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ARMY EDUCATIONAL OUTREACH PROGRAM

JSS

2019 Annual Program Evaluation Report Findings

July 2020

ARMY EDUCATIONAL OUTREACH PROGRAM

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Report JSS_02_04152020 has been prepared for the AEOP Cooperative Agreement and the U.S. Army by NC State 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 North Carolina State University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium.

AEOP Priorities

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

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

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

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 2019 student participation by state for students for whom this information was available. JSS program administrators reported a total of 2,224 participants, including 345 participants from Okinawa and American Samoa who were not registered. This represents an increase of 51% over the 1,081 participants reported by program administrators in FY18. Cvent registration data are available for 1,778 students (446 less than reported by the program). The 1,778 students registered in Cvent represents a 39% increase as compared to FY18. A total of 288 students representing 98 teams attended the national JSS event.

Table 2 provides demographic data reported in Cvent for 2019 student participants in JSS. Similar to FY18, over half (54%) of participants were male (57% in FY18) and over half (60%) of students identified themselves as White (53% in FY18). The proportion of students identifying themselves as Black or African American decreased somewhat in FY19 (9%) as compared to FY18 (11%), although the proportion of Hispanic or Latino/a students increased in FY19 (13%) as compared to FY18 (8%). Over half of students (54%) attended rural schools, 21% urban schools, and 20% suburban schools. Over a third of students (39%) were eligible for free or reduced-price school lunch (FARMS), a commonly used indicator of low socio-economic status. A large majority (89%) reported that English is their first language (9% are English language learners [ELL]), and just over a quarter (27%) will be first generation college attendees. Over two-thirds (67%) of FY19 students met the AEOP definition of underserved (U2)[1], a substantial increase from the 34% of JSS students who met the U2 criteria in FY18.

[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).

Table 1. 2019 JSS State Participation Numbers Provided by TSA (n=1,335)	
State	**No. Of Enrolled Students – Provided by TSA**
Alabama	4
Armed Forces - Americas	5
Armed Forces - Pacific	2
California	5
Colorado	15
Delaware	24
Florida	40
Georgia	35
Illinois	0
Iowa	1
Kansas	9
Kentucky	6
Maryland	14
Mississippi	26
Missouri	7
North Dakota	0
New Jersey	15
New York	6
North Carolina	47
Ohio	799
Oklahoma	59
Pennsylvania	36
South Carolina	14
Tennessee	7
Texas	38
Utah	0
Vermont	0
Virginia	46
Washington	67
West Virginia	8
Total	**1,335**

Table 2. 2019 JSS Student Participant Profile		
Demographic Category		
Gender (n=1,778)		
Female	783	44.0%
Male	963	54.2%
Choose not to report	32	1.8%
Race/Ethnicity (n=1,778)		
Asian	81	4.6%
Black or African American	153	8.6%
Hispanic or Latino	241	13.6%
Native American or Alaska Native	30	1.7%
Native Hawaiian or Other Pacific Islander	6	<1%
White	1,058	59.5%
Other (self-reported, some more than 1 race)	67	3.8%
Choose not to report	142	8.0%
School setting (n=1,778)		
Urban (city)	371	20.9%
Suburban	356	20.0%
Rural (country)	1,000	56.2%
Frontier or tribal School	1	<1%
DoDDS/DoDEA School	13	1.0%
Home school	7	<1%
Online school	2	<1%
Choose not to report	28	1.6%
Receives free or reduced lunch – FARMS (n=1,778)		
Yes	698	39.3%
No	870	48.9%
Choose not to report	210	11.8%
English is a first language (n=1,778)		
Yes	1,575	88.6%
No	153	8.6%
Choose not to report	50	2.8%
One parent/guardian graduated from college (n=1,778)		
Yes	1,041	58.6%
No	479	26.9%
Choose not to report	258	14.5%
U2 Status (n=1,778)		
Yes	1,197	67.3%
No	581	32.7%

Table 3 provides demographic data for adult participants in JSS in FY19. A total of 326 adults participated in JSS program activities in FY19, representing little change compared to FY18 when 328 adults participated, but an 88% decrease compared to the reported 614 adults who participated in FY17. Adult participants reported for 2019 included 268 K-12 teachers and a variety of 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. 2019 Adult JSS Participation

Participant Group	Teachers/Adults
Number of Adults (teachers, mentors, volunteers)	326
Number of Army S&Es	0[2]
Grand Total of Adult Participants	**326**

2019 cost data for JSS is summarized in Table 4. The total cost for JSS in FY19 was $$253,663. The cost per student was $114.

Table 4. 2019 JSS Program Costs

Total Cost	$253,663
Total Travel	$47,745
Participant Travel	$43,419
Total Awards	$1,648
Student Awards/Stipends	$1,648
Adult/Teacher/Mentor Awards	$0
Cost Per Student	$114

[2] [2] The 2019 registration did not include a separate designation for S&E volunteers; therefore S&Es were registered simply as volunteers and it was not possible to discern from registration which volunteers were S&Es. The 2020 registration form will include the category of “S&E volunteers”.

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4 | Evaluation At-A-Glance

NC State 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 and nine focus groups with students at the national event. Tables 5-8 outline the information collected in student and mentor questionnaires and in focus groups 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. 2019 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
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. 2019 Mentor Questionnaires	
Category	**Description**
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of JSS, satisfaction with and suggestions for improving JSS 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 AEOPs; 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. 2019 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. 2019 Mentor Focus Groups	
Category	**Description**
Satisfaction & Suggestions	Perceived value of JSS, benefits to participants suggestions for improving JSS 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 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.[3] 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 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).

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[3] 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.

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 margins of error 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. 2019 JSS Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants (Population)	Participation Rate*	Margin of Error @ 95% Confidence[4]
Students	63	1,778	3.54%	±12.13%
Teachers and Other Volunteers	10	326	3.07%	±30.56%

* Cvent participation data are used for statistical analyses of student data throughout this report

Ninety students participated in nine national student focus groups (35 females, 55 males). Over half of these students (58) were first time participants in JSS. Over a third of focus group participants (38) were rising 9th graders, 31 were rising 8th graders, 13 were rising 7th graders, and 8 were rising 6th grade students. Very few of these students had participated in other AEOPs previously (3 in GEMS, 2 in Camp Invention, and 2 in e-Cybermission). Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, explanation for, or illustrations of student questionnaire data. They add to the overall narrative of JSS's efforts and impact, and highlight areas for future exploration in programming and evaluation

[4] "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.

Respondent Profiles

Student Demographics

JSS student demographics collected from questionnaire respondents at the JSS national competition are presented in Table 10. A larger proportion of males (64%) than females (36%) completed the survey. A majority of survey completers identified as being White (71%); the next most frequently reported race/ethnicity was Asian (13%). Approximately two-thirds of participants collectively indicated they were going into the 8th (38%) or 9th (35%) grade in the next school year. Half of students (51%) reported attending suburban schools, and not being eligible to receive free or reduced price school lunches (49%). A large majority of students reported having a parent who had graduated from college (75%), and nearly all students indicated English was the language they spoke at home (98%). Two-thirds (67%) of JSS survey respondents met the AEOP definition of underserved (U2) [5].

These data suggest that students responding to the questionnaire (and attending the national competition) are somewhat demographically similar to the population of JSS participants for FY19. It should be noted, however, that smaller proportions of responding students were female (37% of respondents versus 44% of enrolled students) than in the overall enrolled population of JSS students, and a larger proportion were White (71% of respondents versus 56% of enrolled students) and Asian (13% of respondents versus 5% of enrolled students).

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[5] 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).

Table 10. 2019 JSS Student Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n=63)		
Female	23	36.5%
Male	40	63.5%
Choose Not to Report	0	0%
Respondent Race/Ethnicity (n=63)		
Asian	8	12.7%
Black or African American	1	1.6%
Hispanic or Latino	5	7.9%
Native American or Alaska Native	0	0.0%
Native Hawaiian or other Pacific Islander	0	0.0%
White	45	71.4%
Other race or ethnicity	2	3.2%
Choose not to report	2	3.2%
Respondent Grade Level‡ (n=63)		
5th	0	0%
6th	6	9.5%
7th	11	17.5%
8th	24	38.1%
9th‡	22	34.9%
Choose Not to Report	0	0%
School Location (n=63)		
Urban	8	12.7%
Suburban	32	50.8%
Rural	16	25.4%
I Don't Know	7	11.1%
Choose Not to Report	0	0%
Free and Reduced Lunch Status (n=63)		
Yes	28	44.4%
No	31	49.2%
I Don't Know	4	6.4%
Choose Not to Report	0	0%
English First Language (n=63)		
Yes	62	98.4%
No	1	1.6%
Choose Not to Report	0	0%
Parent Graduated from College (n=63)		
Yes	47	74.6%
No	11	17.5%
I Don't Know	5	7.9%
Choose Not to Report	0	0%
U2 (n=63)		
Yes	21	33.3%
No	42	66.7%

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

Mentor Demographics

Only 10 mentors completed the mentor questionnaire, thus limiting the generalizability of findings for JSS in regard to adult participants. Ideally, a sample size of over 25 participants is needed to make any evidence-based conclusions based upon the data. However, the data are provided for informational purposes. Table 11 summarizes their demographics and shows that 70% indicated they were female and White. Most adults completing the survey reported being teachers (80%) and competition advisors (70%).

Table 11. 2019 JSS Mentor Profile		
Demographic Category	**Questionnaire Respondents**	
Survey Respondent Gender (n=10)		
Female	7	70%
Male	3	30%
Choose not to report	0	0%
Race/Ethnicity (n=10)		
Hispanic or Latino	3	30%
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	7	70%
Other	0	0%
Choose not to report	0	0%
Occupation (n=10)		
Teacher	8	80%
Scientist, Engineer, or Mathematician in Training (undergraduate or graduate student)	0	0%
Other School Staff	0	0%
University Educator	0	0%
Scientist, Engineer, or Mathematics professional	0	0%
Other, (specify) ‡	2	20%
Role in JSS (n=10)		
Competition advisor	7	70%
Event coordinator or staff	1	10%
Other, (specify)§	2	20%

‡Other=STEM Outreach Coordinator, Parent

§ Other=Volunteer, Parent

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 their learning experiences in school. Table 12 displays student responses to questions about how frequently students engaged in various STEM practices during JSS. More than two-thirds of students (70% -97%) indicated engaging with each STEM practice at least once during JSS, except for working with a person who works in a STEM field on a real world project (62%). Approximately three-quarters or more of JSS students reported performing the following STEM practices at least a few times during their program: finding a question/problem to investigate (73%), examining data/information to make conclusions (76%), and working with others as part of a team (87%).

These survey items were used to compute composite scores[6] for engaging in STEM practices in JSS[7] that are shown in Chart 1. 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 assess group differences in student experiences by U2 status and all subgroups that make up U2 (gender, race/ethnic group, school location, FARMS, ELL[8], and college first generation). No differences in engaging in STEM practices in JSS were found by overall U2 Status or any specific demographic variables.

Participants were asked parallel items about their engagement in the same STEM practices in school. These items were then combined into a composite variable[9]. When comparing "in JSS" to "in school" STEM practices engagement, no significant differences were found. This may be because JSS activities are

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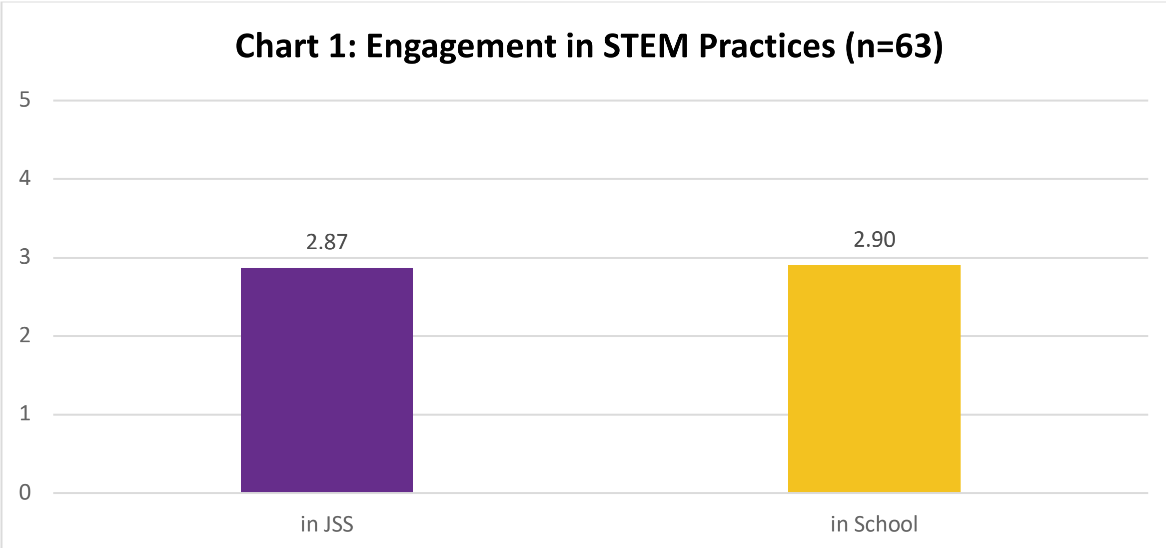
[6] Using multiple statistical tests on related outcomes requires the use of a Type I error rate adjustment to reduce the likelihood of false positives (i.e., detecting a difference when one does not truly exist). However, Type I error rate adjustments lead to a reduction in statistical power (i.e., 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.
[7] The Cronbach's alpha reliability for the 12 Engaging in STEM Practices in JSS items was 0.870.
[8] Differences in all composite variables were not able to be assessed by ELL status because there were too few ELL self-identified students (*n*=2).
[9] Cronbach's alpha reliability for the 12 Engaging in STEM Practices in school items was 0.870.

often completed as a class requirement and students may not see the difference between STEM practices in school and STEM practices in JSS (see Chart 1).

Table 12. Nature of Student STEM Practices During JSS (n=63)

	Not at all	At least once	A few times	Most days	Every day	Response Total
Work with a person who works in a STEM field on their real world project	38.1%	28.6%	14.3%	11.1%	7.9%	
	24	18	9	7	5	**63**
Work with a person who works in a STEM field on my JSS project	30.2%	22.2%	19.0%	22.2%	6.3%	
	19	14	12	14	4	**63**
Plan my own research based on my own ideas	9.5%	27.0%	28.6%	27.0%	7.9%	
	6	17	18	17	5	**63**
Present my project to a judges or the community	28.6%	25.4%	33.3%	12.7%	0.0%	
	18	16	21	8	0	**63**
Interact with people working in STEM careers	25.4%	25.4%	23.8%	15.9%	9.5%	
	16	16	15	10	6	**63**
Use laboratory tools and steps to do an experiment	11.1%	27.0%	36.5%	19.0%	6.3%	
	7	17	23	12	4	**63**
Find questions or problems to investigate	9.5%	17.5%	27.0%	33.3%	12.7%	
	6	11	17	21	8	**63**
Plan and do an investigation or experiment	9.5%	22.2%	33.3%	28.6%	6.3%	
	6	14	21	18	4	**63**
Examine data or information to make conclusions or decisions	3.2%	20.6%	36.5%	30.2%	9.5%	
	2	13	23	19	6	**63**
Work with others as part of a team or group	6.3%	6.3%	25.4%	31.7%	30.2%	
	4	4	16	20	19	**63**
Use a computer to make a model of something	14.3%	27.0%	41.3%	12.7%	4.8%	
	9	17	26	8	3	**63**
Solve real-world problems	12.7%	19.0%	23.8%	27.0%	17.5%	
	8	12	15	17	11	**63**



STEM Knowledge and Skills

Students were asked about the impact of JSS participation on their STEM knowledge (Table 13). More than half of survey participants reported high levels of learning (learned more than a little or learned a lot). Two aspects of STEM knowledge for which than two-thirds of participants reported these levels of learning were new knowledge of a STEM topic (75%) and research on a STEM topic or field (68%).

Table 13. Student Report of Impacts on STEM Knowledge (n=63)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Response Total
New knowledge of a STEM topic	3.2%	22.2%	31.7%	42.9%	
	2	14	20	27	**63**
Research on a STEM topic or field	7.9%	23.8%	39.7%	28.6%	
	5	15	25	18	**63**
How to conduct research in STEM	9.5%	31.7%	27.0%	31.7%	
	6	20	17	20	**63**
How scientists and engineers work on real problems in STEM	9.5%	27.0%	31.7%	31.7%	
	6	17	20	20	**63**
What research work is like in STEM	12.7%	23.8%	33.3%	30.2%	
	8	15	21	19	**63**

STEM knowledge items were used to calculate a composite variable[10] to evaluate differential impacts by U2 status and across underrepresented sub-groups of students. There were no significant differences found by overall U2 or any individual demographics.

JSS participants reported on the impact of the program on their STEM competencies (Table 14). Approximately half or more indicated learning more than a little or a lot (high levels of learning) on all items associated with their STEM competencies. Three-quarters or more of students reported that they learned either "more than a little" or "a lot" in using knowledge and creativity to suggest a solution to a problem (75%) and making a model to show how something works (75%).

A composite score for STEM competencies[11] was created for these items and used to examine whether the JSS program had differential impacts on sub-groups of students or by overall U2 status. Significant differences in STEM competencies were not found by U2 status or any demographic examined.

Twenty-first Century skills include skills such as communication and collaboration that are necessary across a wide variety of fields. JSS participants were asked to rate the impact of their participation in the program on their learning in various areas associated with 21st Century skills (Table 15). More than half of students (51%-81%) reported high levels of learning (learned more than a little or learned a lot) across all 21st Century skills items. Skills for which nearly 80% or more of respondents reported high levels of learning were managing projects to complete them on time (79%), using creative ideas to make a product (79%), working creatively with others (81%), and collaborating with others effectively (80%).

The 21st Century skills item responses were averaged into a composite variable[12] to test for differential impacts across sub-groups of students and by overall U2 status. A significant difference in 21st Century skills gains was found by school location[13], with suburban students reporting greater impact compared to urban/rural students (large effect, d=0.836). No other differences by demographic subgroup or U2 status were found.

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[10] The Cronbach's alpha reliability for the 5 STEM Knowledge items was 0.884.
[11] The Cronbach's alpha reliability for these 14 STEM Competency items was 0.915.
[12] The 21st Century Skills composite of 23 items had a Cronbach's alpha reliability of 0.884.
[13] Independent Samples *t*-test results for 21st Century Skills by School Location: $t(54)=3.07$, $p=.003$.

Table 14. Student Gains in STEM Competencies (n=63)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Total Response
How to explain a problem that can be solved by developing a new product or process	7.9%	28.6%	42.9%	20.6%	
	5	18	27	13	**63**
How to ask a question that could be answered with scientific experiments	7.9%	23.8%	44.4%	23.8%	
	5	15	28	15	**63**
How to use knowledge and creativity to suggest a solution to a problem	3.2%	22.2%	34.9%	39.7%	
	2	14	22	25	**63**
How to make a model to show how something works	6.3%	19.0%	39.7%	34.9%	
	4	12	25	22	**63**
How to design steps for an experiment that work	6.3%	27.0%	33.3%	33.3%	
	4	17	21	21	**63**
How to identify the limitations of the steps and tools used for collecting data	11.1%	31.7%	33.3%	23.8%	
	7	20	21	15	**63**
How to do an experiment and record data correctly	9.5%	28.6%	30.2%	31.7%	
	6	18	19	20	**63**
How to create charts or graphs to show data and find patterns	17.5%	25.4%	41.3%	15.9%	
	11	16	26	10	**63**
How to consider different views of data to decide if something works as planned	12.7%	36.5%	23.8%	27.0%	
	8	23	15	17	**63**
How to support my explanation with my STEM knowledge or data from experiments	14.3%	36.5%	22.2%	27.0%	
	9	23	14	17	**63**
How to identify the strengths and limitations of data or arguments presented in technical or scientific texts	14.3%	38.1%	27.0%	20.6%	
	9	24	17	13	**63**
How to present an argument that uses data and/or findings from an experiment	11.1%	30.2%	34.9%	23.8%	
	7	19	22	15	**63**
How to defend an argument with data	12.7%	27.0%	41.3%	19.0%	
	8	17	26	12	**63**
How to use information from texts or other sources to support my explanation of an experiment or solution to problem	11.1%	25.4%	44.4%	19.0%	
	7	16	28	12	**63**

Table 15. Student Report of Impacts on 21st Century Skills (n=63)

	No new learning	Learned a little	Learned more than a little	Learned a lot	Total Response
How to think creatively	4.8%	23.8%	27.0%	44.4%	
	3	15	17	28	**63**
How to work creatively with others	1.6%	17.5%	34.9%	46.0%	
	1	11	22	29	**63**
How to use my creative ideas to make a product	1.6%	19.0%	38.1%	41.3%	
	1	12	24	26	**63**
How to think about how systems work and how parts interact with each other	1.6%	22.2%	42.9%	33.3%	
	1	14	27	21	**63**
How to evaluate other people's evidence, arguments, and beliefs	4.8%	25.4%	31.7%	38.1%	
	3	16	20	24	**63**
How to solve problems	4.8%	17.5%	25.4%	52.4%	
	3	11	16	33	**63**
How to communicate clearly in speaking and writing forms with others	6.3%	27.0%	28.6%	38.1%	
	4	17	18	24	**63**
How to collaborate with others effectively	6.3%	12.7%	44.4%	36.5%	
	4	8	28	23	**63**
How to interact effectively with others in a respectful and professional manner	4.8%	19.0%	39.7%	36.5%	
	3	12	25	23	**63**
How to get and evaluate information and sources of information in an acceptable time period	4.8%	31.7%	31.7%	31.7%	
	3	20	20	20	**63**
How to use and manage information or data accurately, creatively, and ethically	6.3%	23.8%	38.1%	31.7%	
	4	15	24	20	**63**
How to analyze media or the news to understand the different points of view of people	20.6%	22.2%	38.1%	19.0%	
	13	14	24	12	**63**
How to create media products such as videos, blogs, and social media	30.2%	19.0%	30.2%	20.6%	
	19	12	19	13	**63**
How to use technology for research, organizing ideas, evaluating things, and communicating information	1.6%	44.4%	25.4%	28.6%	
	1	28	16	18	**63**
How to adapt to change when things don't go as planned	4.8%	20.6%	30.2%	44.4%	
	3	13	19	28	**63**

How to use feedback on my work effectively	3.2%	27.0%	27.0%	42.9%	
	2	17	17	27	**63**
How to set goals and use time wisely	4.8%	17.5%	38.1%	39.7%	
	3	11	24	25	**63**
How to work alone and complete tasks on time	12.7%	27.0%	30.2%	30.2%	
	8	17	19	19	**63**
How to take initiative and do work without being told to	6.3%	20.6%	34.9%	38.1%	
	4	13	22	24	**63**
How to manage projects to complete them on time	1.6%	19.0%	30.2%	49.2%	
	1	12	19	31	**63**
How to stick with a task until it is finished to produce results	3.2%	23.8%	25.4%	47.6%	
	2	15	16	30	**63**
How to lead and guide others in a team or group	7.9%	17.5%	22.2%	52.4%	
	5	11	14	33	**63**
How to be responsible to others - thinking about the larger community good	6.3%	19.0%	36.5%	38.1%	
	4	12	23	24	**63**

STEM Identity and Confidence

The impact of JSS on students' STEM Identity was assessed through survey items asking students to rate their agreement with a series of statements (Table 16). Approximately two-thirds or more of students (65%-76%) agreed with all statements. Topics for which three-quarters or more of participants reported agreement were feeling more prepared for more challenging STEM activities (75%), thinking creatively about a STEM project/activity (76%), and feeling like they accomplished something in STEM (76%). A composite score for STEM identity[14] was computed to compare overall U2 status and subgroup demographic differences. Student reports of STEM identity gains were similar regardless of U2 status and subgroup demographics.

[14] The STEM Identity composite with 6 items had a Cronbach's alpha reliability of 0.884.

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

		Strongly disagree	Disagree	Agree	Strongly agree	Total Response
I am interested in a new STEM topic	%	7.9%	20.6%	27.0%	44.4%	
	n	5	13	17	28	**63**
I am thinking about pursuing a STEM career	%	15.9%	19.0%	23.8%	41.3%	
	n	10	12	15	26	**63**
I feel like I accomplished something in STEM	%	0.0%	23.8%	23.8%	52.4%	
	n	0	15	15	33	**63**
I feel more prepared for more challenging STEM activities	%	1.6%	23.8%	34.9%	39.7%	
	n	1	15	22	25	**63**
I am thinking creatively about a STEM project or activity	%	4.8%	19.0%	23.8%	52.4%	
	n	3	12	15	33	**63**
I am interested in connecting with mentors who work in STEM	%	9.5%	22.2%	23.8%	44.4%	
	n	6	14	15	28	**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.

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: [15]

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.

Sixty percent or more of mentors reported using all strategies related to establishing the relevance of learning activities (Table 17). All mentors (100%) indicated they did the following: became familiar with student backgrounds/interests at the beginning of JSS, helped students understand how STEM could help them improve their own community, and asked students to relate real-life events/activities to topics covered in JSS.

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[15] 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.

Table 17. Mentors Using Strategies to Establish Relevance of Learning Activities (n=10)

	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%	
	10	0	**10**
Giving students real-life problems to investigate or solve	90.0%	10.0%	
	9	1	**10**
Selecting readings or activities that relate to students' backgrounds	60.0%	40.0%	
	6	4	**10**
Encouraging students to suggest new readings, activities, or projects	80.0%	20.0%	
	8	2	**10**
Helping students become aware of the role(s) that STEM plays in their everyday lives	90.0%	10.0%	
	9	1	**10**
Helping students understand how STEM can help them improve their own community	100.0%	0.0%	
	10	0	**10**
Asking students to relate real-life events or activities to topics covered in JSS	100.0%	0.0%	
	10	0	**10**

Large majorities of JSS mentors also reported using strategies to support the diverse needs of students as learners (70%-100%) (Table 18). All mentors reported implementing the following strategies: identifying different learning styles of students; using a variety of activities to meet all student needs; providing extra readings, activities, learning support for students lacking essential background skills; and directing students to others for additional support when needed.

Table 18. Mentors Using Strategies to Support the Diverse Needs of Students as Learners (n=10)

	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	100.0%	0.0%	
	10	0	**10**
Interact with students and other personnel the same way regardless of their background	80.0%	20.0%	
	8	2	**10**

Use a variety of teaching and/or mentoring activities to meet the needs of all students	100.0%	0.0%	
	10	0	**10**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	70.0%	30.0%	
	7	3	**10**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	100.0%	0.0%	
	10	0	**10**
Directing students to other individuals or programs for additional support as needed	100.0%	0.0%	
	10	0	**10**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	90.0%	10.0%	
	9	1	**10**

Strategies used to support development of collaboration/interpersonal skills were also used by a majority of mentors (70%-100%) (Table 19). The strategy of "having students tell others about their backgrounds and interests" was the only strategy not used by at least 90% of mentors (70% used this strategy).

Table 19. Mentors Using Strategies to Support Development of Collaboration/Interpersonal Skills (n=10)

	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	70.0%	30.0%	
	7	3	**10**
Having my student(s) explain difficult ideas to others	100.0%	0.0%	
	10	0	**10**
Having my student(s) listen to the ideas of others with an open mind	100.0%	0.0%	
	10	0	**10**
Having my student(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	90.0%	10.0%	
	9	1	**10**
Having my student(s) give and receive constructive feedback with others	90.0%	10.0%	
	9	1	**10**
	100.0%	0.0%	

Having students work on collaborative activities or projects as a member of a team	10	0	**10**
Allowing my student(s) to resolve conflicts and reach agreement within their team	100.0%	0.0%	
	10	0	**10**

All mentors reported using each strategy (Table 20) to support student engagement in "authentic" STEM tasks with the exception of teaching about specific STEM subject matter (70%) and having students review technical research to support their work (80%).

Table 20. Mentors Using Strategies to Support Student Engagement in "Authentic" STEM (n=10)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	70.0%	30.0%	
	7	3	**10**
Having my student(s) search for and review technical research to support their work	80.0%	20.0%	
	8	2	**10**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	100.0%	0.0%	
	10	0	**10**
Supervising my student(s) while they practice STEM research skills	100.0%	0.0%	
	10	0	**10**
Providing my student(s) with constructive feedback to improve their STEM competencies	100.0%	0.0%	
	10	0	**10**
Allowing students to work independently to improve their self-management abilities	100.0%	0.0%	
	10	0	**10**
Encouraging students to learn collaboratively (team projects, team meetings, journal clubs, etc.)	100.0%	0.0%	
	10	0	**10**
Encouraging students to seek support from other team members	100.0%	0.0%	
	10	0	**10**

Half or more of the JSS mentors reported using all strategies to support students' STEM educational and career pathways (Table 21). The two strategies implemented the least were both related to AEOP/DoD: recommending AEOPs aligned with student goals (50%) and discussing STEM career opportunities within the DoD or other government agencies (60%).

Table 21. Mentors Using Strategies to Support Student STEM Educational and Career Pathways (n=10)

	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	90.0%	10.0%	
	9	1	**10**
Recommending extracurricular programs that align with students' goals	90.0%	10.0%	
	9	1	**10**
Recommending Army Educational Outreach Programs that align with students' goals	50.0%	50.0%	
	5	5	**10**
Providing guidance about educational pathways that will prepare my student(s) for a STEM career	100.0%	0.0%	
	10	0	**10**
Discussing STEM career opportunities within the DoD or other government agencies	60.0%	40.0%	
	6	4	**10**
Discussing STEM career opportunities in private industry or academia	100.0%	0.0%	
	10	0	**10**
Discussing the economic, political, ethical, and/or social context of a STEM career	80.0%	20.0%	
	8	2	**10**
Recommending student and professional organizations in STEM to my student(s)	80.0%	20.0%	
	8	2	**10**
Helping students build a professional network in a STEM field	70.0%	30.0%	
	7	3	**10**
Helping my student(s) with their resume, application, personal statement, and/or interview preparations	90.0%	10.0%	
	9	1	**10**

Program Features and Feedback/Satisfaction

Students' satisfaction with JSS program features were evaluated through a series of survey items (Table 22). Approximately half or more of responding students (48%-79%) reported being at least somewhat satisfied with all aspects of the JSS program. Three-quarters or more of students indicated they were at least somewhat satisfied with JSS's location (75%) and the help they received from their teachers or mentors (79%). Although nearly half of students (48%) reported being at least somewhat satisfied with guest speakers, nearly a third (29%) said they did not experience guest speakers in their JSS experience.

Table 22. Student Satisfaction with JSS Features (n=63)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Applying or registering for the program	11.1%	4.8%	20.6%	28.6%	34.9%	
	7	3	13	18	22	**63**
Communicating with the JSS host site organizers	15.9%	11.1%	22.2%	20.6%	30.2%	
	10	7	14	13	19	**63**
The location(s) of JSS's competition	6.3%	4.8%	14.3%	25.4%	49.2%	
	4	3	9	16	31	**63**
The STEM topics discussed in JSS	6.3%	7.9%	15.9%	30.2%	39.7%	
	4	5	10	19	25	**63**
The help my teacher or mentor gave me	6.3%	3.2%	11.1%	20.6%	58.7%	
	4	2	7	13	37	**63**
Materials I was given to use (examples: workbooks, online resources, etc.) used during program activities	6.3%	3.2%	17.5%	22.2%	50.8%	
	4	2	11	14	32	**63**
Guest speakers	28.6%	9.5%	14.3%	20.6%	27.0%	
	18	6	9	13	17	**63**

An open-ended questionnaire item asked students to comment about their overall satisfaction with their JSS experiences. Of the 56 students who provided responses to this item, nearly all (54, or 96%) expressed satisfaction with JSS, and 89% (50 students), responded with only positive comments. Many students provided only simple affirmations of the program such as "It was great" and "Really fantastic experience overall at all times." Among those who provided more detailed comments about their satisfaction with JSS, STEM learning, career information, having fun, and the opportunity to build skills such as collaboration, problem-solving, and leadership were emphasized. Students said, for example, *"I loved working with a group. I felt lucky to be a part of this special event with my friends. I got to work with some of my closest friends, which was amazing. I am glad that this will be on my college resume."* (JSS Student)

"JSS has helped me learn new creative skills, leadership, and participation abilities I hope to use in the future." (JSS Student)

"I loved participating JSS. It helped me with my problem-solving skills and helped me become more confident. This program also helped me learn a lot about STEM. All in all, I am really satisfied with my JSS experience." (JSS Student)

"I'm satisfied with my JSS experience, it helped me learn new things about STEM careers, how to work with other better, and how to accept if my team doesn't succeed and to not give up and try again .I think this will help me when I grow up." (JSS Student)

Four student respondents made positive comments, but offered some caveats, and two students did not make positive comments about their satisfaction with JSS. Students who expressed dissatisfaction or suggested improvements within comments about their satisfaction noted a desire for the program to be extended to high school, dissatisfaction with the amount of work required, dissatisfaction with their team's car, and personal reasons. For example,

"Overall JSS was awesome, but I really wish that JSS could be extended to high school." (JSS Student)

"I was not very satisfied with our car." (JSS Student)

Students were also asked in an open-ended questionnaire item how JSS could be improved. A total of 55 students made at least one suggestion for improvement. Over half (55%) of respondents mentioned improvements to the JSS rules or guidelines or providing more information about these. These comments included suggestions for the following:

- Providing more examples of projects (7)
- Allowing more or different materials, such as better solar panels, different wheels, or expanding the list of allowed materials (7)
- Providing clearer guidelines about documentation (6)
- Allowing a longer track (5)
- Allowing larger cars (2)
- Allowing more options for or larger displays (2)
- Providing more information on the website (2)

- Increasing the amount of money teams can spend (1)
- Standardizing regional and national competition rules (1)
- Not allowing 3D printing (1)

Eighteen students (33%) suggested improvements to the scheduling or organization of the event. These comments included suggestions for a longer event (3), better organization (3), and a later start to the race. The remainder of the suggestions, each made by only one student, included improvements to the dress code and location, and suggestions for a shorter event, better flow to the schedule, and more time to work on cars.

Eleven students (20%) made suggestions about improving elements of the competition. These included suggestions to allow more trials (3), allow more practice runs (2), allowing teams to make changes to their cars before the race (2), providing a better track (2), and awarding participation medals or trophies (2).

Other suggestions included providing students with more mentoring or help, including help with repairs (10), expanding the age range for JSS (6), and making JSS more fun and/or less stressful (3).

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 focused on aspects of the national competition. Suggestions included:

- Standardizing competition competitions (i.e., amount of sunlight and wind)
- Clarifying and/or standardizing requirements for display boards
- Providing more supplies for car repair at the national competition
- Holding "head to head" races rather than time trials
- Allowing a bigger budget for teams
- Allowing for more creative car designs
- Providing examples of cars
- Using a standardized solar panel
- Making the pdf documents used for portfolios transferable into word or google docs
- Requiring less time-consuming documentation

Mentor satisfaction with JSS features results are presented in Table 23. Half or more of mentors (50%-100%) reported being at least somewhat satisfied with all JSS features except for two. Only 30% of mentors indicated they felt somewhat or very much satisfied with JSS invited speakers and field trips, however 60% reported that they had not experienced these program features.

Table 23. Mentor Satisfaction with JSS Features (n=10)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	0.0%	0.0%	0.0%	30.0%	70.0%	
	0	0	0	3	7	**10**
Communicating with Technology Student Association (TSA)	10.0%	10.0%	10.0%	10.0%	60.0%	
	1	1	1	1	6	**10**
Communicating with JSS site coordinators	0.0%	0.0%	20.0%	10.0%	70.0%	
	0	0	2	1	7	**10**
The physical location(s) of JSS's activities	10.0%	0.0%	0.0%	20.0%	70.0%	
	1	0	0	2	7	**10**
Support for instruction or mentorship during program activities	20.0%	0.0%	30.0%	0.0%	50.0%	
	2	0	3	0	5	**10**
Stipends (payment)	30.0%	0.0%	0.0%	0.0%	70.0%	
	3	0	0	0	7	**10**
Invited speakers or "career" events	60.0%	0.0%	10.0%	10.0%	20.0%	
	6	0	1	1	2	**10**
Field trips or laboratory tours	60.0%	0.0%	10.0%	10.0%	20.0%	
	6	0	1	1	2	**10**

A large majority of mentors (70%-90%) reported being at least somewhat satisfied with all JSS online supports. Nearly all mentors reported that they were somewhat or very much satisfied with terminology (90%) and Build A Car resources (90%). There were no online resources for which mentors reported dissatisfaction.

Table 24. Mentor Satisfaction with JSS Online Supports (n=10)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Official Technology Student Association Competition Rules	10.0%	0.0%	20.0%	10.0%	60.0%	
	1	0	2	1	6	**10**
Local Competition Rules	10.0%	0.0%	10.0%	10.0%	70.0%	
	1	0	1	1	7	**10**
Build A Car resources	10.0%	0.0%	0.0%	40.0%	50.0%	
	1	0	0	4	5	**10**
Course Outline	10.0%	0.0%	10.0%	30.0%	50.0%	
	1	0	1	3	5	**10**
STEM Standards	10.0%	0.0%	20.0%	10.0%	60.0%	
	1	0	2	1	6	**10**
Lesson Plans	10.0%	0.0%	10.0%	40.0%	40.0%	
	1	0	1	4	4	**10**
Terminology	10.0%	0.0%	0.0%	30.0%	60.0%	
	1	0	0	3	6	**10**
Video Tutorials	10.0%	0.0%	10.0%	20.0%	60.0%	
	1	0	1	2	6	**10**
JSS Host Guide	20.0%	0.0%	10.0%	10.0%	60.0%	
	2	0	1	1	6	**10**
Calendar of Events	20.0%	0.0%	0.0%	40.0%	40.0%	
	2	0	0	4	4	**10**

The nine mentors who responded to the open-ended questionnaire item asking about their overall satisfaction all made positive comments about JSS. These comments focused on students' learning, the hands-on nature of the activities, the use of the design process, and students' and mentors' enjoyment of the process. As one team advisor said,

> "*I am very satisfied with the JSS experience. I am so grateful for having this opportunity with my students. I want to say THANK YOU to TSA and everyone who was involved in this unforgettable event."* (JSS Team Advisor)

Three of the responding adults made positive comments about JSS, but added caveats. These caveats included difficulties with securing volunteers for events, planning events around weather conditions, event organization, and the process for portfolio scoring at the national event. For example,

> *"I love this program. I feel that the rubric used allows students to see how important it is to document the process and identify steps in the design process. The rubric places a large emphasis on the portfolio and less on the speed of the car, allowing for a deeper educational experience. My only concern or complaint is that at Nationals, the portfolio isn't scored unless the car race time qualifies it for the semi-finals. I realize that there isn't a lot of time at Nationals to score the portfolio, but this part could be submitted electrically in advance. It would also be nice if students and/or advisors could receive feedback on their submissions so that we know where improvements could be made.*" (JSS Team Advisor)

> *"This was my third year to be involved with JSS competition as the site host/race coordinator. The most difficult parts of the event are securing/relying on volunteers, working around the clouds (we want it to truly be a 'solar-powered' event, and how to combine points from notebook judging and race results to determine an over-all first place winner. The best parts of the event are seeing the kids have fun racing their cars and seeing the satisfaction of learning (when the light comes on!)."* (JSS Adult Participant)

In response to an open-ended questionnaire item asking them to list strengths of JSS, the nine responding team advisors and other participating adults identified a number of program strengths. The most frequently mentioned benefits were teamwork (5) and the opportunity for students to engage in problem solving (4). Adults also noted that students' STEM learning (3) and having fun (2) are benefits of JSS. One or two adult respondents also mentioned several 21st Century skills as program strengths, including the opportunity for students to think critically and/or creatively, problem solve, gain confidence, develop communication skills, make real-world connections to their learning, and develop leadership.

Adults were also asked in an open-ended questionnaire item to list ways in which JSS could be improved for future participants. The nine responding adults made a wide variety of suggestions for improvement, none mentioned by more than two adults. Suggested improvements included:

- Providing better or clearer instructions

- Providing more staff at the national competition
- Providing online tutorials or video links for difficult topics (e.g., gear ratio and torque) and the design process
- Updating lesson materials
- Providing free solar panels
- Providing both indoor and outdoor races or an alternative indoor track
- Generally improving the track
- Providing teams with practice runs
- Having three time trials rather than two
- Allowing time for teams to make adjustments or repairs to their cars
- Scoring all portfolios at the national event rather than just the semi-finalists'
- Providing more information or communication about other AEOPs
- Sending JSS staff to visit schools

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). A third or more of participants learned about AEOP from someone who works at their school (42%) and from school communications (newsletter, email, website) (35%).

Table 25. How Student Participants Learned About AEOP (n=26)

	Response Percent	Response Total
Army Educational Outreach Program (AEOP) Website	0.0%	0
AEOP on Facebook, Twitter, Instagram, or other social media	0.0%	0
School or university newsletter, email, or website	34.6%	9
Past participant of program	3.8%	1
Friend	15.4%	4
Family Member	3.8%	1
Someone who works at the school or university I attend	46.2%	12
Someone who works with the program	0.0%	0
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	0.0%	0
Community group or program	7.7%	2
Choose Not to Report	15.4%	4

Students were also asked what motivated them to participate in JSS (Table 26). The top motivators, with half or more students reporting, were interest in STEM (73%), a desire to learn something new or interesting (54%), and having fun (54%).

Table 26. Factors Motivating Students “Very Much” to Participate in JSS (n=26)	
Item	**Questionnaire Respondents**
Interest in science, technology, engineering, or mathematics (STEM)	73.1%
Desire to learn something new or interesting	53.8%
Having fun	53.8%
Teacher or professor encouragement	42.3%
Opportunity to do something with friends	34.6%
Building college application or résumé	26.9%
Interest in STEM careers with the Army	26.9%
An academic requirement or school grade	23.1%
Learning in ways that are not possible in school	23.1%
Exploring a unique work environment	23.1%
Opportunity to use advanced laboratory technology	15.4%
Figuring out education or career goals	15.4%
Desire to expand laboratory or research skills	11.5%
Serving the community or country	11.5%
Earning stipends or awards for doing STEM	7.7%
Seeing how school learning applies to real life	7.7%
Recommendations of past participants	7.7%
Networking opportunities	3.8%
Choose Not to Report	3.8%
The mentor(s)	0.0%

Students in the focus groups at the national event were also asked about their reasons for participating in JSS. Many students indicated that they participated in JSS as part of class requirements, however others indicated that JSS looked “interesting” or “fun,” and some specified that they wanted to learn generally or learn more about solar energy. Other students cited the hands-on building experience or opportunity to be with friends as motivators. For example, as two student focus group participants said,

> *“Our teacher, she gave us a list of all the competitions... To me, JSS stood out. It seemed like one of the more fun competitions.”* (JSS National Student)

> *“I usually do the written things, like writing in binders for other TSA events. Doing this gave me the chance to get out of my comfort zone and do different things and expand my knowledge.”* (JSS National Student)

Mentors were asked which of the AEOP programs they discussed with their students during JSS (Table 27). Most (70%) reported discussing AEOP in general, without reference to a specific program. Few had discussed any specific programs with their students. (70%-90% had not discussed each program).

Table 27. Mentors Explicitly Discussing AEOPs with Students (n=10)

	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)	30.0%	70.0%	
	3	7	**10**
Unite	20.0%	80.0%	
	2	8	**10**
Junior Science & Humanities Symposium (JSHS)	30.0%	70.0%	
	3	7	**10**
Science & Engineering Apprenticeship Program (SEAP)	20.0%	80.0%	
	2	8	**10**
Research & Engineering Apprenticeship Program (REAP)	10.0%	90.0%	
	1	9	**10**
High School Apprenticeship Program (HSAP)	10.0%	90.0%	
	1	9	**10**
College Qualified Leaders (CQL)	20.0%	80.0%	
	2	8	**10**
GEMS Near Peer Mentor Program	20.0%	80.0%	
	2	8	**10**
Undergraduate Research Apprenticeship Program (URAP)	10.0%	90.0%	
	1	9	**10**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	20.0%	80.0%	
	2	8	**10**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	10.0%	90.0%	
	1	9	**10**
I discussed AEOP with my student(s) but did not discuss any specific program	70.0%	30.0%	
	7	3	**10**

Mentors were also asked how they learned about AEOP (Table 28). The most common responses (selected by 40% of mentors) were the TSA website and past JSS participation. AEOP's website and a colleague were also noted by two (20%) of the mentors responding.

Table 28. How Mentors Learned About AEOP (n= 10)

Choice	Response Percent	Response Total
Technology Student Association (TSA) website	40%	4
Army Educational Outreach Program (AEOP) website	20%	2
AEOP on Facebook, Twitter, Pinterest, or other social media	0%	0
A STEM conference or STEM education conference	0%	0
An email or newsletter from school, university, or a professional organization	0%	0
Past JSS participant	40%	4
A student	0%	0
A colleague	20%	2
My supervisor or superior	0%	0
A JSS site host or director	0%	0
Workplace communications	10%	1
Someone who works with the Department of Defense (Army, Navy, Air Force)	10%	1
Other	10%	1

Previous Program Participation & Future Interest

JSS students were asked how many times they had participated in other AEOPs in the past (Table 29). Not surprisingly, students most frequently indicated that they had participated in JSS (81% participated 1-3+ times). A small number of students (16%) reported they had participated in Camp Invention at least once. Large majorities of students had never participated in programs including GEMS (97%), eCM (95%), or JSHS (98%).

Table 29. Student past participation in AEOPs (n=63)

		Never	Once	Twice	Three or more times	Response Total
GEMS	%	96.8%	1.6%	1.6%	0.0%	
	n	61	1	1	0	**63**
JSS	%	19.0%	47.6%	25.4%	7.9%	
	n	12	30	16	5	**63**
eCM	%	95.2%	4.8%	0.0%	0.0%	
	n	60	3	0	0	**63**
JSHS	%	98.4%	1.6%	0.0%	0.0%	
	n	62	1	0	0	**63**
Camp Invention	%	84.1%	7.9%	4.8%	3.2%	
	n	53	5	3	2	**63**

Students were also asked about their interest in participating in other AEOPs in the future (Table 30). A large proportion of students (89%) reported being interested in participating in JSS again. A quarter of participants indicated being interested in GEMS (25%). Fewer than a quarter (14%-24%) indicated interest in participating in any other AEOP.

Table 30. Student "Somewhat" or "Very Much" Interested in Future AEOPs (n=63)

Program	Percent Interested
Junior Solar Sprint (JSS)	88.9%
Gains in the Education of Mathematics and Science (GEMS)	25.4%
College Qualified Leaders (CQL)	23.8%
Science Mathematics and Research for Transformation (SMART) College Scholarship	23.8%
Camp Invention	22.2%
High School Apprenticeship Program (REAP)	22.2%
GEMS Near Peer Mentors Program	22.2%
National Defense Science & Engineering Graduate (NDSEG) Fellowship	22.2%
eCYBERMISSION	20.6%
Science & Engineering Apprenticeship Program (SEAP)	20.6%
Research & Engineering Apprenticeship Program (REAP)	17.5%
Junior Science & Humanities Symposium (JSHS)	15.9%
Undergraduate Research Apprenticeship Program (URAP)	15.9%
Unite	14.3%

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 (Table 32). Approximately three-quarters (76%) 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. Sixty-two percent of students reported learning about at least one DoD STEM job/career, and only 8% said they had learned about five or more.

Table 31. Number of STEM Jobs/Careers Students Learned About During JSS (n=63)

Choice	Response Percent	Response Total
None	23.81%	15
1	7.94%	5
2	19.05%	12
3	28.56%	18
4	1.59%	1
5 or more	19.05%	12

Table 32. Number of Army/DoD STEM Jobs/Careers Learn About During JSS (n=63)

Choice	Response Percent	Response Total
None	38.10%	24
1	14.29%	9
2	22.21%	14
3	15.87%	10
4	1.59%	1
5 or more	7.94%	5

Students participating in focus groups at the national event reported that at the time of the focus groups (immediately after the JSS time trials) they had received little information about STEM careers in the Army or DoD. Two students in focus groups mentioned attending a panel with AEOP representatives that had provided some information about careers.

Students were asked a series of questions about how they learned about DoD STEM careers while in JSS (Table 33). More than half of participations indicated the following resources were helpful: participation in JSS (63%), their teachers (63%), and their JSS mentors (52%).

Table 33. Impact of Resources on Student Awareness of DoD STEM Careers	
Item	**Helped (n=63)**
My Participation in JSS	63.49%
My Teacher	63.49%
My JSS Mentor	52.38%
Invited Speakers	44.44%
AEOP Website	31.75%
AEOP Printed Materials	28.57%
AEOP Social Media	19.05%

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. Thus, students were asked to rate their agreement with several statements about what DoD researchers do and the value of DoD research (Table 34). Findings indicate that approximately two-thirds of students had favorable opinions about three of the four DoD research/researchers items. Less than half of students agreed or strongly agreed that DoD research is important to most people. It should be noted that over a quarter (25%-35%) did not express an opinion (selected "neither agree nor disagree") for each statement, suggesting that students may have had limited exposure to DoD research and researchers in JSS.

Table 34. Student Opinions about DoD Researchers and Research (n=63)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers improve science and engineering fields	3.2%	1.6%	30.2%	30.2%	34.9%	
	2	1	19	19	22	**63**
DoD researchers create new, cutting edge technologies	1.6%	1.6%	30.2%	28.6%	38.1%	
	1	1	19	18	24	**63**
DoD researchers solve real-world problems	3.2%	7.9%	25.4%	27.0%	36.5%	
	2	5	16	17	23	**63**
DoD research is important to most people	4.8%	14.3%	34.9%	19.0%	27.0%	
	3	9	22	12	17	**63**

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. JSS students were asked to rate the increase in their likelihood of participating in various STEM activities outside of their regular school courses after participating in JSS (Table 35). Approximately half or more (49%-75%) reported being more likely or much more likely to engage in all activities. Activities most impacted most by JSS were participation in a STEM camp, club, or competition (65%), using a computer to design or program something (65%), working on a STEM project or experiment in a university or professional setting (67%), and playing/working with a mechanical/electrical device (75%).

Table 35. JSS Impact on Participants' Intent to Engage in STEM Activities Outside of School (n=63)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read about STEM	6.3%	9.5%	33.3%	28.6%	22.2%	
	4	6	21	18	14	**63**
Play or work with a mechanical or electrical device	1.6%	4.8%	19.0%	47.6%	27.0%	
	1	3	12	30	17	**63**
Work on solving mathematical or scientific puzzles	6.3%	4.8%	30.2%	31.7%	27.0%	
	4	3	19	20	17	**63**
Use a computer to design or program something	6.3%	9.5%	19.0%	30.2%	34.9%	
	4	6	12	19	22	**63**
Talk with friends or family about STEM	9.5%	7.9%	23.8%	36.5%	22.2%	
	6	5	15	23	14	**63**
Mentor or teach other students about STEM	12.7%	3.2%	34.9%	27.0%	22.2%	
	8	2	22	17	14	**63**
Help with a community service project related to STEM	6.3%	7.9%	30.2%	30.2%	25.4%	
	4	5	19	19	16	**63**
Participate in a STEM camp, club, or competition	6.3%	7.9%	20.6%	28.6%	36.5%	
	4	5	13	18	23	**63**
Take an elective (not required) STEM class	6.3%	6.3%	23.8%	27.0%	36.5%	
	4	4	15	17	23	**63**
Work on a STEM project or experiment in a university or professional setting	6.3%	6.3%	20.6%	33.3%	33.3%	
	4	4	13	21	21	**63**

Intent to engage in STEM items were used to compute composite scores[16] and these were compared across subgroups of students and by overall U2 status. A significant difference was found by school[17] with suburban students reporting greater gains in their STEM engagement intentions compared to urban/rural students (medium effect, d=0.612). To understand students' educational aspirations, students were asked how far they intended to go in school after participating in JSS (Tables 36). Nearly all students (88%) reported wanting to at least finish college (44%) or get more education after college (44%).

Table 36. After JSS – Student Education Aspirations (n=63)

Choice	Response Percent	Response Total
Graduate from high school	6.35%	4
Go to a trade or vocational school	4.77%	3
Go to college for a little while	0%	0
Finish college (get a Bachelor's degree)	44.44%	28
Get more education after college	44.44%	28

Resources

Mentors were asked to rate the usefulness of various resources for exposing students to AEOPs (Table 37). All mentors reported participation in JSS was at least somewhat useful for this purpose. Further, the AEOP website (80%) and AEOP brochure (60%) were reported as at least somewhat useful for this purpose by more than half of mentors. Resources that half of mentors reportedly did not experience for the purpose of exposing students to AEOPs were AEOP social media and invited speakers.

[16] STEM intentions composite with 10 items had a Cronbach's alpha reliability of 0.917.
[17] Independent Samples t-test Results for STEM Intentions by School Location: *t*(54)=2.25, *p*=.028.

Table 37. Usefulness of Resources in Exposing Students to AEOPs (n=10)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	0.0%	0.0%	20.0%	30.0%	50.0%	
	0	0	2	3	5	**10**
AEOP on Facebook, Twitter, Pinterest or other social media	50.0%	10.0%	0.0%	10.0%	30.0%	
	5	1	0	1	3	**10**
AEOP brochure	20.0%	10.0%	10.0%	30.0%	30.0%	
	2	1	1	3	3	**10**
JSS Program administrator or site coordinator	30.0%	0.0%	10.0%	20.0%	40.0%	
	3	0	1	2	4	**10**
Invited speakers or "career" events	50.0%	0.0%	30.0%	0.0%	20.0%	
	5	0	3	0	2	**10**
Participation in JSS	0.0%	0.0%	0.0%	10.0%	90.0%	
	0	0	0	1	9	**10**

Mentors were also asked how useful these same resources were for exposing students to DoD STEM careers (Table 38). A similar pattern was noted with participation in JSS (70%) being the most frequently chosen as somewhat or very much useful. Over half of mentors indicated that the AEOP website (60%) and AEOP brochure (60%) were at least somewhat useful. Most mentors had not experienced invited speakers (90%) and AEOP social media (70%).

Table 38. Usefulness of Resources in Exposing Students to DoD STEM Careers (n=10)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	20.0%	0.0%	20.0%	30.0%	30.0%	
	2	0	2	3	3	**10**
AEOP on Facebook, Twitter, Pinterest or other social media	70.0%	0.0%	0.0%	20.0%	10.0%	
	7	0	0	2	1	**10**
AEOP brochure	20.0%	10.0%	10.0%	30.0%	30.0%	
	2	1	1	3	3	**10**
JSS Program administrator or site coordinator	60.0%	0.0%	0.0%	10.0%	30.0%	
	6	0	0	1	3	**10**
Invited speakers or "career" events	90.0%	0.0%	0.0%	0.0%	10.0%	
	9	0	0	0	1	**10**
Participation in JSS	20.0%	0.0%	10.0%	0.0%	70.0%	
	2	0	1	0	7	**10**

Table 39 shows student reports of which resources impacted their awareness of the various AEOPs most. Resources deemed helpful by at least half of JSS students were participation in JSS (78%), their teachers (76%), and their JSS mentors (65%).

Table 39. Impact of Resources on Student Awareness of AEOPs

Item	Helped (n=63)
My participation in JSS	77.78%
My Teacher	76.19%
My JSS Mentor	65.08%
Invited Speakers	47.62%
AEOP Printed Materials	42.86%
AEOP Website	41.27%
AEOP Social Media	14.29%

Overall Impact

JSS students were asked about the program's overall impact on them (Table 40). More than a third of students (38%-62%) reported JSS helped them to grow in their interest about each item asked. Students indicated JSS helped them grow the most in the following areas: their STEM knowledge, skills, and abilities confidence (62%); interest in participating in STEM activities outside of school requirements (54%); and interest in earning a STEM degree (51%). Areas in which students reported no growth, or growth that was not related to JSS were all related to the AEOP or DoD and included the following: awareness of other AEOPs (52% no JSS related growth), awareness of DoD STEM research/careers (54% no JSS related growth), interest in participating in other AEOPs (59% no JSS related growth), and interest in pursuing a STEM career with the DoD (62% no JSS related growth).

Table 40. Student Opinions of JSS Impacts (n=63)

	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.	6.3%	4.8%	27.0%	61.9%	
	4	3	17	39	**63**
I am more interested in participating in STEM activities	9.5%	7.9%	28.6%	54.0%	
	6	5	18	34	**63**
I am more aware of other AEOPs.	17.5%	15.9%	19.0%	47.6%	
	11	10	12	30	**63**
I am more interested in participating in other AEOPs.	23.8%	11.1%	23.8%	41.3%	
	15	7	15	26	**63**
I am more interested in taking STEM classes in school.	11.1%	15.9%	28.6%	44.4%	
	7	10	18	28	**63**
I am more interested in earning a STEM degree.	11.1%	15.9%	22.2%	50.8%	
	7	10	14	32	**63**
I am more interested in pursuing a career in STEM.	12.7%	11.1%	34.9%	41.3%	
	8	7	22	26	**63**
I am more aware of Army or DoD STEM research and careers.	19.0%	12.7%	22.2%	46.0%	
	12	8	14	29	**63**
I have a greater appreciation of Army or DoD STEM research.	15.9%	11.1%	33.3%	39.7%	
	10	7	21	25	**63**
I am more interested in pursuing a STEM career with the Army or DoD.	31.7%	9.5%	20.6%	38.1%	
	20	6	13	24	**63**

A composite for the overall impact of JSS was created[18] to compare scores across subgroups of students and overall U2 status. Statistically significant differences were not found.

Students were also asked in an open-ended questionnaire item to list the three most important ways that JSS has helped them. Among the 57 students who responded, the most often cited benefit of JSS participation, mentioned by 30 students (53%), was teamwork or collaboration. The next most frequently mentioned benefit, mentioned by 21 students (38%), was the opportunity to develop STEM skills. Fifteen students (26%) cited STEM learning as a benefit of JSS, 14 (25%) cited problem-solving skills, and 11 (20%) mentioned career information as a benefit of JSS participation. Other benefits, mentioned by fewer than 20% of respondents, included:

- Developing communication skills (10)
- The hands-on nature of JSS (10)
- Developing critical thinking skills ((9)
- The real-world application of JSS (7)
- Developing perseverance (6)
- Making friends (6)
- Developing confidence (6)
- Having fun (4)
- Developing leadership skills (4)

Students participating in focus groups echoed these themes regarding the benefits of participating in JSS. Besides the benefits mentioned above, JSS students participating in focus groups added as benefits learning the design process, the opportunity to be creative, seeing other teams' projects, and the opportunity to travel. Students said, for example,

> *"I liked seeing a bunch of other people's ideas and the cars and models."* (JSS National Student)
>
> *"I learned how gears work."* (JSS National Student)
>
> *"I learned a lot about mechanics."* (JSS National Student)
>
> *"In the future we need to find better, cleaner energy. Junior Solar Sprint is getting us introduced to solar energy."* (JSS National Student)

[18] The Cronbach's alpha reliability for the 10 Overall Impact items was 0.905.

8 | Overall Findings and Recommendations

Summary of Findings

The FY19 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 41.

Table 41. 2019 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 FY19 and continues to reach students from populations historically underrepresented and underserved in STEM.	JSS program administrators reported a total of 2,224 participants, including 345 participants from Okinawa and American Samoa who were not registered. This represents an increase of 51% over the 1,081 participants reported by program administrators in FY18. Cvent registration data are available for 1,778 students (446 less than reported by the program). The 1,778 students registered in Cvent represents a 39% increase as compared to FY18.
	Less than half (44%) of FY19 participants were female, an increase as compared to FY18 (37%). Over half (60%) of students identified themselves as White (53% in FY18). The proportion of students identifying themselves as Black or African American decreased somewhat in FY19 (9%) as compared to FY18 (11%), although the proportion of Hispanic or Latino/a students increased in FY19 (13%) as compared to FY18 (8%).
	Over two-thirds (67%) of FY19 students met the AEOP definition of underserved (U2), a substantial increase from the 34% of JSS students who met the U2 criteria in FY18.
Students reported engaging in STEM practices during JSS.	More than two-thirds of students (70% -97%) indicated engaging with each STEM practice at least once during JSS, except for working with a person who works in a STEM field on a real world project (62%).
	No significant differences in STEM practice engagement were found by U2 status or any demographic area examined.

	No statistical differences were identified between students' STEM engagement in school and in JSS. This may be attributable to the fact that JSS activities are often completed as a class requirement and may therefore be perceived as in-school activities by students.
Students experienced gains in STEM knowledge during JSS.	More than half of survey participants reported high levels of learning (learned more than a little or learned a lot) as a result of JSS. Two aspects of STEM knowledge for which than two-thirds of participants reported these levels of learning were new knowledge of a STEM topic (75%) and research on a STEM topic or field (68%).
	No significant differences in STEM knowledge gains were found by U2 status or any demographic area examined.
Students experienced gains in their STEM competencies or skills.	Approximately half or more of students indicated learning more than a little or a lot (high levels of learning) on all items associated with their STEM competencies. Three-quarters or more of students reported that they learned either "more than a little" or "a lot" in using knowledge and creativity to suggest a solution to a problem (75%) and making a model to show how something works (75%).
	No significant differences in STEM competency learning were found by U2 status or any demographic area examined.
Students reported high levels of learning in 21st Century skills; suburban students reported higher levels of learning than their peers.	More than half of students (51%-81%) reported high levels of learning (learned more than a little or learned a lot) across all 21st Century skills items. Skills for which nearly 80% or more of respondents reported high levels of learning were managing projects to complete them on time (79%), using creative ideas to make a product (79%), working creatively with others (81%), and collaborating with others effectively (80%).
	While no significant differences in 21st Century Skill gains were found by overall U2 status, students attending suburban schools reported greater impact compared to urban/rural students (large effect size).
Students reported substantial gains in their learning related to their STEM identities – their interest in and feelings of capability in STEM.	Approximately two-thirds or more of students (65%-76%) agreed with all statements related to STEM identity. Topics with which three-quarters or more of participants reported agreement were feeling more prepared for more challenging STEM activities (75%), thinking creatively about a STEM project/activity (76%), and feeling like they accomplished something in STEM (76%).
	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	A majority of mentors reported using all strategies associated with each area of effective mentoring.
	Very few mentors (n=10) responded to questionnaire items.

few mentors responded to the questionnaire.	
Most students expressed high levels of satisfaction with their JSS experiences; students also had a variety of suggestions for program improvement.	Approximately half or more responding students (48%-79%) reported being at least somewhat satisfied with all aspects of the JSS program. Three-quarters or more of students indicated they were at least somewhat satisfied with JSS's location (75%) and the help they received from their teachers or mentors (79%). Nearly a third (29%) of students did not experience guest speakers in their JSS experience.
	Students were overwhelmingly positive in their comments about their satisfaction in open-ended questions and in focus groups. STEM learning, career information, having fun, and the opportunity to build skills such as collaboration, problem-solving, and leadership were all cited as sources of satisfaction.
	Students made a wide variety of suggestions for program improvement. Over half (55%) of respondents mentioned improvements to the JSS rules or guidelines or providing more information about these. A third (33%) of students suggested improvements to the scheduling or organization of the event. Other suggestions focused on changing elements of the competition (e.g., the number of trials and track quality), providing more mentoring for students, and expanding the age range for JSS.
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. Half or more of mentors (50%-100%) reported being at least somewhat satisfied with all JSS features they had experienced. Over half had not experienced JSS invited speakers and field trips. A large majority of mentors (70%-90%) reported being at least somewhat satisfied with all JSS online supports. Nearly all mentors reported that they were somewhat or very much satisfied with terminology (90%) and Build A Car resources (90%). There were no online resources for which mentors reported dissatisfaction.
	Mentors responding to open-ended survey questions noted a number of strengths of JSS including teamwork and the opportunity for students to engage in problem solving.
	Mentors suggested a range of program improvements, including the following: • Providing better or clearer instructions • Providing more staff at the national competition • Providing online tutorials or video links for difficult topics (e.g., gear ratio and torque) and the design process • Updating lesson materials • Providing free solar panels • Providing both indoor and outdoor races or an alternative indoor track

	• Generally improving the track • Providing teams with practice runs • Having 3 time trials rather than 2 • Allowing time for teams to make adjustments or repairs to their cars • Scoring all portfolios at the national event rather than just the semi-finalists' • Providing more information or communication about other AEOPs • Sending JSS staff to visit schools
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Students learned about JSS primarily through their schools and reported various motivations for participating. Mentors learned about AEOP primarily through the TSA.	A third or more of participants learned about AEOP from someone who works at their school (42%) and school communications (newsletter, email, website) (35%).
	Students were motivated to participate in JSS by an interest in STEM, a desire to learn something new or interesting, the opportunity to have fun, the opportunity to learn, the hands-on nature of JSS, and the opportunity to be with friends.
	Mentors primarily learned about JSS through the TSA website and past JSS participation.
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.	Most students had never participated in AEOPs in the past, including GEMS (97%) and eCM (95%); 16% had participated in Camp Invention at least once.
	A large proportion of students (89%) reported being interested in participating in JSS again. A quarter of participants indicated being interested in GEMS (25%). Fewer than a quarter (14%-24%) indicated interest in participating in any other AEOP.
	Students were most likely to report that participation in JSS (78%), their teachers (76%), and their JSS mentors (65%) were impactful resources for raising 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 past	Approximately three-quarters (76%) 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. Sixty-two percent of students reported learning about at least one DoD STEM job/career, and only 8% said they had learned about five or more.

participation in JSS and their teachers or mentors as the most helpful resource for learning about DoD STEM careers.	Students were most likely to report that past participation in JSS (63%), their teachers (63%), and their JSS mentors (52%) were impactful in making them aware of DoD STEM careers.
Most students had positive opinions about DoD research and researchers, although many students did not have an opinion about these topics.	Two-thirds of students had favorable opinions about three of the four DoD research/researchers items. Less than half of students agreed or strongly agreed that DoD research is important to most people.
	Over a quarter (25%-35%) did not express an opinion about DoD research and researchers, suggesting that students may have had limited exposure to DoD research and researchers in JSS.
Students reported being somewhat more likely to engage in STEM activities in the future after participating in JSS, although some reported no change in their likelihood of future engagement; students at suburban schools experienced larger impacts than their peers.	Approximately half or more of students (49%-75%) reported being more likely or much more likely to engage in all STEM activities. Activities most impacted most by JSS were participation in a STEM camp, club, or competition (65%); using a computer to design or program something (65%); working on a STEM project or experiment in a university or professional setting (67%); and playing/working with a mechanical/electrical device (75%).
	While few students reported that they were less likely to engage in STEM activities after participating in JSS (2%-13%), up to a third of students (19%-33%) 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 overall U2 status, although students attending suburban schools reported greater gains in their intentions to engage in STEM in the future compared to urban/rural students (medium effect size).
JSS had positive impacts on students in areas of their STEM learning, interest, appreciation for STEM research, and interest in STEM careers; the areas of least learning were associated with the AEOP and the DoD. Students named a range of benefits of participating in JSS.	More than a third of students (38%-62%) reported JSS helped them to grow in their interest in each item about which they were asked. Students indicated JSS helped them grow the most in the following areas: their STEM knowledge, skills, and abilities confidence (62%); interest in participating in STEM activities outside of school requirements (54%); and interest in earning a STEM degree (51%).
	Areas in which students reported no growth, or growth that was not related to JSS were all statements related to the AEOP or DoD and included the following: more awareness of other AEOPs (52% no JSS related growth), more awareness of DoD STEM research/careers (54% no JSS related growth), more interest in participating in other AEOPs (59% no JSS related growth), and more interest in pursuing a STEM career with the DoD (62% no JSS related growth).
	No significant differences in overall impact of JSS participation were found by overall U2 status or any demographic area examined.

	In an open-ended survey item, the most often cited benefit of JSS participation, was teamwork or collaboration followed by the opportunity to develop STEM skills. STEM learning, problem-solving skills, and career information were also cited as benefits.

Recommendations for FY20 Program Improvement/Growth

FY19 was another successful year for JSS, including a substantial increase of participation of underserved students compared to FY18 (67% compared to 34% respectively). Students reported growth in knowledge of STEM (75%) during JSS and 79% learned how to manage and complete a project on time. JSS participants also experienced growth in STEM identity, with 76% reporting that they felt like they had successfully accomplished something in STEM. The FY19 evaluation did uncover some areas for potential improvement that are the basis of recommendations for FY20 program improvement and/or growth which are outlined below.

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

JSS nearly doubled the participation of underserved students in FY19 to an impressive 67%. We commend TSA for this effort and encourage them to continue focus on maintaining and growing the participation of underserved youth in JSS.

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

As in the previous three years, both teachers and students continued to report challenges with the directions, logistics, and judging for the JSS competition. In addition to previously suggested areas for improvement (i.e., clearer instructions, updated lesson materials) participants in FY19 provided additional detailed guidance for TSA on how to make the program more successful. These included having more staff at the national competition, providing online videos or tutorials for difficult topics (e.g. gear ratio and torque), improving the track, allowing teams to adjust their cars, and scoring all portfolios at the national event rather than just the semi-finalists. Some teachers who are leading JSS teams may be doing this as their first experiences with STEM, so providing more scaffolded materials for teachers is one recommendation for FY20. Additionally, we would ask that TSA consider the opportunity for modeling the engineering design process and allowing students to make refinements to their cars, if possible, at competition. Finally, both adults and students asked to have practice runs before the actual race and we ask that TSA consider this request.

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, as over 50% shared they did not learn about other AEOPs during JSS. In FY19, 20% of JSS participants indicated they were not interested in any other AEOPs. It is recommended that TSA find a way to share AEOP information across the board with all participating JSS teams (including those that are not supported by AEOP funds).

2. As in FY18, JSS struggled to obtain necessary response rates for mentors/teachers in FY19 (ten respondents in FY19 compared to four in FY18). It is again 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.