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ARMY EDUCATIONAL OUTREACH PROGRAM

JSS

2018 Annual Program Evaluation Report
Findings

June 2019

ARMY EDUCATIONAL OUTREACH PROGRAM

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Report JSS_06152019 has been prepared for the AEOP Cooperative Agreement and the U.S. Army by Purdue University College of Education on behalf of Battelle Memorial Institute (Lead Organization) under award W911 SR-15-2-0001.

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3 | Introduction

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, Junior Solar Sprint (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 the 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.

Table 1 summarizes 2018 student participation by state. A total of 263 students representing 82 teams attended the national JSS event. Table 2 provides available demographic data for 2018 student participants in JSS. The enrollment of 1,081 students represents a 21% increase as compared to FY17 when 892 students were enrolled and a 77% increase compared to FY16 when 609 students were enrolled in JSS. Over half (57%) of 2018 JSS participants were male, and over half (53%) of students identified themselves as White (compared to 44% in FY17 and 54% in FY16). Another 11% identified themselves as Black or African American (compared to 15% in FY17 and 7% in FY16) and 8% as Hispanic/Latino (compared to 10% in FY17 and 6% in FY16). About one-third (34%) of students met the AEOP definition of underserved (U2).[1]

Table 1. 2018 JSS State Participation Numbers in Cvent

State	No. Of Enrolled Students Per CVENT
Alabama	11
Armed Forces - Americas	1
Armed Forces - Pacific	75
California	47
Colorado	14
Delaware	11
Florida	33
Georgia	56

[1] AEOP's definition of underserved (U2) includes **at least two** of the following: Underserved populations include low-income students (FARMS); students belonging to race and ethnic minorities that are historically underrepresented in STEM (HUR) (i.e., Alaska Natives, Native Americans, Blacks or African Americans, Hispanics, Native Hawaiians and other Pacific Islanders); students with disabilities (ADA); students with English as a second language (ELLs); first-generation college students (1stGEN); students in rural, frontier, or other federal targeted outreach schools (GEO); and females in certain STEM fields (Gender) (e.g., physical science, computer science, mathematics, or engineering).

Illinois	1
Iowa	2
Kansas	2
Kentucky	1
Maryland	98
Mississippi	12
Missouri	12
North Dakota	16
New Jersey	117
New York	8
North Carolina	14
Ohio	17
Oklahoma	17
Pennsylvania	63
South Carolina	14
Tennessee	7
Texas	50
Utah	9
Vermont	1
Virginia	47
Washington	47
West Virginia	4
Total	**807**

*Note – this table only accounts for Cvent registration data. The program reported 1,081 total participants.

Table 2. 2018 JSS Student Participant Profile		
Demographic Category		
Gender (n=1,081)		
Female	399	36.9%
Male	620	57.4%
Not Reported	62	5.7%
Race/Ethnicity (n=1,081)		
Asian	103	9.5%
Black or African American	124	11.4%
Hispanic or Latino	87	8.0%
Native American or Alaska Native	10	<1%
Native Hawaiian or Other Pacific Islander	6	<1%
White	570	52.7%

Other (self-reported, some more than 1 race)	49	4.5%
Choose not to report	132	12.3%
School setting (n=1,081)		
Urban (city)	222	20.0%
Suburban	467	43.2%
Rural (country)	204	18.9%
Frontier or tribal School	3	<1%
DoDDS/DoDEA School	76	7.0%
Home school	9	<1%
Online school	0	0%
Choose not to report	100	9.3%
Receives free or reduced lunch (n=1,081)		
Yes	184	17.0%
No	64	5.9%
Choose not to report	833	77.1%
English is a first language (n=1,081)		
Yes	684	63.3%
No	64	5.9%
Choose not to report	333	30.8%
One parent/guardian graduated from college (n=1,081)		
Yes	571	52.8%
No	112	10.4%
Choose not to report	398	36.8%
U2 Status (n=1,081)		
Yes	368	34.0%
No	712	65.9%
Cannot determine	1	<1%

Table 3 provides demographic data for adult participants in JSS in 2018. A total of 328 adults participated in JSS program activities in FY18, an 87% decrease compared to the reported 614 adults in FY17, but a 24% increase from FY16 when 249 adults participated. Reported adult participants for 2018 included teachers and other volunteers who supported students as they prepared for or participated in a JSS event and played important roles as mentors to JSS students.

Table 3. 2018 Adult JSS Participation

Participant Group	Teachers/Adults
Number of Adults (teachers, mentors, volunteers)	328
Number of Army S&Es	0
Grand Total of Adult Participants	**328**

2018 cost data for JSS is summarized in Table 4. The total cost for JSS in FY18 was $184,552, including a per student cost of $171.

Table 4. 2018 JSS Program Costs	
2018 JSS - Cost Per Student Participant	
Total Participants	1,081
Total Cost	$184,552
Cost Per Student Participant	**$171**
2018 JSS - Cost Breakdown	
Administrative/Overhead & Indirect	$124,918
National Scholarships	$17,701
JSS Solar Panel Kits	$12,296
Other Operational Costs	$29,637
Total Cost	**$184,552**

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4 | 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, 8 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. 2018 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. 2018 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. 2018 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. 2018 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

The JSS Evaluation included examination of participant outcomes and other areas that would inform continuous program improvement. A focus of the evaluation is on efforts toward the long-term goal of JSS and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technological progress. Thus, it is important to consider how JSS is marketed 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 evaluation also collected data about participant perspectives on program processes, resources, and activities for the purpose of recommending improvements as the program moves forward.

Findings are presented in alignment with the three AEOP priorities. The findings presented herein include several components related to AEOP and program objectives, including impacts on students' STEM competencies (e.g., knowledge and skills), STEM identity and confidence, interest in and intent for future STEM engagement (e.g., further education, careers), attitudes toward research, and their knowledge of and interest in participating in additional AEOP opportunities.[2] STEM competencies are necessary for a STEM-literate citizenry and include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are important not only for

[2] 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.

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.

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.

Table 9. 2018 JSS Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate	Margin of Error @ 95% Confidence[3]
Students	86	1081	7.96%	±10.14%
Teachers and Other Volunteers	4	328	1.22%	±48.77%

Sixty-nine students participated in eight national student focus groups (28 females, 41 males). Twelve adults (eight females, four males), including nine teachers, one grant director, and two parents or chaperones 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

[3] "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.

narrative of JSS's efforts and impact, and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Student Demographics

Table 10 summarizes JSS student demographic data collected from questionnaire respondents. Significantly more males (74%) than females (26%) completed the questionnaire. In terms of race/ethnicity, more responding students identified as being White (50%) than with any other single race/ethnicity category. This was followed by 14% of respondents who identified with the Black or African American category, and 13% of respondents who identified with the Hispanic or Latino category. Approximately half of the respondents indicated they were going to be starting 8th grade (47%) in the fall, followed by 9th grade (35%), 7th grade (13%), and 6th grade or lower (5%). These data suggest that students responding to the questionnaire are demographically similar to the population of JSS participants for FY18, however somewhat smaller proportions of responding students were female (26% of respondents versus 37% of enrolled students) than in the overall enrolled population of JSS students and a somewhat larger proportion of questionnaire respondents qualified for U2 status (48%) as compared to the overall population (34%).

Table 10. 2018 JSS Student Respondent Profile

Demographic Category	Questionnaire Respondents	
Respondent Gender (n=86)		
Female	22	25.6%
Male	64	74.4%
Choose Not to Report	0	0%
Respondent Race/Ethnicity (n=86)		
Asian	6	7.0%
Black or African American	12	14.0%
Hispanic or Latino	11	12.8%
Native American or Alaska Native	4	4.7%
Native Hawaiian or other Pacific Islander	1	1.2%
White	43	50.0%
Other race or ethnicity	4	4.7%
Choose not to report	5	5.9%
Respondent Grade Level‡ (n=86)		
5th	1	1.2%
6th	3	3.5%
7th	11	12.8%

8th	40	46.5%
9th‡	30	34.9%
Choose Not to Report	1	1.2%
School Location (n=85)		
Urban	8	9.4%
Suburban	19	22.4%
Rural	15	17.6%
Choose Not to Report	43	50.6%
Free and Reduced Lunch Status (n=85)		
Yes	10	11.8%
No	27	31.8%
Choose Not to Report	48	56.5%
English First Language (n=85)		
Yes	39	45.9%
No	2	2.4%
Choose Not to Report	44	51.8%
Parent Graduated from College (n=85)		
Yes	31	36.5%
No	6	7.1%
Choose Not to Report	44	56.5%
U2 (n=85)		
Yes	20	47.6%
No	22	52.4%
Not Determined	43	%

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

Mentor Demographics

Only four mentors completed the mentor questionnaire. Their demographic data are summarized in Table 11. Half of the mentors reported being female (50%), and all four mentor respondents indicated they were White. Three of the four respondents reported being teachers (75%), and one identified as an undergraduate or graduate student (25%). Three of the four identified themselves as competition advisors while the fourth identified as a team coach (75%).

Table 11. 2018 JSS Mentor Profile		
Demographic Category	Questionnaire Respondents	
Survey Respondent Gender (n=4)		
Female	2	50%
Male	2	50%

Choose not to report	0	0%
Race/Ethnicity (n=4)		
Hispanic or Latino	0	0%
Asian	0	0%
Black or African American	0	0%
Native American or Alaskan Native	0	0%
Native Hawaiian or Other Pacific Islander	0	0%
White	4	100%
Other	0	0%
Choose not to report	0	0%
Occupation (n=4)		
Teacher	3	75%
Scientist, Engineer, or Mathematician in Training (undergraduate or graduate student)	1	25%
Role in JSS (n=4)		
Competition advisor	3	75%
Chaperone	0	0%
Event coordinator or staff	0	0%
Other, (specify)[§]	1	25%

[§] Other=Team coach

5 | Priority #1 Findings

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

STEM Practices

Several items on the JSS student questionnaire focused on students' opportunities to engage in STEM practices and students' learning in JSS and how those experiences compared to their use of STEM practices and learning experiences in school. Table 12 displays student responses to questions about how frequently they engaged in various STEM practices during JSS. Nearly all students (approximately 90% or more) indicated engaging with each STEM Practice in Table 12 at least once during JSS, with the exception of interacting with scientists or engineers, with 70% reporting they had engaged in this practice at least once. Half or more of students reported they engaged with several STEM practices most days or every day of JSS including: working as part of a team (71%); identifying questions or problems to investigate (59%); participating in hands-on STEM activities (58%); building or making a computer model (51%); and coming up with explanations or solutions (51%).

Table 12. Nature of Student STEM Practices During JSS (n=81-85)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Learn about STEM topics that are new to you	4.71%	10.59%	43.53%	35.29%	5.88%	
	4	9	37	30	5	**85**
Apply STEM learning to real-life situations	7.23%	14.46%	42.17%	22.89%	13.25%	
	6	12	35	19	11	**83**
Learn about new discoveries in STEM	7.32%	20.73%	42.68%	21.95%	7.32%	
	6	17	35	18	6	**82**
Learn about different careers that use STEM	13.25%	19.28%	37.35%	25.30%	4.82%	
	11	16	31	21	4	**83**
Interact with scientists or engineers	29.63%	22.22%	25.93%	16.05%	6.17%	
	24	18	21	13	5	**81**
Communicate with other students about STEM	8.43%	20.48%	28.92%	26.51%	15.66%	
	7	17	24	22	13	**83**
Use laboratory procedures and tools	4.82%	9.64%	42.17%	27.71%	15.66%	

	4	8	35	23	13	**83**
Participate in hands-on STEM activities	3.61%	13.25%	25.30%	39.76%	18.07%	
	3	11	21	33	15	**83**
Work as part of a team	0.00%	10.71%	17.86%	35.71%	35.71%	
	0	9	15	30	30	**84**
Identify questions or problems to investigate	2.41%	13.25%	25.30%	46.99%	12.05%	
	2	11	21	39	10	**83**
Design an investigation or experiment	2.38%	21.43%	32.14%	36.90%	7.14%	
	2	18	27	31	6	**84**
Carry out an investigation or experiment	4.88%	17.07%	36.59%	35.37%	6.10%	
	4	14	30	29	5	**82**
Examine or analyze data or information	3.66%	18.29%	40.24%	34.15%	3.66%	
	3	15	33	28	3	**82**
Come up with conclusions from an investigation or experiment	4.76%	11.90%	35.71%	38.10%	9.52%	
	4	10	30	32	8	**84**
Come up with explanations or solutions	0.00%	20.48%	28.92%	39.76%	10.84%	
	0	17	24	33	9	**83**
Build or make a computer model	9.52%	15.48%	23.81%	38.10%	13.10%	
	8	13	20	32	11	**84**

Composite scores[4] were calculated for the set of items corresponding to Engaging in STEM Practices in JSS[5]. 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. The composite score was used to test whether there were differences in student experiences by AEOP defined underrepresented status (U2), and all subgroups that make up U2 (gender, race/ethnic group, school location, FARMS, ELL, and college first generation). Significant differences by race/ethnicity and FARMS status were found in Engaging in STEM Practices in JSS. Minority students reported a significantly greater impact compared to non-minority students (effect size is medium; d=0.738)[6], and students who received free/reduced lunch in school reported significantly greater engagement compared to students who do not receive free/reduced lunch (effect size is large; d=823)[7].

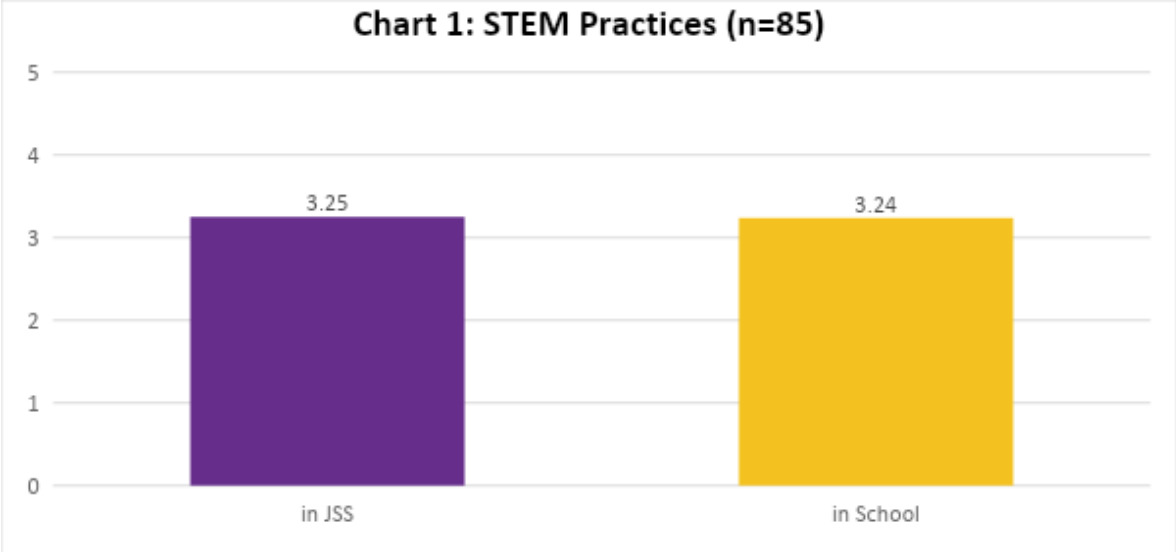
[4] Using multiple statistical tests on related outcomes requires the use of a Type I error rate adjustment to reduce the likelihood of false positives (i.e., detecting a difference when one does not truly exist). However, Type I error rate adjustments lead to a reduction in statistical power (i.e., 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.

[5] The Cronbach's alpha reliability for the 16 Engaging in STEM Practices in JSS items was 0.903.

[6] Independent samples t-test for JSS STEM Practices by race/ethnicity: $t(33)=2.12$, $p=.041$, two-tailed.

[7] Independent samples t-test for JSS STEM Practices by FARMS: $t(34)=2.40$, $p=.022$, two-tailed.

Participants were asked to respond to parallel items about how often they engaged in the same STEM practices in school. These items were then combined into a composite variable[8]. When comparing "in JSS" to "in School" STEM Practices engagement, students reported no significant differences. 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 Practices in School and STEM Practices in JSS (see Chart 1).



Students in focus groups, however, reported that their JSS experiences differed from their regular school STEM activities in various ways, indicating that, as compared to school, JSS offered more hands-on content, applied learning, focus on STEM, independent work, and open-ended content that allowed for creative problem-solving. Students also reported that JSS was more "fun" than their typical school STEM experiences and that they appreciated the competitive aspects of JSS and the feeling of accomplishment they gained from completing their projects. For example, students said:

> "In math and science class, we learn stuff, but we never apply it to a real-life project…[In] JSS, it was cool to see that we can apply what we have learned in class." (JSS National Student)
>
> "At our school…they haven't really focused on STEM. They focus on the science and math [only]." (JSS National Student)
>
> "[JSS] was a lot more competitive [than school]. Just the feeling of being at a competition adds another level of excitement to the project." (JSS National Student)

[8] Cronbach's alpha reliability for the 16 Engaging in STEM Practices in school items was 0.904.

"[In JSS] there's a goal that we're trying to reach and we take different steps to that goal, instead of school where we have a curriculum and we learn things as step by step…[In school], you know how to solve a math problem, but it really doesn't affect you. [In JSS] when you reach the goal, it's like you've accomplished something." (JSS National Student)

STEM Knowledge and Skills

To measure to what extent students build STEM knowledge and skills while engaging in JSS activities, the questionnaire asked participants to report on gains in knowledge and specific skills related to STEM. Approximately two-thirds or more of student respondents indicated high levels of learning (learned more than a little or learned a lot) on all STEM Knowledge items (Table 13). In particular, students reported high levels of learning related to research on a STEM topic or field (71%) and new knowledge of a STEM topic (68%).

Table 13. Student Report of Impacts on STEM Knowledge (n=81-82)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
New knowledge of a STEM topic	6.10%	25.61%	42.68%	25.61%	
	5	21	35	21	**82**
Research on a STEM topic or field	6.10%	23.17%	42.68%	28.05%	
	5	19	35	23	**82**
How to conduct research in STEM	11.11%	27.16%	33.33%	28.40%	
	9	22	27	23	**81**
How scientists and engineers work on real problems in STEM	9.88%	24.69%	37.04%	28.40%	
	8	20	30	23	**81**
What research work is like in STEM	9.76%	25.61%	41.46%	23.17%	
	8	21	34	19	**82**

A composite variable[9] for STEM Knowledge was computed using the five items listed in Table 13 to look for differential impacts by U2 status and across underrepresented sub-groups of students. Significant differences were not found by overall U2 or any individual demographics in terms of STEM Knowledge.

Students also rated the impact of JSS on their STEM competencies or skills (see Table 14). Approximately half or more of participants indicated learning more than a little or learning a lot (high levels of learning) on all but two items about which they were asked. More than a quarter of students reported no new learning for organizing data in charts or graphs (28%) and using computer models of objects or systems to test cause and effect relationships (27%). Items for which students reported high levels of learning

[9] The Cronbach's alpha reliability for the 5 STEM Knowledge items was 0.903.

included making a model of something showing its parts and how they work (72%); carrying out procedures for an experiment and to record data (70%); and using knowledge and creativity to suggest a solution to a problem (70%).

Table 14. Student Gains in STEM Competencies (n=80-83)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Total Response
Ask a question that could be answered with scientific experiments	14.81%	23.46%	38.27%	23.46%	
	12	19	31	19	**81**
Use knowledge and creativity to suggest a potential guess for the outcome of an experiment	7.32%	29.27%	32.93%	30.49%	
	6	24	27	25	**82**
Use knowledge and creativity to suggest a solution to a problem	4.94%	24.69%	35.80%	34.57%	
	4	20	29	28	**81**
Make a model of something showing its parts and how they work	8.43%	19.28%	28.92%	43.37%	
	7	16	24	36	**83**
Design procedures for an experiment that are appropriate for the question to be answered	13.58%	23.46%	35.80%	27.16%	
	11	19	29	22	**81**
Identify the limitations of the procedures used for data collection	11.11%	25.93%	35.80%	27.16%	
	9	21	29	22	**81**
Carry out procedures for an experiment and to record data	10.84%	19.28%	39.76%	30.12%	
	9	16	33	25	**83**
Use computer models of objects or systems to test cause and effect relationships	26.83%	28.05%	24.39%	20.73%	
	22	23	20	17	**82**
Organize data in charts or graphs	28.05%	28.05%	26.83%	17.07%	
	23	23	22	14	**82**
Consider different interpretations of data to decide if the data answer a question	15.00%	30.00%	31.25%	23.75%	
	12	24	25	19	**80**
Consider different interpretations of data to decide if a solution to a problem works	14.63%	26.83%	40.24%	18.29%	
	12	22	33	15	**82**
Support an explanation with STEM evidence or knowledge	12.20%	23.17%	37.80%	26.83%	
	10	19	31	22	**82**
Identify the strengths and limitation of explanations	18.52%	16.05%	45.68%	19.75%	
	15	13	37	16	**81**
Defend an argument	30.49%	20.73%	29.27%	19.51%	

	25	17	24	16	**82**
Identify the strengths and limitations of solutions in terms of how well they meet design criteria	16.05%	24.69%	34.57%	24.69%	
	13	20	28	20	**81**
Identify the strengths and limitations of data, interpretations or arguments presented in texts	17.28%	28.40%	32.10%	22.22%	
	14	23	26	18	**81**
Combine information from texts and other media to support your explanation of an observation	19.75%	25.93%	32.10%	22.22%	
	16	21	26	18	**81**
Communicate about your experiments and explanations in different ways	16.05%	25.93%	35.80%	22.22%	
	13	21	29	18	**81**
Combine information from texts and other media to support your solution to a problem	21.95%	18.29%	35.37%	24.39%	
	18	15	29	20	**82**

A STEM Competencies[10] composite score was calculated for these items and used to examine whether the JSS program had differential impacts on sub-groups of students or by overall U2 status. No significant differences in STEM Competencies were found by U2 status or any demographic area examined.

Twenty-first Century Skills include skills such as communication and collaboration that are necessary across a wide variety of fields (Table 15). Students were asked to rate the impact of their JSS participation on these skills. More than half of students reported high levels of learning (learned more than a little or learned a lot) in all areas of 21st Century Skills. For instance, 78% of students reported high levels of learning in including others' perspectives when making decisions; 76% in in sticking with a task until it is finished; and 75% in making changes when things do not go as planned.

Table 15. Student Report of Impacts on 21st Century Skills (n=81-82)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Total Response
Stick with a task until it is finished	8.54%	15.85%	29.27%	46.34%	
	7	13	24	38	**82**
Make changes when things do not go as planned	8.64%	16.05%	24.69%	50.62%	
	7	13	20	41	**81**
Include others' ideas when making decisions	6.10%	15.85%	40.24%	37.80%	
	5	13	33	31	**82**
Communicate well with others	15.85%	17.07%	26.83%	40.24%	
	13	14	22	33	**82**

[10] The Cronbach's alpha reliability for these 19 STEM Competency items was 0.955.

Build relationships with professionals	16.05%	30.86%	24.69%	28.40%	
	13	25	20	23	**81**
Connect a topic or idea with your person values or beliefs	20.73%	20.73%	24.39%	34.15%	
	17	17	20	28	**82**

The 21st Century Skills items from Table 15 were combined into a composite variable[11] to test for differential impacts across sub-groups of students and by overall U2 status. No differences by subgroup or U2 status were found in terms of 21st Century Skills.

STEM Identity and Confidence

Students were also asked to respond to a series of items intended to measure the impact of JSS participation on their STEM identities. Because students are unlikely to pursue STEM if they do not see themselves as capable of succeeding in STEM,[12] the student questionnaire included a series of items intended to measure the impact of JSS on students' interests in and attitudes toward STEM. Table 16 shows more than three-quarters of students (88%-99%) reported that JSS impacted them in each area of STEM identity. Areas of greatest impact, in which student selected "learned more than a little" or "learned a lot," included feeling like they had accomplished something in STEM (86%), and feeling more prepared for a more challenging STEM activities (84%). A composite score for STEM Identity[13] was developed to compare overall U2 status and subgroup demographic differences. Student reports of STEM Identity gains were similar regardless of U2 status and subgroup demographics.

Table 16. Student Report of Impacts on STEM Identity (n=63-73)

	Strongly disagree	Disagree	Agree	Strongly agree	Total Response
I am interested in a new STEM topic	11.59%	11.59%	30.43%	46.38%	
	8	8	21	32	**69**
I am thinking about pursuing a STEM career	9.72%	13.89%	33.33%	43.06%	
	7	10	24	31	**72**
I feel like I accomplished something in STEM	1.37%	12.33%	34.25%	52.05%	
	1	9	25	38	**73**

[11] The 21st Century Skills composite of 6 items had a Cronbach's alpha reliability of 0.866.
[12] 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.
[13] The STEM Identity composite with 6 items had a Cronbach's alpha reliability of 0.944.

I feel more prepared for more challenging STEM activities	1.43%	14.29%	21.43%	62.86%	
	1	10	15	44	**70**
I am thinking creatively about a STEM project or activity	1.45%	20.29%	30.43%	47.83%	
	1	14	21	33	**69**
I am interested in connecting with mentors who work in STEM	7.94%	14.29%	36.51%	41.27%	
	5	9	23	26	**63**

6 | Priority #2 Findings

Support and empower educators with unique Army research and technology resources.

Mentor Strategies and Support

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. The mentors who responded to the mentor questionnaire reported working with a range of 2 to 120 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: [14]

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.

Half or more of mentor questionnaire participants reported using most strategies to help make learning activities relevant to students (Table 17). All four responding mentors reported becoming familiar with students' backgrounds and interests; encouraging students to suggest new readings, activities, or

[14] 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.

projects; helping students become aware of the role(s) STEM plays in their everyday lives; and asking students to relate real-life events or activities to topics covered in JSS.

Table 17. Mentors Using Strategies to Establish Relevance of Learning Activities (n=4)

	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	100.0%	0.0%	
	4	0	**4**
Giving students real-life problems to investigate or solve	75.0%	25.0%	
	3	1	**4**
Selecting readings or activities that relate to students' backgrounds	50.0%	50.0%	
	2	2	**4**
Encouraging students to suggest new readings, activities, or projects	100.0%	0.0%	
	4	0	**4**
Helping students become aware of the role(s) that STEM plays in their everyday lives	100.0%	0.0%	
	4	0	**4**
Helping students understand how STEM can help them improve their own community	75.0%	25.0%	
	3	1	**4**
Asking students to relate real-life events or activities to topics covered in JSS	100.0%	0.0%	
	4	0	**4**

Mentors also reported supporting the diverse needs of student learners using various strategies (Table 18). Half or more of mentor respondents indicated that they used each of the strategies listed. All four mentors reported using a variety of teaching activities to meet the needs of all students, and interacting with students and other personnel the same way regardless of their background.

Table 18. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=4)

	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	75.0%	25.0%	
	3	1	**4**
Interact with students and other personnel the same way regardless of their background	100.0%	0.0%	

	4	0	**4**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	4	0	**4**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	50.0%	50.0%	
	2	2	**4**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	50.0%	50.0%	
	2	2	**4**
Directing students to other individuals or programs for additional support as needed	50.0%	50.0%	
	2	2	**4**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	75.0%	25.0%	
	3	1	**4**

All responding mentors reported using each strategy to support student development of collaboration and interpersonal skills (Table 19) with the exception of one item. Only 2 of the 4 mentors (50%) reported having their student(s) tell other people about their backgrounds and interests).

Table 19. Mentors Using Strategies to Support Development of Collaboration/Interpersonal Skills (n=4)

	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	50.0%	50.0%	
	2	2	**4**
Having my student(s) explain difficult ideas to others	100.0%	0.0%	
	4	0	**4**
Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	4	0	**4**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	100.0%	0.0%	
	4	0	**4**
Having my student(s) give and receive constructive feedback with others	100.0%	0.0%	
	4	0	**4**
Having students work on collaborative activities or projects as a member of a team	100.0%	0.0%	
	4	0	**4**

Allowing my student(s) to resolve conflicts and reach agreement within their team	100.0%	0.0%	
	4	0	**4**

All mentor questionnaire respondents also reported using all strategies but one associated with supporting student engagement in authentic STEM activities (Table 20). Only two of the 4 mentors (50%) reported teaching (or assigning readings) about specific STEM subject matter.

Table 20. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM (n=4)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	50.0%	50.0%	
	2	2	**4**
Having my student(s) search for and review technical research to support their work	100.0%	0.0%	
	4	0	**4**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	100.0%	0.0%	
	4	0	**4**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	4	0	**4**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	4	0	**4**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	4	0	**4**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	100.0%	0.0%	
	4	0	**4**
Encouraging students to seek support from other team members	100.0%	0.0%	
	4	0	**4**

Mentors also reported using strategies to support student STEM educational and career pathways (Table 21). Three of the responding mentors (75%) reported using each strategy with the exception of helping students build a professional network in a STEM field (2 mentors, or 50%, used this strategy); and helping students with their resumes, applications, personal statements, and/or interview preparations (1 mentor, or 25%, used this strategy).

Table 21. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=4)

	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	100.0%	0.0%	
	4	0	**4**
Recommending extracurricular programs that align with students' goals	100.0%	0.0%	
	4	0	**4**
Recommending Army Educational Outreach Programs that align with students' goals	75.0%	25.0%	
	3	1	**4**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	100.0%	0.0%	
	4	0	**4**
Discussing STEM career opportunities within the DoD or other government agencies	100.0%	0.0%	
	4	0	**4**
Discussing STEM career opportunities in private industry or academia	100.0%	0.0%	
	4	0	**4**
Discussing the economic, political, ethical, and/or social context of a STEM career	75.0%	25.0%	
	3	1	**4**
Recommending student and professional organizations in STEM to my student(s)	100.0%	0.0%	
	4	0	**4**
Helping students build a professional network in a STEM field	50.0%	50.0%	
	2	2	**4**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	25.0%	75.0%	
	1	3	**4**

Program Features and Feedback/Satisfaction

Students were asked how satisfied they were with a number of features of the JSS program. Approximately half or more of responding students indicated they were either somewhat or very much satisfied with all JSS features (Table 22). Specific features students were particularly satisfied with (somewhat or very much satisfied) were the help they received from their teachers/mentors during JSS (79%) and the location of JSS (74%). Few students expressed dissatisfaction with any JSS feature (less than 8%), however, many students reported not experiencing guest speakers during JSS (42%).

Table 22. Student Satisfaction with JSS Features (n=19-83)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying for and registering for JSS	3.61%	4.82%	24.10%	28.92%	38.55%	
	3	4	20	24	32	**83**
Communicating with the JSS staff	15.85%	4.88%	10.98%	30.49%	37.80%	
	13	4	9	25	31	**82**
Location of JSS	1.22%	3.66%	20.73%	28.05%	46.34%	
	1	3	17	23	38	**82**
STEM topics discussed at JSS	12.05%	4.82%	27.71%	25.30%	30.12%	
	10	4	23	21	25	**83**
Help your teacher or mentor gave you during JSS	4.82%	0.00%	15.66%	28.92%	50.60%	
	4	0	13	24	42	**83**
Materials you were given during JSS	6.25%	7.50%	22.50%	36.25%	27.50%	
	5	6	18	29	22	**80**
Guest speakers during JSS	42.11%	5.26%	5.26%	42.11%	5.26%	
	8	1	1	8	1	**19**

An open-ended questionnaire item asked students to comment about their satisfaction with their JSS experiences. Of the 64 students (51 national students and 13 regional) who provided responses to this item, 57 (89%), responded with only positive comments. Many of these were simple affirmations of the program such as "It was fun and very satisfying" and "AMAZING." Others provided detail about what they enjoyed about the program including comments about the opportunity to learn about STEM topics, have fun, work in teams, learn about careers, and develop their critical thinking and problem solving skills. For example:

> "I really enjoyed my JSS experience. I feel that I have grown with my knowledge of mechanics. I learned more about solar panels and how they are used. Creating a car and overcoming obstacles with my teammate was a fun experience. I am glad my friend involved me in JSS and I wish I could do it again." (JSS Regional Student)
>
> "I had a blast with my team and it was fun to see how much adversity we overcame as a team." (JSS National Student)
>
> "I like JSS a lot because it was a lot of fun and it made me think outside of the box." (JSS National Student)

Another 6 student respondents to the questionnaire item (4 national and 2 regional) also made positive comments, but offered some caveats, and 1 national student offered no positive comments. Students who expressed dissatisfaction with program elements made comments about feeling rushed, the stress they experienced in completing their projects, their access to materials and resources, and receiving limited information about the Army. For example,

> "I enjoyed the program and participating in this event is fun but I wish my school would buy better and new parts every year and not reuse the parts which makes it difficult for us to build our cars." (JSS Regional Student)
>
> "Personally, I think the program is great. Building and designing a solar car is very fun, but the program needs to be more educational. To me, it just feels like another TSA event. If anyone were to participate in the event, many wouldn't realize that it is run by the Army. I think the Army should be a bit more involved with the program. I only saw one member in uniform throughout the whole program. (JSS National Student)

Students were also asked in an open-ended questionnaire item how JSS could be improved. A total of 58 students (46 national and 12 regional) made at least one suggestion for improvement. The most frequently mentioned improvements (each mentioned by 12 students, or 21%) suggested the following:

- providing more or better materials and/or equipment
- clarifying the rules generally, and specifically in regard to presentation board requirements, aligning regional and national competition rules, and/or revising rules to allow more diverse car designs.
- Providing more online resources such as examples of successful projects, a question and answer forum on the website, and information about AEOPs

Five students competing at the national level suggested revisions in the competition track (e.g., making it longer, smoother, or providing tighter guidewires).

Students participating in focus groups at the national event were also asked to share their ideas about how JSS could be improved. Student responses generally mirrored those of questionnaire respondents but offered more details about their suggested revisions to rules, including standardizing rules across competition levels, clarifying whether teams need to prepare a presentation board, and providing weight guidelines for the batter. Other suggestions included:

- eliminating the Pitsco template so that teams are not building "by the instructions"
- conducting both indoor and outdoor races
- providing more supplies for car repair at the pit stop (e.g., soldering irons and hot glue guns)
- providing more practice runs
- holding races rather than time trials
- providing more tracks to maximize teams' access to sunlight
- allowing a bigger budget for teams
- using a standardized solar panel
- making sure that all timers for the time trials are trained appropriately

Mentors were also asked to rate their level of satisfaction with various features of JSS. Table 23 shows that the responding mentors were largely satisfied (somewhat or very much) with all components of JSS that they experienced. Those who did not report high satisfaction levels indicated that they had not experienced the feature. For example, half of the mentors reported high satisfaction with their communication with TSA and the other half indicated they did not experience this aspect. Most or all mentors reported not experiencing several features including stipends (75%), invited speakers (100%), and field trips (100%).

Table 23. Mentor Satisfaction with JSS Features (n=4)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	25.0%	0.0%	0.0%	50.0%	25.0%	
	1	0	0	2	1	**4**
Communicating with Technology Student Association (TSA)	50.0%	0.0%	0.0%	25.0%	25.0%	
	2	0	0	1	1	**4**
Communicating with JSS site coordinators	25.0%	0.0%	0.0%	0.0%	75.0%	
	1	0	0	0	3	**4**
The physical location(s) of JSS's activities	25.0%	0.0%	0.0%	0.0%	75.0%	
	1	0	0	0	3	**4**

Support for instruction or mentorship during program activities	25.0%	0.0%	0.0%	25.0%	50.0%	
	1	0	0	1	2	**4**
Stipends (payment)	75.0%	0.0%	0.0%	0.0%	25.0%	
	3	0	0	0	1	**4**
Invited speakers or "career" events	100.0%	0.0%	0.0%	0.0%	0.0%	
	4	0	0	0	0	**4**
Field trips or laboratory tours	100.0%	0.0%	0.0%	0.0%	0.0%	
	4	0	0	0	0	**4**

A similar pattern of mentor satisfaction was reported for JSS online supports as for JSS features (Table 24). In general, if mentors had experienced the JSS online supports they indicated some level of satisfaction. Most mentors, however, had not experienced the majority of online supports about which they were asked, including video tutorials (100%), JSS host guide (75%), terminology (75%), lesson plans (75%), STEM standards (75%), course outline (75%), and build a car resources (75%). Among the online resources mentors had experienced, half or more reported being somewhat or very much satisfied with local competition rules (50%) and official TSA competition rules (50%).

Table 24. Mentor Satisfaction with JSS Online Supports (n=4)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Official Technology Student Association Competition Rules	25.0%	0.0%	25.0%	25.0%	25.0%	
	1	0	1	1	1	**4**
Local Competition Rules	25.0%	0.0%	0.0%	25.0%	50.0%	
	1	0	0	1	2	**4**
Build A Car resources	75.0%	0.0%	0.0%	25.0%	0.0%	
	3	0	0	1	0	**4**
Course Outline	75.0%	0.0%	0.0%	25.0%	0.0%	
	3	0	0	1	0	**4**
STEM Standards	75.0%	0.0%	0.0%	0.0%	25.0%	
	3	0	0	0	1	**4**
Lesson Plans	75.0%	0.0%	0.0%	25.0%	0.0%	
	3	0	0	1	0	**4**
Terminology	75.0%	0.0%	0.0%	25.0%	0.0%	

	3	0	0	1	0	**4**
Video Tutorials	100.0%	0.0%	0.0%	0.0%	0.0%	
	4	0	0	0	0	**4**
JSS Host Guide	75.0%	0.0%	0.0%	25.0%	0.0%	
	3	0	0	1	0	**4**
Calendar of Events	50.0%	0.0%	25.0%	25.0%	0.0%	
	2	0	1	1	0	**4**

Mentors responding to the questionnaire and participating in the focus group indicated that, overall, they were satisfied with their JSS experience. As one mentor said,

> "I LOVE JSS! This was my second year and I will do it again in the future. One of the things that I really like about this opportunity is that it challenges the students to try things and then make decisions for improvements based on evidence and data. Also, this is NOT an area of STEM that I am very familiar with, so I couldn't provide answers for the students, but I could give them tips or strategies for research and problem solving. Since they didn't have a teacher that 'knew the answers' they really had to take some risks and try things. It is amazing to watch them and I had total student engagement throughout the project. It is wonderful!" (JSS Team Advisor)

In focus groups and in response to an open-ended questionnaire item, team advisors and other participating adults mentioned a number of strengths of JSS. Benefits to students included the exposure to hands-on STEM problem solving, the opportunity to see other teams' projects, teamwork, the opportunity to overcome adversity and learn from failure, STEM learning, the value of creating the portfolio as well as the car, and career information. For example,

> "[JSS] teaches them to strategize in terms of solving a specific problem or getting to a specific goal. There are several ways to accomplish a goal and many times students, in a school setting, they're told 'Follow these directions and it will give you this end result.' In this competition, [JSS] allows them to do more exploring to figure out various ways to get to the end result." (JSS National Adult Participant)

> "I like the idea that the students learn that failing is natural and it's a part of growth." (JSS National Adult Participant)

> "I like that two girls beat out a bunch of guys to get here…the fact that they saw that, wow, when you pay attention to the details and it's just not about the car, but… [also] their portfolio got them here." (JSS National Adult Participant)

> "As a result of being involved with the AEOP programming, and being involved with the engineers and the researchers, they now understand that there are other careers [in the DoD] outside of being an enlisted soldier." (JSS National Adult Participant)

Adults were also asked in focus groups and in an open-ended questionnaire item to note ways in which JSS could be improved for future participants. Some suggestions were similar to those made by students, including standardizing rules and competition conditions at the state and national levels, clarifying rules (especially those pertaining to the budget), and providing more examples of successful cars and presentations. Other suggestions included creating a discussion board for team advisors and/or providing a list of email contacts for experienced team advisors who could answer questions from less experienced advisors, providing more questions for advisors to use to prompt student thinking, changing the challenge or the competition track from year to year, and adding a kick-off event. For example,

> "Our state competition wasn't anything like the nationals. In talking to other people about their state and what they had to do to qualify.... [for] nationals, it's all different… [Teams are] coming to nationals with different cars because they have different state regulations for their competitions. I think if the state playing level was fair and even, then when we come to nationals everyone's not going to be confused." (JSS National Adult Participant)

> "The track is pretty much the same every year. If the kids had a different challenge every year, where the track perhaps was a little bit different and they had some other obstacles…That might make it a little more challenging for students that are returning." (JSS National Adult Participant)

Adult participants in the focus group were also asked for suggestions about ways that JSS can reach populations underserved or underrepresented in STEM. Participants suggested that using local Army bases for competitions and using local National Guard groups to disseminate information about JSS might allow the program to reach a broader base of participants and more effectively make connections between JSS and the Army. As one team advisor noted, participants often relate JSS to the TSA and fail to see the Army connection since "we are doing it for the TSA connection, so we're focused on TSA…It's hard sometimes separating that [JSS] is slightly different [than other TSA events]."

7 | Priority #3 Findings

Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army.

How Participants Found out About AEOP

In order to determine what recruitment methods are most effective, students were asked to indicate all of the ways they learned about the AEOP (Table 25). The two most frequently mentioned sources of information about AEOP were someone who works at the school or university the student attends (63%); and a school or university newsletter, email, or website (63%). The only other source mentioned was a friend (13%). It should be noted that only 8 students responded to this item, however.

Table 25. How Student Participants Learned About AEOP (n=8)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	0.00%	0
AEOP on Facebook, Twitter, Instagram, or other social media	0.00%	0
School or university newsletter, email, or website	62.50%	5
Past participant of program	0.00%	0
Friend	12.50%	1
Family Member	0.00%	0
Someone who works at the school or university I attend	62.50%	5
Someone who works with the program	0.00%	0
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	0.00%	0
Community group or program	0.00%	0

Choose Not to Report	0.00%	0

Students were also asked in a questionnaire item to report what motivated them to participate in JSS. Specifically, they were asked how motivating a number of factors were in their decision to participate (Table 26). The top motivators, with half or more students reporting were: having fun (88%); interest in STEM (88%); desire to learn something new or interesting (75%); opportunity to do something with friends (63%); and opportunity to use advanced laboratory technology (50%). Again, only 8 students responded to this questionnaire item.

Table 26. Factors Motivating Students "Very Much" to Participate in JSS (n=8)

Item	Questionnaire Respondents
Interest in science, technology, engineering, or mathematics (STEM)	87.50%
Having fun	87.50%
Desire to learn something new or interesting	75.00%
Opportunity to do something with friends	62.50%
Opportunity to use advanced laboratory technology	50.00%
Teacher or professor encouragement	37.50%
Desire to expand laboratory or research skills	37.50%
Learning in ways that are not possible in school	37.50%
Exploring a unique work environment	37.50%
Seeing how school learning applies to real life	37.50%
The mentor(s)	12.50%
Figuring out education or career goals	12.50%
Recommendations of past participants	12.50%
An academic requirement or school grade	0.00%
Building college application or résumé	0.00%
Networking opportunities	0.00%
Interest in STEM careers with the Army	0.00%

Earning stipends or awards for doing STEM	0.00%
Serving the community or country	0.00%

Students in the focus groups at the national event were also asked about their reasons for participating in JSS. These students indicated that JSS looked "interesting," that they were motivated to participate by the problem-solving and engineering aspects of JSS, that they have an interest in alternative energy sources, that they participated on the recommendation of friends or to be with friends, to get career information, and to have fun. For example,

> "I love to produce stuff with engineering. I thought it would be fun." (JSS National Student)
>
> "[I participated in JSS] because I think it's cool how people are starting to make the movement towards more efficient and longer lasting energy sources." (JSS National Student)
>
> "A high school friend recommended it…It sounded cool. It sounded like a fun event." (JSS National Student)

Mentors were asked which of the AEOP programs they discussed with their students during JSS (Table 27). Most (67%) reported discussing AEOP in general, without reference to a specific program. Three-quarters (75%) of responding mentors reported that they discussed GEMS with their students, while half (50%) reported having discussed JSHS and SMART with students.

Table 27. Mentors Explicitly Discussing AEOPs with Students (n=3-4)

	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)	75.0%	25.0%	
	3	1	**4**
Unite	0.0%	100.0%	
	0	4	**4**
Junior Science & Humanities Symposium (JSHS)	50.0%	50.0%	
	2	2	**4**
Science & Engineering Apprenticeship Program (SEAP)	25.0%	75.0%	
	1	3	**4**
Research & Engineering Apprenticeship Program (REAP)	25.0%	75.0%	
	1	3	**4**

High School Apprenticeship Program (HSAP)	25.0%	75.0%	
	1	3	**4**
College Qualified Leaders (CQL)	25.0%	75.0%	
	1	3	**4**
GEMS Near Peer Mentor Program	25.0%	75.0%	
	1	3	**4**
Undergraduate Research Apprenticeship Program (URAP)	25.0%	75.0%	
	1	3	**4**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	50.0%	50.0%	
	2	2	**4**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	0.0%	100.0%	
	0	4	**4**
I discussed AEOP with my student(s) but did not discuss any specific program	66.7%	33.3%	
	2	1	**3**

Mentors were also asked how they learned about AEOP (Table 28). The most common response, selected by 3 of the 4 responding mentors, was past participation in an AEOP program (33%). Other sources mentioned by one mentor each were: the AEOP website (17%), a friend (17%), and someone who works with the DoD (17%).

Table 28. How Mentors Learned About AEOP (n= 4)

Choice	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	16.67 %	1
AEOP on Facebook, Twitter, Instagram, or other social media	0.00 %	0
School or university newsletter, email, or website	0.00 %	0
Past participant of program	33.33 %	2
Friend	16.67 %	1
Family Member	0.00 %	0
Someone who works at the school or university I attend	16.67 %	1
Someone who works with the program	0.00 %	0

Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	16.67 %	1
Community group or program	0.00 %	0

Previous Program Participation & Future Interest

JSS students were asked how many times they had participated in each of the AEOPs in the past (Table 29). Only 10 (about 12%) student respondents had participated in AEOPs other than JSS (2 in GEMS and 3 in eCybermission) in the past. Almost 40% of all respondents had participated in JSS at least once in the past, however.

Table 29. Student past participation in AEOPs (n=81-85)

	Never	Once	Twice	Three or more times	Response Total
GEMS	91.36%	2.47%	6.17%	0.00%	
	74	2	5	0	**81**
JSS	61.18%	21.18%	11.76%	5.88%	
	52	18	10	5	**85**
eCM	96.34%	0.00%	3.66%	0.00%	
	79	0	3	0	**82**
JSHS	100.00%	0.00%	0.00%	0.00%	
	81	0	0	0	**81**

Students were also asked about their interest in participating in other AEOPs in the future (Table 30). A majority of students (64%) reported being interested in participating in JSS again. Fewer than 20% indicated interest in participating in any other AEOP program, however.

Table 30. Student Interest in Future AEOPs (n=53)	
Camp Invention	11.32%
CQL	5.66%
eCM	11.32%
GEMS	1.89%
GEMS-NPM	3.77%
HSAP	7.55%
JSHS	15.09%
JSS	64.15%
NDSEG	11.32%
REAP	9.43%
SEAP	11.32%
URAP	5.66%
UNITE	0.00%

Awareness of STEM Careers & DoD STEM Careers & Research

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 (Table 31).

Students were further asked to report how many STEM jobs/careers within the DoD they learned about during their experience (Tables 32). More than three-quarters (78%) of students reported learning about at least one STEM job/career in general, with 19% learning about five or more. Students were less likely to have learned specifically about DoD STEM jobs/careers, however, with 56% of students reporting learning about at least one DoD STEM job/career and only 11% reporting learning about five or more.

Table 31. Number of STEM Jobs/Careers Students Learned About During JSS (n=81)

Choice	Response Percent	Response Total
None	22.22%	18
1	11.11%	9
2	18.52%	15
3	22.22%	18
4	7.41%	6
5 or more	18.52%	15

Table 32. Number of Army/DoD STEM Jobs/Careers Learn About During JSS (n=79)

Choice	Response Percent	Response Total
None	44.30%	35
1	10.13%	8
2	17.72%	14
3	13.92%	11
4	2.53%	2
5 or more	11.39%	9

Likewise, students in focus groups mentioned learning about engineering careers in general during JSS, but only 2 reported learning about STEM careers in the Army or DoD. Those who had learned about Army or DoD STEM careers credited the speakers at the national event.

In order to understand how students learn about DoD STEM careers in JSS, students were asked about the impact of a variety of resources on their awareness of these careers. Table 33 shows that the AEOP website (56%) was the resource most likely to be reported as helpful for this purpose. About a quarter or more of students identified the AEOP brochure (33%) and invited speakers (24%) as resources helpful for learning about DoD STEM careers.

Table 33. Impact of Resources on Student Awareness of DoD STEM Careers	
Item	**Helped (n=55)**
AEOP Website	56.36%
AEOP Brochure	32.73%
Invited Speakers	23.64%
My Participation in JSS	10.91%
My JSS Mentor	3.64%

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 (Table 34). Findings indicate that approximately two-thirds of students had favorable opinions about DoD research and researchers. For example, most students agreed that DoD researchers solve real-world problems (67%) and that DoD research is valuable to society (65%). Around a quarter of students (24% - 31%) did not register an opinion about DoD research and researchers.

Table 34. Student Opinions about DoD Researchers and Research (n=79-80)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	3.75%	3.75%	27.50%	32.50%	32.50%	
	3	3	22	26	26	**80**
DoD researchers develop new, cutting edge technologies	2.50%	2.50%	31.25%	37.50%	26.25%	
	2	2	25	30	21	**80**
DoD researchers solve real-world problems	2.53%	6.33%	24.05%	35.44%	31.65%	
	2	5	19	28	25	**79**

DoD research is valuable to society	2.53%	2.53%	30.38%	26.58%	37.97%	
	2	2	24	21	30	**79**

Interest & Future Engagement in STEM

A key goal of the AEOP is to develop a STEM-literate citizenry. As such, students need to be engaged both in and out of school with high-quality STEM activities. The questionnaire asked students to reflect on the likelihood that they would engage in STEM activities outside of required school courses as a result of their JSS experience (Table 35). Approximately half or more of JSS students indicated they were more likely to engage in a number of STEM activities after participating in JSS. STEM activities students in which most students reported increased likelihood of engagement were: playing or working with a mechanical or electrical device (63%); using a computer to design or program something (59%); and working on a STEM project or experiment at a university or professional setting (57%). More than a third of students (31%-61%) reported that their likelihood of engaging in each activity was about the same as before participating in JSS.

Table 35. JSS Impact on Participants' Intent to Engage in STEM Activities Outside of School (n=79-81)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read about STEM	6.25%	6.25%	61.25%	17.50%	8.75%	
	5	5	49	14	7	**80**
Play or work with a mechanical or electrical device	0.00%	6.25%	31.25%	41.25%	21.25%	
	0	5	25	33	17	**80**
Work on solving mathematical or scientific puzzles	0.00%	4.94%	49.38%	28.40%	17.28%	
	0	4	40	23	14	**81**
Use a computer to design or program something	0.00%	7.41%	33.33%	37.04%	22.22%	
	0	6	27	30	18	**81**
Talk with friends or family about STEM	3.75%	6.25%	42.50%	27.50%	20.00%	
	3	5	34	22	16	**80**
Mentor or teach other students about STEM	6.17%	6.17%	43.21%	32.10%	12.35%	
	5	5	35	26	10	**81**
Help with a community service project related to STEM	2.53%	5.06%	44.30%	32.91%	15.19%	
	2	4	35	26	12	**79**

Participate in a STEM camp, club, or competition	0.00%	6.25%	45.00%	23.75%	25.00%	
	0	5	36	19	20	**80**
Take an elective (not required) STEM class	1.23%	11.11%	38.27%	27.16%	22.22%	
	1	9	31	22	18	**81**
Work on a STEM project or experiment in a university or professional setting	2.47%	3.70%	37.04%	32.10%	24.69%	
	2	3	30	26	20	**81**

A composite score was created from the STEM Intentions items in Table 32,[15] and scores were compared across subgroups of students and by overall U2 status. No statistically significant differences were found by U2 status or individual demographic variables.

To understand students' educational aspirations, the student questionnaire asked how far students intended to go in school after participating in JSS (Tables 36). Nearly all students reported wanting to at least finish college (35%) or get more education after college (58%).

Table 36. After JSS – Student Education Aspirations (n=66)

Choice	Response Percent	Response Total
Graduate from high school	3.03%	2
Go to a trade or vocational school	1.52%	1
Go to college for a little while	3.03%	2
Finish college (get a Bachelor's degree)	34.85%	23
Get more education after college	57.58%	38

Resources

Mentors were asked to rate the usefulness of various resources for exposing students to AEOPs (Table 37). None of the responding mentors indicated that any resource was not useful for this purpose. All 3 responding mentors indicated that the following resources were somewhat or very much useful for exposing students to AEOPs: the JSS website, the JSS program administrator or site coordinator, and participation in JSS. None had experienced invited speakers or "career" events or the It Starts Here! magazine.

Table 37. Usefulness of Resources in Exposing Students to AEOPs (n=3)

[15] STEM intentions composite with 10 items had a Cronbach's alpha reliability of 0.917.

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
The Junior Solar Sprint website (jrsolarsprint.org)	0.0%	0.0%	0.0%	66.7%	33.3%	
	0	0	0	2	1	**3**
Technology Student Association (TSA) website	33.3%	0.0%	33.3%	33.3%	0.0%	
	1	0	1	1	0	**3**
Army Educational Outreach Program (AEOP) website	0.0%	0.0%	33.3%	0.0%	66.7%	
	0	0	1	0	2	**3**
AEOP on Facebook, Twitter, Pinterest or other social media	66.7%	0.0%	0.0%	0.0%	33.3%	
	2	0	0	0	1	**3**
AEOP brochure	33.3%	0.0%	0.0%	66.7%	0.0%	
	1	0	0	2	0	**3**
JSS Program administrator or site coordinator	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	3	**3**
Invited speakers or "career" events	100.0%	0.0%	0.0%	0.0%	0.0%	
	3	0	0	0	0	**3**
Participation in JSS	0.0%	0.0%	0.0%	0.0%	100.0%	
	0	0	0	0	3	**3**

Mentors were also asked how useful these same resources were for exposing students to DoD STEM careers (Table 38). The same pattern was noted among the 3 responding mentors – if participants had experienced the resource they found it to be useful. While all three mentors indicated that the JSS program administrator or site coordinator was useful, all again reported to have had no experience with invited speakers or "career" events and the It Starts Here! Magazine for the purpose of exposing students to DoD STEM careers.

Table 38. Usefulness of Resources in Exposing Students to DoD STEM Careers (n=3)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
The Junior Solar Sprint website (jrsolarsprint.org)	33.3%	0.0%	0.0%	0.0%	66.7%	
	1	0	0	0	2	**3**
Technology Student Association (TSA) website	66.7%	0.0%	0.0%	0.0%	33.3%	
	2	0	0	0	1	**3**

Army Educational Outreach Program (AEOP) website	33.3%	0.0%	0.0%	0.0%	66.7%	
	1	0	0	0	2	**3**
AEOP on Facebook, Twitter, Pinterest or other social media	66.7%	0.0%	0.0%	33.3%	0.0%	
	2	0	0	1	0	**3**
AEOP brochure	33.3%	0.0%	0.0%	33.3%	33.3%	
	1	0	0	1	1	**3**
JSS Program administrator or site coordinator	0.0%	0.0%	0.0%	33.3%	66.7%	
	0	0	0	1	2	**3**
Invited speakers or "career" events	100.0%	0.0%	0.0%	0.0%	0.0%	
	3	0	0	0	0	**3**
Participation in JSS	33.3%	0.0%	0.0%	0.0%	66.7%	
	1	0	0	0	2	**3**

Students were asked to identify which resources impacted their awareness of the various AEOPs in order to better understand resource effectiveness. Table 39 illustrates that the AEOP website was frequently rated as helpful in student awareness of AEOPs (57%), and over a third (36%) reported that the AEOP brochure was helpful. Most students, however, rated all other resources as not helpful in terms of impacting their awareness of AEOPs.

Table 39. Impact of Resources on Student Awareness of AEOPs

Item	Helped (n=58)
AEOP Website	56.90%
AEOP Brochure	36.21%
My Participation in JSS	15.52%
My JSS Mentor	6.90%
Invited Speakers	6.90%

Students were also asked to identify which of the same resources impacted their awareness of DoD STEM careers. Table 40 shows that the AEOP website was again frequently rated as being helpful in students' awareness of AEOPs (56%), and a third of students (33%) found the AEOP brochure helpful. Again, most students rated all other resources as not helpful in terms of impacting their awareness of AEOPs.

Table 40. Impact of Resources on Student Awareness of DoD STEM Careers

Item	Helped (n=55)
AEOP Website	56.36%
AEOP Brochure	32.73%
Invited Speakers	23.64%
My Participation in JSS	10.91%
My JSS Mentor	3.64%

Overall Impact

Finally, students were asked about the overall impacts of participating in JSS (Table 41). Most students reported that JSS had a substantial impact on them, with more than 50% of students indicating that JSS helped them to grow in each item related to their interest in, awareness of, and appreciation for STEM. Items for which students reported particularly high levels of JSS impact included confidence in their STEM knowledge, skills, and abilities (67%) and interest in participating in STEM activities outside of school requirements (63%). For items related to AEOPs and the DoD, students also reported growth. In particular, students reported that JSS contributed to their having a greater appreciation of Army or DoD STEM research (61%), and that they were more interested in participating in AEOPs in the future (55%). It is noteworthy, however, that more than a third of students (40%) reported that JSS had not increased their awareness of Army or DoD STEM research and careers. In spite of this, slightly over half (51%) indicated that after JSS they were more interested in pursuing STEM careers with the Army or DoD.

Table 41. Student Opinions of JSS Impacts (n=78-81)

	Disagree - This did not happen	Disagree - This happened but not because of JSS	Agree - Felt this way before JSS	Agree - JSS helped me grow in my interest	Response Total
I am more confident in my STEM knowledge, skills, and abilities.	6.17%	14.81%	12.35%	66.67%	
	5	12	10	54	**81**
I am more interested in participating in STEM activities outside of school requirements.	10.13%	13.92%	12.66%	63.29%	
	8	11	10	50	**79**
I am more aware of other AEOPs.	14.10%	12.82%	14.10%	58.97%	
	11	10	11	46	**78**
I am more interested in participating in other AEOPs.	15.00%	20.00%	10.00%	55.00%	
	12	16	8	44	**80**

I am more interested in taking STEM classes in school.	3.75%	23.75%	15.00%	57.50%	
	3	19	12	46	**80**
I am more interested in earning a STEM degree.	6.33%	20.25%	12.66%	60.76%	
	5	16	10	48	**79**
I am more interested in pursuing a career in STEM.	6.33%	21.52%	15.19%	56.96%	
	5	17	12	45	**79**
I am more aware of Army or DoD STEM research and careers.	17.95%	10.26%	11.54%	60.26%	
	14	8	9	47	**78**
I have a greater appreciation of Army or DoD STEM research.	11.25%	12.50%	15.00%	61.25%	
	9	10	12	49	**80**
I am more interested in pursuing a STEM career with the Army or DoD.	22.50%	16.25%	10.00%	51.25%	
	18	13	8	41	**80**

A composite for Overall Impact of JSS was created from the 10 items in Table 37.[16] Scores were compared across subgroups of students and overall U2 status. No statistically significant differences were found in terms of Overall Impact from JSS participation.

Students were also asked in an open-ended questionnaire item to list the three most important ways that JSS has helped them. A total of 73 students (58 national and 15 regional) commented about one or more benefit of JSS. The most often-mentioned benefits were STEM learning (mentioned by 34 students, or 59%) and the opportunity to acquire STEM skills teamwork (mentioned by 31 students, or 42%). Many students also valued the teamwork experience (mentioned by 26 students, or 36%) and opportunities for problem-solving (mentioned by 22 students, or 30%). Other benefits, mentioned by 15 (21%) or fewer students included developing time management skills, learning about careers, having fun, and increasing their interest in and/or motivating them in STEM. Other benefits, mentioned only by students competing at the national level, included social interactions and making new friends, and learning about AEOPs.

Students participating in focus groups echoed these themes when asked about the benefits of JSS, and added that they appreciated the ties to engineering, and the opportunity to practice skills such as task management, leadership, and perseverance. For example:

> "I learned a lot about critical thinking and problem solving on the spot. If there's a problem, fix it. Working with a team is [also a benefit]." (JSS National Student)

> "I learned how to share my ideas and collaborate better." [JSS National Student]

[16] The Cronbach's alpha reliability for the 10 Overall Impact items was 0.917.

“I’ve learned a lot about task management and working together as a team to reach a common goal.”(JSS National Student)

8 | Overall Findings and Recommendations

Summary of Findings

The FY18 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 Table 42.

Table 42. 2018 JSS Evaluation Findings

Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
JSS served increasing numbers of students in FY18 and continues to reach 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 FY18 JSS registered 1,081 students, a 21% increase in enrollment compared to FY17 when 892 students registered. Over a third (37%) of JSS participants in FY18 were female.
	There were slightly fewer participants identifying as Black or African American in FY18 (11%) as compared to FY17 (15%). The proportion of participants identifying as Hispanic/Latino (8%) also declined slightly relative to FY17 levels (10%).
	About a third (34%) of JSS participants were classified as underserved in STEM according to AEOP's definition of U2. This is similar to the proportion of U2 students enrolled in FY17 (29%).
Students reported engaging in STEM practices during JSS; minority students reported being more engaged than their non-minority peers and low-income students were more engaged than those who were not low-income.	Nearly all students (approximately 90% or more) indicated engaging with most STEM Practices at least once during JSS. An exception to this was that 30% of students reported that they had not interacted with scientists or engineers during JSS.

	Minority students reported significantly greater STEM engagement in JSS compared to non-minority students (medium effect size) and students who received free/reduced lunch in school reported significantly greater engagement compared to students who do not receive free/reduced lunch (large effect size).
	Although no statistical differences were identified between students' STEM engagement in school and in JSS (perhaps due to the fact that JSS activities are often completed as a class requirement), students in focus groups reported that their JSS activities more hands-on and more focused on creative, independent problem-solving than their STEM experiences in school.
Students experienced gains in STEM knowledge during JSS and viewed STEM learning as a primary benefit of the program.	A large majority of students (89% - 94%) reported gains in their knowledge about STEM topics, practices, and real-world research.
	The most frequently mentioned benefit of JSS, identified by more than half of students (59%) in an open-ended question, was STEM learning.
	There were no significant differences in STEM knowledge gains found by U2 status or any demographic area examined.
Students experienced gains in their STEM competencies or skills, although the gains reported varied across skills.	More than half of students (70% - 95%) reported gains in all STEM competencies or skills about which they were asked, although gains varied across specific skills, with students most likely to report having skills in using knowledge and creativity to suggest a solution to a problem and in using knowledge and creativity to suggest a potential guess for the outcome of an experiment, and least likely to report having gained skills in defending an argument and in organizing data in charts and graphs.
	No significant differences in STEM Competencies were found by U2 status or any demographic area examined.
Students reported substantial gains in areas of 21st Century skills, although learning varied across specific skills.	More than three-quarters of students (79% - 94%) reported gains in all 21st Century skills about which they were asked. Students were most likely to report gains in sticking with a task until it is finished, making changes when things do not go as planned, and including others' ideas when making decisions. They were least likely to report gains in connecting a topic or idea with personal values or beliefs.

	Students reported in open-ended questions and in focus groups that the opportunity to develop 21st Century skills such as teamwork, critical thinking, communication, and problem solving are primary benefits of participating in JSS.
	No significant differences in 21st Century Skill gains were found by U2 status or any demographic area examined.
Students reported substantial gains in their learning related to their STEM identities – their interest in and feelings of capability about STEM.	A large majority of students (78% - 99%) reported gains in all areas of their STEM identities as a result of participating in JSS. Students were most likely to report gains in feeling like they had accomplished something in STEM, feeling more prepared for more challenging STEM activities, and thinking creatively about a STEM project or activity. They were least likely to report gains in interest in a new STEM topic.
	No significant differences in STEM identity gains were found by U2 status or any demographic area examined.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Mentors reported using a range of mentoring strategies with students, although very few mentors responded to the questionnaire.	A majority of mentors reported using all strategies associated with each area of effective mentoring with the exception of helping students with their resumes, applications, personal statements, and/or interview preparation.
	Very few mentors (n=3-4) responded to questionnaire items.
Most students expressed high levels of satisfaction with their JSS experiences, although students also had a variety of suggestions for program improvement.	Large majorities of students expressed some level of satisfaction with all features of JSS they had experienced. Students were most likely to be somewhat or very much satisfied with the help they received from their teachers/mentors during JSS (79%) and the location of JSS (74%). Few students expressed dissatisfaction with any JSS feature (less than 8%). Nearly half of students (42%) had not experienced guest speakers during JSS.
	Students were overwhelmingly positive in their comments about their satisfaction in open-ended questions and in focus groups. Students particularly attributed their satisfaction to the opportunity to learn about STEM topics, have fun, work in teams, learn about careers, and develop their critical thinking and problem solving skills
	Students made a wide variety of suggestions for program improvement including providing more or better materials and/or equipment; clarifying

	JSS rules; aligning regional and national competition rules; revising rules to allow more diverse car designs; and providing more online resources and information about AEOPs.
Mentors reported satisfaction with JSS features and online supports and noted a number of strengths of JSS. Mentors also made suggestions for program improvement.	Mentors who responded to the questionnaire reported being satisfied with JSS features they had experienced and the online supports they had experienced (50%-75% somewhat or very much satisfied).
	Mentors responding to open-ended questions and participating in the focus group noted a number of strengths of JSS including students' exposure to hands-on STEM problem solving, the opportunity to see other teams' projects, teamwork, the opportunity to overcome adversity and learn from failure, STEM learning, and career information.
	Mentors suggested a range of program improvements, including standardizing rules and competition conditions at the state and national levels, clarifying rules, providing more examples of successful cars and presentations, creating a discussion board for team advisors and/or providing a list of email contacts for experienced team advisors who could answer questions from less experienced advisors, providing more questions for advisors to use to prompt student thinking, changing the challenge or the competition track from year to year, and adding a kick-off event.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Students reported various motivations for participating in JSS, and most had learned about the program through their teachers or communications through their schools.	The few students (n=8) who responded to questionnaire items about their motivation for participating in JSS cited having fun, an interest in STEM, and the desire to learn something new as primary motivators for participation.
	Students in focus groups were motivated to participate in JSS because of the problem-solving and engineering aspects of the program, interest in alternative energy sources, to be with friends, and to get career information.
	Students learned about AEOP and JSS through their teachers; school newsletters, emails, or websites; and from friends.
Few students had participated in any AEOP other than JSS and most were not interested in participating in AEOPs other than JSS in the future.	A small number of students (12%) had participated in GEMS and/or eCYBERMISSION in the past. No other students had participated in any other AEOP other than JSS although nearly 40% reported having participated in JSS in the past.
	Few students (15% or less) expressed interest in participating in any AEOP other than JSS in the future. Over half (64%) expressed some level of interest in participating in JSS again, however.

	Students were most likely to report that the AEOP website impacted their awareness of AEOPs (57%). Over a third (36%) reported that the AEOP brochure was useful for this purpose. Very few students (7%) indicated that their mentors impacted their awareness of AEOPs.
Students reported learning about STEM careers generally during their JSS experiences and, to a lesser extent, about STEM careers within the Army or DoD and identified the AEOP website as the most helpful resource for learning about DoD STEM careers.	A large majority of students (78%) reported learning about at least one STEM career in general while fewer (56%) reported learning about at least one STEM career within the Army or DoD.
	Students were most likely to report that the AEOP website impacted their awareness of DoD STEM careers (56%). A third of students reported that the AEOP brochure impacted this awareness. Very few students (4%) indicated that their mentors were impactful in terms of their awareness of DoD STEM careers.
Students who had opinions about DoD research and researchers held positive perceptions, although many students did not have an opinion about these topics.	Approximately two-thirds of students had favorable opinions about DoD research and researchers. For example, most students agreed that DoD researchers solve real-world problems (67%) and that DoD research is valuable to society (65%).
	Many students (24%-31%) had no opinion about DoD research and researchers.
Students reported being somewhat more likely to engage in STEM activities in the future after participating in JSS, although many reported no change in their likelihood of future engagement, and male participants experienced larger impacts than females in this area.	About half or more of JSS students indicated they were more likely to engage in a number of STEM activities after participating in JSS including playing or working with a mechanical or electrical device (63%); using a computer to design or program something (59%); and working on a STEM project or experiment at a university or professional setting (57%). More than a third of students (31%-61%) reported that their likelihood of engaging in each activity was about the same as before participating.
	While few students reported that they were less likely to engage in STEM activities after participating in JSS (5%-12%), many students (31%-61%) reported that there was no change in the likelihood that they would engage in future STEM activities after participating in JSS.
	No significant differences in likelihood to engage in STEM activities in the future were found by U2 status or any demographic area examined.
JSS had positive impacts on students in areas of their STEM learning, interest, appreciation for STEM research, and interest in STEM careers.	Most students (51%-72%) reported that JSS impacted their interest in, awareness of, and appreciation for STEM. Items for which students were most likely to report high levels of JSS impact included confidence in their STEM knowledge, skills, and abilities; interest in participating in STEM activities outside of school requirements; and their appreciation of Army or DoD STEM research.

	More than a third of students (40%) reported that JSS had not increased their awareness of Army or DoD STEM research and careers. In spite of this, slightly over half (51%) indicated that after JSS they were more interested in pursuing a STEM career with the Army or DoD.
	No significant differences in overall impact of JSS participation were found by U2 status or any demographic area examined.

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 FY17 made to programs are highlighted along with a summary of efforts and outcomes reflected in the FY18 APR toward these areas.

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

FY17 Finding: 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.

JSS FY18 Efforts and Outcomes:

- Marketing and communications will focus primarily on TSA Title 1 Schools (early in the school year) to implement JSS into the curriculum. Kits will be provided to a certain number of TSA Title 1 Schools.
- Solar kits will continue to be provided to populations/STEM groups that have contacted TSA regarding interest in the JSS program. Examples include Girls, Inc. (Florida), Florida's Governors Council on Indian Affairs, STEM in American Samoa.
- JSS Jumpstart will continue to be promoted to 5th and 6th graders housed in elementary schools with an emphasis on Title 1 schools. Most JSS Jumpstart schools that participated in 2017-2018 were Title 1 Schools.

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

FY17 Finding: 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.

JSS FY18 Efforts and Outcomes:

- Updates to the TSA JSS event guidelines are made at the start of the school year to address any changes or modifications that are necessary to clarify rules. Updates are then posted on the TSA updates page on the website. For the 2019-2020 school year, the TSA Middle School Guide of Competitive Events, to include JSS, will be reviewed, updated, and modified to ensure clarity.
- Resources on the JSS resource page and TSA JSS webpage have been updated to include JSS and Next Generation Science Standards, as well as a link to a recorded webinar on JSS content.

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

FY17 Finding: 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).

JSS FY18 Efforts and Outcomes:

- AEOP branded materials (brochures, age appropriate rack cards-GEMS, JSHS-pencils, stickers) were sent to TSA State Advisors for state conference events.
- A well-attended AEOP speaker panel was held at the 2018 national TSA conference. The panel shared experiences from other AEOP Programs (GEMS, JSHS).
- A well-attended AEOP Special Interest Session was held at the 2018 national TSA conference.
- Jerry Crabb, from the US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND, spoke about AEOP and its' mission at a TSA General Session attended by over 7,000 TSA members. The AEOP video, *IT STARTS HERE! AEOP and Your STEM Future!,* was also shown.
- AEOP presence was highly promoted at the 2018 national TSA conference through AEOP banners, door clings and brochures disseminated at advisor meetings.

FY17 Finding: 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.

JSS FY18 Efforts and Outcomes:

- Participation in on-site focus groups and completion of post-event surveys is a requirement for participating in the Junior Solar Sprint event at the national conference.
- Email reminders were sent to all POC's at army hosted sites reminding of completion of post-event surveys.

Recommendations for FY19 Program Improvement/Growth

FY18 was an overall successful year for JSS, as reflected in the evaluation findings. JSS maintained and slightly grew their percentage of underseved students (from 29% in FY17 to 34% in FY18). JSS participants continued to report strong gains in their STEM content knowledge and 21st Century Skills as a result of participating in the JSS program. However, there are some areas that were identified as challenges for JSS and these areas are the basis for FY19 recommendations for program improvement.

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

In FY18 JSS slightly increased the percentage of underserved student participants in the program to 34% (compared to 29% FY17). It is recommended that in FY19 JSS continue efforts to focus on reaching more potential groups from U2 backgrounds to engage them in the program.

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

As in FY16, FY17, and FY18, participants (teachers/mentors and students) continued to report challenges with aligning regional and national competition rules. It was also suggested that JSS consider revising rules to allow for more creativity in car design. In FY18, JSS revised guidelines for the middle school level and updated the website resources related to rules. However, due to the fact that students and adults still reported issues with clarity, we recommend that JSS continue to work on making things more transparent and accessible to participants while also considering how to possibly allow for more creativity in design if at all possible.

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

1. As in FY16, FY17, and FY18 student respondents (national competition participants) continued to report having little knowledge of other programs in the AEOP. In fact, 15% or less expressed interest in participating in any AEOP other than JSS in the future. The response rate for the mentor survey was incredibly low (only four mentors responded), but of that group, only three discussed GEMS, two discussed JSHS, none discussed Unite, and only one discussed apprenticeship programs with students. This may be correlated to the lack of interest expressed by students. Therefore, we recommend that JSS develop more supports, materials, and requirements that are embedded in the JSS program/compeititon for teachers at the regional level, as well as national level.

2. The low response rates for mentors/teachers in JSS (four respondents) was much too low to do any kind of meaningful analysis of findings for FY18 from this group. It is recommended that JSS develop a strategy for engaging adults in completing the survey. This strategy should include a mandate for participating teachers in the program to complete the survey, particularly for those who have students competing at the national competition.