEM skills such as: knowledge of STEM topics and STEM research; planning and carrying out an experiment; and analyzing and interpreting data. Overall, between 62% and 98% of students reported improvements in a range of STEM skills.

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 75% and 97%) indicated increased competencies in these areas. Students were less likely to report improvements in their skills related to media and technological literacy. Between 27% and 74% 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 GEMS (ranging between 54% and 98%). At least 90% of students indicated that GEMS had a positive influence on their interest in earning a STEM degree. Additionally, 82% of students credited their participation in GEMS as the reason for their increased appreciation for Army/DoD research (roughly 90% on multiple items).

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 50% and 98%.

Overall, both students and mentors reported generally positive experiences with AEOP. Students enjoyed learning about STEM fields and careers, improving their social emotional learning skills through teamwork, and developing technical and critical thinking skills. Mentors enjoyed working with students and STEM professionals in research, solving real-world problems, and providing students with opportunities for hands-on learning experiences.

Participants offered some suggestions for improvement. Respondents most frequently pointed to a desire for more hands-on, authentic, and relevant experiences for students. Some also noted a desire for professional development resources for mentors.

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 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.
- **Update the curriculum to include a variety skills and concepts needed for postsecondary success and career mapping for students**. Mentor surveys indicated satisfaction with the curriculum and thought there was room to teach students about more STEM opportunities available to students after high school. Additionally, such skills will help support the diverse needs of students.
- **Consider pairing mentors with S&E professionals to benefit both mentors and participants. Mentors' surveys indicated a desire for more interaction with STEM professionals throughout the program.** Mentors believe that these interactions will not only benefit themselves but the students as well, as mentors will be better equipped to educate students.
- **Include written resources for mentors to use with students.** Mentors advocated for written resources such as lab and curriculum materials as well as scaffolds for students. Such resources would enable mentors to better meet the needs of students within GEMS.

Evaluation Considerations

- **Continue to examine ways to increase response rates.** As noted above, the variable response rates across programs make it difficult to generalize the findings across AEOP. 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.

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.

GEMS is an Army-sponsored summer STEM enrichment program for students in grades 5–12 held in the summer at participating Army Research Laboratories.

1.2 Overview of Participants

In FY22, GEMS served a total of 2,871 participants: 94% (2,698) were students and 6% (173) were near-peer mentors.

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, 2,113 (78%) of all GEMS student participants met two or more of the Underserved criteria. An additional 20% of student participants met one of the AEOP Underserved criteria.

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. In most cases, AEOP program

staff were responsible for distributing the online survey links to their student participants and mentors at the conclusion of program activities.

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 2 shows the number of completed GEMS surveys.

Table 2. Participant and Mentor Survey Response Rates

	Participant Surveys		Mentor Surveys	
Program	Count	Response Rate	Count	Response Rate
GEMS	1,374	51%	43	25%

2.2 Limitations

It is important to recognize that survey results only reflect those individuals who completed surveys and may not be generalizable within GEMS. Due to the relatively low response rate for both participants and mentors (51% and 25% respectively), it is possible that these responses do not generalize well to the populations that were involved in these programs.

It is also important to consider the characteristics of survey respondents. For example, the majority of respondents had not yet completed high school at the time of the survey. 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

The evaluation team focused on presenting aggregated results for AEOP overall; results for individual programs will be included in forthcoming IPA-level summaries. Evaluation findings presented below are guided by the research questions and organized thematically by topic. Sections include the following:

- Overall Experience
- Site Visit Take-Aways
- 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 GEMS. In addition, both students and mentors indicated that they largely were satisfied with the program.

Students enjoyed learning new STEM skills, working in teams, and learning about community issues. Mentors enjoyed engaging with students in research, solving real-world problems, and providing students with opportunities for hands-on learning experiences. Suggestions for improvement from students were focused on better communication, organization, and planning information (e.g., dates or schedules and details about activities). Mentors also mentioned the need for improved communication; they also expressed a desire for more instructional resources and increased funding.

3.1 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 GEMS experience*.[1] Although many responses were particular to specific programs, several high-level themes stood out.

3.1.1 Student Program Satisfaction

Most students were satisfied with the programs. About 40% of students stated that learning about various areas of STEM and becoming more interested in STEM were the most beneficial parts of the program. As a result of participating in the program, some students reported they are now interested in fields like cybersecurity or forensics. About a quarter of students stated that the program helped in increasing their social-emotional learning (SEL) skills. For example, several students mentioned that they learned how to problem solve, be more responsible, and increased their confidence in public speaking. About 25% of students mentioned that the program has piqued their interest in a career in the STEM field. It gave them a clearer insight into what they want to pursue and in exploring careers relating to science and/or STEM. Other

[1] 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.

benefits that were mentioned included learning how to work in a team environment and learning new technical skills.

Table 3. Reasons students gave for their satisfaction with GEMS

Theme	Quote
Increased interest in STEM fields	*GEMS helped me work with people in a team environment, have greater exposure to different branches of STEM, and work with different materials.*
Improved Social Emotional Learning (SEL) skills	*[GEMS] helped me be more confident in my social skills. It has made me more interested in STEM related things and it has sparked my curiosity in STEM.*
Piqued interest in STEM careers	*[GEMS] gave me clearer insight into what I want to do, [it] gave me insight into what working at WSMR might be like, [and it] gave me a really good opportunity to learn about STEM.*
Developed technical and critical thinking skills	*GEMS helped me a lot with my coding. It also helped me understand problem solving and how critical problem solving is.*
Overall positive experience	*I do not think I know a way for you guys to make GEMS better.*

3.1.2 Mentor Program Satisfaction

Most of the mentors were satisfied with their program. The mentors mentioned a variety of reasons why they were satisfied with their respective program, which included encouraging students to consider STEM careers, engaging students in conducting research, and engaging students in solving real-life problems that pertained to their own community. About 40% of the mentors indicated that GEMS participants increased their knowledge of STEM through engaging with the program. Nearly a quarter of mentors stated that one of the strengths of the GEMS program is that it allows students to learn from scientists and professionals in STEM fields that they may not have done otherwise. Others indicated that GEMS provides an opportunity for students to increase their knowledge of DoD careers and research, develop their collaboration and team-working skills, and learn about a wide-range of STEM topics through “hands-on” activities.

Table 4. Reasons mentors gave for their satisfaction with GEMS

Theme	Quote
Increases students' knowledge of STEM and DoD careers	*I believe that three strengths of GEMS are the fact that it allows students to further their education in different areas of STEM, the fact that it exposes students to possible ways they could/do use STEM in their everyday lives, and the fact that GEMS offers students a way into a successful career in STEM*
Provides opportunities for students to learn from scientists and professionals in STEM fields	*The GEMS program exposes students early on to STEM-related topics. It is very important to recruit talents and have these talents know early on what type of problems or challenges are still to be solved and addressed by society. I'm very satisfied with my experience with the GEMS program.*
Develops students' collaboration and team building skills through hands on STEM activities	*I too myself learn with the students as I help in this program. I feel good with how I felt I was able to reach the students. Repeating crew builds chemistry which just adds to the program.*

3.2 Suggestions for Improvement

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

3.2.1 Students' Suggestions for Improvements

Students' most frequent suggestion (made by one in five students) was to engage in more experiments during their participation in GEMS. Some suggested that a wider variety of experiments should be offered and that experiments could be more "hands-on." About 10% stated that they wanted more group projects, while 10% wanted more games to be incorporated into program activities. Students advocated for *"more opportunities to use cool materials (like microscopes etc.),"* *"more group projects throughout the coding camps,"* and for GEMS to *"have more group projects and more games like Kahoot."*

3.2.2 Mentors' Suggestions for Improvement

On the mentor survey, the three most common suggestions for improvement were related to providing more instructional and training resources, offering a hands-on curriculum focusing on STEM careers, and organizational logistics. Nearly a quarter wanted access to more training and tangible resources, such as curriculum, teacher manuals, and guides. When asked about improvements to GEMS one respondent stated that the *"biggest improvement for participants would be to have S&Es work with the resource teachers prior to the summer, 1 or 2 meetings to go over content and activities would help teachers know what to*

expect and allow S&Es to refine what they are doing based on the age of the participants of the camp."

Additionally, just over 10% of mentors indicated that they wanted more responsibility and opportunities for leadership roles within the GEMS program. About 10% of mentors wanted more interaction with STEM professionals, including scientists, engineers, and researchers. One respondent suggested that *"more of the lessons can be interactive activities (…) so that presenters aren't just talking."* Additionally, mentors stated that "*offering more possible areas of study"* and *"making comprehensive manuals for the students would further improve an already exception experience."* Interactions with STEM professionals would benefit mentors as well, one respondent mentioned that if resource teachers were paired with an S&E then *"at least one RT would know exactly what to expect and have a more in depth knowledge of the content and the S&E would have an opportunity to get feedback on their plan so they know if they need to spend more time or give more support for certain topics or concepts that may be too complex for the age and ability of the students."*

Regarding the logistics of GEMS, other respondents requested better organization, planning, and clearer communication on things such as briefing mentors on the topics they would be teaching or having "consistent security procedures." And finally, respondents asked for an increase in stipend amounts.

Site Visit Take-Aways

Participants in the GEMS program reported in focus groups that they enjoyed both the content and the structure of their camp experience. Students engaged in activities such as coding, programming *Mindstorms* robots, dissection, and conducting lab experiments. Although participants were exposed to different fields of study including chemistry, biology, and engineering, they particularly enjoyed the robotics and engineering parts of the camp.

In discussing what they enjoyed most, one participant shared, *"It was nice to get a taste of things that could happen in the future like, if you want to go into the programming career you would program, or how we went into the lab to see what it was like to actually be in a lab."* Some individuals who came to GEMS with an existing interest in STEM and engineering reported strengthening their interest in engineering after the program. Those who had not considered a career path in engineering realized that STEM could be a possibility for them. For example, one participant remarked*, "I realized that there's so many more parts to engineering than I imagined."* Similarly, another participant noted, *"I think it helped me understand that there's just so many different aspects of engineering and so many fields to go into, so I thought that was pretty interesting."* A few participants even mentioned that they would be interested in working in a place like an Army base, saying the tour activities and career discussions sparked their interest.

GEMS' camp structure was a key benefit of the program, offering students a distinctly different experience than what they had experienced in traditional schooling. The focus on fun games, collaborative activities, and working on problem-solving in smaller groups created an

environment where participants were able to *"get to know"* each other in addition to their independent work. One participant shared, *"I feel like it's better than a school day. You still learn a lot. But it has a much better structure than a school day. It allows time for a break and a rest for your brain and fun activities while still making sure you learn the stuff."* Another participant shared a similar sentiment with an appreciation for the way learning was intentionally embedded learning into high interest activities, saying *"We do science, but then we also play games. So it's not just science."*

Students came into the GEMS program with a wide range of prior exposure to STEM. Some had parents who worked in STEM fields while others had little experience with STEM or came to GEMS with informal exposure to designing and building. Regardless of their past exposure to STEM, students were observed able to collaborate, learn together, and increase their knowledge of STEM careers.

When asked about improvements to the program, participants suggested adjusting the length (e.g., longer, shorter, different start time—starting later). One participant expressed, *"I think it would be better if it was spread out, like three or four times a week, or something, instead of just five days straight."* Additionally, some participants shared that the timing of camp intersected with competing priorities and said that they had to choose between their camp and other sports obligations that were held during the same weeks. They also preferred to have a wider variety for types of science represented, as the program was primarily focused on chemistry, biology, and robotics.

4 Program Activities

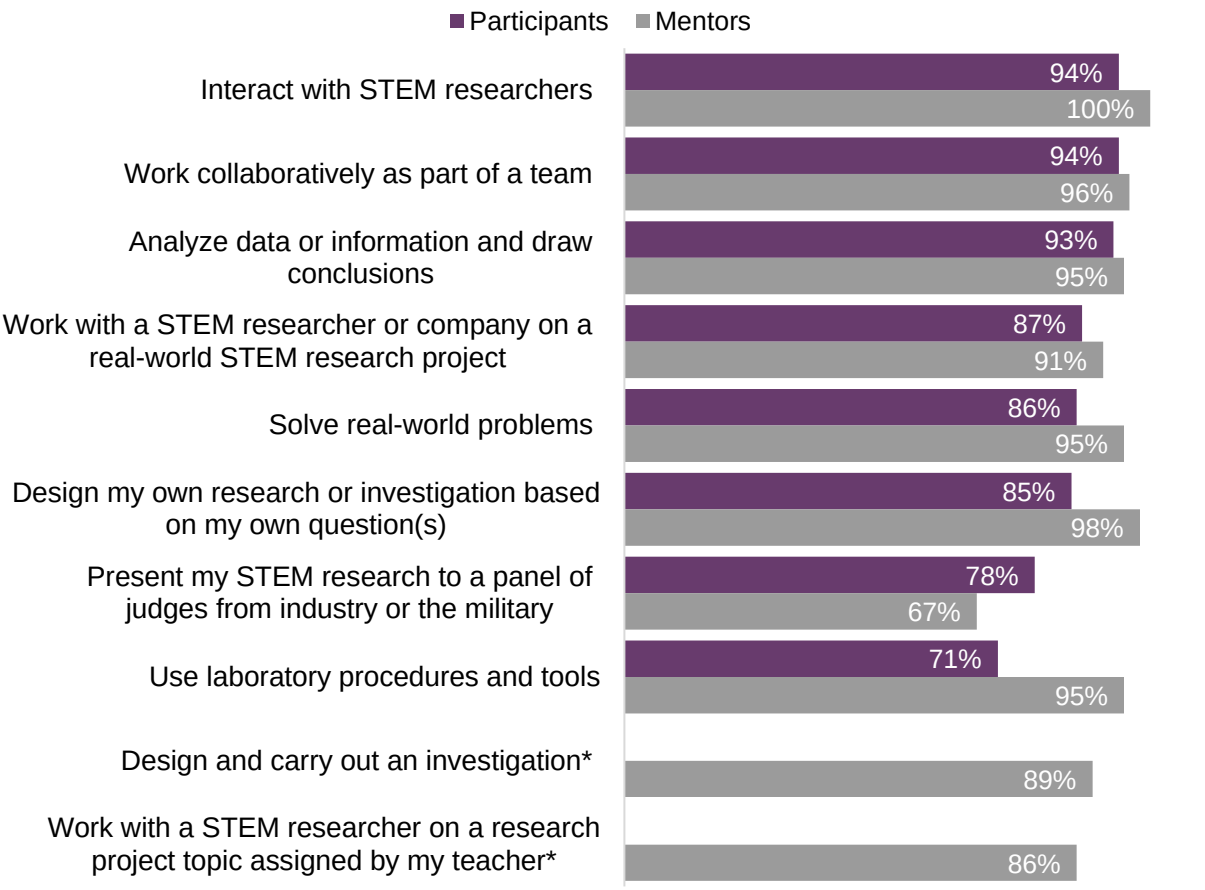
GEMS gave students the opportunity to engage in various STEM-related activities. According to survey results from both participants and mentors, most students had experiences working collaboratively as a team, analyzing data and information, and interacting with STEM researchers. At least 93% of participants and 86% of mentors reported that students had these opportunities. The majority of participants and mentors also reported that participants gained experience solving real world problems (86% of participants and 95% of mentors).

4.1 STEM Practices

GEMS participants had opportunities to engage in a variety of STEM activities. Most participants reported engaging in collaborative teamwork (94%), interacting with STEM researchers, and analyzing data and information (93%). Results from mentor surveys were similar, with the vast majority of mentors reporting that their students engaged in each of these activities (Figure 1).

By comparison, fewer participants reported working with a STEM researcher or company on a real-world STEM research project (87%), solving real-world problems (86%), and designing their own research projects (85%); mentors' responses were generally consistent with participants'. 94% of participants reported that they interacted with STEM researchers and a slightly smaller proportion of participants noted that they worked with a STEM researcher or company on a real-world STEM project (87%).

Figure 1. GEMS participants had opportunities to engage in a variety of STEM activities



Participant Survey (n = 1,374)
Mentor Survey (n = 43)
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.”
*This question was not asked of GEMS participants

5 Development of STEM Skills

Participants reported gains in a number of STEM research skills as a result of their participation in GEMS. Students improved their knowledge of STEM topics and increased their knowledge of how scientists and engineers work on real problems through everyday research within the STEM field.

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 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 and participants were equally likely to report that students experienced gains as a result of their participation in GEMS.

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	2%	12%	32%	54%	**98%**
	Mentor	0%	7%	33%	61%	**100%**
Knowledge of research processes, ethics, and rules for conduct in STEM*	Participant	-	-	-	-	**-**
	Mentor	2%	9%	41%	48%	**98%**
Knowledge of how scientists and engineers work on real problems in STEM	Participant	3%	21%	36%	40%	**97%**
	Mentor	2%	5%	11%	82%	**98%**
Knowledge of what everyday research work is like in STEM	Participant	5%	21%	33%	41%	**95%**
	Mentor	2%	7%	30%	61%	**98%**
Supporting an explanation with STEM knowledge*	Participant	-	-	-	-	**-**
	Mentor	9%	21%	32%	39%	**91%**
Making a model to show how something works*	Participant	-	-	-	-	**-**
	Mentor	9%	14%	36%	41%	**91%**

Participant Survey (n = 1,361)

Mentor Survey (n = 44)

*This question was not asked of GEMS 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	-	-	-	-	**-**
	Mentor	14%	25%	30%	32%	**86%**
Creating a hypothesis or explanation that can be tested in an experiment/problem*	Participant	-	-	-	-	**-**
	Mentor	2%	14%	42%	42%	**98%**
Carrying out an experiment and recording data accurately	Participant	14%	25%	30%	31%	**86%**
	Mentor	9%	11%	30%	50%	**91%**
Defining a problem that can be solved by developing a new or improved product or process*	Participant	-	-	-	-	**-**
	Mentor	0%	25%	41%	34%	**100%**
Presenting an argument that uses data and/or findings from an experiment or investigation	Participant	17%	29%	29%	26%	**84%**
	Mentor	14%	14%	34%	39%	**86%**

Participant Survey (n = 1,352)

Mentor Survey (n = 44)

*This question was not asked of GEMS participants

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-fourth (23%) of students said that they "did not learn" this in GEMS program, which may be an indication that this was not a major component of GEMS programming.

Table 7. Students developed skills in data analysis and interpretation

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
Considering multiple interpretations of data to decide if something works as intended*	Participant	-	-	-	-	**-**
	Mentor	12%	12%	42%	35%	**88%**
Identifying the strengths and limitations of data or arguments presented in technical or STEM texts*	Participant	-	-	-	-	**-**
	Mentor	16%	25%	32%	27%	**84%**
Identifying the limitations of the methods and tools used for collecting data	Participant	12%	27%	36%	25%	**88%**
	Mentor	12%	14%	42%	33%	**89%**
Creating charts or graphs to display data and find patterns	Participant	39%	28%	18%	16%	**62%**
	Mentor	23%	25%	25%	27%	**77%**

Participant Survey (n = 1,351)

Mentor Survey (n = 44)

*This question was not asked of GEMS participants

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 GEMS programs 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

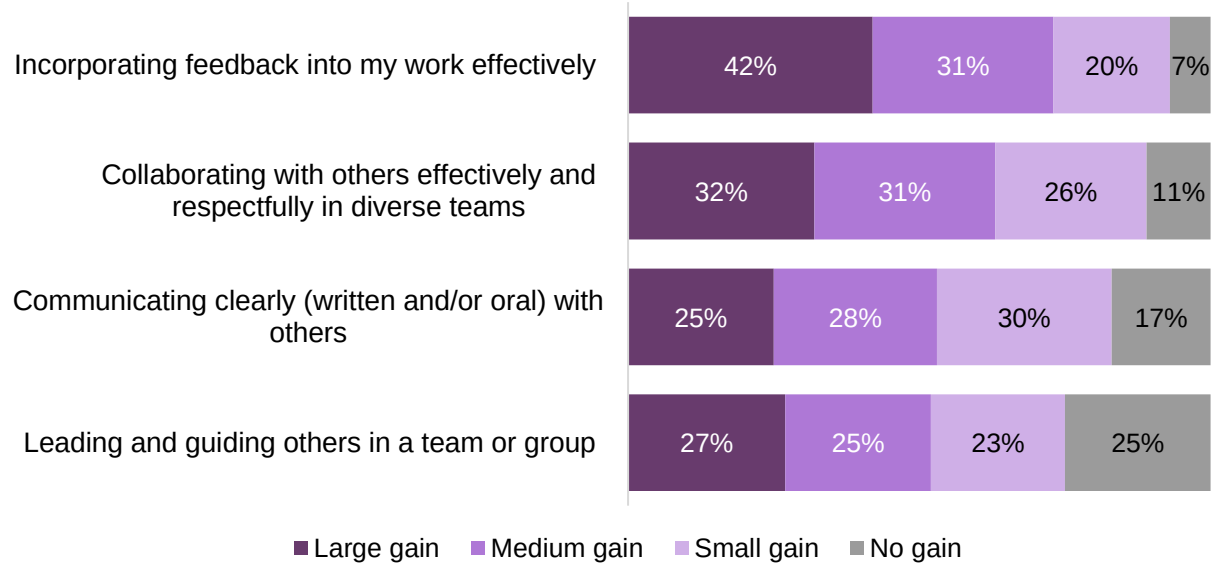
Results from each domain are below.

6.1 Communication and Collaboration

Overall, students reported gains in their communication and collaboration skills. They reported that they gained skills in incorporating feedback into their work (93%), collaborating with others effectively and respectfully in diverse teams (89%), and communicating clearly (written and/or oral) with others (83%). Participants were least likely to report gains in leading and guiding others in a team or group (75%), though this may not have been a central focus of all AEOP programs.

Figure 2 below shows responses to these items, including the full range of scaled responses (i.e., from “no gain” to “large gain”).

Figure 2. Students improved their communication and collaboration skills, but were less likely to report improved skills leading within a team

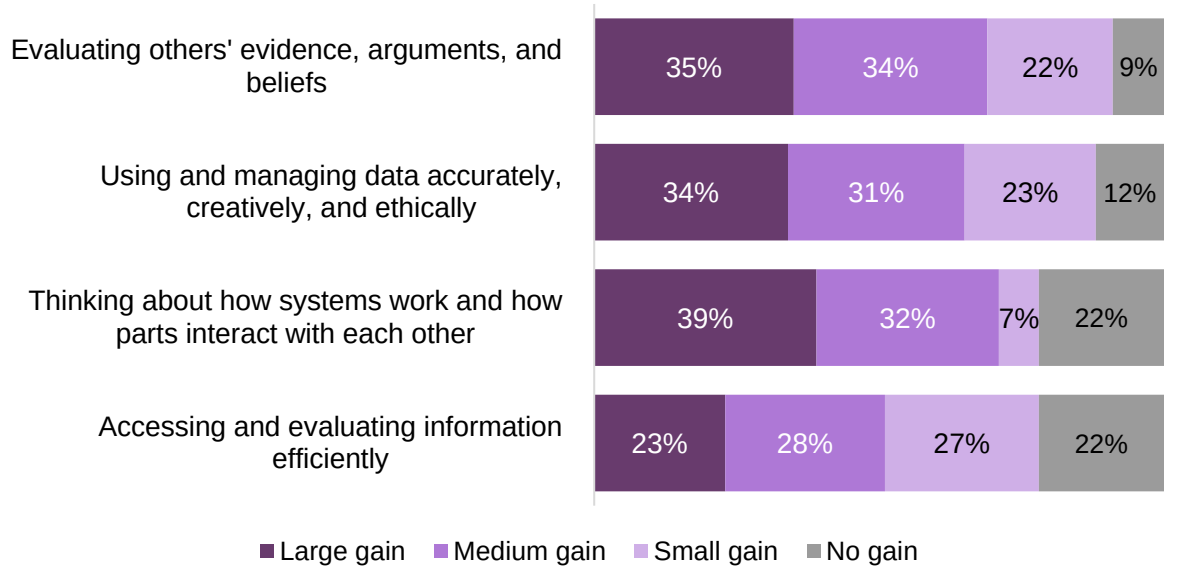


Participant Survey (n = 1,346)

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 evaluate others’ evidence, arguments, and beliefs (91%); use and manage data accurately, creatively, and ethically (88%); think about how systems work and how parts interact with each other (78%); and evaluate others’ evidence, arguments, and beliefs (78%). See Figure 3 below for the full range of responses to these items.

Figure 3. Students improved various critical thinking and problem solving skills

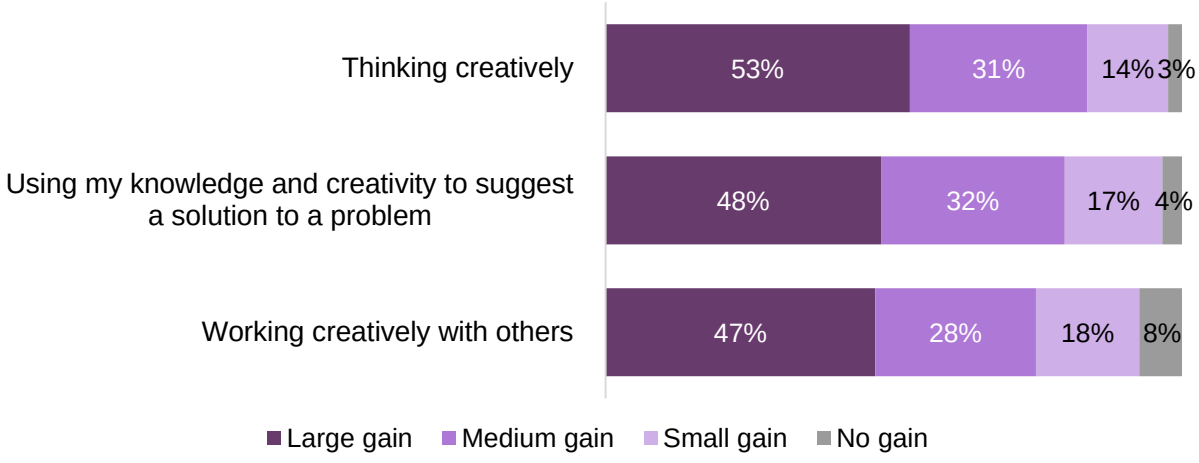


Participant Survey (n = 1,345)

6.3 Creativity and Innovation

Students increased their innovation skills and ability to use creative approaches to address problems. As Figure 4 shows, most students reported that they increased their skills at thinking creatively (97%), using knowledge and creativity to suggest a solution to a problem (96%), and working creatively with others (92%).

Figure 4. Students increased their ability to work more flexibly and creatively.

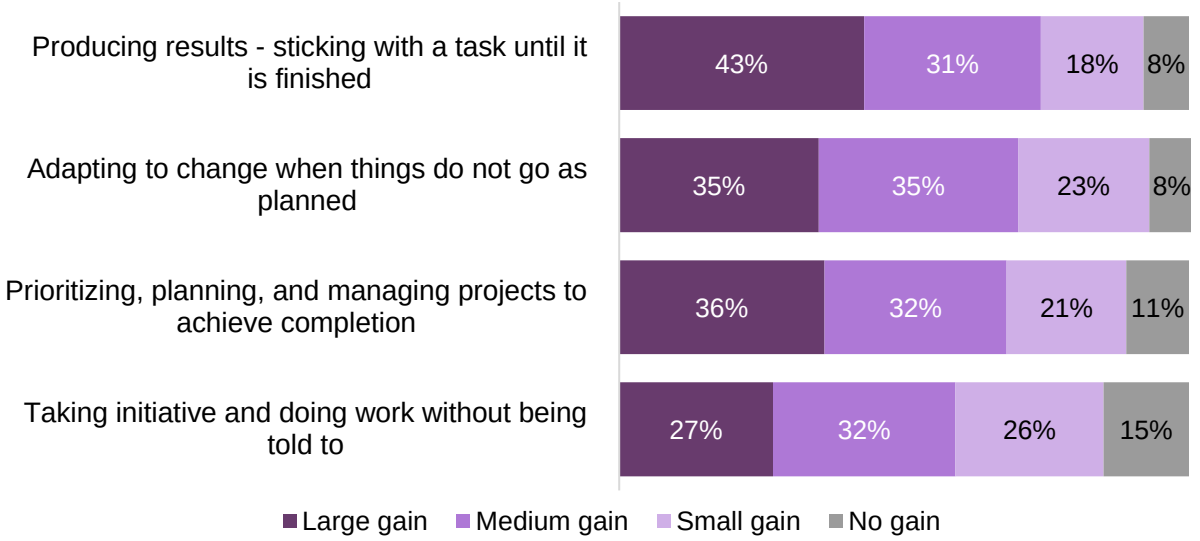


Participant Survey (n = 1,349)

6.4 Initiative, Self-Direction, and Flexibility

The majority of students reported gains in work habits related to producing results and adapting to change. On a list of several items, producing results and adapting to change when things do not go as planned were at the top of the list, with 92% of all participants reporting gains in each area. By contrast, a slightly smaller proportion of students (89%) reported improvement in prioritizing, planning, and managing projects to achieve completion. Taking initiative and doing work without being told to had the highest proportion of students who reported "no gain" (15%) or "a small gain" (26%). See Figure 5 for the full list of items and range of responses.

Figure 5. Students increased work habits related to taking initiative, self-direction, and flexibility

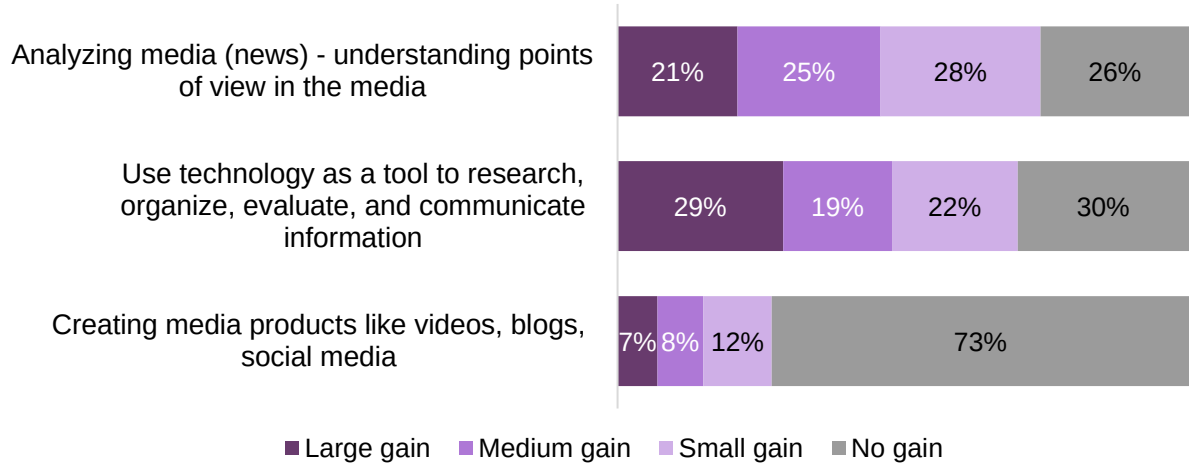


Participant Survey (n = 1,336)

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 27% and 74% of students reported gains in this area (see Figure 6). These relatively lower percentages are most likely due to GEMS programs not engaging in related activities—especially creating media projects like videos, blogs, and social media.

Figure 6. Students were less likely to report gains in media and technological literacy



Participant Survey (n = 1,337)

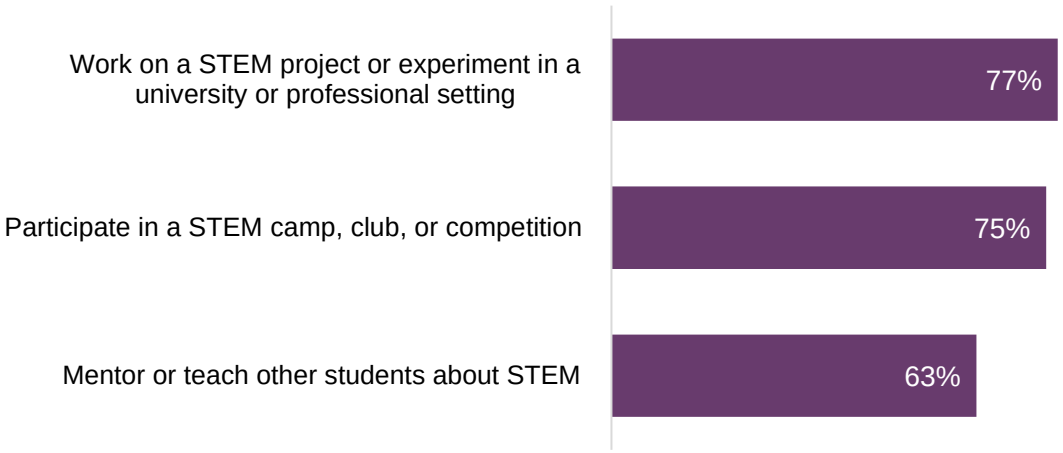
7 Interest in STEM and STEM Careers

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

7.1 Interest in STEM

Most students reported that they were more likely to engage in other STEM activities after their participation in AEOP. More than three-fifths of all students reported a higher inclination to engage in STEM education and training opportunities such as working on a STEM project or experiment (77%) or participating in a STEM camp, club, or competition (75%) after participating in GEMS (Figure 7).

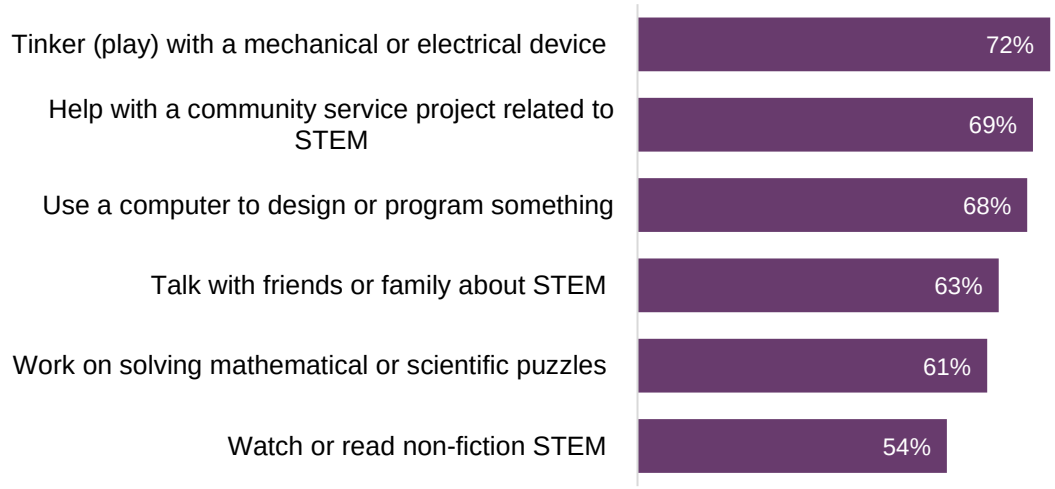
Figure 7. Most students reported an increase in their interest in participating in other kinds of STEM-related activities



Participant Survey (n = 1,318)
Responses include those who reported, “more likely” and “much more likely.”

As Figure 8 shows, a notable proportion of students were also more interested in exploring other activities like tinkering with mechanical or electrical devices (72%), helping with a community service project related to STEM (69%), using a computer to design or program something (68%), and discussing STEM topic with others (63%).

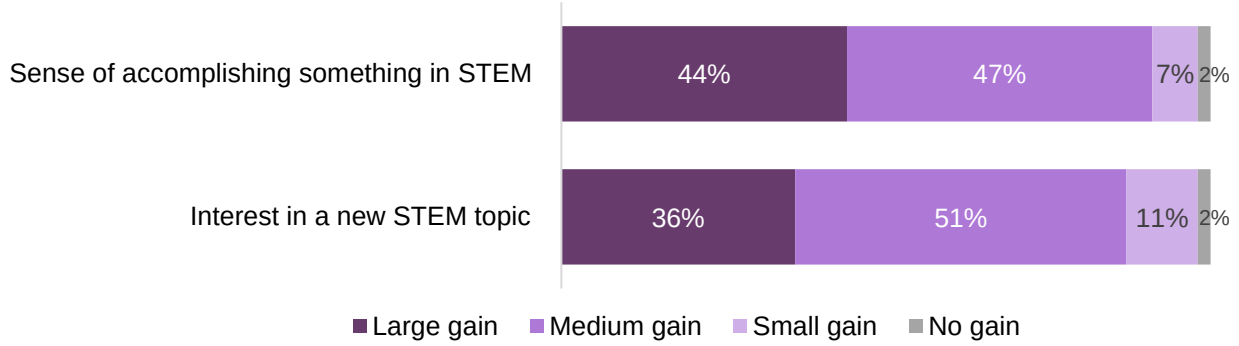
Figure 8. More than half of students reported an increase in their interest in STEM information and exploration



Participant Survey (n = 1,314)
Responses include those who reported, “more likely” and “much more likely.”

Most students indicated they gained an interest in a new STEM topic (98%) and a sense of accomplishing something in STEM (98%) due to participating in GEMS (Figure 9).

Figure 9. Most students said GEMS increased their STEM Confidence

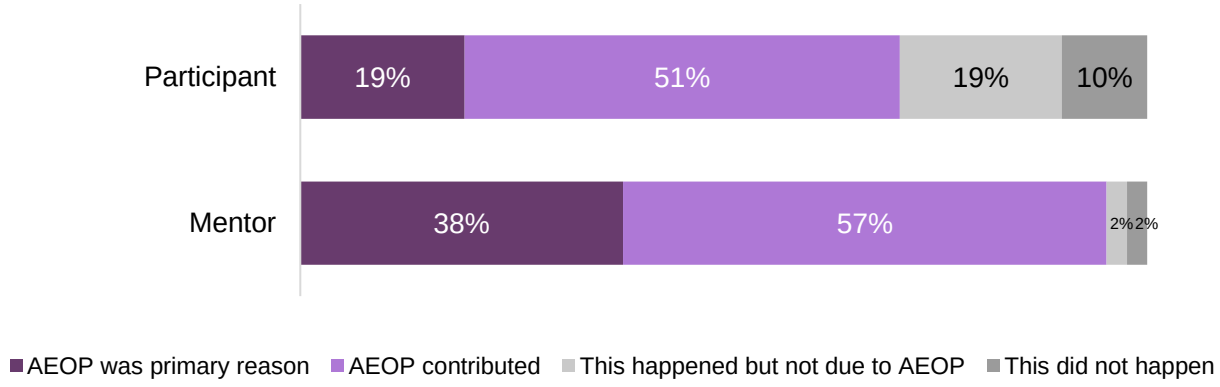


Participant Survey (n = 1,325)

7.2 Interest in Pursuing STEM Education and Careers

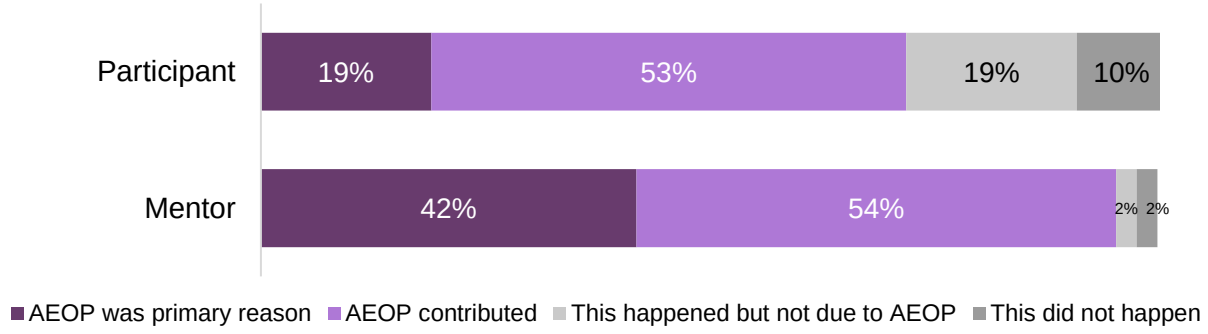
GEMS had a positive influence on students' interests in STEM education and careers. The surveys asked both participants and mentors about students' interests in earning a STEM degree and pursuing a STEM career (see Figure 10 and Figure 11). Overall, both groups reported students had increased interest, although a higher proportion of mentors than participants reported that AEOP contributed to students' interest. As Figure 10 shows, 70% of participants and 95% 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*, 72% of participants and 96% of mentors indicated that AEOP had an influence (Figure 11).

Figure 10. GEMS had a positive influence on students' interest in earning a STEM degree



Participant Survey (n = 1,293)

Figure 11. GEMS contributed to increasing students' interests in pursuing a STEM career

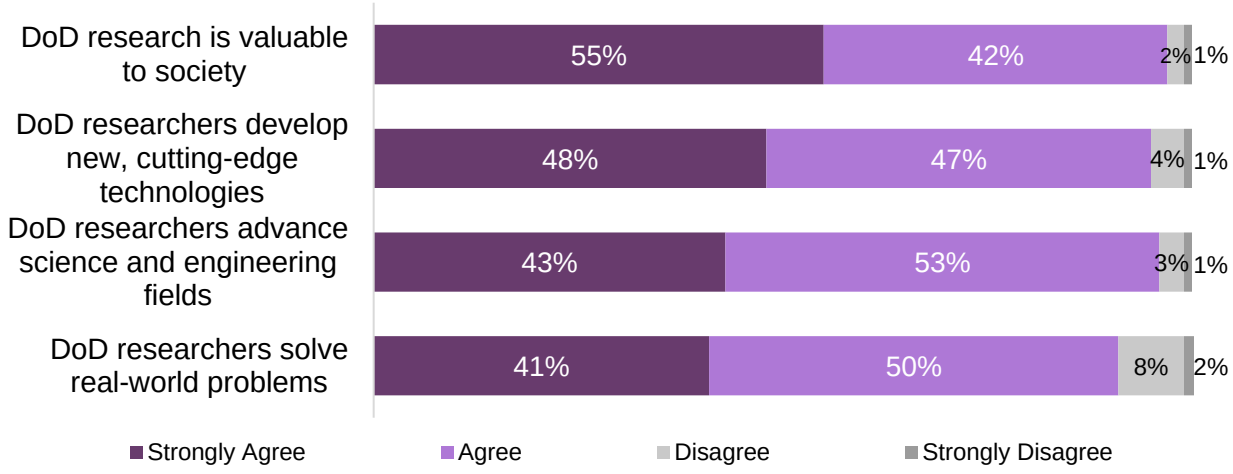


Participant Survey (n = 1,296)
Mentor Survey (n = 43)

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 GEMS. AEOP has an explicit connection to the Army and DoD. Roughly 90-95% of participants 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 12).

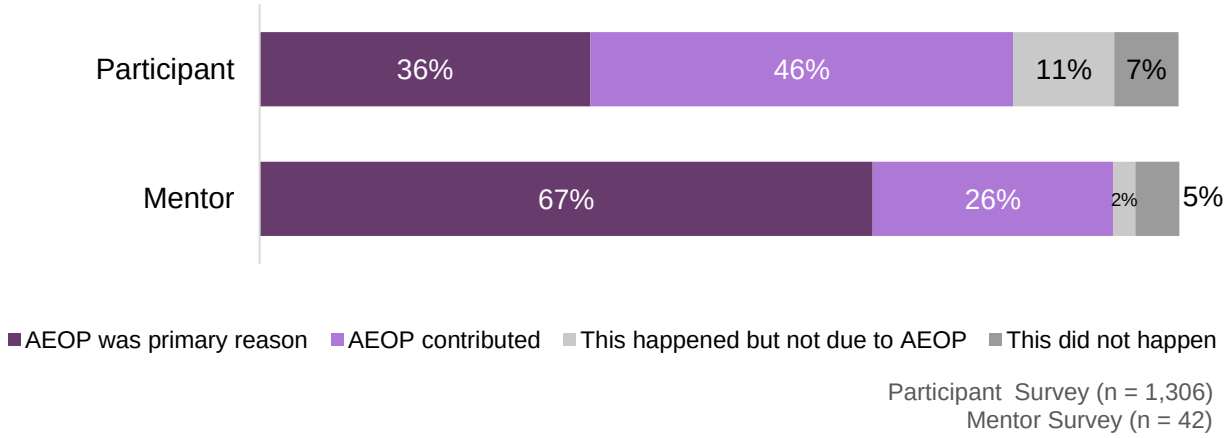
Figure 12. Students understand that DoD research is important



Participant Survey (n = 1,314)

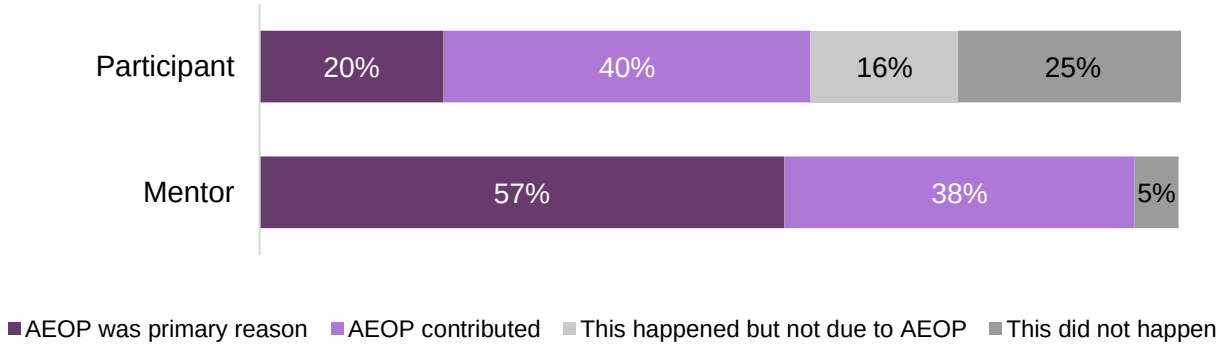
The majority of participants (82%) and mentors (93%) agreed that AEOP contributed to students' appreciation of Army/DoD research (Figure 13). In addition, 60% of participants and 95% of mentors reported that students' interests in an Army or DoD career increased as result of AEOP (Figure 14).

Figure 13. GEMS contributed to increasing students' appreciation for Army/DoD research



Participant Survey (n = 1,306)
Mentor Survey (n = 42)

Figure 14. GEMS contributed to increasing students' interest in Army/DoD STEM Careers



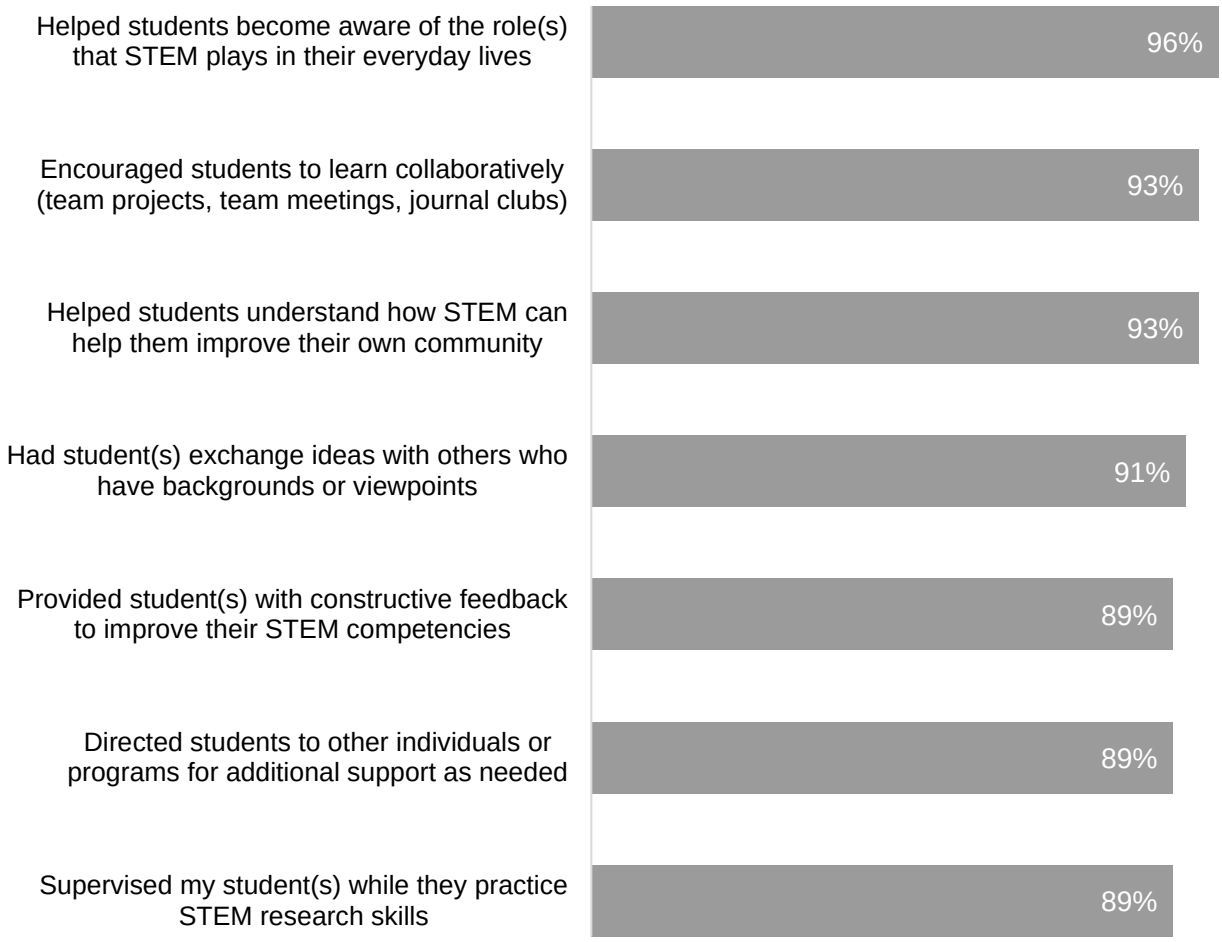
Participant Survey (n = 1,312)
Mentor Survey (n = 42)

8 Impact of S&E Mentors on Program participants

Mentors play an important role in AEOP, and survey results suggest mentors had a strong impact on GEMS participants.

Mentors reported a high use of strategies commonly used to achieve AEOP goals. The survey asked mentors about a range of mentor strategies employed in AEOP (see Figure 15). For example, over four-fifths of mentors (89%) reported that they helped participants in each of the seven categories, including helping students become aware of the role that STEM plays in their everyday lives (96%) and supervising students while they practiced STEM research skills (89%).

Figure 15. GEMS mentors reported they used various strategies commonly used across AEOP



Mentor Survey (n = 44)

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

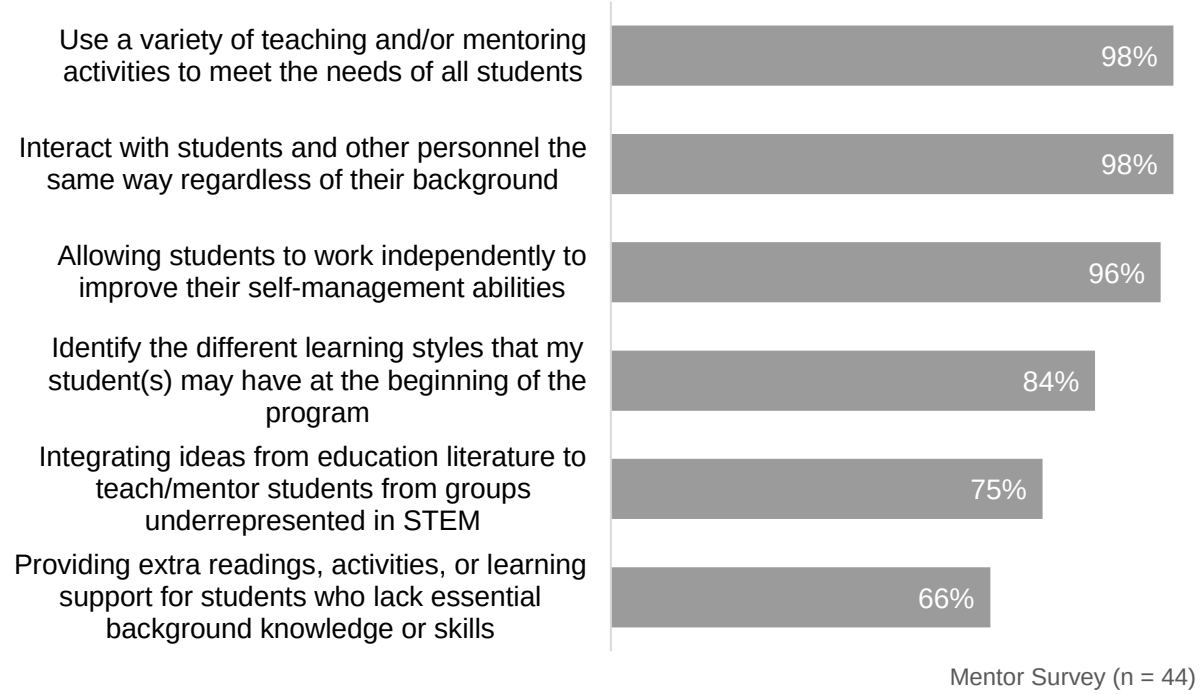
Findings from each of these core areas are below.

8.1 Supporting the Diverse Needs of Students as Learners

Mentors used multiple strategies to meet participants' diverse needs. For example, as shown in Figure 16, mentors reported that they used a variety of teaching and/or mentoring

activities to meet the needs of students (98%). Mentors noted that they allowed students to work independently (96%) and interacted with students and personnel the same way regardless of their background (98%). Even the lowest reported teaching strategies—identifying different learning styles (84%), integrating ideas from education literature to teach students from underrepresented groups (75%), and providing for students who lack essential background (66%)—were reported as being used by the majority of mentors.

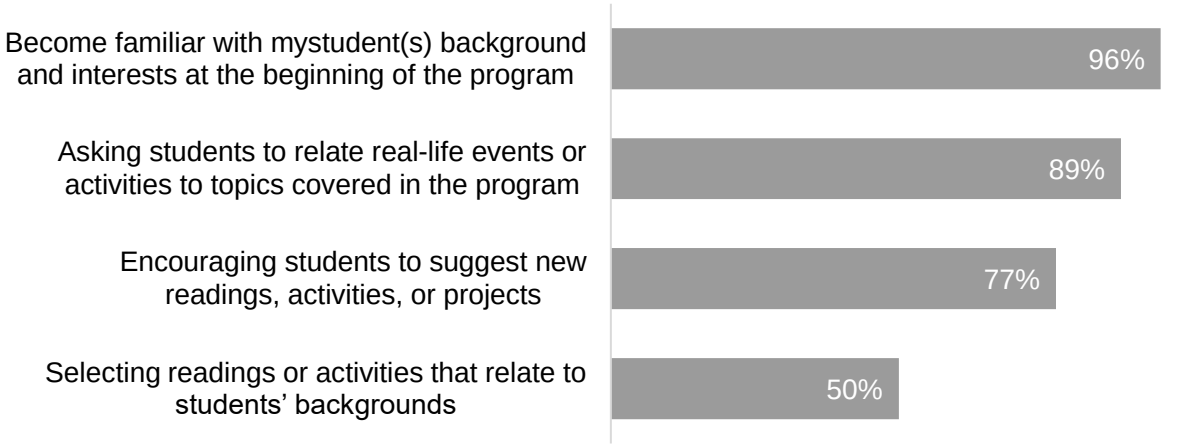
Figure 16. Mentors used multiple strategies to meet students' diverse needs



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 GEMS participants included becoming familiar with student background and interests at the beginning of the program (96%), asking students to relate real-life events or activities to topics covered in the program (89%), and encouraging students to suggest new readings, activities, or project (77%) (Figure 17). Only one strategy was reportedly used by only half of mentors: selecting readings or activities that relate to students' backgrounds (50%).

Figure 17. Mentors used different teaching strategies to enhance the relevance of learning activities

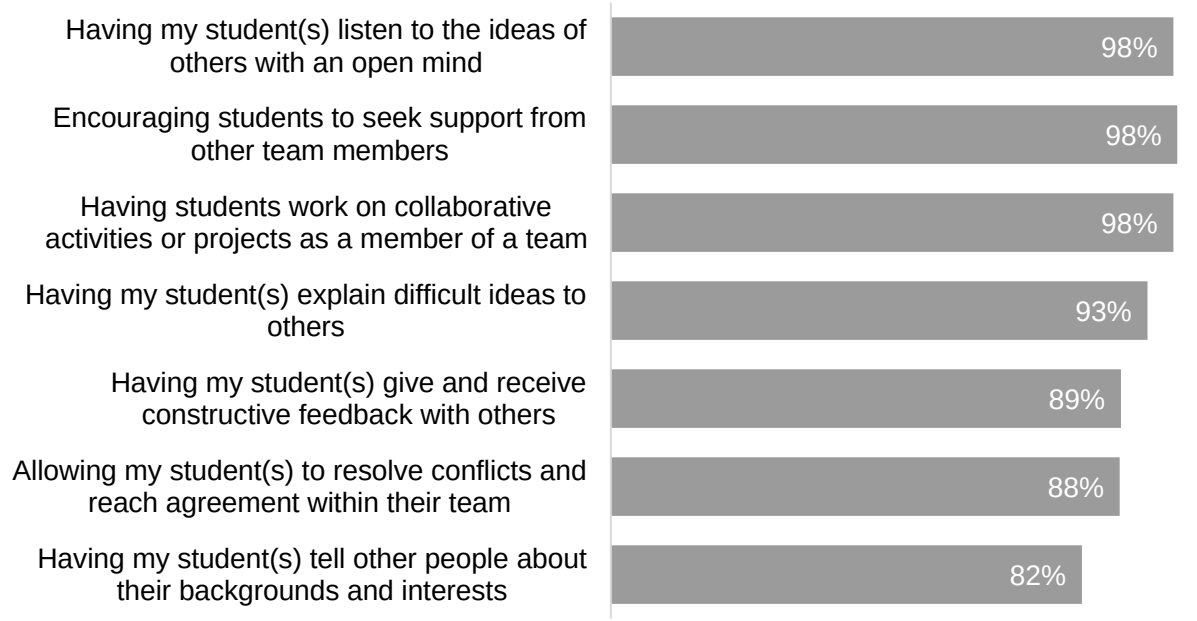


Mentor Survey (n = 44)

8.3 Supporting Student Development of Collaboration and Interpersonal Skills

Mentors frequently fostered communication and interpersonal skills. Almost all mentors (98%) reported having students listen to the ideas of others with an open mind. Most (89%) reported having students give and receive constructive feedback. The least reported strategies were having students tell other people about their backgrounds and interests (82%) and allowing students to resolve conflicts when working with a team (88%). See Figure 18 for the full list of responses.

Figure 18. Mentors frequently fostered communication and interpersonal skills

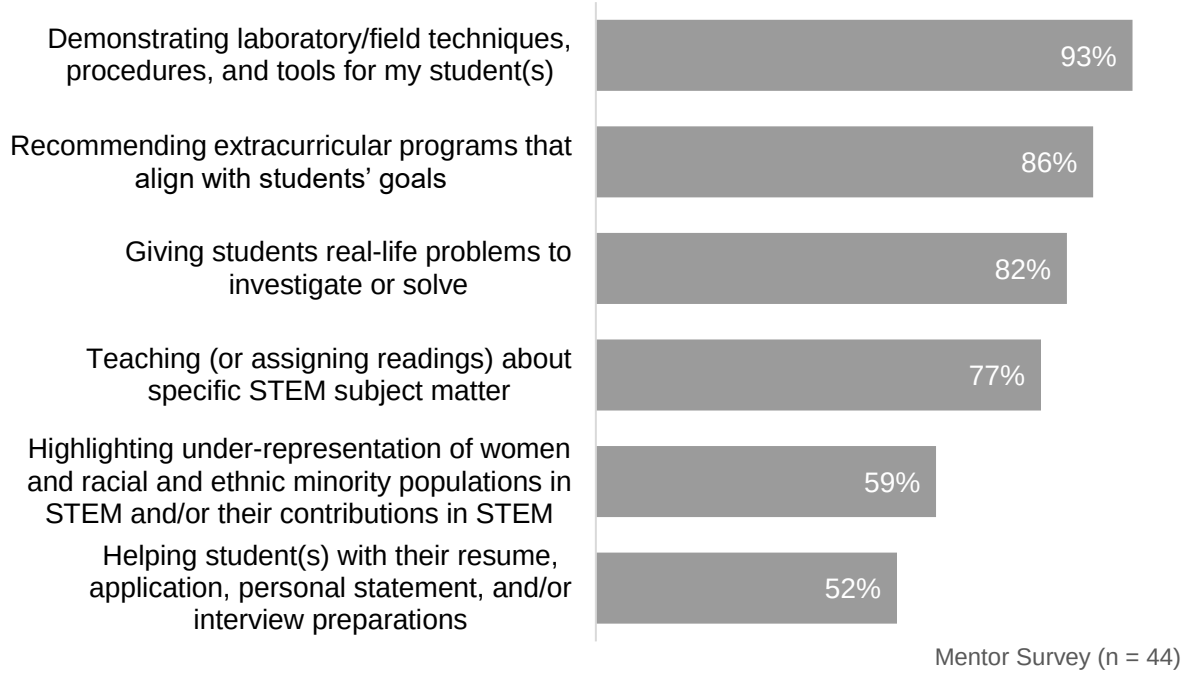


Mentor Survey (n = 44)

8.4 Supporting Student STEM Activities and Educational Pathways

Mentors reported using different strategies to support participant engagement in STEM, with hands-on research strategies being the most common strategy. The majority of mentors (82%) reported giving students real-life problems to investigate or solve, demonstrating laboratory and field techniques to students (92%), and recommending extracurricular programs that align with participants' goals (86%) (Figure 19). Slightly fewer mentors reported teaching (or assigning readings) about specific STEM subject matter (77%). Far fewer mentors reported highlighting under-representation of women and racial and ethnic minorities contributions in STEM (59%) or helping students with their resumes, applications, personal statements and interview preparation (52%).

Figure 19. 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 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.
- **Update the curriculum to include a variety skills and concepts needed for postsecondary success and career mapping for students**. Mentor surveys indicated satisfaction with the curriculum and thought there was room to teach students about more STEM opportunities available to students after high school. Additionally, such skills will help support the diverse needs of students.
- **Consider pairing mentors with S&E professionals to benefit both mentors and participants. Mentors' surveys indicated a desire for more interaction with STEM professionals throughout the program.** Mentors believe that these interactions will not only benefit themselves but the students as well, as mentors will be better equipped to educate students.
- **Include written resources for mentors to use with students.** Mentors advocated for written resources such as lab and curriculum materials as well as scaffolds for students. Such resources would enable mentors to better meet the needs of students within GEMS.

Evaluation Considerations

- **Continue to examine ways to increase response rates.** As noted above, the variable response rates across programs make it difficult to generalize the findings across AEOP. The EDC evaluation team is working with IPAs to troubleshoot these issues and develop strategies to improve response rates.