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Army Educational Outreach Program

Junior Solar Sprint (JSS)

2017 Annual Program Evaluation Report

PART 2: Evaluation Findings

April 2018

aeop
ARMY EDUCATIONAL OUTREACH PROGRAM

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3 | Introduction

AEOP Priorities

Goal 1: STEM Literate Citizenry. Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base.

Goal 2: STEM Savvy Educators. Support and empower educators with unique Army research and technology resources.

Goal 3: Sustainable Infrastructure. Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army.

The Army Educational Outreach Program (AEOP) vision is to offer a collaborative and cohesive portfolio of Army sponsored science, technology, engineering and mathematics (STEM) programs that effectively engage, inspire, and attract the next generation of STEM talent through K-college programs and expose participants to Department of Defense (DoD) STEM careers. The consortium, formed by the Army Educational Outreach Program Cooperative Agreement (AEOP CA), supports the AEOP in this mission by engaging non-profit, industry, and academic partners with aligned interests, as well as a management structure that collectively markets the portfolio among members, leverages available resources, and provides expertise to ensure the programs provide the greatest return on investment in achieving the Army's STEM goals and objectives.

This report documents the evaluation of one of the AEOP elements, JSS. The JSS program is administered on behalf of the Army by the Technology Student Association (TSA). The evaluation study was performed by Purdue University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium.

Program Overview

JSS is a STEM education competition in which 5th-8th grade students apply scientific understanding, creativity, experimentation, and teamwork to design, build, and race a model solar car. JSS activities occur nationwide in classrooms and schools, through extracurricular clubs and student associations, and as community-based events that are independently hosted and sponsored. The AEOP's investment in JSS-based programming is managed by TSA. The AEOP's JSS programming is designed to support the instruction of STEM in categories such as alternative fuels, engineering design, and aerodynamics. Through JSS, students develop teamwork and problem-solving abilities, investigate environmental issues, gain hands-on engineering skills, and use principles of science and mathematics to create the fastest, most interesting, and best crafted vehicle possible.

In 2017, students participated in JSS through 22 TSA-affiliated state competitions, 4 regional Army

laboratory-hosted locations, and one national competition in Orlando, Florida. In 2017, the AEOP's contributions to JSS programming were guided by the following priorities:

1. Create a national infrastructure to manage local, regional, and national JSS events and increase participation;
2. Enhance training opportunities and resources for teachers/mentors;
3. Coordinate tracking and evaluation opportunities for student and teacher participation in JSS; and
4. Leverage AEOP through cross-program marketing efforts.

Table 1 summarizes 2017 student participation by site.

Table 2 provides demographic data for student participants in JSS in 2017. The enrollment of 892 students represents a 46% increase in enrollment as compared to FY16 when 609 students were enrolled in JSS. The representation of underserved students in JSS increased in FY17. JSS participants were predominantly female (61%) in FY17. This is a notable increase in female participation as compared to FY16 when only 27% of participants were female. Slightly less than half (44%) of students identified themselves as White (compared to 54% in FY16) while 15% identified themselves as Black or African American (compared to 7% in FY16) and 10% as Hispanic/Latino (compared to 6% in FY16). AEOP's definition of underserved includes at least two of the following: low-income students; students belonging to race and ethnic minorities that are historically underrepresented in STEM; students with disabilities; students with English as a second language; first-generation college students; students in rural, frontier, or other Federal targeted outreach schools; females in certain STEM fields.

Table 3 provides demographic data for adult participants in JSS in 2017. A total of 614 adults participated in JSS program activities in FY17, over 100% increase from FY16 when 249 adults participated. Adult participants included team advisors, many of whom were teachers; volunteers; and Army Scientists and Engineers (S&Es). These adults supported students as they prepared for or participated in a JSS event and played important roles as mentors to JSS students.

Table 1. 2017 JSS Site Participation Numbers [t]

2017 JSS Site	No. Of Enrolled Students Per CVENT
National TSA Conference (Nashville, TN)-June 28th-July 2nd, 2017	228
Alabama TSA state competition-Birmingham	6
Colorado TSA state competition-Denver	30
Delaware TSA state competition-Harrington	11

Florida TSA state competition-Orlando	41
Georgia TSA state competition-Athens	27
Idaho TSA state competition-Twin Falls	No data in Cvent
Iowa TSA state competition-Altoona	1
Kansas TSA state competition-Salina	No data in Cvent
Kentucky TSA state competition-Louisville	2
Montana TSA state competition-Billings	No data in Cvent
Mississippi TSA state competition-Jackson	6
Missouri TSA state competition-Rolla	15
New Hampshire TSA state competition-Bartlett	No data in Cvent
New Jersey TSA state competition-Ewing	16
New Mexico TSA state competition-Los Lunas	No data in Cvent
New York TSA state competition-Oswego	4
North Carolina TSA state competition-Greensboro	18
Oklahoma TSA state competition-Midwest City	25
Pennsylvania TSA state competition-Champion	56
South Carolina TSA state competition-Myrtle Beach	7
Tennessee TSA state competition-Chattanooga	14

[t] data was provided from JSS program administrator and collected from both Cvent and from state advisors that reported their state conference JSS event numbers.

Table 2. 2017 JSS Student Participant Profile		
Demographic Category		
Gender (n = 892)		
Female	548	61%
Male	308	34%
Not Reported	36	4%
Race/Ethnicity (n = 892)		
Asian	129	15%
Black or African American	130	15%
Hispanic or Latino	89	10%
Native American or Alaska Native	7	>1%
Native Hawaiian or Other Pacific Islander	4	>1%
White	394	44%
Other (self-reported, some more than 1 race)	44	5%
Choose not to report	95	11%
School setting (n=778)		
Urban (city)	185	21%
Suburban	418	47%
Rural (country)	131	15%
Frontier or tribal School	1	>1%

DoDDS/DoDEA School	121	14%
Home school	3	>1%
Online school	n/a	n/a
Choose not to report	33	4%
Receives free or reduced lunch (n=892)		
Yes	179	21%
No	540	60%
Choose not to report	174	19%

Table 3. 2017 Adult JSS Participation	
Participant Group	**Teachers/Adults**
Number of Adults (teachers, mentors, volunteers)	290
Number of Army S&Es	37
Grand Total of Adult Participants	**327**

The total cost of the 2017 JSS program was $135,176 (based on budget through July 2017). The average cost per student participant was $151. Table 4 summarizes these and other 2017 JSS program costs.

Table 4. 2017 JSS Program Costs	
2017 JSS - Cost Per Student Participant	
Total Participants	892
Total Cost	$150,000
Cost Per Student Participant	$168
2017 JSS - Cost Breakdown	
Administrative Cost to TSA	$106,422
Other Operational Costs	$25,670
Total Cost	**$150,000**

4 | Evidence - Based Program Change

The AEOP tasks its programs with achieving three broad priorities: (1) STEM Literate Citizenry – Broaden, deepen, and diversify the pool of STEM talent in support of our defense industry base; (2) STEM Savvy Educators – Support and empower educators with unique Army research and technology resources; and (3) Sustainable Infrastructure – Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army. The AEOP has three key objectives for the portfolio in FY17:

1. Increase outreach to populations that are underserved in STEM;
2. Increase participants' awareness of Army/DoD STEM careers; and
3. Increase participants' awareness of other AEOP opportunities.

In support of these priorities and objectives, the TSA established the following objectives for the JSS program in 2017:

1. Increase and promote participation in JSS events and activities targeting underserved populations. Highlight uniqueness of JSS targeting the middle school population. Promote STEM education to participants at the national conference;
2. Enhance resources, training opportunities and communication among teachers, mentors and students of JSS; and
3. Provide and simplify evaluation opportunities for student and teacher participation in JSS. Leverage AEOP through cross-program marketing efforts and promote AEOP opportunities at state conferences and the national conference to create awareness, excitement and interest in STEM-related careers.

TSA took the following actions in FY17 in light of these objectives, the FY16 JSS evaluation study, and site visits conducted by TSA, the Army, and Purdue University:

I. Increase and promote participation in JSS events and activities targeting historically underserved populations. Highlight uniqueness of JSS targeting the middle school population. Promote STEM education to participants at the national conference *(supports AEOP Priority 1).*

a) Increased outreach, communication and promotional materials early in the school year to army bases and TSA middle school chapters to encourage more JSS participation;
b) Provided year-long support to the Strategic Outreach Partners in the planning of their JSS regional events and planning for attendance at the national TSA conference;
c) Provided solar kits to army hosted events and the first 150 chapter advisors to register on

the Cvent registration;

d) Collaborated with other groups on (solar businesses, regional districts, etc.) involvement and promotion of a JSS event;
e) Provided kits to two underserved population groups wanting to participate in JSS but unable to afford the cost of kits.

II. **Enhance resources, training opportunities and communication among teachers, mentors and students of JSS** *(supports AEOP Priorities 1, 2, and 3).*

a) Shared tip sheets/preparation materials used for the national conference with those new sites hosting a JSS event;
b) Promoted JSS via social media, i.e., tips, reminders and promotional materials related to the AEOP and JSS;
c) Began discussion with veteran TSA advisors on creating a webinar for new advisors and/or participants to JSS;
d) Coordinated collaboration between veteran JSS hosts and new hosts of JSS events

III. **Provide and simplify evaluation opportunities for student and teacher participation in JSS. Leverage AEOP through cross-program marketing efforts and promote AEOP opportunities at state conferences and the national conference to create awareness, excitement and interest in STEM-related careers.** *(supports AEOP Priorities 1, 2, and 3).*

a) TSA state advisors were sent AEOP/TSA promotional materials prior to their state conference JSS event;
b) Monthly state advisor news included information on the AEOP programs with a direct link to the AEOP website as well as links to the post evaluation surveys;

5 | Evaluation At-A-Glance

Purdue University, in collaboration with TSA, conducted a comprehensive evaluation of JSS. The JSS logic model below presents a summary of the expected outputs and outcomes for JSS in relation to the AEOP and JSS-specific priorities. This logic model provided guidance for the overall Unite evaluation strategy.

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• Army sponsorship • TSA providing —capacity to establish national network of JSS participants —online JSS educational and event resources —national JSS competition • JSS participants, inclusive of local event hosts, educators, and students seeking resources and event information • Awards for student winner(s) of national JSS competition • Centralized branding and comprehensive marketing of AEOP • Centralized evaluation	• Event hosts, educators, and students access and use JSS educational and event resources • Students build, test, and register solar cars in state, Army, and national JSS competitions • TSA-selected judges evaluate solar cars at JSS competitions and select winner(s) • Program activities that expose students to AEOP programs and/or STEM careers in the Army or DoD •	• Number of event hosts, educators, and students using online JSS educational and event resources • Number and diversity of students participating in national JSS competition • Number of and Title 1 status of schools served through event host, educator, or student engagement • Event hosts, educators, students, others, and TSA contributing to evaluation	• Increased student knowledge, skills and abilities, and confidence in STEM • Increased student interest in future STEM engagement • Increased participant awareness of and interest in other AEOP opportunities • Increased participant awareness of and interest in Army/DoD STEM research and careers • Implementation of evidence-based recommendations to improve TSA's JSS offerings	• Increased participant engagement in other AEOP opportunities and Army/DoD-sponsored programs • Increased student pursuit of STEM coursework in secondary and post-secondary schooling • Increased student pursuit of STEM degrees • Increased student pursuit of STEM careers • Increased student pursuit of Army/DoD STEM careers • Continuous improvement and sustainability of JSS

The JSS evaluation gathered information from multiple participant groups about JSS processes, resources, activities, and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and JSS program objectives. The assessment strategy for JSS included student and mentor questionnaires, 4 focus groups with students at the national event, and 1 focus group with mentors at the national event. Tables 5-8 outline the information collected in student and mentor questionnaires and focus groups and interviews that is relevant to this evaluation report.

Key Evaluation Questions

- What aspects of JSS motivate participation?
- What aspects of JSS structure and processes are working well?
- What aspects of JSS could be improved?
- Did participation in JSS:
  - Increase apprentices' STEM competencies?
  - Increase apprentices' interest in future STEM engagement?
  - Increase apprentices' awareness of and interest in other AEOP opportunities?
  - Increase apprentices' awareness of and interest in Army/DoD STEM research and careers?

Table 5. 2017 Student Questionnaires	
Category	**Description**
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level, confidence to achieve educational goals, field sought
AEOP Goal 1	**Capturing the Student Experience:** In-school vs. In-program experience
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in 21st Century Skills
	STEM Identity: Gains in STEM identity, intentions to participate in STEM, and STEM-oriented education and career aspirations; contribution of AEOP
	AEOP Opportunities: Past participation, awareness of, and interest in participating in other AEOP programs; contribution of AEOP, impact of AEOP resources
	Army/DoD STEM: Exposure to Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers, change in interest for STEM and Army/DoD STEM jobs; contribution of AEOP, impact of AEOP resources
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies (students respond to a subset)
	Comprehensive Marketing Strategy: impact of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 6. 2017 Mentor Questionnaires	
Category	**Description**
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of JSS, satisfaction with and suggestions for improving HSAP programs, benefits to participants
AEOP Goal 1	**Capturing the Student Experience:** In-program experience
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in 21st Century Skills
	AEOP Opportunities: Past participation, awareness of other AEOP programs; efforts to expose students to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing student AEOP metrics

	Army/DoD STEM: attitudes toward Army/DoD STEM research and careers, efforts to expose students to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing student Army/DoD career metrics
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies
	Comprehensive Marketing Strategy: how mentors learn about AEOP, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 7. 2017 Student Focus Groups	
Category	**Description**
Satisfaction & Suggestions	Awareness of JSS, motivating factors for participation, awareness of implications of research topics, satisfaction with and suggestions for improving JSS programs, benefits to participants
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Extent to which apprentices were exposed to other AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Extent to which apprentices were exposed to STEM and Army/DoD STEM jobs

Table 8. 2017 Mentor Focus Groups	
Category	**Description**
Satisfaction & Suggestions	Perceived value of JSS, benefits to participants suggestions for improving HSAP programs
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Efforts to expose apprentices to AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Efforts to expose apprentices to STEM and Army/DoD STEM jobs
	Mentor Capacity: Local Educators – Strategies used to increase diversity/support diversity in JSS

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan. The reader is strongly encouraged to review Appendix A to clarify how data are summarized, analyzed, and reported in this document. Findings of statistical and/or practical significance are noted in the report narrative, with tables and footnotes providing results from tests for significance. The student and mentor interview protocols are provided in Appendix B (student) and Appendix C (mentor); and student and mentor questionnaire instruments are located in Appendix D (student) and Appendix E (mentor).

Study Sample

Table 9 provides an analysis of student and mentor participation in the JSS questionnaires, the response rate, and the margin of error at the 95% confidence level (a measure of how representative the sample is of the population). The margin of errors for both the student and adult surveys are larger than generally acceptable, indicating that the samples may not be representative of their respective populations. The student response rate declined as compared to FY16 when 14% of participants

responded to the questionnaire. Likewise, the mentor response rate is lower than in FY16 when 16% of mentors responded.

Table 9. 2017 JSS Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence[1]**
Students	79	893	8.8%	±10.53%
Team Advisors	23	255	9.0%	±19.53%

Thirty-two students participated in the four national student focus groups (3 females, 29 males). Fourteen mentors (6 females, 8 males) participated in the focus group held at the national JSS event. Focus groups and interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of student questionnaire data. They add to the overall narrative of JSS' efforts and impact, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Student Demographics

JSS student demographic data collected from questionnaire respondents are summarized in Table 10. More males (53.2%) than females (45.6%) completed the questionnaire. In terms of race/ethnicity, more responding students identified as being White (55.7%) than with any other single race/ethnicity category. Approximately 14% of respondents identified with the Hispanic or Latino category, and only 6.3% of respondents identified with the Black or African American category. Half (50.6%) of respondents were 9th graders, followed by while 27.8% in the 8th grade, 16.5% in the 7th grade, and only 2.5% in the 6th grade. These data suggest that students responding to the questionnaire are demographically similar to the population of JSS participants for FY17, however smaller proportions of responding students were female (46% of respondents versus 61% of enrolled students) and larger proportions of responding students were White (56% of respondents versus 44% of enrolled students) than in the overall enrolled population of JSS students.

[1] "Margin of error @ 95% confidence" means that 95% of the time, the true percentage of the population who would select an answer lies within the stated margin of error. For example, if 47% of the sample selects a response and the margin of error at 95% confidence is calculated to be 5%, if you had asked the question to the entire population, there is a 95% likelihood that between 42% and 52% would have selected that answer. A 2-5% margin of error is generally acceptable at the 95% confidence level.

Table 10. 2017 JSS Student Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 79)		
Female	36	45.6%
Male	42	53.2%
Choose Not to Report	1	1.2%
Respondent Race/Ethnicity (n =79)		
Asian	6	7.6%
Black or African American	5	6.3%
Hispanic or Latino	11	13.9%
Native American or Alaska Native	2	2.5%
Native Hawaiian or other Pacific Islander	0	0.0%
White	44	55.7%
Other race or ethnicity	5	6.3%
Choose not to report	6	7.6%
Respondent Grade Level‡ (n =79)		
6th	2	2.5%
7th	13	16.5%
8th	22	27.8%
9th‡	40	50.6%
Not Reported	2	2.5%

‡ Students who indicated being in the 9th grade started their participation in JSS during their 8th grade year.

Mentor Demographics

Table 11 summarizes mentor survey respondent demographics. Over half of the mentor respondents reported being female (56.52%). All but one of the responding mentors indicated they were teachers (95.65%), and most identified their role in JSS as a competition advisor (86.96%).

Table 11. 2017 JSS Mentor Profile		
Demographic Category	Questionnaire Respondents	
Survey Respondent Gender (n = 23)		
Female	13	56.52%
Male	10	43.48%
Choose not to report	0	0.00%
Race/Ethnicity (n = 23)		
Hispanic or Latino	0	0.00%
Asian	0	0.00%
Black or African American	3	13.04%
Native American or Alaskan Native	1	4.35%
Native Hawaiian or Other Pacific Islander	0	0.00%

White	17	73.91%
Other	0	0.00%
Choose not to report	2	8.70%
Occupation (n = 23)		
Teacher	22	95.65%
Other School Staff	1	4.35%
Role in JSS (n = 23)		
Competition advisor	20	86.96%
Chaperone	0	0.00%
Event coordinator or staff	1	4.35%
Other, (specify)[§]	2	8.70%

[§] Other = Chapter Advisor; Team Advisor (Volunteer in class)

6 | Actionable Program Evaluation

The Actionable Program Evaluation is intended to provide assessment and evaluation of program processes, resources, and activities for the purpose of recommending improvements as the program moves forward. A focus of the Actionable Program Evaluation is efforts toward the long-term goal of JSS and all of the AEOPs to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technology progress. Thus, it is important to consider how JSS is marketed to and ultimately recruits student participants, the factors that motivate students to participate in JSS, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. The following sections report perceptions of students and mentors that pertain to current programmatic efforts and recommend evidence-based improvements to help JSS achieve outcomes related to AEOP programs and objectives. While outreach to underserved populations is not a key objective of JSS hosts and educators nationwide, it is an Army priority across AEOPs and therefore it is important to view these results with a perspective that focuses on how JSS can expand participation from and support STEM education for students from underrepresented and underserved groups.

Marketing and Recruiting Underrepresented and Underserved Populations

The JSS program employed multi-pronged efforts to market events to students on a broad scale. Although schools identified as serving large populations of traditionally underrepresented and underserved students were not a particular focus of this effort, JSS marketed its program in a variety of ways to reach a diverse population of students:

- Increased outreach, communication and promotional materials early in the school year to army bases and TSA middle school chapters to encourage more JSS participation
- Promoted JSS via social media, i.e., tips, reminders and promotional materials related to the AEOP and JSS
- Marketing/promotion emails were sent to all TSA chapter advisors providing information on those AEOP programs rising 9th graders would be eligible for.
- AEOP marketing materials were disseminated at the SAME (Society of American Military Engineers) conference; the conference attendees included small businesses looking to connect with STEM based programs in schools.
- Outreach to TSA chapters encouraged female participation in JSS.
- TSA Title 1 schools were provided with an incentive of receiving two free solar kits for participating in JSS
- A new initiative, JSS Jumpstart, was created for the purpose of growing the JSS program. 5th and 6th graders housed in elementary schools interested in participating in JSS at a local level were

the target population. Kits were provided to five elementary schools that were classified as Title 1.

Factors Motivating Apprentice Participation

In order to understand what features of JSS motivate students to participate, students participating in focus groups were asked about what motivated them to participate in JSS.

Students mentioned having fun, interest in STEM, interest in engineering and innovation, a class requirement, and the opportunity to have new experiences as motivators for participating in JSS. For example,

> *From what I observed last year when I tagged along with the other student, [JSS] looked pretty interesting, and I wanted to see if I could replicate what he had made except something better.* [JSS National Student]
>
> *I participated in JSS because I want to be an engineer when I grow up.* [JSS National Student]
>
> *We did JSS because we like to create new things and try to think of new ways to do stuff.* [JSS National Student]
>
> *[JSS] sounded fun.* [JSS National Student]

The JSS Experience

Several items on the JSS student questionnaire focused on student experiences in JSS and how those experiences compared to STEM learning and engagement experiences in school. Table 12 displays student responses to questions about students' STEM Learning during JSS. Approximately one-third to a half of students indicated that they applied STEM learning to real-life situations (48.71%), communicated with other students about STEM (44.15%), learned about new STEM topics (36.71%), and learned about new discoveries in STEM (36.70%) on most or every day of their JSS experience. About one-quarter (27.84%) of students reported learning about careers that use STEM most days or every day, however almost 80% of the students reported learning about these careers at least once during their JSS experience.

Table 12. Nature of Student Learning in JSS (n=77-79)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Learn about STEM topics that are new to you	7.59%	18.99%	36.71%	26.58%	10.13%	
	6	15	29	21	8	**79**

Apply STEM learning to real-life situations	5.13%	14.10%	32.05%	33.33%	15.38%	
	4	11	25	26	12	**78**
Learn about new discoveries in STEM	7.59%	22.78%	32.91%	29.11%	7.59%	
	6	18	26	23	6	**79**
Learn about different careers that use STEM	21.52%	26.58%	29.11%	13.92%	8.86%	
	17	21	23	11	7	**79**
Interact with scientists or engineers	17.72%	13.92%	40.51%	22.78%	5.06%	
	14	11	32	18	4	**79**
Communicate with other students about STEM	7.79%	18.18%	29.87%	28.57%	15.58%	
	6	14	23	22	12	**77**

Students were also asked to indicate how often they engaged in STEM activities throughout JSS. Findings show students believed they were actively engaged in a wide array of STEM practices during JSS (see Table 13). For example, 79.75% of students who responded indicated working as part of a team on most days or every day, 59.49% reported coming up with creative explanations or solutions on most days or every day, and 56.96% indicated analyzing data or information on most days or every day of their JSS experience.

Table 13. Nature of Student Engagement in STEM Activities in JSS (n=79)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Use laboratory procedures and tools	6.33%	15.19%	29.11%	36.71%	12.66%	
	5	12	23	29	10	**79**
Participate in hands-on STEM activities	1.27%	10.13%	32.91%	39.24%	16.46%	
	1	8	26	31	13	**79**
Work as part of a team	0.00%	5.06%	15.19%	45.57%	34.18%	
	0	4	12	36	27	**79**
Identify questions or problems to investigate	2.53%	10.13%	35.44%	37.97%	13.92%	
	2	8	28	30	11	**79**
Design an investigation	0.00%	21.52%	34.18%	37.97%	6.33%	

	0	17	27	30	5	**79**
Carry out an investigation	3.80%	18.99%	35.44%	35.44%	6.33%	
	3	15	28	28	5	**79**
Analyze data or information	2.53%	11.39%	29.11%	44.30%	12.66%	
	2	9	23	35	10	**79**
Draw conclusions from an investigation	1.27%	20.25%	26.58%	40.51%	11.39%	
	1	16	21	32	9	**79**
Come up with creative explanations or solutions	0.00%	6.33%	34.18%	41.77%	17.72%	
	0	5	27	33	14	**79**
Build or make a computer model	27.85%	18.99%	29.11%	17.72%	6.33%	
	22	15	23	14	5	**79**

Composite scores[2] were calculated for sets of items corresponding to Learning about STEM[3] and Engaging in STEM Practices[4]. Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and the average across all items in the scale was calculated. Composite scores were used to test whether there were differences in student experiences across subgroups of gender, race/ethnicity, and socio-economic status (SES). For both Learning about STEM and Engaging in STEM Practices in JSS, no significant differences were found by gender, race/ethnic group, or SES. These findings suggest that regardless of demographics, students had similar experiences in terms of learning about STEM and engaging with STEM practices while participating in JSS.

Participants were asked to respond to parallel items about their STEM learning in school and engagement in STEM practices in school, giving participants the opportunity to report on how often they engaged in the same activities in school. These items were then combined into two composite variables: "Learning about STEM in School,"[5] and "Engaging in STEM Practices in School"[6]. When comparing "in JSS" to "in School" activities, students reported no significant differences in terms of STEM Engagement.

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[2] Using multiple statistical tests on related outcomes requires the use of a Type I error rate adjustment to reduce the likelihood of false positives (i.e., detecting a difference when one does not truly exist). However, Type I error rate adjustments lead to a reduction in statistical power (i.e., the ability to detect a difference if it does exist). The use of a composite score helps avoid both of these problems by reducing the total number of statistical tests used. In addition, composite scores are typically more reliable than individual questionnaire items.

[3] The Cronbach's alpha reliability for these 6 items was 0.859.

[4] The Cronbach's alpha reliability for these 10 items was 0.915.

[5] Cronbach's alpha reliability of 0.851.

[6] Cronbach's alpha reliability of 0.890.

However, there was a significant difference for STEM Learning. Students reported Learning more about STEM significantly more while in school compared to when in JSS (moderate effect size, d = 0.657)[7]. This may be attributable to the fact that JSS activities are often completed as a class requirement and, as a result, students may not differentiate between STEM Learning in School and in JSS.

Students in focus groups, however, reported that their JSS experiences differed from their regular school class activities in terms of the hands-on content, their choice in participation, and their level of interest. For example, students said:

> *I don't like science in school, but in [JSS] I liked it more.* [JSS National Student]
>
> *We like it because it was a project that we got to pick that we wanted to do instead of something that was assigned, and we didn't have to worry getting a bad grade on it because it was an event that was fun.* [JSS National Student]
>
> *We learn in science class about solar energy and how it works, but we never get any hands-on treatment with it.* [JSS National Student]

In alignment with the JSS goal of increasing the number and diversity of students who pursue STEM careers, students were asked how many STEM jobs/careers they had learned about during JSS (see Table 15). Students were further asked, how many DoD STEM jobs/careers they learned about during their experience (see Tables 16). Table 14 shows that 69.74% of students reported learning about at least one STEM job/career, with 22.37% learning about five or more. Students, however, were less likely to indicate they learned about DoD STEM jobs/careers (see Table 15) with only 51.95% of students reporting learning about at least DoD STEM job/career.

Table 14. Number of STEM Jobs/Careers Students Learned About During JSS (n = 76)

Choice	Response Percent	Response Total
None	30.26%	23
1	11.84%	9
2	19.74%	15
3	11.84%	9
4	3.95%	3
5 or more	22.37%	17

[7] Dependent Samples t-test: $t(78) = 2.90$, $p = .005$, two-tailed.

Table 15. Number of Army/DoD STEM Jobs/Careers Learn About During JSS (n = 77)

Choice	Response Percent	Response Total
None	48.05%	37
1	11.69%	9
2	10.39%	8
3	12.99%	10
4	1.30%	1
5 or more	15.58%	12

Likewise, students in focus groups reported learning about engineering careers in general during JSS, but none reported learning about STEM careers in the Army or DoD. As one student participant at the National event commented, "I'm still not really sure what this has to do with the Army," suggesting that JSS has the opportunity to make more explicit connections between the program and the Army and DoD.

Students were asked about the impact of a variety of resources on their awareness of DoD STEM careers. Table 16 shows student responses. The AEOP website (71.43%) was by far the most influential resource reported by students. Participation in JSS and the AEOP Brochure were also reported as being helpful resources by nearly a quarter of students. Several of the resources included were indicated to have not helped most students in their awareness of DoD STEM careers, including Invited Speakers (61.11%) and JSS Mentors (61.11%).

Table 16. Impact of Resources on Student Awareness of DoD STEM Careers		
Item	**Helped (n=63)**	**Did Not Help (n=54)**
AEOP Website	71.43%	33.33%
AEOP Brochure	20.63%	44.44%
My JSS Mentor	9.52%	61.11%
My Participation in JSS	20.63%	55.56%
Invited Speakers	9.52%	61.11%

The Role of Mentors

JSS mentors, typically teachers, play a critical role in the JSS program by designing and facilitating learning activities, delivering content through instruction, supervising and supporting collaboration and teamwork, providing one-on-one support to students, and chaperoning students at JSS events. On

average, mentors responding to the mentor questionnaire reported working with 10 students, with a range of 2 to 90 students.

Mentors were asked to report on their use of mentoring strategies when working with students. These strategies comprised five main areas of effective mentoring or team advising:[8]

1. Establishing the relevance of learning activities;
2. Supporting the diverse needs of students as learners;
3. Supporting students' development of collaboration and interpersonal skills;
4. Supporting students' engagement in "authentic" STEM activities; and
5. Supporting students' STEM educational and career pathways.

Nearly three-quarters or more of mentors reported using most strategies to help make learning activities relevant to students (see Table 17). More than 80% of mentors reported becoming familiar with students' backgrounds and interests (87.0%), giving students real-life problems to investigate (87.0%), and helping students become aware of the role(s) STEM plays in their everyday lives (82.6%). The exception was the strategy of selecting readings or activities that related to students' backgrounds, which only 39% of mentors reported using.

Table 17. Mentors Using Strategies to Establish Relevance of Learning Activities (n = 23)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Become familiar with my student(s) background and interests at the beginning of the JSS experience	87.0%	13.0%	
	20	3	**23**
Giving students real-life problems to investigate or solve	87.0%	13.0%	
	20	3	**23**

[8] Mentoring strategies examined in the evaluation were best practices identified in various articles including:

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education*, *95*(5), 877-907.

Ornstein, A. (2006). The frequency of hands-on experimentation and student attitudes toward science: A statistically significant relation (2005-51-Ornstein). *Journal of Science Education and Technology*, *15*(3-4), 285-297.

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, *96*(3), 411-427.

Selecting readings or activities that relate to students' backgrounds	39.1%	60.9%	
	9	14	**23**
Encouraging students to suggest new readings, activities, or projects	73.9%	26.1%	
	17	6	**23**
Helping students become aware of the role(s) that STEM plays in their everyday lives	82.6%	17.4%	
	19	4	**23**
Helping students understand how STEM can help them improve their own community	78.3%	21.7%	
	18	5	**23**
Asking students to relate real-life events or activities to topics covered in JSS	73.9%	26.1%	
	17	6	**23**

Adults reported supporting the diverse needs of student learners with mentoring strategies (see Table 18). Half or more of adult respondents indicated that they used each of the strategies listed. The three strategies used most, by 86.4% each, were: using a variety of activities; integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM; and directing students to others for additional support as needed.

Table 18. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n = 22)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Identify the different learning styles that my student (s) may have at the beginning of the JSS experience	77.3%	22.7%	
	17	5	**22**
Interact with students and other personnel the same way regardless of their background	81.8%	18.2%	
	18	4	**22**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	86.4%	13.6%	
	19	3	**22**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	86.4%	13.6%	
	19	3	**22**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	50.0%	50.0%	
	11	11	**22**

Directing students to other individuals or programs for additional support as needed	86.4%	13.6%	
	19	3	**22**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	68.2%	31.8%	
	15	7	**22**

More than 70% of adults reported implementing each of the strategies listed to support student development of collaboration and interpersonal skills, with the exception of having students tell other people about their backgrounds and interests, which only 39.1% of mentors reported using (see Table 19). The four strategies adults reported using most in this domain were: having students work on collaborative activities as a team member (91.3%), having students listen to ideas of others with an open mind (87.0%), and having students give/receive constructive feedback with others (87.0%), and allowing students to resolve conflicts and reach agreements within teams (86.4%).

Table 19. Mentors Using Strategies to Support Student Development of Collaboration and Interpersonal Skills (n = 23)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having my student(s) tell other people about their backgrounds and interests	39.1%	60.9%	
	9	14	**23**
Having my student(s) explain difficult ideas to others	73.9%	26.1%	
	17	6	**23**
Having my student(s) listen to the ideas of others with an open mind	87.0%	13.0%	
	20	3	**23**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	73.9%	26.1%	
	17	6	**23**
Having my student(s) give and receive constructive feedback with others	87.0%	13.0%	
	20	3	**23**
Having students work on collaborative activities or projects as a member of a team	91.3%	8.7%	
	21	2	**23**
Allowing my student(s) to resolve conflicts and reach agreement within their team	86.4%	13.6%	
	19	3	**22**

Adult questionnaire respondents also reported supporting student engagement in authentic STEM activities through a variety of strategies. Table 20 shows that approximately 70% or more used all strategies. The most frequently chosen strategy adult mentors used was encouraging students to seek support from other team members (95.5%). Teaching (or assigning readings) about specific STEM subject matter was the least-used strategy in this category (68.2%).

Table 20. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM Activities (n = 22)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	68.2%	31.8%	
	15	7	**22**
Having my student(s) search for and review technical research to support their work	86.4%	13.6%	
	19	3	**22**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	77.3%	22.7%	
	17	5	**22**
Supervising my student(s) while they practice STEM research skills	86.4%	13.6%	
	19	3	**22**
Providing my student(s) with constructive feedback to improve their STEM competencies	86.4%	13.6%	
	19	3	**22**
Allowing students to work independently to improve their self-management abilities	81.8%	18.2%	
	18	4	**22**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	86.4%	13.6%	
	19	3	**22**
Encouraging students to seek support from other team members	95.5%	4.5%	
	21	1	**22**

Reports of the use of strategies to support student STEM educational and career pathways ranged widely (see Table 21). More than three-quarters of adult respondents reported using strategies such as asking students about their educational and/or career goals (82.6%) and providing guidance about educational pathways that will prepare students for a STEM career (78.3%). Only 30.4% reported discussing STEM career opportunities with the DoD or other government agencies, while 60.9% of mentors discussed STEM career opportunities in private industry or academia. Given the AEOP goal of

broadening the talent pool in STEM fields this is an area of potential growth. Further, given the AEOP interest in having students participate in other AEOP opportunities, it is important to note that only 18.2% of mentors recommended other AEOPs to students.

Table 21. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n = 23)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	82.6%	17.4%	
	19	4	**23**
Recommending extracurricular programs that align with students' goals	78.3%	21.7%	
	18	5	**23**
Recommending Army Educational Outreach Programs that align with students' goals	18.2%	81.8%	
	4	18	**22**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	78.3%	21.7%	
	18	5	**23**
Discussing STEM career opportunities within the DoD or other government agencies	30.4%	69.6%	
	7	16	**23**
Discussing STEM career opportunities in private industry or academia	60.9%	39.1%	
	14	9	**23**
Discussing the economic, political, ethical, and/or social context of a STEM career	73.9%	26.1%	
	17	6	**23**
Recommending student and professional organizations in STEM to my student(s)	69.6%	30.4%	
	16	7	**23**
Helping students build a professional network in a STEM field	47.8%	52.2%	
	11	12	**23**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	56.5%	43.5%	
	13	10	**23**

Mentors were asked which of the AEOP programs they discussed with their students during JSS. The vast majority did not discuss specific AEOPs with students (see Table 22). Over a third (36.4%) reported

discussing GEMS with students, and another 36.4% of mentors reported discussing AEOP, but not specific programs, with students.

Table 22. Mentors Explicitly Discussing AEOPs with Students (n = 23)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Gains in the Education of Mathematics and Science (GEMS)	36.4%	63.6%	
	8	14	**22**
Unite	14.3%	85.7%	
	3	18	**21**
Junior Science & Humanities Symposium (JSHS)	9.1%	90.9%	
	2	20	**22**
Science & Engineering Apprenticeship Program (SEAP)	13.6%	86.4%	
	3	19	**22**
Research & Engineering Apprenticeship Program (REAP)	9.1%	90.9%	
	2	20	**22**
High School Apprenticeship Program (HSAP)	9.5%	90.5%	
	2	19	**21**
College Qualified Leaders (CQL)	9.1%	90.9%	
	2	20	**22**
GEMS Near Peer Mentor Program	9.1%	90.9%	
	2	20	**22**
Undergraduate Research Apprenticeship Program (URAP)	9.1%	90.9%	
	2	20	**22**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	9.1%	90.9%	
	2	20	**22**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	4.5%	95.5%	
	1	21	**22**
I discussed AEOP with my student(s) but did not discuss any specific program	36.4%	63.6%	
	8	14	**22**

Mentors were asked to rate the usefulness of various resources in exposing students to AEOPs. The TSA website (78.2%), participation in JSS (73.9%), and the JSS website (60.8%) were most often reported as "very much" or "somewhat" useful by mentors (see Table 23). More than two-thirds of mentors reported not experiencing resources such as invited speakers or "career" events (78.3%), the It Starts Here! Magazine (78.3%), and AEOP on social media (69.6%), and over half (56.5%) had not experienced the AEOP brochure.

Table 23. Usefulness of Resources in Exposing Students to AEOPs (n=23)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Technology Student Association (TSA) website	4.3%	0.0%	17.4%	30.4%	47.8%	
	1	0	4	7	11	**23**
Army Educational Outreach Program (AEOP) website	34.8%	4.3%	13.0%	26.1%	21.7%	
	8	1	3	6	5	**23**
AEOP on Facebook, Twitter, Pinterest or other social media	69.6%	13.0%	0.0%	17.4%	0.0%	
	16	3	0	4	0	**23**
AEOP brochure	56.5%	8.7%	13.0%	17.4%	4.3%	
	13	2	3	4	1	**23**
JSS Program administrator or site coordinator	52.2%	13.0%	13.0%	17.4%	4.3%	
	12	3	3	4	1	**23**
Invited speakers or "career" events	78.3%	8.7%	4.3%	4.3%	4.3%	
	18	2	1	1	1	**23**
Participation in JSS	17.4%	0.0%	8.7%	26.1%	47.8%	
	4	0	2	6	11	**23**

Mentors were also asked how useful these same resources were for exposing students to DoD STEM careers (see Table 24). Again, mentors reported participation in JSS (40.9%) and the TSA website (43.5%) more often than other resources to have been "very much" or "somewhat" useful. The majority of mentors reported not having experienced most other resources including: invited speakers or "career" events (73.9%), AEOP on social media (73.9%), and the AEOP brochure (69.6%).

Table 24. Usefulness of Resources in Exposing Students to DoD STEM Careers (n=23)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total

Technology Student Association (TSA) website	21.7%	13.0%	21.7%	17.4%	26.1%	
	5	3	5	4	6	**23**
Army Educational Outreach Program (AEOP) website	43.5%	8.7%	26.1%	8.7%	13.0%	
	10	2	6	2	3	**23**
AEOP on Facebook, Twitter, Pinterest or other social media	73.9%	13.0%	4.3%	8.7%	0.0%	
	17	3	1	2	0	**23**
JSS Program administrator or site coordinator	60.9%	13.0%	8.7%	13.0%	4.3%	
	14	3	2	3	1	**23**
Invited speakers or "career" events	73.9%	8.7%	4.3%	8.7%	4.3%	
	17	2	1	2	1	**23**
Participation in JSS	36.4%	4.5%	18.2%	9.1%	31.8%	
	8	1	4	2	7	**22**

Mentors were asked how they learned about AEOP (see Table 25). The three most common responses with approximately 25% of mentors reporting were: past participants of the program (27.78%), the AEOP website (22.22%), and a community group of program (22.22%). Smaller proportions of mentors reported hearing about AEOP from someone who works with the program (11.11%) and school or university newsletter, email, or website (5.56%).

Table 25. How Mentors Learned About AEOP (n= 16)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	22.22 %	4
AEOP on Facebook, Twitter, Instagram, or other social media	0.00 %	0
School or university newsletter, email, or website	5.56 %	1
Past participant of program	27.78 %	5
Friend	0.00 %	0
Family Member	0.00 %	0
Someone who works at the school or university I attend	0.00 %	0
Someone who works with the program	11.11 %	2
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	0.00 %	0

Community group or program	22.22 %	4

Satisfaction with JSS

An open-ended questionnaire item for students asked about their satisfaction with their JSS experience. Of the 67 students who provided responses to this item, 50 responded with only positive comments. Many of these were simple affirmations of the program such as "Amazing – 5 stars" and "It is fun and a great program!!! So glad I had the chance to participate in it." Others provided detail about what they enjoyed about the program including comments about the opportunity to work on hands-on engineering projects, meet people, build confidence, work with a team, and learn about STEM. For example:

> *I am very pleased with my JSS experience. It taught me so many things and made me confident in complicated scenarios. All of the people I met and my mentors helped me out so much. I loved my experience and had a great time.* [JSS National Student]

> *JSS has given me the chance to work on real engineering tasks, and it also allowed me to research all of the different STEM possibilities that I can participate in.* [JSS National Student]

> *It was a nice experience to learn to work together as a team, and to compete together.* [JSS National Student]

Another 11 student respondents to the questionnaire item also included positive comments, but offered some caveats, and 6 offered no positive comments. Students who expressed dissatisfaction with program elements made comments about perceived lack of fairness, problems with organization, limited learning, and unclear rules. For example,

> *JSS was a good experience overall to build character, but I did not enjoy it. Rules were unclear. Competition was very casual. I did not learn more than I already do in school and from my excellent teacher. AEOP seems to be a great program, but nothing makes me want to join again…Perhaps it was just not for me though, and I appreciate the experience.* [JSS National Student]

> *I like most of the process. However, I have found it to be a little disorganized at the convention. This disappointed me considering it was a TSA activity.* [JSS National Student]

> *There should have been more elaborated rules. Although we followed every guideline, our car was unable to race due to discrepancies in the fishing line and the ground. In the future, we advise for a cleaner execution of the rules and regulations portion of JSS. Overall, however, the*

planning and building of our solar vehicle was an exciting, fun experience. [JSS National Student]

Students were also asked in an open-ended questionnaire item to list the three most important ways that JSS has helped them. Sixty-seven students wrote about one or more benefit of JSS. A variety of benefits were mentioned in student responses. The most often-mentioned benefits were teamwork (mentioned in 32 responses), building STEM knowledge and skills (mentioned in 31 responses) and problem solving (mentioned in 28 responses). Other benefits students listed included the opportunity to make real-world connections with their learning (mentioned in 14 responses), learning about careers (mentioned in 12 responses), and developing skills such as communication (9 responses), perseverance (9 responses), and time management (6 responses). Another 7 responses noted that developing and using creativity was a benefit of JSS participation.

Students participating in focus groups echoed these themes when asked about the benefits of JSS. For example:

I've learned a lot of new things that I didn't know before, like that you can actually make something run from just a small solar panel. [JSS National Student]

Teamwork – that's the big thing for when you're working in a group. [JSS National Student]

It was fun working with a team with people that you never knew before. [JSS National Student]

[JSS] improves your mental span of thinking. [JSS National Student]

Students participating in focus groups at the National event were also asked to share their ideas about how JSS could be improved. Students offered a wide range of suggestions. Eight students made suggestions that focused on standardizing the JSS experience and competition for students, including comments about unequal access to materials and resources (3 students commented on this) and (1 comment each) standardizing timing by using lasers rather than stopwatches, standardizing the track at competitions so that there are no bumps, racing indoors with artificial lights to standardize light for all teams, holding both indoor and outdoor trials, and waiting for the sun to appear to hold races. For example:

Some people just don't have the resources to compete with [certain teams]. If you could 3D print a car, you know how expensive the polymers for that are? We just can't afford that. [JSS National Student]

An idea that they could to do to stop the lumps [on the race course] is maybe put solid things under the track not just being bare on the concrete…during the race, my car was just going and hit that bump. That bump actually broke the clip off my car. [JSS National Student]

I think we should [compete] indoors with artificial light because I've seen it on YouTube. It shows them doing it indoors with these lights. [JSS National Student]

Other suggestions for improvements focused on the instructions and rules, including comments (1 comment each) about having shorter instructions, better instructions including videos, more specific rules, less strict design requirements, and allowing more than one car for each team as back-ups (2 comments). As one student said,

[An improvement would be] a video that went over the rules and how the race is conducted here [JSS National Student]

Four students made comments associated with their personal comfort and the hot weather during the race at the national competition, suggesting that a relaxed dress code be allowed for outdoor races and that water be provided for students while they are outdoors.

Mentors were asked to rate their level of satisfaction with various features of JSS. Table 26 shows that the responding mentors were largely satisfied with most components of JSS. For example, 82.6% of mentors were at least somewhat satisfied with their communications with the TSA and physical location(s) of JSS activities. Additionally, 72.7% were at least somewhat satisfied with the JSS application or registration process. The vast majority of mentors were not dissatisfied with any component of JSS. However, the majority of mentors reported having not experienced stipends (73.9%), invited speakers or "career" events (65.2%), and field trips or laboratory tours (60.9%).

Mentors expressed moderate satisfaction with a variety of JSS online supports (see Table 27). More than two-thirds of mentors were at least somewhat satisfied with the official TSA competition rules (82.6%) and local competition rules (69.5%). Over half of JSS mentors reported having not experienced several online resources including lesson plans (56.5%), calendar of events (56.5%), JSS host guide (56.5%), and video tutorials (52.2%).

Table 26. Mentor Satisfaction with JSS Features (n = 23)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	13.6%	0.0%	13.6%	40.9%	31.8%	
	3	0	3	9	7	**22**
Communicating with Technology Student Association (TSA)	8.7%	4.3%	4.3%	30.4%	52.2%	
	2	1	1	7	12	**23**
Communicating with JSS site coordinators	17.4%	8.7%	4.3%	39.1%	30.4%	
	4	2	1	9	7	**23**
The physical location(s) of JSS's activities	4.3%	4.3%	8.7%	30.4%	52.2%	
	1	1	2	7	12	**23**
Support for instruction or mentorship during program activities	17.4%	8.7%	26.1%	21.7%	26.1%	
	4	2	6	5	6	**23**
Invited speakers or "career" events	65.2%	8.7%	13.0%	4.3%	8.7%	
	15	2	3	1	2	**23**
Field trips or laboratory tours	60.9%	8.7%	17.4%	0.0%	13.0%	
	14	2	4	0	3	**23**

Table 27. Mentor Satisfaction with JSS Online Supports (n = 23)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Official Technology Student Association Competition Rules	4.3%	0.0%	13.0%	30.4%	52.2%	
	1	0	3	7	12	**23**
Local Competition Rules	17.4%	0.0%	13.0%	30.4%	39.1%	
	4	0	3	7	9	**23**
Build A Car resources	40.9%	4.5%	18.2%	18.2%	18.2%	
	9	1	4	4	4	**22**
Course Outline	43.5%	4.3%	13.0%	21.7%	17.4%	
	10	1	3	5	4	**23**
STEM Standards	34.8%	0.0%	17.4%	26.1%	21.7%	
	8	0	4	6	5	**23**
Lesson Plans	56.5%	4.3%	8.7%	17.4%	13.0%	
	13	1	2	4	3	**23**
Terminology	39.1%	4.3%	13.0%	21.7%	21.7%	
	9	1	3	5	5	**23**
Video Tutorials	52.2%	4.3%	13.0%	17.4%	13.0%	
	12	1	3	4	3	**23**
JSS Host Guide	56.5%	4.3%	13.0%	17.4%	8.7%	
	13	1	3	4	2	**23**
Calendar of Events	56.5%	4.3%	8.7%	21.7%	8.7%	
	13	1	2	5	2	**23**

Mentors were also asked to share their overall satisfaction with their JSS experience in an open-ended questionnaire item. Of the 15 mentors who responded to this question, 13 had only positive comments. For example:

> *I thought the overall experience was great. The students learned so much and they enjoyed what they were doing.* [JSS Mentor]

> *JSS has opened the door to STEM related career fields for all of my students. 90% of my former students that have graduated from high school are not in the military in STEM fields or enrolled in college in STEM related programs. All of them built and raced in the JSS.* [JSS Mentor]

While one mentor made no positive comments about the program, noting "I was not satisfied because I did not feel that an effort was made to include us," one mentor made positive comments about the program, but offered caveats about the vagueness of rules and way that the Army's role in JSS was communicated. This mentor said:

> *Overall, I was very satisfied. Sometimes the directions were more vague than we would like, but it was a great experience for the students. They learned to work together and problem solve. I think that the DoD and Army affiliation could be more apparent. I had no idea they were connected.* [JSS Mentor]

In another open-ended question, mentors were asked to identify the three most important strengths of JSS. Twenty mentors responded to this question, mentioning various benefits of the program. The most often-mentioned benefits included teamwork (11 responses), STEM knowledge (9 responses), and problem-solving and critical thinking (9 responses).

Mentors in the focus group were also asked to comment about the benefits of JSS. Mentors' comments in focus groups echoed the themes identified in the open-ended questionnaire items, emphasizing the STEM learning, hands-on problem-solving aspects of the program, and perseverance. Mentors also noted that they benefited from the interaction with students. For example:

> *It teaches me, as an adult, how to communicate, how to interact, how important it is to have teamwork, and understanding how to work through frustration and anger. This has been an eye-opening experience, not only for the students, but also for the adults.* [JSS Mentor]

> *For [students] to have an opportunity to go and do something – fail at it, do well at it, or whatever – and then be pushed the next year to learn from those experiences, that is what life is all about.* [JSS Mentor]

Mentors were also asked in an open-ended questionnaire item to note three ways in which JSS could be improved for future participants. Fifteen mentors provided at least one suggestion for improvements. Nearly half (7 responses) focused on the instructions provided, indicating that they could be more clear or more detailed. Another 4 responses suggested revisions in materials such as allowing 2 solar panels, permitting additional materials, or ensuring the equivalency of material access between teams. Other responses (mentioned by 1 or 2 respondents) included providing examples, more clear communication, more career information, easier registration, information about the DoD connection to JSS, more mentoring, more student participation, and improvements to the website.

Mentors participating in the focus group also offered suggestions for improvement. These responses were similar to those on the open-ended questionnaire item, although 3 participants suggested providing more student interaction with judges in the form of a questioning session. Other comments and suggestions included altering the cost and materials requirements or expressing confusion over these requirements (5 comments), frustration with the registration experience (4 comments), requests for more Army presence in JSS (3 comments), requests for more detailed or clear information or guidelines (3 comments), comments that on-line resources in lesson plans were not available (2 comments), a request for a webinar for general information and questions (1 comment), and a request for examples of successful projects (1 comment). For example:

> *I had a hard time with the cost part of it. A lot of it is simply because I run a lab, and we have 3D printers, laser cutters, and scrap material. I tried my best to estimate and live within the law, [but]…I feel like the rules were made before the last five years, when all this fabrication equipment came in.* [JSS Mentor]
>
> *[An improvement might be] limiting what materials could be used in some way, instead of putting a price on it. I get that one team shouldn't be able to use carbon fiber and laser-cut a super light body* [JSS Mentor]
>
> *[Gear ratios are] missing entirely out of every piece of curriculum. I only found that out because I have a friend of mine is in drivetrain. When we started this a year ago, he said 'Look, you can set your gears, but you also have to pay attention to your wheel size.'* [JSS Mentor]
>
> *I think if there's a part [where judges] could talk to the kids and understand how they assembled themselves together and had roles, and 'How did you do that?' it would really give more weight to JSS in general.* [JSS Mentor]
>
> *[There were] lesson plans online for us to follow. I was planning to follow the lesson plan format. In some of the days, they listed resources that were available online, but I couldn't find them.* [JSS Mentor]

Is there a way to publish what you think are successful things? That's the way the kids are going to learn…It really raises the bar for everybody by showing them, 'Here's what's expected when you come to nationals'…go through how did this one meet the rubric or not meet the rubric. [JSS Mentor]

Findings from the Actionable Program Evaluation indicate that JSS is actively engaging students in authentic STEM experiences. Although students report learning about STEM jobs and careers generally, they are learning less about DoD STEM jobs and careers. There is also evidence that JSS actively engages students in learning about STEM and in STEM practices, and mentors use a range of strategies to support student learning and engagement.

7 | Outcomes Evaluation

The evaluation of JSS included measurement of several outcomes related to AEOP and program objectives, including impacts on students' STEM knowledge, STEM competencies or skills, STEM identity and confidence, interest in and intent for future STEM engagement, attitudes towards Army or DoD research, and their knowledge of and interest in participating in additional AEOP opportunities.[9] Foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately, are necessary for a STEM-literate citizenry. STEM competencies are important not only for those engaging in STEM enterprises but also for all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The evaluation of JSS measured students' self-reported gains in STEM competencies and engagement in opportunities intended to develop what are considered to be critical STEM skills in the 21st century—collaboration and teamwork.

STEM Knowledge and Skills

Medium or large gains were reported on all items related to STEM knowledge by two-thirds or more of JSS student participants (see Table 28). For example, most students reported making at least medium gains in learning about STEM topics during JSS (72.37%) and learning about how scientists and engineers work on real world problems (65.78%).

[9] The outcomes measured in the evaluation study were informed by the following documents:

Committee on STEM Education. (2013). Federal Science, Technology, Engineering, and Mathematics (STEM) education 5-year strategic plan: A report from the Committee on STEM Education, National Science and Technology Council. Washington, DC: The White House, Office of Science and Technology Policy.

National Research Council. (2009). Learning science in informal environments: People, places, and pursuits. Committee on Learning Science in Informal Environments. Philip Bell, Bruce Lewenstein, Andrew W. Shouse, and Michael A. Feder, Editors. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

President's Council of Advisors on Science and Technology (P-CAST). (February 2012). Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. Executive Office of the President.

Report of the Academic Competitiveness Council (ACC). (2007). U.S. Department of Education. Available on the Department's Web site at: http://www.ed.gov/about/inits/ed/competitiveness/acc-mathscience/index.html.

Table 28. Student Report of Impacts on STEM Knowledge (n = 75-76)

	No gain	Small gain	Medium gain	Large gain	Response Total
Learn about STEM topics during JSS	0.00%	23.68%	35.53%	36.84%	**76**
	3	18	27	28	
Learn about research conducted in a STEM area or field in JSS	10.53%	23.68%	35.53%	30.26%	**76**
	8	18	27	23	
Learn about scientists and engineers work on real world problems in STEM during JSS	11.84%	22.37%	32.89%	32.89%	**76**
	9	17	25	25	
Learn about what everyday research work is like in STEM during JSS	16.00%	20.00%	37.33%	26.67%	**75**
	12	15	28	20	

A composite variable[10] for STEM Knowledge was computed using the items listed in Table 28 to look for differential impacts across sub-groups of students in terms of gender, race/ethnicity, and SES. No significant differences were found between any demographic groups in terms of STEM Knowledge.

Students also rated the impact of JSS on their STEM competencies or skills (see Table 29). More than half of students reported medium to large gains on all STEM competency items except for making computer models (46.05% reported at least medium gains). Over 70% of student reported at least medium gains in making a model of something showing its parts and how they work (74.32%), using knowledge and creativity to suggest a potential guess for the outcome of an experiment (73.98%), using knowledge and creativity to suggest a solution to a problem (73.68%), and designing procedures for an experiment that are appropriate for the question to be answered (72.00%).

[10] The Cronbach's alpha reliability for these 4 items was 0.901.

Table 29. Student Gains in STEM Competencies (n = 70-76)

	No gain	Small gain	Medium gain	Large gain	Response Total
Ask a question that could be answered with scientific experiments	15.71%	21.43%	38.57%	24.29%	**70**
	11	15	27	17	
Use knowledge and creativity to suggest a potential guess for the outcome of an experiment	6.85%	19.18%	38.36%	35.62%	**73**
	5	14	28	26	
Design procedures for an experiment that are appropriate for the question to be answered	8.00%	20.00%	38.67%	33.33%	**75**
	6	15	29	25	
Use knowledge and creativity to suggest a solution to a problem	3.95%	22.37%	34.21%	39.47%	**76**
	3	17	26	30	
Make a model of something showing its parts and how they work	9.46%	16.22%	31.08%	43.24%	**74**
	7	12	23	32	
Identify the limitations of the procedures used for data collection	13.16%	21.05%	44.74%	21.05%	**76**
	10	16	34	16	
Carry out procedures for an experiment and to record data	9.33%	21.33%	36.00%	33.33%	**75**
	7	16	27	25	
Make computer models	32.89%	21.05%	23.68%	22.37%	**76**
	25	16	18	17	
Organize data in charts or graphs	29.33%	13.33%	32.00%	25.33%	**75**
	22	10	24	19	

	No gain	Small gain	Medium gain	Large gain	Response Total
Consider different interpretations of data to decide if a solution to a problem works	19.74%	19.74%	30.26%	30.26%	**76**
	15	15	23	23	
Support an explanation with STEM evidence or knowledge	16.00%	21.33%	28.00%	34.67%	**75**
	12	16	21	26	
Identify the strengths and limitation of explanations	15.79%	28.95%	30.26%	25.00%	**76**
	12	22	23	19	
Defend an argument	21.05%	15.79%	34.21%	28.95%	**76**
	16	12	26	22	
Identify the strengths and limitations of data, interpretations or arguments presented in texts	18.67%	25.33%	32.00%	24.00%	**75**
	14	19	24	18	
Communicate about your experiments and explanations in different ways	14.47%	22.37%	32.89%	30.26%	**76**
	11	17	25	23	
Combine information from texts and other media to support your solution to a problem	17.11%	25.00%	35.53%	22.37%	**76**
	13	19	27	17	

A STEM Competencies[11] composite score was calculated for these items and used to examine whether the JSS program had differential impacts on sub-groups of students. No significant differences in STEM Competencies were found for gender, race/ethnicity, or SES.

Twenty-first Century Skills include skills such as communication and collaboration that are necessary across a wide variety of fields (see Table 30). Students were asked to rate the impact of participating in

[11] The Cronbach's alpha reliability for these 16 items was 0.961.

JSS on these skills. More than half of students reported medium or large gains in all areas of 21st Century Skills. For instance, 80.00% of students reported medium or large gains in making changes when thing do not go as planned, 77.33% in including others' perspectives when making decisions, 76.00% in communicating effectively with others, and 73.33% in sticking with a task until it is finished.

Table 30. Student Report of Impacts on 21st Century Skills (n = 75-76)

	No gain	Small gain	Medium gain	Large gain	Response Total
Sticking with a task until it is finished	8.00%	18.67%	29.33%	44.00%	**75**
	6	14	22	33	
Making changes when things do not go as planned	8.00%	12.00%	28.00%	52.00%	**75**
	6	9	21	39	
Including others' perspectives when making decisions	10.67%	12.00%	33.33%	44.00%	**75**
	8	9	25	33	
Communicating effectively with others	10.67%	13.33%	37.33%	38.67%	**75**
	8	10	28	29	
Desire to build relationships with professionals in a field	21.33%	24.00%	29.33%	25.33%	**75**
	16	18	22	19	
Connecting a topic or field with their personal values	24.00%	18.67%	32.00%	26.67%	**76**
	18	14	24	20	

The 21st Century Skills items from Table 30 were combined into a composite variable[12] to test for differential impacts across sub-groups of students in gender, race/ethnicity, and SES. No statistically significant differences were found between any of the groups.

STEM Identity and Confidence

In order to increase the likelihood that students will pursue STEM further in their education and/or careers, they must see themselves as capable of succeeding in STEM.[13] Therefore, the student questionnaire included a series of items intended to measure the impact of JSS on students' STEM

[12] The Cronbach's alpha reliability for these 6 items was 0.901.

[13] Chang, M. J., Sharkness, J., Hurtado, S. and Newman, C. B. (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. J. Res. Sci. Teach., 51: 555–580.

identities. A composite score for STEM Identity[14] was developed to compare subgroup differences. Student reports of STEM Identity gains were similar regardless of gender, race/ethnicity, or SES. Table 31 shows more than 50% of students reported that JSS impacted them in all areas of STEM identity. The areas of greatest impact, in which student selected "somewhat agree" or "agree," included feeling more prepared for more challenging STEM activities (80.26%), feeling like they had accomplished something in STEM (76.32%), and thinking creatively about a STEM project or activity (72.37%). These responses suggest that JSS positively impacted students' STEM identities.

Table 31. Student Report of Impacts on STEM Identity (n = 75-76)

	Strongly Disagree	Disagree	Don't Disagree or Agree	Somewhat Agree	Agree	Response Total
I am interested in a new STEM topic	9.21%	3.95%	19.74%	36.84%	30.26%	**76**
	7	3	15	28	23	
I am thinking about pursuing a STEM career	10.53%	9.21%	17.11%	21.05%	42.11%	**76**
	8	7	13	16	32	
I feel like I accomplished something in STEM	7.89%	5.26%	10.53%	25.00%	51.32%	**76**
	6	4	8	19	39	
I feel more prepared for more challenging STEM activities	6.58%	2.63%	10.53%	32.89%	47.37%	**76**
	5	2	8	25	36	
I am thinking creatively about a STEM project or activity	7.89%	5.26%	14.47%	30.26%	42.11%	**76**
	6	4	11	23	32	
I am interested in connecting with people who work in STEM	8.00%	4.00%	30.67%	22.67%	34.67%	**75**
	6	3	23	17	26	

Interest and Future Engagement in STEM

In order to accomplish the goal of the AEOP to develop a STEM-literate citizenry, students must be engaged with high-quality STEM activities in and out of school. To investigate the impact of JSS on students' interest in future engagement in STEM, participants were asked to reflect on whether the likelihood of their engaging in STEM activities outside of regular school classes changed as a result of their JSS experience (Table 32). Approximately half of JSS students indicated they were more likely to engage in a number of STEM activities after participating in JSS. For example, 61.33% reported being

[14] The STEM Identity composite with 6 items has a Cronbach's alpha reliability of 0.901.

more likely to participate in a STEM camp, club, or competition and 58.67% of students indicated being more likely to tinker with a mechanical or electrical device after participating in JSS. Substantial numbers of students (25.33%-46.05%) reported that the likelihood of engaging in these activities was about the same as before participating in JSS.

Table 32. Change in Likelihood Students Will Engage in STEM Activities Outside of School (n = 74-76)

	Much less likely	Less likely	About the same	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	7.89%	1.32%	46.05%	30.26%	14.47%	**76**
	6	1	35	23	11	
Tinker (play) with a mechanical or electrical device	8.00%	5.33%	28.00%	30.67%	28.00%	**75**
	6	4	21	23	21	
Work on solving mathematical or scientific puzzles	5.41%	6.76%	37.84%	29.73%	20.27%	**74**
	4	5	28	22	15	
Use a computer to design or program something	5.26%	9.21%	32.89%	31.58%	21.05%	**76**
	4	7	25	24	16	
Talk with friends or family about STEM	6.67%	9.33%	26.67%	32.00%	25.33%	**75**
	5	7	20	24	19	
Mentor or teach other students about STEM	6.58%	6.58%	32.89%	31.58%	22.37%	**76**
	5	5	25	24	17	
Help with a community service project related to STEM	5.26%	11.84%	28.95%	36.84%	17.11%	**76**
	4	9	22	28	13	
Participate in a STEM camp, club, or competition	5.33%	8.00%	25.33%	37.33%	24.00%	**75**
	4	6	19	28	18	
Take an elective (not required) STEM class	9.33%	8.00%	29.33%	26.67%	26.67%	**75**
	7	6	22	20	20	
Work on a STEM project or experiment in a university or professional setting	5.33%	8.00%	29.33%	30.67%	26.67%	**75**
	4	6	22	23	20	

A composite score was created from the STEM Intentions items in Table 32,[15] and scores were compared across sub-groups of students. Statistically significant differences by gender, race/ethnicity, and SES were not found.

[15] The behavioral STEM intentions composite with 10 items has a Cronbach's alpha reliability of 0.955.

Additionally, students were asked about their awareness of and future interest in participating in other AEOP programs in the future (Table 33). Aside from JSS (95.59% awareness), students reported being largely unaware of other AEOPs (less than 15% were aware of other AEOPs). A large majority (70.49%) of students reported being interested in participating in JSS again. Fewer than 20% indicated interest in participating in any other AEOP program, however.

Table 33. Student Interest in Future AEOP Programs (n=61)		
	Aware of this program (n=68)	**Interested in participating in this program (n=61)**
Camp Invention	14.71%	18.03%
CQL	2.94%	11.48%
eCM	8.82%	4.92%
GEMS	13.23%	13.11%
GEMS-NPM	4.41%	8.20%
HSAP	7.35%	16.39%
JSHS	5.88%	11.48%
JSS	95.59%	70.49%
NDSEG	8.82%	18.03%
REAP	5.88%	13.11%
SEAP	7.35%	19.67%
URAP	5.88%	9.84%
UNITE	7.35%	13.11%

Students were asked to identify which resources impacted their awareness of the various AEOPs in order to better understand resource effectiveness. Table 34 illustrates that the AEOP website was frequently rated as helpful in student awareness of AEOPs (79.03%). Most students rated all other resources as not helpful in terms of impacting their awareness of AEOPs.

Table 34. Impact of Resources on Student Awareness of AEOPs		
Item	**Helped (n=74)**	**Did Not Help (n=51)**
AEOP Website	79.03%	23.53%
AEOP Brochure	22.58%	39.22%
My JSS Mentor	12.90%	58.82%
My Participation in JSS	8.06%	56.86%
Invited Speakers	4.84%	72.55%

Attitudes toward DoD Research

Student attitudes about the importance of DoD research can be used as an indicator of students' potential future involvement in DoD STEM careers and research. As such, students were asked their opinions of what DoD researchers do and the value of DoD research (see Table 35). Findings indicate that approximately two-thirds of students had favorable opinions about DoD research and researchers. For example, most students agreed most with DoD researchers solving real-world problems (68.92%) and DoD research being valuable to society (68.92%). Around a quarter of students (24.32% - 30.67%) did not register an opinion about DoD research and researchers, however.

Table 35. Student Opinions about DoD Researchers and Research (n = 74-75)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	0.00%	6.67%	26.67%	37.33%	29.33%	**75**
	0	5	20	28	22	
DoD researchers develop new, cutting edge technologies	0.00%	5.33%	30.67%	32.00%	32.00%	**75**
	0	4	23	24	24	
DoD researchers solve real-world problems	0.00%	4.05%	27.03%	37.84%	31.08%	**74**
	0	3	20	28	23	
DoD research is valuable to society	0.00%	6.76%	24.32%	35.14%	33.78%	**74**
	0	5	18	26	25	

Education and Career Aspirations

The student questionnaire asked how far students intended to go in school after participating in JSS (see Tables 36). Nearly all students reported wanting to at least finish college (40.00%) or get more education after college (49.33%).

Table 36. After JSS – Student Education Aspirations (n = 75)

Choice	Response Percent	Response Total
Graduate from high school	6.67%	5
Go to a trade or vocational school	0.00%	0
Go to college for a little while	4.00%	3
Finish college (get a Bachelor's degree)	40.00%	30

Get more education after college	49.33%	37

Overall Impact

Finally, students were asked about the overall impacts of participating in JSS (Table 37). Students reported that JSS had a substantial impact on them, with more than 50% of students indicating that JSS impacted them for each item on this section of the questionnaire, both in terms of STEM interest in-school and outside-of-school. For instance, 77.63% reported being more interested in taking STEM classes in school, and 76.32% indicated JSS increased their interest in participating in STEM activities outside of school requirements. In general, most students believed JSS contributed to their increased confidence in STEM knowledge, skills, and abilities (76.32%), and their interest in pursuing STEM careers (64.47%). Related to AEOPs and the DoD, students also reported that JSS contributed to their having greater appreciation of army or DoD STEM research (69.74%), and that they are more interested in participating in more AEOPs (64.47%). It is noteworthy that about a quarter of students (23.68%) reported that JSS had not increased their awareness of Army or DoD STEM research and careers. In spite of this, slightly over half (55.40%) indicated that after JSS they were more interested in pursuing a STEM career with the Army or DoD.

A composite was created from the 10 items in Table 37.[16] Scores were compared across sub-groups of students and there were no statistically significant differences by gender, race/ethnicity or SES in terms of Overall Impact from JSS participation.

Mentors were also asked about impacts on students in these areas and reported somewhat similar gains, however mentors reported impacts that were somewhat higher than those of students in all general STEM areas. In contrast, mentors were less likely than students to report that JSS impacted student awareness or interests when related to all AEOP or DoD items.

Table 37. Student Opinions of JSS Impacts (n = 74-76)

	Disagree - This did not happen	Disagree - This happened but not because of JSS	Agree - JSS contributed	Agree - JSS was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	7.89% 6	15.79% 12	65.79% 50	10.53% 8	**76**

[16] The Cronbach's alpha reliability for these 10 items was 0.947.

I am more interested in participating in STEM activities outside of school requirements	9.21%	14.47%	59.21%	17.11%	**76**
	7	11	45	13	
I am more aware of other AEOPs	23.68%	13.16%	53.95%	9.21%	**76**
	18	10	41	7	
I am more interested in participating in other AEOPs	24.32%	10.81%	50.00%	14.86%	**74**
	18	8	37	11	
I am more interested in taking STEM classes in school	6.58%	15.79%	64.47%	13.16%	**76**
	5	12	49	10	
I am more interested in earning a STEM degree	14.47%	25.00%	46.05%	14.47%	**76**
	11	19	35	11	
I am more interested in pursuing a career in STEM	13.16%	22.37%	46.05%	18.42%	**76**
	10	17	35	14	
I am more aware of Army or DoD STEM research and careers	23.68%	15.79%	46.05%	14.47%	**76**
	18	12	35	11	
I have a greater appreciation of Army or DoD STEM research	21.05%	9.21%	60.53%	9.21%	**76**
	16	7	46	7	
I am more interested in pursuing a STEM career with the Army or DoD	28.38%	16.22%	43.24%	12.16%	**74**
	21	12	32	9	

8 | Findings and Recommendations

Summary of Findings

The FY17 evaluation of JSS collected data about participants; their perceptions of program processes, resources, and activities; and indicators of achievement in outcomes related to AEOP and program objectives. A summary of findings is provided in the following table.

2017 JSS Evaluation Findings	
Participant Profiles	
JSS served increasing percentages of students from populations historically underrepresented and underserved in STEM, indicating that JSS's efforts to engage these groups has been met with some success.	In FY17 JSS experienced a 46% increase in enrollment compared to FY16. Over half (61%) of JSS participants in FY17 were female, a notable increase from FY16, when only about a quarter of participants were female (a population historically underrepresented and underserved in STEM fields).
	There were substantially more participants identifying as Black or African American in FY17 as compared to FY16 (15% in FY17 compared to 7% in FY16). There was an increase participants identifying as Hispanic/Latino in FY17 (10% in FY17 compared to 6% in FY16).
	A total of 29% of JSS participants were classified at U2 according to AEOP's definition of U2. AEOP's definition of underserved includes at least two of the following: low-income students; students belonging to race and ethnic minorities that are historically underrepresented in STEM; students with disabilities; students with English as a second language; first-generation college students; students in rural, frontier, or other Federal targeted outreach schools; females in certain STEM fields.
Actionable Program Evaluation	
Students are motivated to participate in JSS by a variety of factors.	Students in focus groups identified having fun, interest in STEM, a class requirement, and the opportunity for new experiences as motivators for participating in JSS.

Students learned about STEM and engaged in STEM activities in JSS, however it was unclear how these experiences compared to their regular school course activities.	A large majority of students reported learning about STEM during JSS. Approximately one-third to a half of students applied STEM learning to real-life situations (49%), communicated with other students about STEM (44%), learned about new STEM topics (37%), and learned about new discoveries in STEM (37%) on most or every day of their JSS experience.
	A large majority of students reported engaging in all STEM activities they were questioned about. For example, 80% of students who responded indicated working as part of a team on most days or every day, 59% reported coming up with creative explanations or solutions on most days or every day, and 57% indicated analyzing data or information on most days or every day of their JSS experience.
	While there were no significant differences between students' in-school and out-of-school STEM engagement, students reported significantly higher STEM learning in school than in JSS. Since students often participate in JSS as part of a school class, however, this may indicate that students do not differentiate between STEM learning in school and STEM learning in JSS.
	Students in focus groups reported that their JSS activities differed from regular school class activities because of the hands-on nature of activities and indicated that JSS engaged their interest in ways that science classes may not.
Students have limited awareness of STEM jobs and careers in general and even less awareness of Army or DoD jobs after participating in JSS.	About 30% of students had learned about no STEM jobs or careers during JSS, although 22% reported learning about 5 or more STEM jobs or careers.
	Nearly half of students (48%) had heard of no Army or DoD STEM jobs or careers during JSS and about a quarter (24%) reported that JSS had not increased their awareness of Army or DoD STEM research and careers. In spite of this, slightly over half (55%) indicated that JSS had resulted in them being more interested in pursuing a STEM career with the Army or DoD.
Mentors used a variety of strategies with students during JSS.	Large majorities of mentors reported using mentoring strategies as they advised teams. Mentors used strategies to establish the relevance of learning activities, support the diverse needs of students as learners, support students' development of collaboration and interpersonal skills, and support students' engagement in authentic STEM activities. Over three-quarters of mentors reported using most strategies associated with each area of these areas of mentoring.
Students and mentors reported overall satisfaction with the JSS experience and offered various suggestions for improvements	About three-quarters of students who commented on their satisfaction with JSS had only positive comments, focusing on the opportunity to work on hands-on engineering projects, meet people, build confidence, work with a team, and learn about STEM.
	As improvements for JSS, students suggested standardizing the experience by taking measures to equalize resource access and standardizing competition conditions.

	A large majority of mentors reported being satisfied with the program components they had experienced. For example, 83% of mentors were at least somewhat satisfied with their communications with the TSA and physical location(s) of JSS activities and 73% were at least somewhat satisfied with the JSS application or registration process.
	As improvements for JSS, mentors suggested improvements to the clarity or detail of instructions provided, altering material and cost criteria, improving the registration process, and providing more Army presence in JSS.
Outcomes Evaluation	
JSS students reported gains in STEM knowledge and competencies.	Medium or large gains were reported on all items related to STEM knowledge by two-thirds or more of JSS student participants. This included medium or large gains in areas such as learning about STEM topics (72%) and learning about research in a STEM field (72%).
	More than half of students reported medium to large gains on all STEM competencies except for making computer models, for which nearly half (46%) reported no gain. Around three-quarters of students reported gains at least medium gains in areas such as making a model of something showing its parts and how they work (74%), using knowledge and creativity to suggest a potential guess for the outcome of an experiment (74%), and using knowledge and creativity to suggest a solution to a problem (74%).
JSS students reported gains in 21st Century Skills.	More than half of students reported medium or large gains in all areas of 21st Century Skills. Over three-quarters of students reported at least medium gains in areas such as making changes when thing do not go as planned (80%), including others' perspectives when making decisions (77%), in communicating effectively with others (76%), and in sticking with a task until it is finished (73%).
JSS students reported gains in their STEM identities and reported that they were somewhat more likely to engage in STEM activities outside of regular school classes in the future.	More than half of students reported that JSS impacted them in all areas of STEM identity. The areas of greatest impact (students selected "somewhat agree" or "agree") included feeling more prepared for more challenging STEM activities (80%), feeling like they had accomplished something in STEM (76%), and thinking creatively about a STEM project or activity (72%).
	Approximately half of JSS students indicated they were more likely to engage in a number of STEM activities after participating in JSS. For example, 61% reported being more likely to participate in a STEM camp, club, or competition and 59% of students indicated being more likely to tinker with a mechanical or electrical device after participating in JSS. Between 25% and 41% of students reported no change in their likelihood of engaging in STEM activities after JSS.
	Fewer than 15% of students were aware of any AEOPs other than JSS.

Students and mentors participating in JSS have limited experience with and knowledge of other AEOPs, and adult mentors provided little information to students about AEOPs other than JSS.	A large majority of students (70%) indicated interest in participating in JSS again.
	Most students did not indicate interest in participating in other AEOPs, including those for which they may be currently eligible including eCM (5% interested in participating) and GEMS (13% interested in participating).
	Only 18% of adult mentors reported recommending other AEOPs to students. Slightly over a third of mentors reported discussing GEMS with students and similar numbers reported discussing AEOP but without reference to a specific program. Few mentors (between 9% and 14%)reported discussing any other AEOPs with students.
Students had positive opinions about DoD research and researchers after JSS.	About two-thirds of students reported favorable opinions about DoD research and researchers. For example, most students agreed most with DoD researchers solving real-world problems (69%) and DoD research being valuable to society (69%). Around a quarter of students (24% - 301%) did not register an opinion about DoD research and researchers, however, and 21% of students reported that JSS did not impact their appreciation of Army or DoD STEM research.
JSS had positive impacts on students.	Students reported that JSS had a substantial impact on them, with more than 50% of students indicating that JSS impacted them both in terms of STEM interest in school and outside-of-school. Most students believed JSS contributed to their increased confidence in STEM knowledge, skills, and abilities (76%), and their interest in pursuing STEM careers (65%).

Responsiveness to FY17 Evaluation Recommendations

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. In previous years the timing of the delivery of the annual program evaluation reports has precluded the ability of programs to use the data as a formative assessment tool. However, beginning with the FY17 evaluation, the goal is for programs to be able to leverage the evaluation reports as a means to target specific areas for improvement and growth.

Evaluation recommendations from FY16 made to programs are highlighted along with a summary of efforts and outcomes reflected in the FY17 APR toward these areas.

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

FY16 Finding: Although not an explicit goal of JSS, the AEOP objective of broadening, deepening, and diversifying the pool of STEM talent continues to be a challenge for JSS. The available demographic enrollment data for the past three years suggests that little change in the rates of participation of underserved and underrepresented groups of students has occurred. Previous recommendations (made in the 2013, 2014, and 2015 JSS evaluation reports) for the program to consider doing more to recruit students from schools serving historically underrepresented and underserved groups are therefore repeated. In particular, since many students participate in JSS via the TSA, it is important to consider ways of reaching a broader range of schools through both the TSA and through Army-hosted events. One strategy may be to market the program to fifth graders, a group that has been largely unrepresented in JSS to date. JSS has not marketed the program to 5th or 6th grade students housed in elementary schools in the past due to TSA's focus being middle and high school. Therefore, it is recommended that TSA consider reaching out to potential elementary school participants to engage more students from younger age groups in the program.

JSS FY17 Efforts and Outcomes:

- Solar panels were provided to populations/schools that are interested in participating but unable to due to lack of financial support. Examples of these populations included a rural school in Oklahoma serving an underserved population and a summer based STEM program for an underserved Native American population in Florida.
- TSA Title 1 schools were provided with an incentive of receiving two free solar kits for participating in JSS.
- A new initiative, JSS Jumpstart, was created to grow the JSS program. 5th and 6th graders housed in elementary schools interested in participating in JSS at a local level is the target population. Kits were provided to five elementary schools that were classified as Title 1.
- The number of participants registered in Cvent reflect a higher diversity of participants as compared to last year.

AEOP Priority: Support and empower educators with unique Army research and technology resources

FY16 Finding: Mentors and students expressed overall satisfaction with the resources available to them through TSA. At the same time, however, both mentors and students reported little familiarity with Army resources such as the AEOP website, the It Starts Here! magazine, and the AEOP brochure. This suggests that participants may not make connections between JSS and Army sponsorship, particularly since participants' primary organizational connection is with the TSA. The fact that Army representatives at one regional TSA event were unaware that JSS is an AEOP initiative and, more importantly, were unfamiliar with the AEOP, suggests that stronger connections between JSS and the AEOP could be made. Although the TSA website makes clear the association of JSS with the AEOP, it may be useful to ensure that AEOP brochures are on hand at all state and regional TSA events, and to educate Army personnel who staff student events about the AEOP and its various initiatives. Further, TSA may consider providing some presentation to the full group at the conference during general

sessions regarding the partnership with AEOP in JSS.

JSS FY17 Efforts and Outcomes:

- AEOP materials (AEOP brochures, pencils, RITR notebooks and AEOP banners) were sent to all state conferences holding a JSS event. Brochures contained rack cards-specifically JSHS and GEMS- which are age appropriate for JSS participants.
- Over 300 postcards promoting the Junior Solar Sprint program were distributed to schools; postcards included the AEOP website address and Cvent registration link.
- Interested JSS participants were required to register on the Cvent link which is found on the AEOP site.
- The AEOP special interest session at the 2017 national TSA conference was heavily promoted prior to the conference. AEOP representatives attended the national TSA conference and conducted a special interest session for students, teachers, and parents on AEOP programs and the AEOP pipeline.
- AEOP representatives attended the TSA Meet and Greet, a networking opportunity for students, teachers, parents and other conference attendees, at the national TSA conference and spoke to conference attendees about AEOP programs.
- TSA ran a full-page ad on the inside back cover of the national conference program promoting the AEOP and their STEM programs.

AEOP Priority: Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army

FY16 Finding: Students continue to report having little knowledge of other programs in the AEOP. Because of the goal of creating a pipeline of programs in which participants progress from JSS into other AEOPs, this is an area of concern. While over half of students indicated that JSS had an impact on their interest in participating in AEOPs in the future, students were largely unaware of programs for which they are or will soon be eligible such as JSHS and GEMS. In spite of this, over half of responding students reported that the TSA website was helpful in learning about JSS and other AEOPs. Likewise, over half of responding students reported that their JSS mentors were helpful in learning about AEOPs. A large majority of mentors reported that found the TSA website was a useful resource to expose students to DoD STEM careers and, to a lesser extent, that the JSS website was useful for this purpose. This suggests that there is an opportunity for these websites to be used for targeted marketing of programs for which JSS students are or will soon be eligible such as GEMS, JSHS, and SEAP. In addition, since mentors are an important source of student information, additional efforts should be made to educate mentors about the AEOP and programs for which their students are eligible. Further, JSS should consider marketing participation in eCM – as it is available to students regardless of location and is a similar competition-based AEOP.

JSS FY17 Efforts and Outcomes:

- Marketing/promotion emails were sent to all TSA chapter advisors providing information on

those AEOP programs rising 9th graders would be eligible for.

- AEOP marketing materials were disseminated at the SAME (Society of American Military Engineers) conference; the conference attendees included small businesses looking to connect with STEM based programs in schools.

FY16 Finding: The TSA provided support to the JSS objective of creating a national infrastructure to support events and increase participation in JSS. The expansion of the number of regional events is evidence of this work, however it should be noted that JSS participation declined in 2016. As noted above, since many students participate in JSS via the TSA, it is important to consider ways of reaching a broad range of schools through both the TSA and through Army-hosted events. In addition, although demographic data for participants is more widely available than in past years, use of Cvent remains limited and, for some regional competitions, no participation data was available. The TSA should therefore continue to emphasize the importance of collecting enrollment and participation data with state and regional TSA chapters and other groups holding state and regional competitions.

JSS FY17 Efforts and Outcomes:

- The Cvent registration link was provided to all state and chapter advisors in TSA as well as those participants wanting to compete in a JSS event at an army hosted site for FY17 via email and mailings. The link was also provided to all inquiries (email and phone) from teachers/administrators that were interested in participating in Junior Solar Sprint. Results of Cvent registration improved this year as it was communicated to all those participating (and those interested in participating) that registration was required. The number of Cvent registrations, however, still does not account for all that participate in a JSS event and still does not capture all those participants participating at a state conference holding a JSS event. State conferences do not require Cvent registration to participate at their JSS event.

FY16 Finding: The low response rates for student and mentor questionnaires continue to be an area with potential for growth. There were 10 regional sites and one Army Lab that did not participate in the evaluation survey. Although response rates for mentors have displayed an upward trend over the past three years, the student response rate remained constant from FY15 to FY16. The program may want to consider ways to communicate the importance of these evaluations with individual program sites. Streamlining evaluation instruments may also increase response rates by reducing the time commitment of respondents.

JSS FY17 Efforts and Outcomes:

- The Cvent registration was provided to all state and chapter advisors as well as those participants wanting to compete in a JSS event at an army hosted site for FY17. Evaluation surveys were provided via Cvent link to participants and chapter advisors prior to, and after the state level conferences. Email reminders were also sent multiple times to state and chapter

advisors prior to, and after state level conferences. At the national level, tablets were used for student participants to complete the surveys and the link was provided to adult participants. The link was sent again after the completion of the national conference. An incentive was sent via email to both student and adult participants in May to increase completion of the surveys.

- Focus groups attendance and access to evaluations (via tablets) were included in the Junior Solar Sprint schedule of events at the national conference. Attendance of the focus groups was required to participate in the JSS national event. Adults were provided incentives upon attending the focus group.

Recommendations for FY18 Program Improvement/Growth

FY17 was an overall successful year for JSS, as reflected in the evaluation findings. JSS was able to increase their participant base by 46% from FY16. Further, the percentage of female participants grew from around 25% in FY16 to over half (61%) in FY17 and there was also growth in the percentages of Black/African American (up to 15% from 75 in FY16) and Latino/Hispanic groups (up to 10% from 6% in FY16).

As in FY16, JSS had high levels of mentor and student satisfaction with the program and there was continued evidence of gains in students' STEM knowledge and competencies and gains in students' 21st Century Skills as a result of the JSS experience. While these successes are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY17 and beyond:

AEOP Priority: Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base

JSS has made strong strides in FY17 to grow the representation of participants from underserved groups, as mentioned above. We recommend that JSS continues to focus on growing the percentage of ethnic/racial groups again in FY18 to bring even more participation of students from those groups in the program.

AEOP Priority: Support and empower educators with unique Army research and technology resources

As in FY16, participants (adult and youth) valued the resources available to them through TSA. However, many students reported that directions for the JSS competition were unclear or incorrect. It is recommended that TSA review all rules, guidelines, and resources and update with relevant current information.

Nearly half of students (48%) reported no awareness of Army/DoD STEM jobs or careers. Further, 24% shared JSS had not increased their awareness of Army/DoD STEM research. Mentors reported very little knowledge of other AEOPs and AEOP/DoD careers. Interestingly, 55% of participants indicated an interest in STEM careers with the Army/DoD. Therefore, it is recommended that JSS continue to find ways to integrate this content into the programming at regional and national competitions. Further, JSS should provide more support to adults who will serve as mentors to students in the form of training and awareness of AEOPs and AEOP/DoD careers. One potential strategy may be to engage more Army/DoD scientists & engineers in the national and regional competitions.

AEOP Priority: Develop and implement a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army

1. As in FY16, student participants continued to report having little knowledge of other programs in the AEOP. In fact, fewer than 15% were aware of any AEOPs besides JSS. As a result, most students did not indicate interest in participating in other AEOPs. Only 5% were interested in eCM and 13% in GEMS specifically. This may be due to the fact that most mentors (82%) reported they did not recommend other AEOPs to students. Similar to FY16, it is recommended that JSS invest significant efforts into making this a focus of the marketing and programming for JSS at both regional and national levels. JSS should specifically promote all AEOPs with special emphasis on those programs that would be next in the pipeline for participants (e.g. eCM, GEMS).

2. The low response rates for regional completion of JSS evaluation survey(s) continued to be an issue that was more persistent in FY17. A new effort to grow national level participation produced excellent participation through the use of evaluators on site with tablets and facilitated groups of students completing the evaluation survey. It is recommended that this format continue to be followed in FY18. Further, after discussion with TSA and the CAM the evaluation will only focus on Army labs for the regional level evaluation completion in FY18. TSA should work closely with the Army labs to provide support and encouragement to complete the required components.