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ARMY EDUCATIONAL OUTREACH PROGRAM

JSHS

2020 Annual Program Evaluation Report Findings

August 2021

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ARMY EDUCATIONAL OUTREACH PROGRAM

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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.

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.

This report documents the evaluation of one of the AEOP elements, the Junior Science & Humanities Symposia Program (JSHS). The Junior Science & Humanities Symposia Program (JSHS) is an Army, Navy, and Air Force program funded by the research arm of the Tri-Services and is administered by the National Science Teaching Association (NSTA) as part of the cooperative agreement award to Battelle and its Consortium Partners. JSHS is an AEOP pre-collegiate science, technology, engineering, and mathematics (STEM) research competition for high school students. JSHS encourages high school students to engage in original research in preparation for future STEM career pathways. In regional (R-JSHS) and national (N-JSHS) symposia, students present their research in a forum of peer researchers and practicing researchers from government (in particular the DoD), industry, and academia. The evaluation study was performed by North Carolina State University in cooperation with Battelle, the Lead Organization (LO) in the AEOP CA consortium.

Program Overview

JSHS is an AEOP pre-collegiate STEM competition. JSHS encourages high school students to engage in original research in preparation for future STEM career pathways. The categories of competition are:

1. Biomedical sciences
2. Chemistry
3. Engineering and technology
4. Environmental science
5. Life Sciences
6. Mathematics and computer science, computer engineering
7. Medicine and health/behavioral sciences
8. Physical sciences, including physics, astronomy, internet of things

In regional (R-JSHS) and national (N-JSHS) symposia, students present their research in a forum of peer researchers and practicing researchers from the government (in particular the DoD), industry, and academia. In addition, they receive public recognition and awards for their research achievements while competing for scholarship funds.

Regional symposia were hosted by 45 university campus sites nationwide in 2020. The top five students in each region received were selected to participate in N-JSHS. Of these five, the top two students were invited to present their research orally as part of the national competition; the remaining three students were invited to present a poster of their research as part of the national competition. Because of the pandemic, the N-JSHS competition was held as a virtual event, with competitors presenting their research to judges online rather than in person. In 2020, 92 students made oral presentations and 123 students made poster presentations at the virtual N-JSHS competition. NSTA has established guidelines and "Ground rules" for the student research paper competition and provides these guidelines to JSHS regional symposia and other cooperating organizations. These resources allow for a general consistency in student experience and outcome, while still allowing sites the flexibility to design the details of their program to meet the unique needs of their students. All JSHS programs are designed to meet the following objectives:

1. Promote research and experimentation in STEM at the high school level;
2. Recognize the significance of research in human affairs and the importance of humane and ethical principles in the application of research results;
3. Search out talented youth and their teachers, recognize their accomplishments at symposia, and encourage their continued interest and participation in the sciences, mathematics, and engineering;
4. Recognize innovative and independent research projects of youth in regional and national symposia;

5. Expose students to academic and career opportunities in STEM and to the skills required for successful pursuit of STEM;
6. Expose students to STEM careers in the Army and/or DoD laboratories; and
7. Increase the future pool of talent capable of contributing to the nation's scientific and technological workforce.

The 45 R-JSHS sites reported that they received applications from 4,511 students; 3,462 of these students competed in regional competitions. The number of applicants in FY20 was nearly the same (.4% increase) as in FY19 when 4,493 students applied and continues the reversal of a multiyear downward trend in the number of JSHS applicants (4,279 applicants in FY18; 8,663 in FY17; 8,947 in FY16; 9,347 in FY15). There was a substantial increase in student participation, however, with a 31% increase in participants as compared to FY19 when 2,651 students competed. This increase begins to reverse the multiyear downward trend in participation since FY15 (3,069 participants in FY18; 5,577 in FY17; 5,620 in FY16; and 5,829 in FY15). Table 1 summarizes applicants and participants as reported by the sites.

Table 1. 2020 JSHS Reports of Applicants and Participants

Region	Students Applied	Student Participants	Teachers Participants
Alabama	62*	52*	23
Alaska	13*	13*	Not Reported
Arizona	55+	54+	16
Arkansas	60*	40+	7
California Northern & Western Nevada	61*	61+	0
California Southern	39+	39+	0
Connecticut	213+	212+	29
Europe DoDEA	99+	99+	1
Florida	274+	269+	39
Georgia	182*	152+	8
Hawaii	85*	58*	17
Illinois	6*	6*	2
Illinois - Chicago	35*	15*	0
Intermountain	67*	54+	16
Iowa	119*	60+	8
Kansas-Nebraska-Oklahoma	39*	39+	6
Kentucky	26*	26+	7
Louisiana	88+	76+	7
Maryland	142+	141+	4

Michigan Southeastern	28+	28+	15
Missouri**	89*	88*	14
New England Northern	140*	121*	11
New England Southern	79*	63*	9
New Jersey Rutgers	155+	153+	56
New Jersey Shore	126+	69+	21
New York Long Island	167*	100*	15
New York Metro	189*	92+	1
New York Upstate	678*	323+	54
North Carolina	109+	107+	19
North Central	86*	84+	Not reported
Ohio	162*	162*	26
Oregon	16*	16+	8
Pacific DoDEA	144*	125*	9
Pennsylvania	33+	33+	21
Philadelphia	18+	18+	Not Reported
Puerto Rico	43*	43*	10
South Carolina	128+	30+	24
Southwest	35*	35+	7
Tennessee	36+	34+	13
Texas	73*	53*	30
Virginia	63+	62+	15
Washington D.C.	106+	30+	10
West Virginia	12+	12+	2
Wisconsin & Upper Michigan	45+	40*	8
Wyoming & Eastern Colorado	86*	75*	1
Totals	**4,511**	**3,462**	**589**

*Note: Some sites reported larger application and/or participation numbers than those recorded in Cvent. Sites that reported more applicants/participants than Cvent are marked with an asterisk (*) and the site-reported number is used to include applicants/participants who may not have registered in Cvent. A plus sign (+) is marked behind applicant/participant numbers where Cvent had a higher reported number of applicants/participants than sites.

**MO site reported more participants than applicants. The Cvent number of participants was used as it was lower than the site-reported number of applicants.

In addition to students, JSHS engaged a reported 2,025 K-12 teachers, college or university faculty, graduate students, Army or DoD scientists and engineers (S&Es), regional directors, and other volunteers. This is a decrease (23%) as compared to FY19 when 2,636 of these adults participated (FY18, 2,015). A

total of 233 S&Es participated in FY20, slightly less (8%) as compared to FY19 when 252 participated (FY18, 139). These decreases may be due to the transition of the N-JSHS event and many regional events to virtual formats that require fewer volunteers than on-site programs. A total of 20 Army/DoD research laboratories and centers collaborated with JSHS. Table 2 provides an overview of students, teachers, college and university faculty and staff, and DoD S&Es who participated in JSHS in 2020.

Table 2. 2020 NSTA Reports of JSHS Participation	
Participant Group	**No. of Participants**
High school students (grades 9-12)	3,462
K-12 teachers	589
College/university faculty or other personnel	774
Army/DoD Scientists & Engineers	233
Regional Directors & Co-Regional Directors	82
Volunteers	347
Total	**5,487**

In FY20, Cvent total enrollment included 3,129 students while site reports reflected slightly larger enrollments totaling 3,462 students (See Note under Table 1). Demographic information for student participants who both registered in Cvent and provided their demographic data (n=3,126) is found in Table 3. Cvent data indicate that slightly more than half (58%) of R-JSHS students were female and 41% were male, a distribution very similar to previous program years. Less than half (43%) of students identified themselves as White (compared to 50% in FY19 and 57% in FY18). Slightly less than a third (31%) of R-JSHS students identified themselves as Asian (27% in FY19; 20% in FY18). Less than 10% of students identified themselves as Black or African American (5% in FY 20; 5% in FY19; 6% in FY18) or Hispanic/Latino (6% in FY20; 7% in FY19; 5% in FY18). Another 6% of students chose not to report their race/ethnicity, and 6% self-identified as more than one race or ethnicity. Slightly more R-JSHS students met the AEOP criteria for underserved status (underserved)[1] as compared to previous years (44% in FY20; 41% in FY19; 37% in FY18). The demographic make-up of students participating in N-JSHS was similar to that of the overall population of R-JSHS students substantially more students in the N-JSHS population were Asian (44%) as

[1] AEOP's definition of underserved (underserved) 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).

compared to the overall R-JSHS population (31%), and only 2% of N-JSHS students were Black or African American and only 2% were Hispanic or Latino.

Table 3. 2020 JSHS Student Profile				
Demographic Category	**R-JSHS Participants**		**N-JSHS Participants***	
Gender	**n=3,126**		**n=217**	
Female	1,806	57.7%	130	59.9%
Male	1,277	40.8%	87	40.1%
Choose not to report	43	1.5%	0	0%
Race/Ethnicity	**n=3,125**		**n=217**	
Asian	979	31.3%	96	44.2%
Black or African American	168	5.4%	4	1.8%
Hispanic or Latino	199	6.4%	5	2.3%
Native American or Alaska Native	21	<1%	2	<1%
Native Hawaiian or Other Pacific Islander	15	<1%	3	<1%
White	1,339	42.8%	80	36.9%
More than one race	178	5.7%	10	4.6%
Other race or ethnicity	44	1.4%	2	<1%
Choose not to report	182	5.8%	15	6.9%
Grade Level	**n=3,125**		**n=217**	
6th	9	<1%	0	0%
7th	7	<1%	0	0%
8th	22	<1%	0	0%
9th	262	8.4%	15	6.9%
10th	665	21.3%	41	18.9%
11th	997	31.9%	83	38.2%
12th	1144	36.6%	77	35.5%
College – Freshman	1	<1%	0	0%
College – Sophomore	2	<1%	0	0%
College – Junior	6	<1%	1	<1%
College – Senior	3	<1%	0	0%
Graduate Student	1	<1%	0	0%
Choose not to report	6	<1%	0	0%
School Location	**n=3,075**		**n=217**	
Urban (city)	823	26.8%	52	24.0%
Suburban	1,638	53.3%	129	59.4%
Rural (country)	383	12.5%	24	11.1%
Frontier or tribal School	1	<1%	0	0%
DoDDS/DoDEA School	124	4.0%	8	3.7%
Home school	10	<1%	1	<1%

Online school	4	<1%	0	0%
Other	19	<1%	0	0%
Choose not to report	73	2.4%	3	1.4%
Receives Free or Reduced-Price Lunch (FARMS)	**n=3,125**		**n=217**	
Yes	455	14.6%	16	7.4%
No	2,460	78.7%	188	86.6%
Choose not to report	210	6.7%	13	6.0%
English is First Language	**n=3,126**		**n=217**	
Yes	2,621	83.8%	190	87.6%
No	408	13.1%	23	10.6%
Choose not to report	97	3.1%	4	1.8%
One or More Parent/Guardian Graduated from College	**n=3,125**		**n=217**	
Yes	2,662	85.2%	204	94.0%
No	322	10.3%	9	4.2%
Choose not to report	141	4.5%	4	1.8%
Underserved Status	**n=3,129**		**n=217**	
Yes	1,372	43.8%	74	34.1%
No	1,514	48.4%	133	61.3%
Insufficient data to make determination**	243	7.8%	10	4.6%

*includes student observers who did not present at N-JSHS

** Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for underserved status.

Overall, 34% of N-JSHS students met the criteria for underserved according to AEOP. Table 4 outlines costs of the JSHS program for 2020. The total cost was $1,243,304. The cost per student participant for FY20 was $359.

Table 4. 2019 JSHS Program Costs	
Total Cost	$1,243,304
Total Travel*	$13,404
Participant Travel	$8,024
Total Awards	$407,405
Student Awards/Stipends	$387,405
Adult/Teacher/Mentor Awards	$20,000
Cost Per Student	$359

*The reported travel costs for FY20 programs are from pre-pandemic travel (October 2019-February 2020) and from non-refundable travel expenses that were booked prior to shifting to virtual programming.

4 | Evaluation At-A-Glance

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

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• Tri-service sponsorship • NSTA providing oversight of regional and national programs • Operations conducted by university and DoD partners • Students participating in regional and national programs • STEM professionals and educators serving as research mentors, judges, personnel and volunteers of regional and national programs • Awards for student competitors, and recognition for STEM professionals and educators in support roles • Centralized branding and comprehensive marketing • Centralized evaluation	• Students conduct "authentic" STEM and humanities research, often mentored by STEM professionals and educators • Students present their research in poster or oral presentations at regional symposia • STEM professionals judge presentations and select regional winners • Regional winners advance to N-JSHS (virtual event for 2020). • Program activities that expose students to AEOP programs and/or STEM careers in the Army or DoD	• Number and diversity of student participants engaged in programs • Number and diversity of STEM professionals and educators serving as research mentors, judges, personnel and volunteers of regional and national programs • Number and diversity of DoD scientists and engineers and other military personnel engaged in programs • Number and Title 1 status of high schools served through participant engagement • Students, regional directors, national judges, and NSTA contributing to evaluation	• Increased participant 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 DoD STEM research and careers • Implementation of evidence-based recommendations to improve JSHS regional and national programs	• Increased student participation in other AEOP and 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 DoD STEM careers • Continuous improvement and sustainability of JSHS

The JSHS evaluation gathered information from multiple participant groups about JSHS 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 JSHS program objectives.

Key Evaluation Questions

- What aspects of JSHS motivate participation?
- What aspects of JSHS structure and processes are working well?
- What aspects of JSHS could be improved?
- Did participation in JSHS:
  - 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. 2020 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; mentored research experience and products (students)
	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
	Future STEM Engagement: Gains in interest/intent for future STEM engagement (informal activities, education, career)
	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: How students learn about AEOP, motivating factors for participation, impact of AEOP resources on awareness of AEOP and Army/DoD STEM research and careers
	Program Specific Online Resources: Usefulness of online resources for participating in AEOP
Satisfaction & Suggestions	Benefits to participants, suggestions for improving programs, overall satisfaction

Table 6. 2020 Mentor Questionnaires	
Category	**Description**
Profile	**Demographics:** Participant gender, race/ethnicity, occupation, past participation
Satisfaction & Suggestions	Awareness of JSHS, motivating factors for participation, satisfaction with and suggestions for improving JSHS programs, benefits to participants
AEOP Goal 1	**Capturing the Student Experience:** In-program experience
	STEM Competencies: Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP
	Transferrable Competencies: Gains in 21st Century Skills
	AEOP Opportunities: Past participation, awareness of other AEOP; efforts to expose students to AEOP, 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 AEOP and Army/DoD STEM research and careers
	Program Specific Online Resources: Usefulness of online resources for supporting students in participating in AEOP

Table 7. 2020 Student Interviews	
Category	**Description**
Profile	Gender, grade level, past participation in JSHS
Satisfaction & Suggestions	Motivating factors for participation, satisfaction with and suggestions for improving JSHS programs, benefits to participants
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Extent to which students were exposed to other AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Extent to which students were exposed to STEM and Army/DoD STEM jobs

Table 8. 2020 Mentor Interviews	
Category	**Description**
Profile	Gender, occupation, role in JSHS, past participation in JSHS, past participation in other AEOP
Satisfaction & Suggestions	Perceived value of JSHS, benefits to participants suggestions for improving JSHS programs
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Efforts to expose students to AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Efforts to expose students to STEM and Army/DoD STEM jobs
	Mentor Capacity: Local Educators – Strategies used to increase diversity/support diversity in JSHS

Table 9. 2020 Program Information Provided by NSTA	
Category	**Description**
Program	Description of symposia categories and activities
AEOP Goal 1 and 2 Program Efforts	**Underserved Populations:** mechanisms for marketing to and recruitment of students from underserved populations
	Army STEM: Army/DoD STEM Careers – Exposure to Army STEM research and careers (varies by regional, national event); Participation of Army S&Es and/or Army research facilities in event activities (varies by regional, national event)
	Mentor Capacity: Local Educators - University faculty and student involvement, teacher involvement

The JSHS evaluation included an examination of participant outcomes and other areas that inform program continuous improvement. A focus of the evaluation is on efforts toward the long-term goal of JSHS 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 JSHS, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. The evaluation also collected data about participant perspectives on program processes, resources, and activities for the purpose of recommending improvements as the program moves forward.

Findings are presented in alignment with the three AEOP priorities. The findings presented herein include several components related to AEOP and program objectives, including impacts on students' STEM competencies (e.g., knowledge and skills), STEM identity and confidence, interest in and intent for future STEM engagement (e.g., further education, careers), attitudes toward research, and their knowledge of and interest in participating in additional AEOP opportunities.[2] STEM competencies are necessary for a

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

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

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

President's Council of Advisors on Science and Technology (P-CAST). (February 2012). *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics.* Executive Office of the President.

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

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 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 JSHS 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. Interview protocols are provided in Appendix B (students) and Appendix C (mentors); questionnaires are provided in Appendix D (students) and Appendix E (mentors). Major trends in data and analyses are reported herein.

Study Sample

Students participating in JSHS regional competitions and mentors from regional sites make up the respondents to evaluation questionnaires. N-JSHS students were not surveyed this year due to COVID-19. Regardless of how many students mentored, mentors only complete the questionnaire once. Whether students advanced to N-JSHS or not, mentors filled out the same regional level survey. Thus, mentor responses do not differentiate for R-JSHS or N-JSHS competition level. The number of respondents for items may vary in the reporting of results (as indicated in report tables) because participants may choose to skip items. Table 10 shows response rates for R-JSHS students (9.11%) and mentors (5.04%) and corresponding margins of error which were slightly higher than desired (2%-5% acceptable).

Table 10. 2020 JSHS Questionnaire Participation

Participant Group	Respondents (Sample)	Total Participants* (Population)	Participation Rate	Margin of Error @ 95% Confidence[3]
R-JSHS Students	285	3,129	9.11%	±5.54%
N-JSHS Students	N/A	N/A	N/A	N/A
Adult Volunteers/Mentors	102	2,025	5.04%	±9.46%

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

[3] "Margin of error @ 95% confidence" means that 95% of the time, the true percentage of the population who would select an answer lies within the stated margin of error. For example, if 47% of the sample selects a

A single student questionnaire (R-JSHS) was administered in FY20 since changes in the national event resulting from the pandemic precluded administering a separate N-JSHS questionnaire to students on-site. All students, both those who competed at the regional level and those who competed at the national level, had the opportunity to complete this questionnaire. A single set of questionnaire results, labeled "R-JSHS" is therefore reported for FY20.

Because the national JSHS event scheduled to be held in Virginia Beach, Virginia in April was canceled and a virtual presentation format was instituted in its place, phone interviews rather than focus groups were conducted with N-JSHS students and mentors. Phone interviews were conducted with 12 N-JSHS students (six oral presenters and six poster presenters) and with 13 adults (six teachers and/or parents, four regional directors, and two regional representatives). Interviews were not intended to yield generalizable findings; rather they were intended to provide additional evidence of an explanation for, or illustrations of questionnaire data. They add to the overall narrative of JSHS's efforts and impact and highlight areas for future exploration in programming and evaluation.

Respondent Profiles

Participant Demographics

Student questionnaire respondent demographic data are provided in Table 11. For FY20, gender composition (59% female, 41% male) remained similar to FY19 (61% female, 39% male), with approximately 60% of respondents self-reporting as female. In past years, half or more R-JSHS student respondents self-identified with the race/ethnicity of White over any other single race/ethnicity, with a third self-identifying as Asian. In FY20, both White (42%) and Asian (41%) were selected equally. Most respondents were rising 11th graders (37%) or 12th graders (34%). Similar to past years, very few students indicated they received free or reduced lunch in school (FARMS) (15%), that they would be first-generation college students (9%) or were English language learners (ELL) (7%). Slightly less than half of the students reported attending suburban schools (45%) (Table 12). Students were identified as meeting AEOP's definition of underrepresented status (underserved) if they possessed two or more of the following demographics: female, non-White and non-Asian in race/ethnicity, urban/rural/frontier school location, FARMS, ELL status, or college first generation. Half (50%) of FY20 R-JSHS participants were identified as meeting AEOP's underserved criteria – this is a substantial increase from 40% in FY19. Demographic data for R-JSHS questionnaire respondents are similar to that of the overall population of R-JSHS student participants.

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response and the margin of error at 95% confidence is calculated to be 5%, if you had asked the question to the entire population, there is a 95% likelihood that between 42% and 52% would have selected that answer. A 2-5% margin of error is generally acceptable at the 95% confidence level.

Table 11. 2020 R-JSHS Student Respondent Profile		
Demographic Category	**R-JSHS Questionnaire Respondents**	
Gender (n=285)		
Female	169	59.3%
Male	116	40.7%
Choose not to report	0	0%
Race/Ethnicity (n=285)		
Asian	118	41.3%
Black or African American	13	4.6%
Hispanic or Latino	13	4.6%
Native American or Alaska Native	7	2.5%
Native Hawaiian or Other Pacific Islander	7	2.5%
White	120	42.0%
Other race or ethnicity (specify)*	7	2.5%
Grade Level (n=285)		
9th	29	10.2%
10th	50	17.5%
11th	105	36.8%
12th	97	34.0%
Other	4	1.5%
School Location (n=285)		
Urban (city)	103	36.1%
Suburban	129	45.3%
Rural (country)	45	15.8%
Frontier or tribal school	0	0%
DoDDS or DoDEA School	0	0%
Home school	0	0%
Online school	0	0%
Choose not to report	8	2.8%
Receives Free or Reduced-Price Lunch (FARMS) (n=285)		
Yes	43	15.1%
No	237	83.2%
Choose not to report	5	1.7%
English is First Language (n=285)		
Yes	265	93.0%
No	20	7.0%
Choose not to report	0	0%
One or More Parent/Guardian Graduated from College (n=285)		
Yes	250	87.7%
No	26	9.1%
Choose not to report	9	3.2%
underserved Status (n=285)		
Yes	141	49.5%
No	140	49.1%

Insufficient data to make determination**	4	1.4%

*Other = Chinese & White, Indonesian, Chinese, & American, Middle Eastern, Mixed, Mixed (Black & White), Multiracial, Prefer Not to Answer

** Insufficient data is defined as participants who are missing/chose not to report two or more demographic fields OR are missing/chose not to report one demographic field and satisfies only one other condition for underserved status.

Student R-JSHS highest level of JSHS competition is presented in Table 12. Nearly all participants indicated they were involved in some form of presenting role (88%). Only 12% of R-JSHS respondents reported participating in non-presenting roles (student delegate/observer).

Table 12. 2020 JSHS Student Respondent Roles

Highest Level of Competition Achieved in 2020	R-JSHS Questionnaire Respondents (n = 285)
Oral presenter	69%
Poster presenter	13%
Non-presenting participant	12%
Non-competitive poster presenter	6%

Mentor Demographics

FY20 mentor survey demographics are provided in Table 13. More than half of the mentors self-reported being female (59%) and White (63%). Most mentors reported their occupation as teacher (48%), while 16% said they were professional scientists, engineers, or mathematicians and 11% were university educators.

Table 13. 2020 JSHS Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 102)		
Female	60	58.8%
Male	41	40.2%
Choose not to report	1	1.0%
Respondent Race/Ethnicity (n = 102)		
Asian	22	21.6%
Black or African American	3	2.9%
Hispanic or Latino	3	2.9%
Native American or Alaska Native	3	2.9%
Native Hawaiian or Other Pacific Islander	1	1.0%
White	64	62.8%
Other race or ethnicity, (specify):[†]	1	1.0%
Choose not to report	5	4.9%
Respondent Occupation (n = 102)		
Teacher	49	48.0%
Other school staff	4	3.9%
University educator	11	10.8%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	5	4.9%
Scientist, Engineer, or Mathematics professional	17	16.7%
Other, (specify)[‡]	16	15.7%
Respondent Role in JSHS* (n = 102)		
Research Mentor	32	25.3%
Competition advisor	4	3.1%
Other, (specify)[§]	23	18.1%
Teacher	44	34.6%
Invited Speaker	2	1.6%
Judge	22	17.3%

[†] No responses provided.

[‡] Retired (4); medical doctor (2); graduate student; software engineer; program manager (3); Navy; marketing; parent (3)

[§] Parent (14); Guest (3); Chaperone (2); Teacher Aide (2); Sponsor (2)

*Question allowed for multiple responses, so the sum of responses is greater than the number of respondents.

5 | Priority #1 Findings

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

STEM Practices

JSHS actively seeks to engage high school students in practices associated with STEM research and innovation. STEM practices are ways that students "do STEM" by actively engaging in STEM research and with other STEM researchers. STEM practices include, for example, the extent to which students contribute their own ideas to research projects, use laboratory equipment and research techniques, analyze data, and work with professionals in STEM outside of their school settings. In order to understand how effectively JSHS is engaging students in STEM research and innovation, the questionnaire included items in which participants were asked to report on the frequency with which they engaged in various STEM practices both in JSHS and in their typical school experiences in STEM.

Student-reported frequencies for engaging in STEM practices in school and R-JSHS are reported in Tables 14 and 15 respectively. For all items except one (working collaboratively), students indicated performing each STEM practice more often (weekly or every day) in JSHS than in school. This is not surprising, as JSHS is an individual research competition. STEM practices which half or more of participants reporting engaging in most often (weekly or every day) in JSHS were analyzing data or information and drawing conclusions (65% in JSHS compared to 61% in school); solving real-world problems (56% in JSHS compared to 52% in school); designing and carrying out an investigation (56% in JSHS compared to 48% in school); using laboratory procedures and tools (53% in JSHS compared to 48% in school); and designing their own research or investigations based on their own question(s) (51% in JSHS compared to 42% in school).

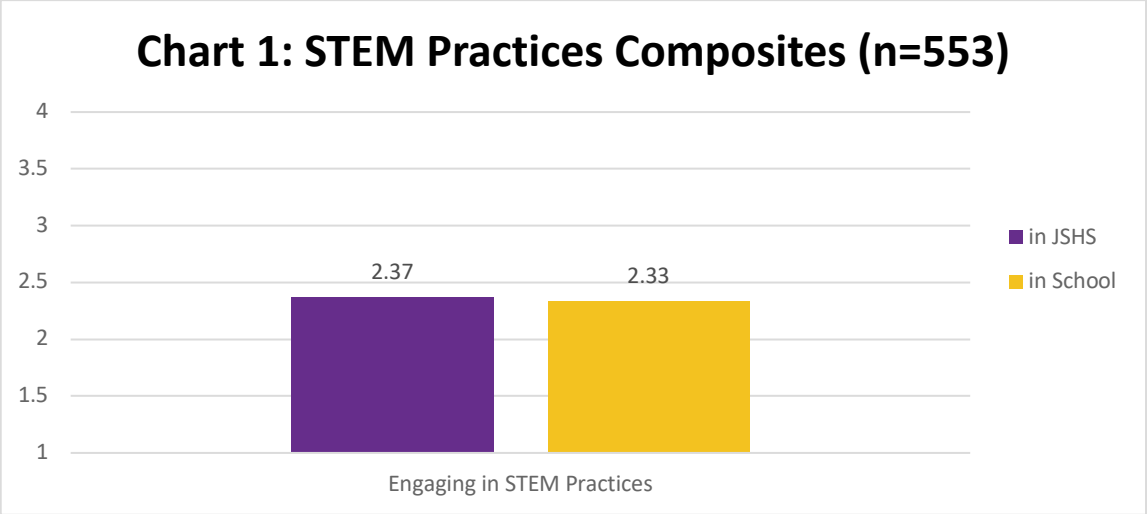
Table 14. Nature of Student STEM Practices in School for R-JSHS Respondent (n = 285)

	Not at all	At least once	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	37.9%	28.4%	27.7%	6.0%	
	108	81	79	17	**285**
Work with a STEM researcher on a research project topic assigned by my teacher	59.6%	23.9%	14.4%	2.1%	
	170	68	41	6	**285**
Design my own research or investigation based on my own question(s)	11.9%	46.3%	26.0%	15.8%	
	34	132	74	45	**285**
Present my STEM research to a panel of judges from industry or the military	39.6%	55.8%	3.9%	0.7%	
	113	159	11	2	**285**
Interact with STEM researchers	18.2%	42.8%	27.7%	11.2%	
	52	122	79	32	**285**
Use laboratory procedures and tools	11.6%	37.2%	39.3%	11.9%	
	33	106	112	34	**285**
Design and carry out an investigation	8.1%	44.2%	32.3%	15.4%	
	23	126	92	44	**285**
Analyze data or information and draw conclusions	3.9%	34.7%	41.4%	20.0%	
	11	99	118	57	**285**
Work collaboratively as part of a team	11.2%	30.2%	33.7%	24.9%	
	32	86	96	71	**285**
Solve real-world problems	7.7%	40.7%	25.3%	26.3%	
	22	116	72	75	**285**

Table 15. Nature of Student STEM Practices in JSHS for R-JSHS Respondents (n = 285)

	Not at all	At least once	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real-world STEM research project	33.0%	30.2%	28.1%	8.8%	
	94	86	80	25	**285**
Work with a STEM researcher on a research project topic assigned by my teacher	58.9%	20.4%	14.7%	6.0%	
	168	58	42	17	**285**
Design my own research or investigation based on my own question(s)	9.8%	39.3%	31.6%	19.3%	
	28	112	90	55	**285**
Present my STEM research to a panel of judges from industry or the military	35.1%	54.0%	9.8%	1.1%	
	100	154	28	3	**285**
Interact with STEM researchers	19.6%	36.1%	31.9%	12.3%	
	56	103	91	35	**285**
Use laboratory procedures and tools	16.1%	31.2%	36.1%	16.5%	
	46	89	103	47	**285**
Design and carry out an investigation	7.0%	36.8%	33.0%	23.2%	
	20	105	94	66	**285**
Analyze data or information and draw conclusions	6.0%	29.1%	40.7%	24.2%	
	17	83	116	69	**285**
Work collaboratively as part of a team	28.8%	28.1%	25.6%	17.5%	
	82	80	73	50	**285**
Solve real-world problems	10.5%	33.3%	29.8%	26.3%	
	30	95	85	75	**285**

Composite scores were calculated for each set of items: "STEM Practices in School" and "STEM Practices in JSHS".[4] Response categories were converted to a scale of 1 = "Not at all" to 4 = "Every day" and then averaged across all items to create composites. Composite scores were compared, and no significant difference was found between students' perceived STEM practice engagement in school compared to in JSHS (see Chart 1). It is important to note, however, that these data may not reflect the impact of JSHS as compared to typical school experiences since students may have participated in JSHS as a part of a school class and may not view STEM practices in JSHS and STEM practices in school as separate phenomena.



Composite scores for STEM Practices in JSHS were used to test whether there were differences in student experiences by overall underserved status and each individual component of underserved (gender, race/ethnicity group, FARMS, ELL, school location, college first generation). There were no significant differences in JSHS STEM practices engagement by overall underserved status or any of the individual demographics. This suggests that all students (regardless of demographics) engaged in JSHS STEM practices similarly.

N-JSHS students participating in phone interviews were asked to reflect on how their JSHS experience compared to their typical school STEM experiences. Students noted several differences in their engagement in STEM in JSHS as compared to in school, including the opportunities JSHS provides to interact with scientists, to present research, and to receive expert feedback on their research; the broader exposure to STEM topics JSHS provides, the career information students gained, the hands-on research

[4] The Cronbach's alpha reliability for Engaging in STEM in JSHS items was 0.888 and for Engaging in STEM in School was 0.867.

experience, the opportunity to see others' projects, and the opportunity to interact with like-minded peers.

STEM Knowledge and Skills

Students reported on how their gains in STEM Knowledge were impacted by participating in JSHS (Table 16). Three-quarters or more of R-JSHS students reported medium or large gains in all STEM knowledge areas as a result of participating in the program. For example, approximately 80% of students reported medium to large gains in in-depth knowledge of a STEM topic (81%) and knowledge of how scientists and engineers work on real problems in STEM (77%).

STEM knowledge items were combined into a composite variable[5] to test for differences between underserved status and subgroups of students. No significant differences between any demographic subgroups or overall underserved status were found for STEM knowledge.

Table 16. R-JSHS Participant Reports of Impact on STEM Knowledge (n = 285)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	2.5%	16.1%	38.2%	43.2%	
	7	46	109	123	**285**
Knowledge of research processes, ethics, and rules for conduct in STEM	6.3%	18.2%	35.1%	40.4%	
	18	52	100	115	**285**
Knowledge of how scientists and engineers work on real problems in STEM	3.2%	19.6%	32.3%	44.9%	
	9	56	92	128	**285**
Knowledge of what everyday research work is like in STEM	5.3%	19.3%	30.2%	45.3%	
	15	55	86	129	**285**

Gains in STEM competencies as a result of participating in JSHS were rated by R-JSHS students (see Table 17). Across STEM competencies, approximately two-thirds or more of students (64%-81%) reported medium or large gains. Approximately 80% of students reported medium to large gains in multiple STEM competencies: using knowledge and creativity to suggest a solution to a problem (78%); carrying out an experiment and recording data accurately (79%); and presenting an argument that uses data and/or findings from an experiment (81%).

[5] The Cronbach's alpha reliability for STEM Knowledge items was 0.897.

Composite scores were computed for student STEM competency items[6] and investigated for differential programmatic impacts. No significant differences by overall underserved status. In terms of demographic comparisons, significant differences were found by FARMS status with free/reduced lunch students reporting significantly greater impact on their STEM competencies compared to regular lunch status students (d=0.263, small effect size)[7]. Also, significant differences were found by race/ethnicity with underserved minority students reporting significantly greater JSHS impact on their STEM competencies compared to racial/ethnic non-minority students (d=0.257, small effect size)[8].

Table 17. R-JSHS Participant Gains in STEM Competencies-Science and Engineering Practices (n = 285)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	6.7%	20.7%	37.2%	35.4%	
	19	59	106	101	**285**
Creating a hypothesis or question that can be tested in an experiment	8.1%	19.3%	38.9%	33.7%	
	23	55	111	96	**285**
Using my knowledge and creativity to suggest a solution to a problem	4.6%	17.2%	37.5%	40.7%	
	13	49	107	116	**285**
Making a model to show how something works	10.5%	25.3%	29.1%	35.1%	
	30	72	83	100	**285**
Designing procedures or steps for an experiment that work	6.0%	21.1%	35.4%	37.5%	
	17	60	101	107	**285**
Identifying the limitations of the methods and tools used for collecting data	6.7%	19.3%	33.3%	40.7%	
	19	55	95	116	**285**
Carrying out an experiment and recording data accurately	4.9%	16.5%	35.1%	43.5%	
	14	47	100	124	**285**
Creating charts or graphs to display data and find patterns	5.6%	18.2%	31.2%	44.9%	
	16	52	89	128	**285**
Considering multiple interpretations of data to decide if something works as intended	7.7%	17.5%	37.9%	36.8%	
	22	50	108	105	**285**

[6] The STEM Competencies composite had a Cronbach's alpha reliability of 0.962.
[7] Independent samples t-test results for STEM Competencies by FARM: $t(283)=2.21$, $p=.028$.
[8] Independent samples t-test results for STEM Competencies by race/ethnicity: $t(283)=2.16$, $p=.032$.

Supporting an explanation with my STEM knowledge or data from experiments	5.6%	20.0%	30.2%	44.2%	
	16	57	86	126	**285**
Identifying the strengths and limitations of data or arguments presented in technical or scientific texts	5.3%	17.9%	37.9%	38.9%	
	15	51	108	111	**285**
Presenting an argument that uses data and/or findings from an experiment	3.2%	16.1%	35.8%	44.9%	
	9	46	102	128	**285**
Defending an argument based upon findings from an experiment or other data	5.6%	19.3%	32.6%	42.5%	
	16	55	93	121	**285**

Table 18 shows student responses about the impact of JSHS on their 21st Century skills. With the exception of one 21st Century Skill (creating media products, for which 36% reported no gain), more than half of students (54%-85%) reported at least medium gains in all 21st Century skills. Areas with largest reported 21st Century skills gains (approximately 80% or more reporting medium to large gains) included: taking initiative and doing work without being told to (79%); incorporating feedback on work effectively (79%); adapting to change when things do not go as planned (80%); and communicating clearly with others (85%).

A 21st Century skills[9] composite variable was created from these items. A significant difference in 21st Century skills was found by race/ethnicity with racial/ethnic minority students reporting significantly higher gains in 21st Century skills (effect size is small, d=0.351).[10] Significant differences in 21st Century skills gains were not found by overall underserved status or any other demographic variables examined.

Table 18. R-JSHS Participant Reports of Impacts on 21st Century Skills (n = 285)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	4.2%	20.4%	36.1%	39.3%	
	12	58	103	112	**285**
Working creatively with others	13.0%	24.6%	29.8%	32.6%	
	37	70	85	93	**285**
Using my creative ideas to make a product	11.9%	17.5%	34.0%	36.5%	
	34	50	97	104	**285**

[9] The 21st Century Skills composite had a Cronbach's alpha reliability of 0.969.
[10] Independent samples t-test results for 21st Century Skills by race/ethnicity: $t(283)=2.95$, $p=0.003$.

Thinking about how systems work and how parts interact with each other	7.7%	23.5%	32.6%	36.1%	
	22	67	93	103	**285**
Evaluating others' evidence, arguments and beliefs	4.2%	20.0%	38.9%	36.8%	
	12	57	111	105	**285**
Solving problems	3.2%	17.2%	35.4%	44.2%	
	9	49	101	126	**285**
Communicating clearly (written and oral) with others	2.8%	12.6%	30.5%	54.0%	
	8	36	87	154	**285**
Collaborating with others effectively and respectfully in diverse teams	11.6%	21.8%	31.9%	34.7%	
	33	62	91	99	**285**
Interacting effectively with others in a respectful and professional manner	3.9%	18.9%	31.6%	45.6%	
	11	54	90	130	**285**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	3.9%	18.6%	34.7%	42.8%	
	11	53	99	122	**285**
Using and managing data accurately, creatively, and ethically	4.9%	20.4%	32.6%	42.1%	
	14	58	93	120	**285**
Analyzing media (news) – understanding points of view in the media	17.2%	28.4%	26.3%	28.1%	
	49	81	75	80	**285**
Creating media products like videos, blogs, social media	36.1%	24.2%	20.0%	19.6%	
	103	69	57	56	**285**
Use technology as a tool to research, organize, evaluate, and communicate information	4.9%	24.2%	28.4%	42.5%	
	14	69	81	121	**285**
Adapting to change when things do not go as planned	3.9%	16.1%	34.0%	46.0%	
	11	46	97	131	**285**
Incorporating feedback on my work effectively	5.3%	16.1%	33.0%	45.6%	
	15	46	94	130	**285**
Setting goals and utilizing time wisely	6.0%	17.2%	31.2%	45.6%	
	17	49	89	130	**285**

Working independently and completing tasks on time	5.6%	16.8%	28.1%	49.5%	
	16	48	80	141	**285**
Taking initiative and doing work without being told to	7.0%	14.4%	30.2%	48.4%	
	20	41	86	138	**285**
Prioritizing, planning, and managing projects to achieve completion	5.6%	16.8%	29.5%	48.1%	
	16	48	84	137	**285**
Producing results – sticking with a task until it is finished	5.6%	16.8%	26.7%	50.9%	
	16	48	76	145	**285**
Leading and guiding others in a team or group	18.2%	25.6%	27.7%	28.4%	
	52	73	79	81	**285**
Being responsible to others – thinking about the larger community	7.4%	21.4%	34.0%	37.2%	
	21	61	97	106	**285**

STEM Identity and Confidence

Research shows that students are unlikely to pursue STEM education and/or careers future paths if they do not see themselves as capable of succeeding in STEM.[11] Deepening students' STEM identities and confidence are important factors for increasing the likelihood of students pursuing future STEM pathways. Thus, R-JSHS students were asked about the impact of JSHS on their STEM identities (Table 19). Three-quarters or more of students (74%-81%) reported medium or large gains across all STEM identity items. Areas of the greatest reported gains (80% or higher in medium/large) were: confidence to try out new ideas or procedures on STEM projects (81%); desire to build relationships with mentors who work in STEM (81%); and being better prepared for more challenging STEM activities (80%).

Composite scores for STEM identity[12] items were used to investigate potential differential impacts of JSHS participation on subgroups of students. While there were no statistical differences in STEM identity found by overall underserved status, there were differences found by several individual demographic variables. Statistical differences were found in STEM identity gains by FARMS status (FARMS students reporting higher gains); race/ethnicity (racial/ethnic minority students reporting higher gains); and gender (female students reporting higher gains)[13]. All differences (FARMS status, racial/ethnic identification, gender identification) had small effect sizes (d=0.283, d=0.260, d=282 respectively).

Table 19. R-JSHS Participant Reports on JSHS Impacts on STEM Identity (n = 285)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	7.4%	16.8%	30.5%	45.3%	
	21	48	87	129	**285**
Interest in pursuing a STEM career	7.0%	18.6%	23.2%	51.2%	
	20	53	66	146	**285**
Sense of accomplishment from my work in the program	4.2%	16.5%	25.6%	53.7%	
	12	47	73	153	**285**

[11] Chang, M. J., Sharkness, J., Hurtado, S. and Newman, C. B. (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. J. Res. Sci. Teach., 51: 555–580.
[12] The Cronbach's alpha reliability for STEM Identity items was 0.919.
[13] Independent samples t-test results for STEM Identity by FARMS: $t(283)=2.38$, $p=0.018$; race/ethnicity: $t(283)=2.19$, $p=0.029$; and gender: $t(283)=2.37$, $p=0.019$.

Better prepared for more challenging STEM activities	2.5%	16.8%	29.5%	51.2%	
	7	48	84	146	**285**
Confidence to try out new ideas or procedures on my own in a STEM project	3.2%	15.4%	25.6%	55.8%	
	9	44	73	159	**285**
Desire to build relationships with mentors who work in STEM	4.2%	14.7%	23.5%	57.5%	
	12	42	67	164	**285**

6 | Priority #2 Findings

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

Mentor Strategies and Support

Mentors play a critical role in the JSHS program. Mentors provide one-on-one support to students, chaperone students, advise students on educational and career paths, may provide opportunities for students to use laboratory space and/or equipment, or generally serve as STEM role models for JSHS students. About two-thirds (69%) of mentors responding to the mentor questionnaire reported working with 5 or fewer students, while 13% of mentors reported working with 6-10 students. The remaining 18% of mentors responded with "other," possibly indicating that they were working with more than 10 students. Mentors were asked whether or not they used a number of strategies when working with students. These strategies comprised five main areas of effective mentoring: [14]

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

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

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

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

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

Two-thirds or more (67%-84%) of mentors indicated they used all strategies related to establishing the relevance of learning activities (Table 20). Strategies that more than 80% of mentors reporting using were: becoming familiar with students' backgrounds and interests at the beginning of JSHS (84%) and encouraging students to suggest new readings, activities, or projects (82%).

Table 20. Mentor Strategies to Establish the Relevance of Learning Activities (n = 84-85)

	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 JSHS experience	83.5%	16.5%	**85**
	71	14	
Giving students real-life problems to investigate or solve	77.6%	22.4%	**85**
	66	19	
Selecting readings or activities that relate to students' backgrounds	66.7%	33.3%	**84**
	56	28	
Encouraging students to suggest new readings, activities, or projects	82.4%	17.6%	**85**
	70	15	
Helping students become aware of the role(s) that STEM plays in their everyday lives	76.5%	23.5%	**85**
	65	20	
Helping students understand how STEM can help them improve their own community	76.5%	23.5%	**85**
	65	20	
Asking students to relate real-life events or activities to topics covered in JSHS	74.1%	25.9%	**85**
	63	22	

Approximately two-thirds or more (61%-74%) of mentors reported using each strategy associated with supporting the diverse needs of learners (Table 21). Strategies that more than 70% or mentors reported using were: interacting with students and other personnel the same way regardless of their background (74%); using a variety of teaching and/or mentoring activities to meet the needs of all students (74%); and directing students to other individuals or programs for additional support as needed (72%).

Table 21. Mentor Strategies to Support the Diverse Needs of Learners (n = 82-84)

	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 JSHS experience	60.7%	39.3%	
	51	33	**84**
Interact with students and other personnel the same way regardless of their background	73.5%	26.5%	
	61	22	**83**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	74.4%	25.6%	
	61	21	**82**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	62.7%	37.3%	
	52	31	**83**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	66.3%	33.7%	
	55	28	**83**
Directing students to other individuals or programs for additional support as needed	72.3%	27.7%	
	60	23	**83**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	60.7%	39.3%	
	51	33	**84**

Larger proportions of JSHS mentors (70%-83%) indicated using all strategies to support students' development of collaboration and interpersonal skills (Table 22). Approximately 80% or more of mentors reported: having participant(s) explain difficult ideas to each other (80%); having participant(s) give and receive constructive feedback with others (82%); and having participant(s) listen to the ideas of others with an open mind (83%).

Table 22. Mentor Strategies to Support Participant Development of Collaboration and Interpersonal Skills (n = 81-83)

	Yes – I used this strategy	No - I did not use this strategy	Response Total
Having participant(s) tell other people about their backgrounds and interests	69.9%	30.1%	
	58	25	**83**
Having participant(s) explain difficult ideas to others	79.5%	20.5%	
	66	17	**83**
Having participant(s) listen to the ideas of others with an open mind	83.1%	16.9%	
	69	14	**83**
Having participant(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	74.7%	25.3%	
	62	21	**83**
Having participant(s) give and receive constructive feedback with others	81.5%	18.5%	
	66	15	**81**

For strategies related to engaging students in "authentic" STEM activities, two-thirds or more of mentors reported using each strategy listed (Table 23). Strategies implemented by nearly three-quarters or more of JSHS mentors were allowing participant(s) to work independently to improve their self-management abilities (76%), providing participants with constructive feedback to improve their STEM competencies (74%), and Supervising participant(s) while they practice STEM research skills (72%).

Table 23. Mentor Strategies to Support Participant Engagement in "Authentic" STEM Activities (n = 83-84)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	61.9%	38.1%	
	52	32	**84**
Having participant(s) search for and review technical research to support their work	69.0%	31.0%	
	58	26	**84**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	66.7%	33.3%	
	56	28	**84**
Supervising participant(s) while they practice STEM research skills	72.3%	27.7%	
	60	23	**83**
Providing participant(s) with constructive feedback to improve their STEM competencies	73.8%	26.2%	
	62	22	**84**
Allowing participant(s) to work independently to improve their self-management abilities	76.2%	23.8%	
	64	20	**84**

Table 24 shows mentor responses for strategies they used to support students' STEM education and career pathways. The most frequently used strategies in this area included asking students about their educational and/or career goals (81%) and providing guidance about educational pathways that will prepare students for STEM careers (73%). Mentors were more likely to discuss STEM careers and opportunities that were not related to AEOP or the DoD with their students than those opportunities related to AEOP or DoD. Approximately two-thirds of mentors reported discussing STEM career opportunities in industry or academia (63%) with their students, while only 37% of mentors indicated discussing STEM career opportunities within the DoD or other government agencies with their students.

Table 24. Mentors Using Strategies to Support Student STEM Education and Career Pathways (n=83-84)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking participant(s) about their educational and/or career goals	81.0%	19.0%	
	68	16	**84**
Recommending extracurricular programs that align with participants' goals	67.9%	32.1%	
	57	27	**84**
Recommending Army Educational Outreach Programs that align with participants' goals	34.5%	65.5%	
	29	55	**84**
Providing guidance about educational pathways that will prepare participant(s) for a STEM career	72.6%	27.4%	
	61	23	**84**
Discussing STEM career opportunities within the DoD or other government agencies	37.3%	62.7%	
	31	52	**83**
Discussing STEM career opportunities in private industry or academia	63.1%	36.9%	
	53	31	**84**
Discussing the economic, political, ethical, and/or social context of a STEM career	54.2%	45.8%	
	45	38	**83**
Recommending student and professional organizations in STEM to my student(s)	56.0%	44.0%	
	47	37	**84**
Helping participant(s) build a professional network in a STEM field	60.7%	39.3%	
	51	33	**84**
Helping participant(s) with their resume, application, personal statement, and/or interview preparations	67.9%	32.1%	
	57	27	**84**

Students were also asked about multiple teaching and mentoring strategies implemented by their mentors during student research and preparation for the JSHS competition (Table 25). The most frequently reported strategies (approximately three-quarters of students) include: Providing feedback to improve in STEM (79%); Giving extra help when needed (78%); Learning or practicing STEM skills (73%); and Using varied strategies to support learning (73%). While the majority of students reported mentors

discussing the education needed for STEM careers (56%), students indicated their mentors were less likely to recommend AEOP that align with student interests (21%) or discuss DoD STEM careers (19%).

Table 25. R-JSHS Student Reports of Teaching and Mentoring Strategies used by Mentors (n=285)

	Yes – my mentor used this strategy	No – my mentor did not use this strategy	Response Total
Helped me become aware of STEM in my everyday life	59.6%	40.4%	
	170	115	**285**
Helped me understand how I can use STEM to improve my community	62.8%	37.2%	
	179	106	**285**
Used a variety of strategies to help me learn	72.6%	27.4%	
	207	78	**285**
Gave me extra support when I needed it	78.2%	21.8%	
	223	62	**285**
Encouraged me to share ideas with others who have different backgrounds or viewpoints than I do	67.7%	32.3%	
	193	92	**285**
Allowed me to work on a team project or activity	51.9%	48.1%	
	148	137	**285**
Helped me learn or practice a variety of STEM skills	73.0%	27.0%	
	208	77	**285**
Gave me feedback to help me improve in STEM	79.3%	20.7%	
	226	59	**285**
Talked to me about the education I need for a STEM career	55.8%	44.2%	
	159	126	**285**
Recommended Army Educational Outreach Programs that match my interests	20.7%	79.3%	
	59	226	**285**
Discussed STEM careers with the DoD or government	18.9%	81.1%	
	54	231	**285**

Mentors discussing AEOP with their students is one way to ensure students are aware of the program pipeline and can continue to grow in their STEM abilities, interest, and confidence. Table 26 displays mentors' responses to an item asking them which of the AEOP they discussed with their students. While a large proportion of mentors reported speaking with students about JSHS (70%), far fewer (9%-22%) discussed other specific AEOP, and 15% said they discussed AEOP in general, without reference to any specific program, with their students.

Table 26. Mentors Discussing Other AEOP with Participants (n = 83-89)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
Unite	22.1%	77.9%	
	19	67	**86**
Junior Science & Humanities Symposium (JSHS)	69.7%	30.3%	
	62	27	**89**
Science & Engineering Apprenticeship Program (SEAP)	17.0%	83.0%	
	15	73	**88**
Research & Engineering Apprenticeship Program (REAP)	18.6%	81.4%	
	16	70	**86**
High School Apprenticeship Program (HSAP)	16.5%	83.5%	
	14	71	**85**
College Qualified Leaders (CQL)	10.6%	89.4%	
	9	76	**85**
GEMS Near Peer Mentor Program	9.4%	90.6%	
	8	77	**85**
Undergraduate Research Apprenticeship Program (URAP)	12.9%	87.1%	
	11	74	**85**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	16.5%	83.5%	
	14	71	**85**
	10.6%	89.4%	

National Defense Science & Engineering Graduate (NDSEG) Fellowship	9	76	**85**
I discussed AEOP with participant(s) but did not discuss any specific program	15.7%	84.3%	
	13	70	**83**
eCYBERMISSION	10.7%	89.3%	
	9	75	**84**

R-JSHS students reported on their mentor's primary position (Table 27) and general availability (Table 28). Most students said their mentor was either a STEM researcher (47%) or teacher (31%). A large proportion of students reported their mentor was available at least half of the time (70%). Fewer students reported their mentor was available less than half of the time (11%) or never available (3%), and 16% of students said they did not have a mentor at all.

Table 27. R-JSHS Participant Reports of their Mentor's Primary Position (n=285)

	Response Percent	Response Total
I did not have a research mentor	16.1%	46
Teacher	31.2%	89
Coach	0%	0
Parent	3.5%	10
Club or activity leader (School club, Boy/Girl Scouts, etc.)	0%	0
STEM researcher (industry, university, or DoD/government employee, etc.)	47.4%	135
Other, (specify):	1.8%	5

Table 28. R-JSHS Participant Reports of Availability of Mentors (n = 285)

	Response Percent	Response Total
I did not have a mentor	16.1%	46
The mentor was never available	2.8%	8
The mentor was available less than half of the time	10.9%	31
The mentor was available about half of the time of my project	10.2%	29
The mentor was available more than half of the time	26.0%	74
The mentor was always available	34.0%	97

Program Features and Feedback/Satisfaction

Students were asked to respond to several survey items about the nature of their experiences in JSHS. In terms of project design input (Table 29) nearly all (86%) reported having some degree of participation in designing their projects. Specifically, 38% independently designed their entire project, while another 24% reported working with their mentor to design their project, and 19% designed their project with their mentor and members of a research team. Approximately 10% of students indicated not having a project.

Table 29. Participant Input on the Design of Their Project (n = 285)

	Response Percent	Response Total
I did not have a project	9.5%	27
I was assigned a project by my mentor	4.5%	13
I worked with my mentor to design a project	23.9%	68
I had a choice among various projects suggested by my mentor	5.3%	15
I worked with my mentor and members of a research team to design a project	19.3%	55
I designed the entire project on my own	37.5%	107

Table 30 shows that most JSHS students actively participated in scholarly discourse through research dissemination. Two-thirds of R-JSHS students (66%) indicated they had attended a symposium or conference. More than half of R-JSHS participants reported presenting either a talk/poster to other students or faculty (67%) or presenting a talk/poster at a professional symposium/conference (54%). Fewer students noted future plans to share their research through research journals (15%), had already published their work in research journals (17%) or through technical papers/patents (10%). Approximately a quarter (21%) of participants indicated they had won an award or scholarship based on their research.

Table 30. Students' Engagement with Research Dissemination Activities During R-JSHS (n = 285)

	Response Percent	Response Total
I presented a talk or poster to other students or faculty	67.4%	192
I presented a talk or poster at a professional symposium or conference	54.0%	154
I attended a symposium or conference	66.3%	189
I wrote or co-wrote a paper that was/will be published in a research journal	16.5%	47
I wrote or co-wrote a technical paper or patent	9.8%	28
I will present a talk or poster to other students or faculty	32.3%	92

I will present a talk or poster at a professional symposium or conference	27.0%	77
I will attend a symposium or conference	31.6%	90
I will write or co-write a paper that was/will be published in a research journal	15.4%	44
I will write or co-write a technical paper or patent	5.3%	15
I won an award or scholarship based on my research	20.7%	59

R-JSHS students and mentors were both asked to rate their satisfaction with a number of features of the JSHS program. Table 31 shows students' responses to items asking them about their experiences at the R-JSHS event they attended. More than half of students (54%-93%) reported being at least somewhat satisfied with all event features except for team building activities (40% somewhat or very much satisfied, 52% did not experience). Event features with high frequencies of satisfaction (somewhat/very much satisfied reported by approximately 75% or more of students) were student oral presentations (93%), judging process (78%), and feedback from judges (76%). Approximately 10% or less of students expressed dissatisfaction with any R-JSHS feature.

Table 31. Student Satisfaction with R-JSHS Event Features (n = 285)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Student Oral Presentations	4.2%	2.5%	27.7%	65.6%	
	12	7	79	187	**285**
Student Poster Presentations	38.2%	3.2%	19.3%	39.3%	
	109	9	55	112	**285**
Judging Process	11.9%	10.2%	32.3%	45.6%	
	34	29	92	130	**285**
Feedback from Judges	15.4%	8.4%	32.6%	43.5%	
	44	24	93	124	**285**
Feedback from VIPs and Peers	33.3%	4.6%	31.2%	30.9%	
	95	13	89	88	**285**
Invited Speaker Presentations	25.3%	6.7%	31.6%	36.5%	
	72	19	90	104	**285**

Tours or Field Trips	41.4%	4.2%	21.1%	33.3%	
	118	12	60	95	**285**
Team Building Activities	52.3%	8.1%	15.1%	24.6%	
	149	23	43	70	**285**
Social Events	33.7%	5.3%	23.5%	37.5%	
	96	15	67	107	**285**

An open-ended item on the R-JSHS questionnaire asked students to comment on their overall satisfaction with their JSHS experience. Nearly all of the 177 students who provided responses had something to positive to say about JSHS (172, or 97%) had something positive to say about JSHS, and a large majority (152, or 86%) commented only on positive aspects of their JSHS experience. While some students provided only simple affirmations of their program experiences such as "JSHS was a wonderful experience," others provided more detailed feedback about the positive aspects of their JSHS experiences. These students' comments focused upon their satisfaction with meeting new people and networking, the opportunity to present their research, the opportunity to learn about other students' research, the opportunity to learn research and other STEM skills, the judges and the feedback they received, and event features such as the activities offered and the quality of the speakers. Students said, for example,

> *"I truly enjoyed my experiences at JSHS. Meeting new people and hearing about their research was incredibly inspiring for me…The judges were kind, and the coordinators informed the students well throughout the process."* (R-JSHS Student)

> *"Having the practice rooms filled with students asking and watching other people's presentations was really fun. Having discussions between students and judges was also really fun. I'm also glad that we did a lot of team bonding experiences because I got to meet new people and made a new group of friends. Overall, it was a really fun experience. While I got to learn about STEM and new fields and awards, I mainly got the experience of connecting with other people interested in STEM, and that was the most important aspect for me."* (R-JSHS Student)

> *"JSHS was truly a great experience for me. JSHS guided me on how to work on research papers and how to manage time while doing individual sections during the research process. The best experience I have was that I was able to present my research to a bigger audience which gave me a lot of confidence and encouraged me to work further on my passions and interests in scientific research. I was also able to interact with students of my similar interests."* (R-JSHS Student)

"JSHS has been one of my most enjoyable experiences in my high school STEM career. It has taught me the value of scientific research and the value of conferences and presenting one's research. JSHS has taught me the value of diversity in STEM and the importance of scientific research for shaping the future." (R-JSHS Student)

Twenty (11%) of the R-JSHS student respondents made positive comments about the program but also offered caveats, and five students did not have anything positive to say about their JSHS experience. These comments were most frequently focused on dissatisfaction with judging, including lack of or quality of feedback and/or interaction with judges and the perception that judging was biased; suggestions for more specific project categories; teams; a desire for more social interaction time; a desire for more information about other programs; and comments about logistical features of events (e.g., equipment difficulties, lack of organization), and differentiating between mentored and unmentored projects. These students said, for example,

"I had a fun experience overall, but my category was engineering energy which was placed in general engineering but there was no electrical engineers to provide me with accurate feedback." (R-JSHS Student)

"I was very satisfied with my JSHS experience; however, I was not pleased with the judging process. It should have been less biased, as lots of presenters already knew the judges. Also, the judges gave too much value to a singular question, even if the presentation was great. A more diverse group of judges would be better." (R-JSHS Student)

"…The JSHS competition itself was fine. The part that bugged me was the judges themselves. In my presentation, I talked about buffer capacity of soils. I calculated each soil's buffer capacities but did not put units because buffer capacity DOES NOT have a unit-it's unit-less. But the judges kept criticizing me about how I didn't have a unit for buffer capacity. They even wrote such a concept in my judge's feedback page." (R-JSHS Student)

"Students should NOT have been able to present research that they did not do. A lot of students do not do research, rather they just follow what their mentor tells them to." (R-JSHS Student)

"I think that we need to be grouped by types of projects, like 'marine biology', 'engineering', and 'microbial science' as a few examples and have judges that relate to that field. I felt as though the judges in the room I was competing in were biased towards engineering projects because 2/3 of the judges were engineers… The judges were able to ask relevant questions to the two engineering projects in the break-out sessions, but did not know how to address the people that were not engineers...When I was talking with some of the participants afterwards, they expressed their frustrations with being paired up with projects that they felt they had no chance against due to

the judges that were there as well as the difference in 'complexity' of the project and the complete irrelevance it has to their own." (R-JSHS Student)

N-JSHS students were also asked in interviews to share their impressions of their regional events as opposed to the national event. Several students observed that they had been able to attend an in-person regional event and therefore were able to participate in workshops and interact with professionals to a greater extent than at the virtual N-JSHS event. Most students who responded commented upon differences in the judging processes at the regional versus the national level competitions. Several students commented that the judging at the N-JSHS level was more tailored to their project's topic, that N-JSHS judges asked more detailed questions, and that the N-JSHS judges represented more specialized fields. Some students commented that they did not receive feedback from judges at their regional events and were glad that they were able to talk with the judges at the national event. Other students commented that there was less time for judging at N-JSHS as opposed to at their regional event and that they were not able to see their judges at the N-JSHS event.

For example, N-JSHS students made the following comments about judging:

"The original [regional] judging, I feel like was focused on how did you do the project and the like what did you do? And did you understand it? But the national [judging] was more like the little intricacies of everything because I feel like [the judges] had more time or they've had a little more time to like actually to dig into your research and your paper and so. But it's fairly similar. I think the [judging] process is the same and I think it works." (N-JSHS Student)

"For regionals, [the judges] asked all the contestants…the same questions…The questions were not tailored to our project at all. It was just like, I guess, very like surface level questions… like why did you do this research? Like what was your hypothesis and stuff like that…But then for nationals, like they asked me really, really specific questions. [The N-JSHS judges] definitely had a deeper understanding of like what I was saying in my topic…[They asked] more specific and advanced questions [than the R-JSHS judges]." (N-JSHS Student)

"It was kind of disconcerting [at N-JSHS]…I couldn't see the faces of the judges. I didn't know if they were understanding it, if I was explaining it in a way that was optimal. I wasn't a hundred percent sure if I had fully answered everything, whereas when I did my oral presentation at the regional symposium… I could take follow-up questions [and could] physically see their reactions, see how effective my explanations were being." (N-JSHS Student)

Many N-JSHS students and adults participating in phone interviews made positive comments on the virtual format of the N-JSHS competition. The tone of the comments was gratitude that the event was not canceled and appreciation for the hard work of the event organizers to arrange the virtual event.

The only somewhat negative comments about the virtual format of the event were that students were not able to watch other students' presentations and that they were unable to see the judges.

R-JSHS students were asked in a questionnaire item to rate the usefulness of various JSHS resources (Table 32). Nearly half or more (47%-84%) of students reported all resources to be somewhat or very much useful. Resources found to be most useful by students were paper submission and completion deadlines (84%); participation guidelines (78%); and JSHS ground rules for student presentations (74%). Resources not used by more than a third of participants were poster guidelines (46%), selected articles– conducting research (45%), and sample papers (46%).

Table 32. Usefulness of R-JSHS Resources for Participants (n = 285)

	I did not use this resource	Not at all	Somewhat	Very much	Response Total
JSHS Ground Rules for Student Presentations	23.2%	2.8%	31.9%	42.1%	
	66	8	91	120	**285**
Paper Submissions and Competition Deadlines	13.7%	2.8%	28.1%	55.4%	
	39	8	80	158	**285**
Sample Papers	46.0%	7.4%	20.4%	26.3%	
	131	21	58	75	**285**
Oral Presentation Tips	34.0%	5.3%	26.0%	34.7%	
	97	15	74	99	**285**
Selected Articles – Conducting Research	45.3%	4.9%	23.9%	26.0%	
	129	14	68	74	**285**
Poster Guidelines	46.0%	3.2%	23.5%	27.4%	
	131	9	67	78	**285**
Participation Guidelines	20.0%	2.1%	31.9%	46.0%	
	57	6	91	131	**285**

Approximately 80% of R-JSHS students (79%-93%) reported that they were at least somewhat satisfied with all features of their overall JSHS research experience items (Table 33) Students were particularly satisfied with the research experience overall (93% somewhat/very satisfied) and the amount of time they spend doing meaningful research in JSHS (92% somewhat/very satisfied).

Table 33. R-JSHS Participant Satisfaction with their JSHS Research Experience (n=285)

	Did not experience	Not satisfied	Somewhat satisfied	Very satisfied	Response Total
My working relationship with my mentor	16.8%	2.1%	14.0%	67.0%	
	48	6	40	191	**285**
The amount of time I spent doing meaningful research	6.0%	2.5%	22.8%	68.8%	
	17	7	65	196	**285**
The amount of time I spent with my research mentor	16.5%	4.9%	20.7%	57.9%	
	47	14	59	165	**285**
The research experience overall	6.0%	1.4%	19.3%	73.3%	
	17	4	55	209	**285**

R-JSHS students were asked to respond to an open-ended questionnaire item asking respondents to list three ways in which the program could be improved. In the sample of 100 responses analyzed, issues related to event logistics were mentioned the most frequently (90 times). The most frequent topic of students' comments about logistics was presentation details (40) including scheduling of presentations, the length of presentations, general time management at events, allowing longer presentations or more time for questions, and improving time keeping. Improvements to tours and activities (29) and speakers (12) were also mentioned as well as other improvements including comments about the food and housing at regional events and the event venues and timing of events. The next most frequently mentioned area of improvement was judging and awards (mentioned 29 times), with suggestions for general improvements in judging, more judge feedback, more topically diverse judges, and more awards or prizes. Students also suggested improvements to communication (21), having more or different categories for projects (10), providing examples or clearer presentation guidelines (8), and improving registration or submission processes (6).

N-JSHS students participating in interviews were also asked for their suggestions for program improvement. Seven of the 12 students interviewed offered no suggestions for improvement. The five students who responded to this question with improvements suggested making the website easier to navigate, holding in-person events, ensuring that regional events provide sufficient space for poster presentations, rescheduling N-JSHS to the summer so that it does not coincide with AP exams, and providing assistance in identifying mentors. In regard to the last item, the student said,

> *"Some kids…might not have a person that like guides them through everything. So, I kind of feel like they should have the mentors…just because some kids might not have the same resources other kids have and some people's teachers might not be as inclined to help them"* (N-JSHS Student)

JSHS Mentors were also asked about their satisfaction with features of the program (Table 34). More than half (61%-91%) of mentors indicated they were at least somewhat satisfied with all program features except for communicating with NSTA (37% somewhat/very much satisfied; 58% had not experienced). Additionally, 30% of mentors reported having not experienced support for instruction or mentorship during JSHS activities. Very few mentors expressed dissatisfaction with any feature of JSHS.

Table 34. Mentor Satisfaction with JSHS Program Features (n = 100)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	11.0%	2.0%	4.0%	16.0%	67.0%	
	11	2	4	16	67	**100**
Communicating with NSTA	58.0%	1.0%	4.0%	9.0%	28.0%	
	58	1	4	9	28	**100**
Communicating with your JSHS site's organizers	5.0%	0.0%	4.0%	9.0%	82.0%	
	5	0	4	9	82	**100**
Support for instruction or mentorship during program activities	30.9%	2.1%	6.2%	12.4%	48.5%	
	30	2	6	12	47	**97**
Support for instruction or mentorship during JSHS activities	30.0%	3.0%	4.0%	10.0%	53.0%	
	30	3	4	10	53	**100**
Research abstract preparation requirements	24.0%	0.0%	3.0%	15.0%	58.0%	
	24	0	3	15	58	**100**
The physical location(s) of JSHS activities	11.0%	4.0%	4.0%	11.0%	70.0%	
	11	4	4	11	70	**100**

Mentor respondents were also asked to comment on their overall satisfaction with JSHS in an open-ended questionnaire item. Of the 66 mentors and other adults who responded sampled, nearly all (62, or 94%) indicated that they were satisfied with JSHS. Mentors commented on the value of students' opportunity to see others' research, students' learning, the quality of the judging, the speakers and activities at events, and the organization of the JSHS program and events. For example:

> *"The student presentations were outstanding this year and the location of the symposium was great. Fun activities for the students after the first day of competition, good food on both days, and superior keynote presentations! I would look around the room and see that all students were*

engaged during the competition and that they were genuinely interested in learning about other students' projects. Students supported and encouraged each other, and I saw their interest in conducting science research increase. My own students were really excited after the event, started planning new experiments, and felt really proud of their symposium presentations! A tremendous amount of learning and self-growth occurred. Thank you for providing this opportunity for my native Hawaiian students who are severely underrepresented in STEM! With programs like JSHS, we will have a more diversified workforce in the future to address our planet's problems." (JSHS Mentor)

"JSHS has been giving opportunities for our students to excel in the field of STEM. As a teacher and mentor, I saw a lot of growth from my students since the time they were preparing until the day of presentation. JSHS enabled them to think beyond. Thank you JSHS!" (JSHS Mentor)

"EXCEPTIONALLY planned and implemented [regional event] … The financial supports make it possible for our students to participate and attend- including transportation and accommodations. While our students have not had access to professional labs and apprenticeships, the presentations gives them experiences to reach for. It also challenges our teachers to network with community partners to be able to provide interactions for our students…Great event! Thank you for continued support." (JSHS Mentor)

Ten mentors (15%) made positive comments but also offered some caveats, while four respondents (6%) offered no positive comments. These respondents' remarks focused on questions about students' contribution to or originality of their research, students' equitable access to resources, judging, event logistics and scheduling, and the inappropriateness of the evaluation survey for judges. For example,

"The premise of JSHS is great. I just feel that students should do the full scientific method. Most of the winners in JSHS are students who work on existing researchers' ideas and not their own. It is different if the student starts with the idea and the researcher helps them to become reality, but it started with the student. Also, it seemed that a lot of the presentation at our region were analyzing data created elsewhere or by a machine. The student understood the process but didn't actually conduct the process, or the other way around, they kind of did the process but did really understand it. I would rather see a student conduct their own research from scratch and it be less rigorous than to work so closely with a researcher that the line of separation is nonexistent." (JSHS Mentor)

"Overall, I think this was a great experience for our student. However, it was obvious that our student comes from a rural school without access to ongoing basic science research in a world class and well-funded lab. Of the 12 presenters in her room, she was the only one that apparently had designed, implemented, analyzed, and prepared her presentation on her own. All others had

piggy-backed off ongoing medical or scientific research at large clinical research facilities... Furthermore, as far as I could tell, all other students were from private schools, where our student is from a rural public high school in a very poor agricultural part of [the state]. Our student also knows how to do western blots and many other biochemical processes, however since she does not have access to a world class lab, she couldn't couch her ability in a way that made her look like she was about to publish in NEJM or Nature. If I had been a judge, I would have found it very challenging to discern who was simply a good presenter that spend a few afternoons in a University lab connected with their high school, and who actually had designed, completed, and analyzed a project from scratch. I fear that for our student, the experience may have actually enforced the stereotype that wealth and access create opportunities and success." (JSHS Mentor)

"The manner in which the regional JSHS was conducted [in our region] was most disappointing… It turns out that neither the system nor the judges were adequate to provide a fair evaluation…ALL students should present to the SAME judges, or at least there should be 2 rooms with half of the students presenting to the same judges in each…The judges were clearly incompetent…Students and staff should NOT be judges…Overall, many meritorious projects were overlooked and excluded unfairly from the 5 finalists. This was a most disappointing experience. It was inconsiderate for many students who invested a lot of time and effort into this." (JSHS Mentor)

"This year's JSHS experience was fantastic…Overall the judges were fantastic: thoughtful, patient, kind, respectful and creative in their questioning strategies. However, several judges were distinctly not patient, respectful, kind or creative in their questioning strategies. A couple judges were downright disrespectful, condescending, disdainful and snide in their questions and remarks…The whole point of this program is to inspire and encourage students to foster an understanding and a love for science. Adult judges who are disrespectful in their questions and remarks are a powerful disservice to this mission. I simply recommend having even a brief video tutorial training for the judges to remember the power of sensitivities when judging and recommendations for more creative questioning strategies." (JSHS Mentor)

In another open-ended questionnaire item, mentors were asked to identify three strengths of JSHS. Among the responses from the 68 mentors who provided at least one strength, the most often cited strength of JSHS, mentioned by 33 mentors (49%), was the opportunity for students to present their research. Another 21 mentors (31%) cited the opportunity of seeing other students' research and/or the quality of students' research as a program strength and 19 (28%) mentioned the research skills and experience students gain in JSHS. Networking was cited as a strength of JSHS by 17 (25%) of mentors, with 12 (18%) specifically citing the opportunity for students to network with peers as a strength of JSHS. The judging in JSHS was a strength cited by 11 mentors (16%). Other strengths, mentioned by ten or fewer mentors, included the organization and staff associated with their JSHS participation, communication, the

encouragement and motivation students gain from participating, the STEM learning students experience, the exposure to speakers, the diversity of participants in JSHS, and the DoD information students receive.

Mentors and other adults participating in interviews also commented upon the benefits of JSHS. These mentors cited student benefits similar to the program strengths mentioned in open-ended question responses on the questionnaire. Adult interview participants indicated that the opportunity to present research, get feedback from professions, be exposed to peers' work, and network with peers were particular benefits to students. Interview participants said, for example,

> *"The connections that students make [are a benefit of JSHS]...I taught in a rural school and so kids were a lot often times isolated and then they come to these competitions and they see kids and are around kids that have similar interests to them...My oldest daughter is going to turn or just turned thirty-eight and she's still in contact with some of these kids that she met in science fair and JSHS."* (JSHS Mentor)

> *"[A benefit of JSHS is] having them be able to see a diversity of other kinds of projects and... the quality of the papers and being able to learn from each other".* (JSHS Mentor)

> *"JSHS offers benefits for all students. One of the primary benefits in my opinion is that this format, which, which typically includes some kind of interaction with a panel of judges…it best serves to challenge students to think on their feet and be able to handle critical questions and be able to come up with and kind of defend and validate their approach."* (JSHS Mentor)

> *"They're learning how to do that research, analyze, draw conclusions, all of the things you want college kids to do. In general, it just teaches them…really good skills on problem-solving because it never goes as you plan. So, they have to figure out how to solve their problems. They have to find people who can help them figure out the problems if they can't find an answer."* (JSHS Mentor)

Mentors and other adults participating in the interviews also cited benefits to themselves as professional educators. These participants cited the value to themselves of seeing the range of student research presented, the networking they experience while participating in JSHS, the satisfaction of helping students create successful presentations, building rapport with students, and the professional development value of teacher breakout sessions at regional events. Participants said, for example,

> *"It was invaluable to me to… to see kind of what other students were doing."* (JSHS Mentor)

> *"[JSHS] helped me connect with my students... I'm still in contact with them, you know, five years later...And even the students who don't fall in love with it...they come back to me a couple of years later and they're like, 'can you write recommendations?'… It helps me build a better rapport with my students."* (JSHS Mentor)

"I'm making a lot more contacts with teachers around [the state]… And so, I'm personally benefiting from a lot of connections with a) very good teachers and b) very good students." (JSHS Regional Director)

Mentors were also asked to respond to an open-ended item asked them to describe three ways in which JSHS could be improved. There were a wide variety of suggestions made by the 53 mentors who responded to this questionnaire item. The most frequently mentioned suggestions made by 34 mentors (64%) had to do with logistics of the regional events. These comments included suggestions for improvements to the schedule (7), offering more or different activities (7), offering more opportunities for students to interact with one another (4), and offering teacher sessions or workshops (3). The next most frequent suggestion, made by 19 mentors (36%) was improvements in judging, including suggestions for generally improved judging (6), more feedback from judges (7), more or better judges (3), judge training (2), and more judges from the military (1). Other suggestions, mentioned by ten or fewer adult respondents, included conducting more outreach for the program or increasing the numbers of participants, accounting for differentials in access to resources and/or mentoring in judging, and more clearly communicating the rules for presentations.

The adults who participated in phone interviews also offered suggestions for improvements to JSHS. These mentors mentioned several broad programmatic improvements including providing additional supports for teachers and incentives for teachers to participate as mentors, disseminating information about JSHS through pre-service teacher education programs, improving communication between the national and regional levels, providing travel grants at the regional level, incorporating more humanities-based research, and conducting additional outreach to increase the numbers of students participating. Some interview participants made suggestions specific to the national event, including increasing the diversity of speakers at N-JSHS and increasing opportunities for peer engagement. Interview participants said, for example,

"We're piling so much - so many tasks and responsibilities - on teachers by asking them to take on one more thing. It's sometimes a little overwhelming, especially since we don't provide any monetary incentive for these teachers to spend hours every day with these kids...a lot of these teachers just do it out of the goodness of their heart because they're… so passionate about teaching but…if we don't catch them as a pre-service teacher, they may never learn about any of these programs....ninety-nine percent of my pre-service teachers have never heard of JSHS." (JSHS Regional Director)

"If they have to do [N-JSHS] virtually again, I would think that if they could find a way [to connect students with each other], like my student who's presenting - I feel bad for her and she says that she wanted to see what other students were doing…She wanted to see other students, she wanted

to interact with other students. She wanted to have time to meet and make new friends." (JSHS Mentor)

"The name of it is Junior Science and Humanities Symposium, but it's truly not humanities because at the national level they combine psychology with medicine. So, when those psych kids get in a room to get judged, it's like they're kindergarteners compared to the kids presenting on medicine. And...now less and less regionals will send a good psychology [project] because they know they'll be in the medicine [category] and they won't have a chance of winning. So, then it's a wasted spot where you could potentially put a kid in a different category who wasn't as good a presenter because they might have a better shot because it's just their category against then something heavy duty like medicine." (JSHS Mentor)

"What we have found in a lot of our rural schools is, our teachers don't have understanding of the research process and an in-depth understanding of how to do good data collection and…good data analysis techniques and how to interpret results… I haven't been successful in finding help guides for teachers for how to learn about research and how to teach kids how to do research….I don't know if that would be something that JSHS would be interested in supporting and interested in having. You know, experts in their different regions help create different modules for teachers and for students." (JSHS Mentor)

When asked about ways that the program could engage more students from underserved or under-represented populations, adults participating in phone interviews made several suggestions. The most frequent suggestions focused on outreach to and supports for teachers, included providing funding for outreach to teachers, providing workshops or other professional development on research skills to teachers, providing monetary incentives for teachers to participate in JSHS, and engaging middle school teachers to start research programs with students. Another topic frequently discussed was ways to account for or equalize resource disparities between students, including matching students with mentors, pairing students with graduate students at local universities, and/or providing funding to meet the unique needs of underserved and underrepresented students such as stipends to allow students to give up summer jobs and transportation funding for students' travel to lab settings. Another mentor suggested expanding the categories of competition to include, for example, academic writing, in order to allow a greater diversity of students to participate. Other suggestions included partnering with other programs such as TRIO and Upward Bound, making efforts to expand the reach of regional events to public schools beyond magnet schools or governor's schools, and ensuring that there are diverse speakers at events.

7 | Priority #3 Findings

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

How Participants Found out About AEOP

R-JSHS participants were asked how they learned about AEOP (Table 35). The most frequently selected sources of information were school/university newsletter, email, or website (32%) and someone who works at the school/university the student attended (42%). Other responses that more than 10% of students selected were past program participant (17%) and a friend (13%). All other response options were selected by approximately 10% or fewer students.

Table 35. How R-JSHS Participants Learned About AEOP (n = 244)

	Response Percentage	Response Total
Army Educational Outreach Program (AEOP) website	4.9%	12
AEOP on Facebook, Twitter, Instagram, or other social media	1.6%	4
School or university newsletter, email, or website	32.0%	78
Past participant of program	17.2%	42
Friend	12.7%	31
Family member	8.6%	21
Someone who works at the school or university I attend	41.8%	102
Someone who works with the program	2.5%	6
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	0.0%	0
Community group or program	2.0%	5
Choose not to report	6.1%	15

Mentors' responses to how they learned about JSHS are provided in Table 36. The most common responses were related to some form of personal contact including past participation in JSHS (36%), a colleague (28%), a JSHS site host or director (18%), or a student (15%).

Table 36. How JSHS Mentors Learned about AEOP (n = 102)

	Response Percentage	Response Total
National Science Teaching Association (NSTA) website	4.9%	5
Army Educational Outreach Program (AEOP) website	3.9%	4
AEOP on Facebook, Twitter, Pinterest, or other social media	0%	0
A STEM conference or STEM education conference	4.9%	5
An email or newsletter from school, university, or a professional organization	9.8%	10
Past JSHS participant	36.3%	37
A student	14.7%	15
A colleague	27.5%	28
My supervisor or superior	2.9%	3
A JSHS site host or director	17.6%	18
Workplace communications	2.9%	3
Someone who works with the Department of Defense (Army, Navy, Air Force)	2.0%	2
Other, (specify):	5.9%	6

R-JSHS students reported a variety of factors for why they choose to participate in the program (Table 37). The top two motivating factors were interest in STEM (78%) and the desire to learn something new (72%). These were followed by teacher encouragement (58%), having fun (56%), and a desire to expand laboratory or research skills (54%).

Table 37. Factors Motivating Student Participation in R-JSHS (n = 244)

	Response Percentage	Response Total
Teacher or professor encouragement	58.2%	142
An academic requirement or school grade	12.7%	31
Desire to learn something new or interesting	71.7%	175
The mentor(s)	18.0%	44
Building college application or résumé	42.6%	104
Networking opportunities	41.8%	102
Interest in science, technology, engineering, or mathematics (STEM)	77.9%	190
Interest in STEM careers with the Army	13.1%	32
Having fun	55.7%	136
Earning stipends or awards for doing STEM	33.6%	82
Opportunity to do something with friends	20.9%	51
Opportunity to use advanced laboratory technology	36.5%	89
Desire to expand laboratory or research skills	54.1%	132
Learning in ways that are not possible in school	46.3%	113
Serving the community or country	25.8%	63
Exploring a unique work environment	35.2%	86
Figuring out education or career goals	39.8%	97
Seeing how school learning applies to real life	32.4%	79
Recommendations of past participants	18.4%	45
Choose not to report	2.9%	7

N-JSHS students who participated in phone interviews reported learning about JSHS primarily through their teachers, family members or friends, or from their own research. schools, and either from teachers or science fair advisors. These students reported various motivations for participating, including the opportunity to present their research, the networking opportunities, the opportunity to improve their research skills, school or graduation requirements, and having had fun participating previously.

Previous Program Participation and Future Interest

Students were asked to indicate which AEOP they had participated in previously (Table 38). Over half (60%) of respondents reported they had participated in JSHS before. Very few students had participated in any AEOP other than JSHS. Other AEOP students reported past participation in included GEMS (2%), eCYBERMISSION (2%), JSS (<1%), UNITE (<1%), REAP (<1%).

Table 38. R-JSHS Participant Past AEOP Participation (n = 285)

	I have not participated in this program	Once	Twice	Three or more times	Response Total
Gains in the Education of Mathematics and Science (GEMS)	97.9%	1.8%	0.0%	0.4%	
	279	5	0	1	**285**
Junior Solar Sprint (JSS)	99.6%	0.4%	0.0%	0.0%	
	284	1	0	0	**285**
eCYBERMISSION	97.5%	1.4%	0.4%	0.7%	
	278	4	1	2	**285**
Unite	99.6%	0.4%	0.0%	0.0%	
	284	1	0	0	**285**
Junior Science & Humanities Symposium (JSHS)	40.0%	48.4%	7.7%	3.9%	
	114	138	22	11	**285**
Research & Engineering Apprenticeship Program (REAP)	99.6%	0.4%	0.0%	0.0%	
	284	1	0	0	**285**
Science & Engineering Apprenticeship Program (SEAP)	100.0%	0.0%	0.0%	0.0%	
	285	0	0	0	**285**
High School Apprenticeship Program (HSAP)	100.0%	0.0%	0.0%	0.0%	
	285	0	0	0	**285**
GEMS Near Peer Mentor Program	100.0%	0.0%	0.0%	0.0%	
	285	0	0	0	**285**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	99.6%	0.4%	0.0%	0.0%	
	284	1	0	0	**285**

National Defense Science & Engineering Graduate (NDSEG) Fellowship	100.0%	0.0%	0.0%	0.0%	
	285	0	0	0	**285**

R-JSHS students reported on their interest in participating in future AEOP programs (Table 39). Few students expressed they were "not at all" interested in other AEOP (4%-5%), however, more than half of students (58%-76%) reported they had not heard of programs other than JSHS. Many students were interested in participating in other programs, and between 20% and 39% of students expressed at least some future interest in all programs. For example, 48% were at least somewhat interested in the SMART scholarship and 33% were at least somewhat interested in REAP. A large majority of JSHS students (91%) expressed interest in participating again. For example, 48% were at least somewhat interested in the SMART scholarship and 33% were at least somewhat interested in RESAP. A large majority of JSHS students (91%) expressed interest in participating again.

Table 39. R-JSHS Participant Interest in Future AEOP Programs (n = 285)

	I've never heard of this program	Not at all	Somewhat interested	Very interested	Response Total
Unite	76.1%	3.5%	11.9%	8.4%	
	217	10	34	24	**285**
Junior Science & Humanities Symposium (JSHS)	4.6%	4.2%	29.8%	61.4%	
	13	12	85	175	**285**
Science & Engineering Apprenticeship Program (SEAP)	65.3%	2.8%	14.4%	17.5%	
	186	8	41	50	**285**
Research & Engineering Apprenticeship Program (REAP)	64.2%	2.8%	16.5%	16.5%	
	183	8	47	47	**285**
High School Apprenticeship Program (HSAP)	66.0%	3.9%	15.4%	14.7%	
	188	11	44	42	**285**
College Qualified Leaders (CQL)	69.8%	3.5%	14.7%	11.9%	
	199	10	42	34	**285**
GEMS Near Peer Mentor Program	70.5%	4.2%	14.7%	10.5%	
	201	12	42	30	**285**
	64.9%	3.2%	14.7%	17.2%	

Undergraduate Research Apprenticeship Program (URAP)	185	9	42	49	**285**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	58.2%	2.8%	15.8%	23.2%	
	166	8	45	66	**285**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	66.7%	4.9%	12.6%	15.8%	
	190	14	36	45	**285**

Awareness of STEM Careers and DoD STEM Careers and Research

A goal of AEOP is to increase both the number and diversity of students who pursue STEM careers. Thus, the student survey included items to assess students' exposure to STEM careers in general and STEM careers within the DoD more specifically. A large proportion (85%) of R-JSHS students reported learning about at least one STEM job/career during JSHS, and 28% indicated they had learned about five or more (Table 40). Students, however, had learned about far fewer DoD STEM jobs/careers, with approximately half (52%) reporting having heard of at least one, and only 15% having learned about five or more during JSHS (Table 41). These findings are similar to those from FY19.

Table 40. Number of STEM Jobs/Careers Students Learned About During R-JSHS (n =285)

Number of STEM Jobs/Careers	Response Percent	Response Total
None	14.7%	42
One job	9.5%	27
Two jobs	20.7%	59
Three jobs	19.3%	55
Four jobs	8.1%	23
Five or more	27.7%	79

Table 41. Number of Department of Defense (DoD) STEM Jobs/Careers Learned About During R-JSHS (n = 285)

Number of DoD STEM Jobs/Careers	Response Percent	Response Total
None	48.1%	137
One job	12.6%	36
Two jobs	13.0%	37
Three jobs	8.4%	24

Four jobs	2.5%	7
Five or more	15.4%	44

To further explore students' exposure to STEM career opportunities in the DoD, N-JSHS student interview participants were asked whether and how they had learned about STEM career opportunities in the DoD during JSHS. Students responded that their primary exposure to DoD STEM career opportunities occurred by interacting with judges or from previous participation at on-site N-JSHS events. Four students reported learning something about STEM careers in the Army or DoD at their regional events. Students said, for example,

> *"This morning when I was sent the judging panel introductions…I looked and saw fourteen PhD scientists all working for different branches of the…Army and all different branches of the government… I would say that was probably the biggest influence – seeing…the careers, the specific job titles and where they were working currently and that was really interesting."* (N-JSHS Student)

> "*One thing that I was previously unaware of [before JSHS] was how many career opportunities there were with the military."* (N-JSHS Student)

Adults participating in phone interviews concurred that judge interaction, exposure at regional events, and past participation in N-JSHS were primary sources of information about STEM careers in the Army or DoD. One regional director noted a potential downfall of attempting to engage military personnel in regional events. She reported that her region utilized judges from the armed services and provided breakout sessions for students to interact with military personnel, but that the focus of the conversations with students became recruiting, at which point, she reported "the students shut off."

Positive student attitudes about the importance of DoD research are an important prerequisite to continued student interest in the field and potential involvement in the future. As such, Table 42 shows survey results of R-JSHS participants' opinions regarding DoD researchers and research. Nearly all students (96%-97%) selected "strongly agree" or "agree" for each item.

Table 42. R-JSHS Participant Opinions about DoD Researchers and Research (n = 285)

	Strongly Disagree	Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	2.8%	1.4%	57.5%	38.2%	
	8	4	164	109	**285**
	1.8%	1.1%	56.8%	40.4%	

DoD researchers develop new, cutting edge technologies	5	3	162	115	**285**
DoD researchers solve real-world problems	1.8%	2.1%	51.9%	44.2%	
	5	6	148	126	**285**
DoD research is valuable to society	2.5%	1.4%	49.1%	47.0%	
	7	4	140	134	**285**

Interest and Future Engagement in STEM

Developing a STEM-literate citizenry is a key goal of AEOP. To evaluate the impact of JSHS on student interests and likelihood of future engagement in STEM outside of their required school coursework, students rated a series of survey items (Table 43). More than 80% of R-JSHS students reported they were more likely or much more likely to participate in all STEM activities after JSHS. STEM activities in which nearly all students (95% or more) indicated an increased likelihood of participation were: participate in a STEM camp, club, or competition (95%); take an elective STEM class (95%); and work on a STEM project or experiment in a university or professional setting (97%).

A composite score[15] was generated from these future STEM engagement items to test for differences among subgroups of students. No significant differences in students' intent to engage in STEM out of school were found by overall underserved status. However, there were significant differences found by First Generation status (1st gen students less likely to engage) and school location (urban/rural less likely to engage)[16] (*d* = 0.288 and *d*=0.240 respectively, small effect sizes).

Table 43. R-JSHS Impact on Participants' Intent to Engage in STEM Out of School (n = 285)

	Much less likely	Less likely	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	1.8%	7.7%	64.2%	26.3%	
	5	22	183	75	**285**
Tinker (play) with a mechanical or electrical device	2.1%	13.0%	57.5%	27.4%	
	6	37	164	78	**285**

[15] The Likely to Engage composite had a Cronbach's alpha reliability of 0.924.
[16] Independent samples *t*-test results for STEM Identity by First Generation Status: $t(283) = 2.42$, $p = 0.016$; and School Location: $t(283) = 2.02$, $p = 0.044$.

Work on solving mathematical or scientific puzzles	4.2%	9.1%	54.0%	32.6%	
	12	26	154	93	**285**
Use a computer to design or program something	3.5%	15.1%	48.8%	32.6%	
	10	43	139	93	**285**
Talk with friends or family about STEM	1.4%	4.2%	48.1%	46.3%	
	4	12	137	132	**285**
Mentor or teach other students about STEM	1.4%	6.3%	44.9%	47.4%	
	4	18	128	135	**285**
Help with a community service project related to STEM	0.7%	6.3%	46.7%	46.3%	
	2	18	133	132	**285**
Participate in a STEM camp, club, or competition	0.7%	3.9%	44.9%	50.5%	
	2	11	128	144	**285**
Take an elective (not required) STEM class	1.1%	4.2%	44.9%	49.8%	
	3	12	128	142	**285**
Work on a STEM project or experiment in a university or professional setting	1.1%	2.5%	40.4%	56.1%	
	3	7	115	160	**285**

R-JSHS students' education aspirations after participating in JSHS are reported in Table 44. Nearly all students (97%) reported planning to earn at least a bachelor's degree. Further, 85% of students reported they intend to earn a master's degree or higher, and 72% said that they plan to earn a terminal degree (doctorate, medical degree, professional law or business degree).

Table 44. After R-JSHS - Participant Education Aspirations (n = 285)

After JSHS Aspirations	Response Percent	Response Total
Graduate from high school	1.8%	5
Go to a trade or vocational school	0.7%	2
Go to college for a little while	<1%	1
Finish college (get a bachelor's degree)	9.5%	27
Get more education after college	2.8%	8
Get a master's degree	13.0%	37

Get a Ph.D.	27.0%	77
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	20.0%	57
Get a combined masters/ Ph.D.	19.3%	55
Get another professional degree (law, business, etc.)	5.6%	16

Resources

R-JSHS survey participants were asked which resources impacted their awareness of AEOP (Table 45). Resources that more than half of students indicated had at least somewhat of an impact on their awareness of AEOP were: JSHS program staff or site coordinators (64%); presentations or information shared at the competition (60%); and invited speakers (55%). JSHS mentors had less of an impact, with less than half of R-JSHS students (42%) reporting that mentors helped them learn about AEOP. AEOP electronic efforts had the least impact of the resources with nearly two-thirds or more indicating they did not experience the AEOP website (65%) or AEOP social media (73%).

Table 45. Impact of Resources on R-JSHS Participant Awareness of AEOP (n = 285)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	64.6%	7.0%	19.6%	8.8%	
	184	20	56	25	**285**
AEOP on Facebook, Twitter, Pinterest or other social media	73.0%	9.8%	13.0%	4.2%	
	208	28	37	12	**285**
AEOP printed materials	67.7%	7.7%	17.5%	7.0%	
	193	22	50	20	**285**
JSHS program staff or site coordinator	28.1%	8.1%	39.3%	24.6%	
	80	23	112	70	**285**
Invited speakers at JSHS	35.4%	9.5%	31.9%	23.2%	
	101	27	91	66	**285**
Presentations or information shared at the JSHS competition	29.1%	10.9%	31.2%	28.8%	
	83	31	89	82	**285**
	47.7%	10.5%	20.4%	21.4%	

My JSHS mentor(s)	136	30	58	61	**285**

Table 46 shows R-JSHS students' reports about the usefulness of various AEOP resources for learning about DoD STEM careers. Resources rated by more than half of students as having at least somewhat of an impact on their learning about DoD STEM careers were presentations or information shared at the competition (54%); invited speakers (51%); and JSHS program staff or site coordinators (53%). JSHS mentors had less of an impact with 37% of R-JSHS students reporting that mentors impacted their learning about DoD STEM careers. Again, AEOP electronic efforts had the least impact of the resources with many students reporting they did not experience AEOP social media (75%) or the AEOP website (69%).

Table 46. Impact of Resources on R-JSHS Student Awareness of DoD STEM Careers (n = 285)

	Did not experience	Not at all	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	68.8%	6.3%	17.2%	7.7%	
	196	18	49	22	**285**
AEOP on Facebook, Twitter, Pinterest or other social media	75.1%	8.4%	12.6%	3.9%	
	214	24	36	11	**285**
AEOP printed materials	68.4%	6.0%	18.2%	7.4%	
	195	17	52	21	**285**
JSHS program staff or site coordinator	36.1%	10.9%	32.6%	20.4%	
	103	31	93	58	**285**
Invited speakers or career events	39.3%	10.2%	27.4%	23.2%	
	112	29	78	66	**285**
Presentations or information shared at the JSHS competition	34.7%	11.2%	32.6%	21.4%	
	99	32	93	61	**285**
My JSHS mentor(s)	51.6%	11.9%	21.4%	15.1%	
	147	34	61	43	**285**

Tables 47 and 48 show mentor responses to the same usefulness of resources items. Mentors felt somewhat more strongly than students about the usefulness of resources related to exposing students to AEOP compared to DoD STEM careers. Resources mentors reported as most useful (somewhat or very much) were JSHS program staff of site coordinators (75% AEOP, 67% DoD STEM careers); presentations

or information shared at the JSHS competitions (68% AEOP, 57% DoD STEM careers); and invited speakers or "career" events (46% AEOP, 51% DoD STEM careers).

Table 47. Mentor Responses about Usefulness of Resources for Exposing Students to AEOP (n = 102)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	66.7%	2.9%	4.9%	11.8%	13.7%	
	68	3	5	12	14	**102**
AEOP on Facebook, Twitter, Pinterest or other social media	82.4%	2.0%	4.9%	3.9%	6.9%	
	84	2	5	4	7	**102**
AEOP printed materials	63.7%	2.9%	5.9%	9.8%	17.6%	
	65	3	6	10	18	**102**
JSHS program staff or site coordinator	17.6%	2.0%	5.9%	11.8%	62.7%	
	18	2	6	12	64	**102**
Invited speakers or "career" events	46.1%	2.9%	4.9%	16.7%	29.4%	
	47	3	5	17	30	**102**
Presentations or information shared at the JSHS competition	26.5%	3.9%	2.0%	18.6%	49.0%	
	27	4	2	19	50	**102**

Table 48. Usefulness of Resources for Exposing Students to DoD STEM Careers (n = 102)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	67.6%	2.9%	8.8%	7.8%	12.7%	
	69	3	9	8	13	**102**
AEOP on Facebook, Twitter, Pinterest or other social media	82.4%	0.0%	4.9%	4.9%	7.8%	
	84	0	5	5	8	**102**
AEOP printed materials	62.7%	1.0%	7.8%	12.7%	15.7%	
	64	1	8	13	16	**102**
JSHS program staff or site coordinator	24.5%	2.0%	6.9%	10.8%	55.9%	
	25	2	7	11	57	**102**
Invited speakers or "career" events	39.2%	4.9%	4.9%	17.6%	33.3%	
	40	5	5	18	34	**102**

Presentations or information shared at the JSHS competition	32.4%	4.9%	5.9%	13.7%	43.1%	
	33	5	6	14	44	**102**

Overall Impact

Table 49 presents findings on the overall impact of participating in JSHS and the program's impact on student awareness of and interest in STEM opportunities; perceptions of the impact on JSHS on their skills, confidence, and knowledge; and knowledge of and appreciation for STEM research and careers in the DoD. Half or more of R-JSHS students (50%-81%) agreed that JSHS contributed to or was primarily responsible for their growth in all areas. Students felt particularly impacted in the areas of confidence in their STEM knowledge, skills, and abilities (81%); interest in participating in STEM activities outside of school requirements (77%); and interest in earning a STEM degree (70%).

Overall impact of JSHS items were combined into a composite variable[17] to assess for differences between student subgroups. No significant differences were found in overall impact were found by underserved status or any individual demographic factors.

Table 49. R-JSHS Participant Opinion of JSHS Impacts (n = 285)

	Disagree - This did not happen	Disagree - This happened but not because of JSHS	Agree - JSHS contributed	Agree - JSHS was primary reason	Response Total
I am more confident in my STEM knowledge, skills, and abilities	3.5%	15.1%	66.3%	15.1%	
	10	43	189	43	**285**
I am more interested in participating in STEM activities outside of school requirements	1.8%	21.8%	61.8%	14.7%	
	5	62	176	42	**285**
I am more interested in taking STEM classes in school	3.2%	27.4%	56.8%	12.6%	
	9	78	162	36	**285**
I am more interested in earning a STEM degree	4.6%	24.6%	58.6%	12.3%	
	13	70	167	35	**285**
I am more interested in pursuing a career in STEM	4.6%	26.0%	56.8%	12.6%	
	13	74	162	36	**285**

[17] The Cronbach's alpha reliability for Overall Impact items was 0.879.

I have a greater appreciation of Army or DoD STEM research	22.1%	11.9%	43.5%	22.5%	
	63	34	124	64	**285**
I am more interested in pursuing a STEM career with the Army or DoD	37.2%	13.0%	35.1%	14.7%	
	106	37	100	42	**285**

In order to further understand the impact of regional participation in JSHS on students, an open-ended item on the questionnaire asked R-JSHS students to list the three most important ways they benefited from JSHS. Among the 100 responses sampled, students noted a variety of benefits of JSHS participation. The most frequently mentioned benefit cited by two-thirds of respondents (66 students) was the opportunity to present their research and develop presentation and communication skills. Networking, either in general, with peers, or with professionals, was the next most frequently mentioned benefit (32%), followed by STEM learning (28%), developing research or STEM skills (25%), and exposure to others' research (24%). Twenty participants (20%) cited the feedback they received on their research and the judging as benefits, while 19% cited the career information they received. Other benefits mentioned by 12%-16% of responding students were developing confidence and increasing interest and motivation for STEM.

N-JSHS students participating in phone interviews cited similar benefits. These students emphasized the value of presentation experience, interacting with the judges, being able to learn about others' research, the value of the career information they received, being able to network with other student participants (referencing the 2019 national event), and the value of the feedback they received on their projects. Students said, for example,

> *"You get to interact with all these amazing scientists, and they get to question you about your work and it's just a great learning experience."* (N-JSHS Student)

> *"If you listen to other people's presentations, you're able to learn about topics that don't get covered in your typical chemistry or biology curriculum. And it's really cool to learn about specific fields of STEM people are pursuing within their research projects."* (N-JSHS Student)

> *"Being able to speak to a general audience was probably the most beneficial thing because…being able to, um, change my presentation in a way that more people can understand is very beneficial."* (N-JSHS Student)

> *"A benefit of [JSHS] is definitely the people that I've connected with when I was there last year…I think in the future we'll definitely stay friends and I don't know, maybe we'll…do some big projects together."* (N-JSHS Student)

8 | Findings and Recommendations

Summary of Findings

The FY20 evaluation of JSHS 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 below in Table 50.

Table 50. 2020 JSHS Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
The number of JSHS applicants in FY20 remained about the same as in FY19, however there was a substantial increase in program-reported student participation, reversing a multi-year downward in participation.	This number of applicants in FY20 (4,511) was nearly the same (.4% increase) as in FY19 when 4,493 students applied; this continues the positive growth in the number of JSHS applicants in the two most recent years, reversing a previous decline experienced from FY15 to FY17 (4,279 applicants in FY18; 8,663 applicants in FY17; 8,947 in FY16; 9,347 in FY15).
	There was a substantial increase in student participation in FY20 (3,462 participants), as 31% more students participated as compared to FY19 when 2,651 students competed. This increase begins to reverse the multiyear downward trend in participation since FY15 (3,069 participants in FY18; 5,577 in FY17; 5,620 in FY16; and 5,829 in FY15).
	Program managers reported that no consistent definition for "JSHS participant" has been used by sites in reporting participation, resulting in inconsistent site reports of student participation. The program rectified this by defining a participant as any student who submits their research in Cvent when registering; this definition will be used by sites going forward.
JSHS continues a trend of enrolling a majority of female participants.	Slightly more than half (58%) of R-JSHS students were female and 41% were male, a distribution very similar to previous program years (FY19, 59% female, 40% male: FY18, 58% female, 40% male).
The ethnic/racial diversity of JSHS remains relatively constant compared to previous program years, with White and Asian being the most	Less than half (43%) of students identified themselves as White (compared to 50% in FY19 and 57% in FY18). Slightly less than a third (31%) of R-JSHS students identified themselves as Asian (27% in FY19; 20% in FY18). Less than 10% of students identified themselves as Black

frequently reported races/ethnicities, however the proportion of White students continues a multiyear decline while the percentage of Asian students continues to increase as compared to previous years.	or African American (5% in FY20; 5% in FY19; 6% in FY18) or Hispanic/Latino (6% in FY20; 7% in FY19; 5% in FY18).
The population of N-JSHS participants was similar to that of R-JSHS although more students were Asian, and fewer were other races/ethnicities as compared to the overall R-JSHS population.	The demographic make-up of students participating in N-JSHS was similar to that of the overall population of R-JSHS students substantially more students in the N-JSHS population were Asian (44%) as compared to the overall R-JSHS population (31%), and only 2% of N-JSHS students were Black or African American and only 2% were Hispanic or Latino.
The proportion of JSHS students meeting the AEOP definition of underserved increased slightly in FY20	In FY20, there was some growth in reaching underserved students by JSHS, as 44% overall met the underserved criteria for AEOP, as compared to previous years (44% in FY20; 41% in FY19; 37% in FY18).
Students reported that they actively engaged in STEM practices in JSHS but that this engagement was not significantly more frequent than in their typical school experiences.	Students reported engaging in a wide variety of STEM practices in their JSHS experiences and indicated that they performed each STEM practice more often (weekly or every day) during JSHS than in school, with the exception of working collaboratively as part of a team (30% did not do this in JSHS as compared to 11% in school). Students engaged in the following activities more frequently in JSHS than in school: analyzing data or information and drawing conclusions (65% in JSHS compared to 61% in school); solving real-world problems (56% in JSHS compared to 52% in school); designing and carrying out an investigation (56% in JSHS compared to 48% in school); using laboratory procedures and tools (53% in JSHS compared to 48% in school); and designing their own research or investigations based on their own questions (51% in JSHS compared to 42% in school).
	There was no significant difference in engagement in STEM practices by underserved status or by any individual demographic component of underserved status.
	Students participating in phone interviews noted several differences in their engagement in STEM in JSHS as compared to in school, including the opportunities JSHS provides to interact with scientists, to present research, and to receive expert feedback on their research; the broader exposure to STEM topics JSHS provides, the career information students gained, the hands-on research experience, the opportunity to see others' projects, and the opportunity to interact with like-minded peers.
Students reported gains in their STEM knowledge and	A majority (75% or more) of JSHS students reported medium or large gains in all areas of STEM knowledge due to their participation in JSHS.

STEM competencies (skills in science and engineering practices) as a result of participating in JSHS; FARMS and underserved racial/ethnic minority students reported larger STEM competency gains than their peers.	For example, approximately 80% of students reported medium to large gains in in-depth knowledge of a STEM topic (81%) and knowledge of how scientists and engineers work on real problems in STEM (77%).
	There was no significant difference in gains in STEM knowledge by underserved status or by any individual demographic component of underserved status.
	Approximately two-thirds or more of students (64%-81%) reported medium or large gains in their STEM competencies as a result of participating in JSHS. More than three-quarters of students reported medium to large gains in multiple STEM competencies, including using knowledge and creativity to suggest a solution to a problem (78%); carrying out an experiment and recording data accurately (79%); and presenting an argument that uses data and/or findings from an experiment (81%).
	There was no significant difference in gains in STEM competencies by overall underserved status, however students who received free or reduced-price lunch (FARMS) reported a significantly greater impact on their STEM competencies compared to their peers who did not receive free or reduced-price lunch (small effect size). Significant differences were also identified by race/ethnicity, with underserved minority students reporting significantly greater JSHS impact on their STEM competencies compared to their peers (small effect size).
Students reported gains in their 21st Century skills as a result of participating in JSHS.	With the exception of one of the 21st Century Skills (creating media products, for which 36% reported no gain), more than half of students (54%-85%) reported at least medium gains in all 21st Century skills. Areas with largest reported 21st Century skills gains (approximately 80% or more reporting medium to large gains) included: taking initiative and doing work without being told to (79%); incorporating feedback on work effectively (79%); adapting to change when things do not go as planned (80%); and communicating clearly with others (85%).
	There was no significant difference in gains in 21st Century skills by overall underserved status or by any individual demographic component of underserved status.
Students reported gains in their STEM identities as a result of participating in JSHS; FARMS students, students from underserved racial/ethnic minority groups, and female students reported larger gains than their peers.	Three-quarters or more of students (74%-81%) reported medium or large gains across all STEM identity items. Areas of the greatest reported gains (80% or higher in medium/large) were: confidence to try out new ideas or procedures on STEM projects (81%); desire to build relationships with mentors who work in STEM (81%); and being better prepared for more challenging STEM activities (80%).
	There was no significant difference in gains in STEM identity by overall underserved status, however FARMS students, students from underserved racial/ethnic minority groups, and female students reported larger gains than their peers (small effect sizes).

Priority #2: *Support and empower educators with unique Army research and technology resources.*	
Most JSHS students had worked with mentors who were either teachers or STEM researchers; most mentors were available to students at least half of the time.	Most students indicated their mentor was either a STEM researcher (47%) or teacher (31%). A large proportion of students reported their mentor was available at least half of the time (70%).
Most students participated in the design of their research projects either independently or with their mentors.	Nearly all students (86%) reported having some degree of participation in designing their research projects. Specifically, 38% independently designed their entire project, while another 24% reported working with their mentor to design their project, and 19% designed their project with their mentor and members of a research team.
Most mentors used a variety of effective mentoring strategies with their students, however few discussed AEOP other than JSHS with their students.	Most responding mentors (54%-84%) reported using strategies associated with establishing the relevance of learning activities to students, supporting the diverse needs of learners, supporting students' development of collaboration and interpersonal skills, and supporting students' engagement in "authentic" STEM activities.
	Although over two-thirds (70%) of mentors discussed JSHS with students and 22% discussed Unite, relatively few mentors (11%-17%) reported speaking with students about other AEOP specifically or about AEOP generally.
Students reported high levels of satisfaction with JSHS program components.	More than half of students (54%-93%) reported being at least somewhat satisfied with all event features except for team building activities (40% somewhat or very much satisfied, 52% did not experience). Event features with high frequencies of satisfaction (somewhat/very much satisfied reported by approximately 75% or more of students) were student oral presentations (93%), judging process (78%), and feedback from judges (76%).
	Few students expressed dissatisfaction with any JSHS features on the questionnaire although, similar to FY19, 10% expressed dissatisfaction with the judging process and 8% with feedback from judges. As in FY19, about half of students had not experienced team-building activities, however a slightly larger proportion of students (8%) expressed dissatisfaction with this element as compared to FY19 (6%).
	Qualitative data from students suggest that students particularly valued meeting new people and networking, the opportunity to present their research, the opportunity to learn about other students' research, the opportunity to learn research and other STEM skills, the judges and the feedback they received.

	Students who commented on judging during the interviews noted that the judging at the N-JSHS level was more tailored to their project's topic, that N-JSHS judges asked more detailed questions, and that the N-JSHS judges represented more specialized fields. Some students commented that they did not receive feedback from judges at their regional events. Other students commented that there was less time for judging at N-JSHS as opposed to at their regional event and that they were not able to see their judges at the N-JSHS event.
Students and mentors made positive comments about the virtual N-JSHS event.	Many N-JSHS students and adults participating in phone interviews commented positively on the virtual format of the N-JSHS competition. The tone of the comments was gratitude that the event was not canceled and appreciation for the hard work of the event organizers to arrange the virtual event. Most comments about the virtual event were also positive. The only somewhat negative comments about the virtual format of the event were that students were not able to watch other students' presentations and that they were unable to see the judges.
JSHS students made various suggestions for program improvement.	JSHS students suggested a range of improvements in survey responses, including the following: • Improvements to event logistics, including the scheduling and length of presentations (allowing a longer time), time management at events, and improving tours, event activities, and speakers • Improvements to judging and awards such as providing more judge feedback, more topically diverse judges, and more awards or prizes • Improvements to communication • Providing more or different categories for projects • Providing examples and/or clearer presentation guidelines • Improving the registration or submission process.
	Most N-JSHS students participating in phone interviews had no suggestions for improvement. The five who made suggestions recommended making the website easier to navigate, holding in-person events (rather than virtual), ensuring that regional events provide sufficient space for poster presentations, rescheduling N-JSHS to the summer so that it does not coincide with AP exams, and providing assistance in identifying mentors.
Mentors reported high levels of satisfaction with JSHS and suggested various program improvements.	More than half (61%-91%) of mentors indicated they were at least somewhat satisfied with all program features except for communicating with NSTA (37% somewhat/very much satisfied; 58% had not experienced). Additionally, 30% of mentors reported having not experienced support for instruction or mentorship during JSHS activities. Very few mentors (1%-4%) expressed dissatisfaction with any feature of JSHS.

	Qualitative data from mentors indicate that mentors particularly valued students' opportunity to see others' research, students' learning, the quality of the judging and judges' feedback, the speakers and activities at events, students' opportunities to network with professionals and peers, and the organization of the JSHS program and events.
	Mentors suggested that JSHS could be improved by the following: • Improving event logistics and scheduling, including providing more or different activities, more opportunities for students to interact with one another, and teacher sessions or workshops • Increasing the diversity of speakers at events • Improving judging, including more feedback from judges, more or better judges, providing training for judges, and providing more judges from the DoD • Providing additional supports for teachers and incentives for teachers to participate as mentors • Increasing publicity for or improving program outreach, and disseminating JSHS information to preservice teacher programs • Improving communication between the national and regional levels.
	Mentors participating in interviews suggested ways to broaden the reach of JSHS, including the following: • Focusing on outreach to and supports for teachers, including providing funding for participating teachers, disseminating program information to preservice teacher education programs, and engaging middle school teachers to encourage them to start research programs. • Devising ways to account for or equalize resource disparities between students, including matching students with mentors, pairing students with graduate students at local universities, and/or providing funding to meet the unique needs of underserved and underrepresented students such as stipends • Partnering with programs such as TRIO and Upward Bound • Expanding the categories of competition to include, for example, academic writing, in order to allow a greater diversity of students to participate.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Students' primary source of Information about AEOP is communication through their schools; students were	The most frequently selected sources of information for JSHS students were school/university newsletter, email, or website (32%) and someone who works at the school/university the student attended (42%).

motivated to participate by their interest in STEM and their desire to learn. Mentors learned about AEOP primarily through personal or professional contacts.	The top two factors motivating students to participate in JSHS were interest in STEM (78%) and the desire to learn something new (72%). These were followed by teacher encouragement (58%), having fun (56%), and a desire to expand laboratory or research skills (54%).
	The most common ways mentors learned about AEOP related to some form of personal contact including past participation in JSHS (36%), a colleague (28%), a JSHS site host or director (18%), or a student (15%).
Most students had not heard of most AEOP other than JSHS although many expressed interest in participating in other AEOP in the future. Program staff and event presentations were the most impactful resources for both mentors and students to learn about other AEOP.	Few students expressed they were "not at all" interested in participating in AEOP in the future (4%-5%), however, more than half of students (58%-76%) reported they had not heard of programs other than JSHS.
	Between 20% and 39% of students expressed at least some future interest in all programs. For example, 48% were at least somewhat interested in the SMART scholarship and 33% were at least somewhat interested in REAP. A large majority of JSHS students (91%) expressed interest in participating again.
	Resources that more than half of students indicated had at least somewhat of an impact on their awareness of AEOP were: JSHS program staff or site coordinators (64%); presentations or information shared at the competition (60%); and invited speakers (55%). JSHS mentors had less of an impact, with less than half of JSHS students (42%) reporting that mentors helped them learn about AEOP; another 11% indicated that AEOP information from mentors was not helpful. Around two-thirds of students had not experienced the AEOP website (65%) and AEOP printed materials (68%).
	Mentors reported that the most useful resources of AEOP information were: JSHS program staff of site coordinator (75%), presentations or information shared at the JSHS competitions (68%) and invited speakers or "career" events (46%). Around two-thirds of mentors had not experienced the AEOP website (67%) and AEOP printed materials (64%).
JSHS participants learned about STEM careers in JSHS, although they learned about more STEM careers generally than about STEM careers in the DoD was limited; students had positive perceptions of DoD research and researchers.	A large proportion (85%) of JSHS students reported learning about at least one STEM job/career during JSHS, and 28% indicated they had learned about five or more. Students, however, had learned about far fewer DoD STEM jobs/careers, with approximately half (52%) reporting having heard of at least one, and only 15% having learned about five or more during JSHS.
	N-JSHS students noted in interviews that their exposure to DoD STEM career opportunities was primarily from interacting with judges during the N-JSHS event or from previous participation at N-JSHS events rather than from regional competitions.

	JSHS students were asked to identify which resources were most impactful on their awareness of DoD STEM careers. Resources rated by more than half of students as having at least somewhat of an impact on their learning about DoD STEM careers were presentations or information shared at the competition (54%); invited speakers (51%); and JSHS program staff or site coordinators (53%). JSHS mentors had less of an impact with 37% of R-JSHS students reporting that mentors impacted their learning about DoD STEM careers (52% said that they did not experience this).
	Resources mentors reported as most useful (somewhat or very much) for exposing students to DoD STEM careers were JSHS program staff of site coordinators (67%), presentations or information shared at the JSHS competitions (57%) and invited speakers or "career" events (51%).
	JSHS students had positive opinions about DoD research and researchers. Nearly all students (96%-97%) selected "strongly agree" or "agree" for each survey item they responded to, including that DoD researchers solve real-world problems (96%) and develop new cutting-edge technologies (97%).
JSHS students reported being more likely to engage in STEM activities outside of required school courses in the future; students who would be first-generation college attendees and those who attended suburban schools were more likely to report intentions to engage in STEM in the future than their peers.	More than 80% of R-JSHS students reported they were more likely or much more likely to participate in all STEM activities after JSHS. STEM activities in which nearly all students (95% or more) indicated an increased likelihood of participation were: participate in a STEM camp, club, or competition (95%); take an elective STEM class (95%); and work on a STEM project or experiment in a university or professional setting (97%).
	While there were no differences in likelihood of future engagement in STEM by overall underserved status, students who would be first-generation college attendees and those who attended suburban or non-urban/non-rural schools were more likely to report intentions to engage in STEM in the future than their peers (small effect sizes).
Nearly all JSHS participants had educational aspirations beyond earning an undergraduate degree after participating in JSHS.	Nearly all students (97%) reported planning to earn at least a bachelor's degree. Further, 85% of students reported they intend to earn a master's degree or higher, and 72% said that they plan to earn a terminal degree (doctorate, medical degree, professional law or business degree).
JSHS students reported positive impacts from their JSHS participation and experienced a variety of benefits from participating.	Half or more of R-JSHS students (50%-81%) agreed that JSHS contributed to or was primarily responsible for their growth in all areas associated with their interest in STEM opportunities; their STEM skills, confidence, and knowledge; and their knowledge of and appreciation for STEM research and careers in the DoD. Students reported particularly great impacts in the areas of their STEM knowledge, skills, and abilities (81%); interest in participating in STEM activities outside of

	school requirements (77%); and interest in earning a STEM degree (70%).
	More than a third of JSHS students (37%) reported that JSHS had not increased their interest in pursuing a STEM career with the DoD.
	There was no significant difference in impact of JSHS by overall underserved status or any individual demographic component of underserved status.
	Student responses to an open-ended questionnaire item indicate that students experienced a number of benefits from participating in JSHS, including the following: • The opportunity to present their research and develop presentation and communication skills • Networking, either in general, with peers, or with professionals • STEM learning • Developing research or STEM skills • Exposure to others' research • Feedback on research and judging • Career information • Confidence • Increasing interest in or motivation for STEM.

Recommendations for FY21 Program Improvement/Growth

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. FY20 JSHS evaluation findings indicate that JSHS experienced success as in previous years, including continuing a two-year trend of growing participation in the program overall. Regarding underserved student participation, JSHS increased this percentage to 44% in FY20. Participants were overwhelmingly positive about the delivery of JSHS through the virtual format – as many commented about being pleased that this opportunity was made available to them during the pandemic when so many other things were being cancelled.

Other notable successes for the year include continual impacts on STEM knowledge, STEM identity, and 21st Century skills. While these successes are commendable, there are some areas that remain with the potential for growth and/or improvement. The evaluation team, therefore, offers the following recommendations for FY21 and beyond:

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

JSHS continued to make progress in growing both the number and diversity of participants (44% underserved) in the program in FY20. It is recommended that JSHS continue to explore growing the geographical reach of engagement in the program – as findings from the evaluation this year indicate JSHS has the greatest impact (statistically significant differences) on students from lower socio-economic status groups and those coming from rural and urban areas. Growing participation across these target groups will continue to increase the percentage of underserved students in JSHS each year.

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

Empowering educators and mentors with Army resources and support is something JSHS has been actively working to improve each year. However, in FY20 mentors reported two persistent concerns that continue to be a challenge for JSHS to address. First, most mentors (83%) reported they had not discussed any other AEOP specifically or in general with students. There appears to be some disconnect between JSHS and AEOP overall for the educators and other adults participating in the program, as 67% shared they were not familiar with the AEOP website. Second, only 52% of JSHS participants reported learning about one more DoD STEM jobs/careers. Findings for FY20 in this area indicate a need for NSTA/JSHS to revisit current resources/strategies for supporting educators with AEOP information, materials, and AEOP pipeline program details. Educators should be well equipped to introduce, discuss, and promote AEOP and DoD programs, as well as jobs/careers with JSHS participants. NSTA/JSHS should revisit current resources/strategies for supporting educators with DoD information, materials, etc, to include jobs/careers within in the DoD, not just AEOP.

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

Related to findings for educators in FY20 under the second priority, participants in JSHS overwhelmingly (58% to 76%) had not heard about other AEOP besides JSHS. This is not surprising given that few educators/adults reported discussing AEOP with participants. Despite not hearing about other programs, 91% indicated interest in participating in JSHS again. Between 20-39% of participants expressed some interest in future AEOP program (other than JSHS) participation. This finding has been prevalent across evaluations from FY15 to present without much improvement despite some efforts to encourage regional sites to promote AEOP. Due to the significance and importance of making participants aware of the other AEOP and resources in the pipeline, we strongly encourage NSTA to implement a plan of how to better grow mentor and participant awareness of other AEOP in FY21. A recommendation is to consider adding a section to the JSHS website that advertises various AEOP, Air Force, Navy STEM programs and career opportunities.

Other feedback specific to JSHS improvements that were suggested by both mentors and participants that warrant attention by NSTA include: improving event logistics and scheduling (allowing more time for presentation), more feedback from judges (multiple years this has been requested), and more diversity in judges and speakers. It is recommended that NSTA develop a plan for addressing these areas as well.