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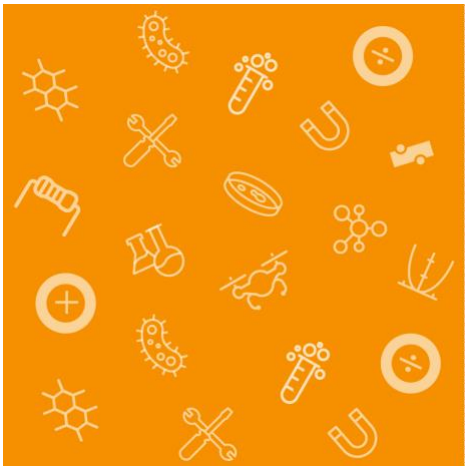

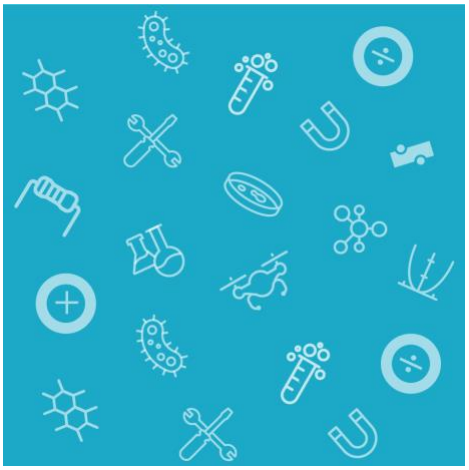

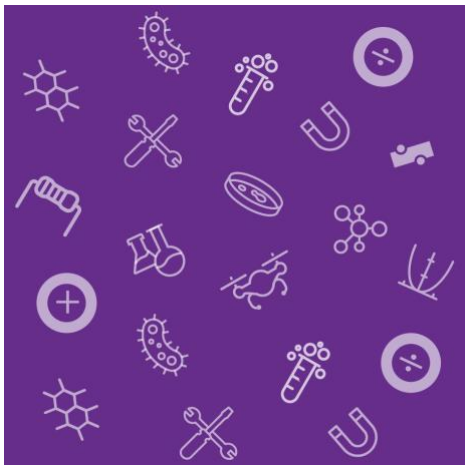


ARMY EDUCATIONAL OUTREACH PROGRAM

JSHS

2018 Annual Program Evaluation Report Findings

August 2019

aeop
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 Academy of Applied Science (AAS) 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 Purdue 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 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 held at 46 university campus sites nationwide in 2018. The top five students in each region received an expense-paid trip to the 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. The AAS 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 national's scientific and technological workforce.

The 46 R-JSHS sites reported that they received applications from 4,279 students and were able to accommodate 71% of these. This is a substantial decrease in applications compared to FY17 when applications were received from 8,663 students and FY16 when 8,947 students applied and FY15 when 9,347 students applied. Fewer applicants were selected in FY18 than in FY17 when 5,577 students were served (23% decrease). This continues a multi-year downward trend since in FY16 when 5,620 students were selected and since FY15 when 5,829 were selected. Table 1 summarizes interest and final selection as reported by the sites.

Table 1. 2018 JSHS Site Applicant and Selection Numbers			
2018 JSHS Site	**No. of Student Applicants**	**No. of Selected Students**	**No. of Selected Teachers**
Alabama	49	49	18
Alaska	23	22	5
Arizona	54	54	10
Arkansas	42	42	5
California No. & W. Nevada	49	39	
California Southern	25	23	26
Connecticut	226	163	37
Europe	57	34	12
Florida	125	178	37
Georgia	145	54	8
Hawaii	85	52	8
Illinois	19	19	6
Illinois-Chicago	8	8	
Indiana	32	32	
Intermountain	69	68	17
Iowa	258	18	57
Kansas-Nebraska-Oklahoma	37	35	15
Kentucky	33	32	19
Louisiana	95	87	10
Maryland	69	36	
Michigan Southeastern	34	23	11
Missouri	97	97	15
New England Northern	79	79	8
New England Southern	39	39	16
New Jersey Shore	80	127	13
New Jersey Rutgers	128	70	34
New York Long Island	189	102	49
New York Metro	213	100	42
New York Upstate	427	131	67
North Carolina	95	91	32
North Central	90	89	7
Ohio	273	251	24
Oregon- Did not host in 2018	0	0	0
Pacific	315	116	20
Pennsylvania	24	23	25

Puerto Rico	98	50	11
Philadelphia	23	23	3
South Carolina	186	186	36
Southwest	18	15	1
Tennessee	42	42	19
Texas	78	60	20
Virginia	87	87	18
Washington	45	30	5
Washington D.C.	70	144	16
West Virginia	5	5	2
Wisconsin	30	30	8
Wyoming-Eastern Colorado	14	14	3
Total	**4279**	**3069**	**804**

In addition to students, JSHS engaged approximately 2,015 teachers, faculty, graduate students, and others, including 139 DoD STEM scientists and engineers (S&Es). Table 2 provides an overview of participants by category.

Table 3 displays demographic information for student participants reported by AAS. As in previous years, not all JSHS regions collected demographic data about participants through Cvent. In FY18, these data were available for 2,995 of the total of 3,069 students enrolled (65%). For the R-JSHS students for whom demographic data were available, slightly more than half (58%) were female and 40% were male. Over half (57%) of students identified themselves as White with another 20% identifying themselves as Asian. While 2% of students chose not to report their race/ethnicity, 6% identified themselves as Black or African American and 5% as Hispanic or Latino. Over a third of R-JSHS students (37%) met the AEOP criteria for U2.

Table 2. 2018 JSHS Participation	
Participant Group	**No. of Participants**
High school students (grades 9-12)	3,069
K-12 teachers	804
College/university faculty or other personnel	1072
Army/DoD Scientists & Engineers	139
Total	**6615**

Table 2. 2018 JSHS Student Profile (for registrants opting to complete this information)				
Demographic Category	**R-JSHS Participants (n=2,955)**		**N-JSHS Participants (n=202)**	
Participant Gender				
Female	1,712	57.9%	120	59.4%
Male	1,168	39.5%	81	40.1%
Choose not to report	75	2.5%	1	<1%
Participant Race/Ethnicity				
Asian	597	20.2%	60	29.7%
Black or African American	174	5.9%	6	1.5%
Hispanic or Latino	155	5.2%	8	4.0%
Native American or Alaska Native	7	<1%	0	0.0%
Native Hawaiian or Other Pacific Islander	8	<1%	0	0.0%
White	1,681	56.9%	108	53.5%
Other race or ethnicity	91	3.1%	8	4.0%
Choose not to report	47	1.6%	15	7.4%
School Location				
Urban (city)	679	23.0%	53	26.2%
Suburban	1,325	44.8%	98	48.5%
Rural (country)	393	13.3%	28	13.9%
DoDDS/DoDEA School	48	1.6%	7	3.5%
Home school	6	<1%	2	1.0%
Online school	2	<1%	1	<1%
Frontier or Tribal school	2	<1%	0	0.0%
Choose not to report	500	16.9%	13	6.4%
Free or Reduced Price Lunch Recipient				
Yes	323	10.9%	13	6.4%
No	1,653	55.9%	142	70.3%
Choose not to report	979	33.1%	33	16.3%
English is a first language				
Yes	1,870	63.3&	155	76.7%
No	223	7.5%	10	5.0%
Choose not to report	862	29.2%	37	18.3%
First Generation Status				
Yes	235	8.0%	12	5.9%
No	1,807	61.2%	150	74.3%
Choose not to report	795	26.9%	40	19.8%
U2 Classification				
Yes	1,088	36.8%	77	38.1%
No	1,834	62.1%	125	61.9%
Choose not to report or no data	33	1.1%	0	0.0%

Table 3 outlines costs of the JSHS program for 2018. The cost per student participant for FY18 was $609 and total cost was $1,871,919.

Table 3. 2018 JSHS Program Costs	
2017 JSHS – Summative Cost Breakdown	
Administrative/Overhead/Indirect/Cost Share	$314,963
Regional JSHS Support	$730,335
National Program	$328,832
Scholarships and Awards	$420,000
Other Operational Costs	$59,084
Travel Costs – Paid for S&E's	$18,705
Total Cost	**$1,871,919**
Cost Per Student Participant	**$609**

4 | Evaluation At-A-Glance

Purdue University, in collaboration with AAS, 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 • AAS 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 46 regional symposia • STEM professionals judge presentations and select regional winners • Regional winners advance to N-JSHS (Hunt Valley, MD). • 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 AAS 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 4. 2018 Student Questionnaires

Category	Description
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level, confidence to achieve educational goals, field sought
AEOP Goal 1	**Capturing the Student Experience:** In-school vs. In-program experience; 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 AEOPs 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 5. 2018 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 programs; efforts to expose students to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing student AEOP metrics
	Army/DoD STEM: attitudes toward Army/DoD STEM research and careers, efforts to expose students to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing student Army/DoD career metrics
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies
	Comprehensive Marketing Strategy: How mentors learn about AEOP, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
	Program Specific Online Resources: Usefulness of online resources for supporting students in participating in AEOP

Table 6. 2018 Student Focus Groups	
Category	**Description**
Profile	Gender, grade level, past participation in JSHS, past participation in other AEOP programs
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 7. 2018 Mentor Focus Groups	
Category	**Description**
Profile	Gender, occupation, role in JSHS, past participation in JSHS, past participation in other AEOP programs
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 8. 2018 Annual Program Report	
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 engineers 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 examination of participant outcomes and other areas that would 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 technology progress. Thus, it is important to consider how JSHS is marketed and ultimately recruits student participants, 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.[1] STEM competencies are necessary for a

[1] 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.

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. Focus group protocols are provided in Appendix B (students) and Appendix C (mentors); questionnaires are provided in Appendix D & E (students) and Appendix F (mentors). Major trends in data and analyses are reported herein.

Study Sample

Students participating in the JSHS national competition, students from 29 of the 46 regional competitions, and mentors from 34 of the 46 regional sites make up the respondents to evaluation questionnaires. Regardless of number of students mentored, mentors completed the mentor questionnaire once. Whether students advanced to N-JSHS or not they completed the same regional level survey, and therefore their responses do not distinguish between R-JSHS and N-JSHS. For each item on the survey, participants have the option to skip an item or not respond to the question. Therefore the number of respondents for items may vary in the reporting of results as indicated in tables in this report.

Table 9 provides outcomes of student and mentor participation in the JSHS questionnaires, response rates, and the margins of error at the 95% confidence level (a measure of how representative the sample is of the population). The margin of error for the regional student survey is within an acceptable range although the margins of error for mentor surveys and for national student surveys are larger than generally acceptable, indicating that the samples may not be representative of these populations.

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

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

Table 9. 2018 JSHS Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence[2]**
R-JSHS Students	429	3,069	9.32%	±4.39%
N-JSHS Students	28	240	11.67%	± 17.44%
Adult Volunteers/Mentors	165	4,199	3.93%	± 7.48%

Focus groups were conducted at the national JSHS event in Hunt Valley, Maryland. The student focus group included 15 students (8 females, 7 males). The mentor focus groups included 2 mentors (1 female, 1 male). Focus groups were not intended to yield generalizable findings; rather they were intended to provide additional evidence of, 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

Table 10 illustrates the demographic information provided by FY18 JSHS questionnaire respondents. For FY18 there was an increase in females responding to the questionnaire (63% female, 37% male), compared to the gender distribution for respondents in FY17 (female 59%; male 41%). Similar to FY17, among R-JSHS respondents, more students identified with the race/ethnicity category of White 56% (compared to 55% in FY17) than any other single race/ethnicity category. Also, there continued to be substantial representation of Asian (26%) respondents. Over a third of respondents (38%) were rising 11th graders or 12th graders (35%). Table 11 shows that a majority of JSHS regional respondents attended public schools (84%), and more than half attended schools in suburban areas (53%). Few students reported receiving free and reduced lunch (FARMS) (14%), being a college first generation student (13%), or an English language learner (ELL) (6%). Students were identified as meeting AEOPs underrepresented status (U2) if they possessed two or more of the following demographics: female, racial/ethnic minority, urban/rural/frontier school location, FARMS, ELL status, or college first generation. More than half (55%) of the survey participants met AEOPs U2 criteria.

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

In FY18, CVENT was used by a total of 34 of 46 JSHS Regional Symposia and the National JSHS. AEOP common questions and demographic data collection were consistently accessed through those regions who implemented CVENT as their registration tool. Since 12 of the 46 regional symposia did not use CVENT and therefore provided incomplete demographic information for participants, it is difficult to make any strong comparisons between the survey respondent group and actual program participation. Available data suggests, however, that survey respondents who provided demographic information are similar to the overall population of enrolled students for whom data is available in terms of gender and race or ethnicity. A somewhat larger proportion of R-JSHS questionnaire respondents qualified for U2 status as compared to the overall population (55% of questionnaire respondents; 37% of R-JSHS participants).

Table 10. 2017 R-JSHS Student Respondent Profile

Demographic Category	R-JSHS Questionnaire Respondents	
Respondent Gender (n = 429)		
Female	272	63%
Male	157	37%
Respondent Race/Ethnicity (n = 429)		
Asian	113	26%
Black or African American	25	6%
Hispanic or Latino	25	6%
Native American or Alaska Native	4	1%
Native Hawaiian or Other Pacific Islander	3	1%
White	242	56%
Other race or ethnicity (specify):[†]	17	4%
Respondent Grade Level (n = 429)		
9th	30	7%
10th	72	17%
11th	164	38%
12th	149	35%
1st Year College Student	1	<1%
Other	13	3%
Free and Reduced Lunch Status (FARMS) (n = 426)		
Yes	61	14%
No	257	60%
Choose Not to Report	108	26%
English Language Leaner (ELL) Status (n = 426)		
Yes	25	6%
No	317	74%
Choose Not to Report	84	20%
College First Generation (n = 426)		
Yes	54	13%
No	277	65%
Choose Not to Report	95	22%
U2 Status (2 or more underrepresented indicators) (n = 426)		
Yes	232	55%
No	131	30%
Choose Not to Report	63	15%

[†]Other = Mediterranean; Asian Latina; Indian (3); Half White, Half Indian; Japanese, White; Mix-White, Native American, African American; I prefer not to say; Mixed (3); White and Asian (2); Half Asian, Half White; Jew; Half White Half Pacific Islander; Middle Eastern; Choose not to report; Bi-racial

Table 11. 2018 R-JSHS Student Respondent School Information

Demographic Category	R-JSHS Questionnaire Respondents	
Respondent School Location (n=429)		
Suburban	227	53%
Urban (city)	110	26%
Rural (country)	91	21%
Frontier or tribal school	1	<1%
Respondent School Type (n=429)		
Public school	355	84%
Private school	55	13%
Department of Defense school (DoDDS or DoDEA)	12	3%
Home school	4	<1%
Online school	3	<1%

Table 12 shows student respondents by the highest level of competition they achieved in JSHS. While 21% of responding R-JSHS students participated in non-presenting roles (student delegate/observer), all but 4% of responding N-JSHS students participated in presenting roles. Distribution of respondents' participation at R-JSHS and N-JSHS are aligned with the focus of each competition level. Specifically, student delegate and observer roles at R-JSHS are intended to facilitate future participation at the R-JSHS level while N-JSHS is structured so that most participants present their research.

Table 12. 2018 JSHS Student Respondent Roles		
Highest Level of Competition Achieved in 2018	**R-JSHS Questionnaire Respondents (n = 429)**	**N-JSHS Questionnaire Respondents (n = 28)**
Oral presenter	48%	39%
Poster presenter	23%	57%
Non-presenting participant	21%	0%
Non-competitive poster presenter	8%	0%
Other	0%	4%

Mentor Demographics

FY18 mentor questionnaire respondent demographics are provided in Table 13. Over half of mentors responding to the questionnaire were female (63%). Responding mentors were predominantly White

(81%). Few mentors of color (11%) responded to the questionnaire (8% Asian, 2% Black or African American, 1% Hispanic). Most of the mentors identified their occupations as teachers (68%), while nearly a tenth indicated they were university educators (8%) or professional scientists, engineers, or mathematicians (8%).

Table 13. 2018 JSHS Mentor Respondent Profile

Demographic Category	Questionnaire Respondents	
Respondent Gender (n = 165)		
Female	104	63%
Male	60	36%
Choose not to report	1	1%
Respondent Race/Ethnicity (n = 165)		
Asian	13	8%
Black or African American	4	2%
Hispanic or Latino	2	1%
Native American or Alaska Native	1	1%
Native Hawaiian or Other Pacific Islander	0	0%
White	134	81%
Other race or ethnicity, (specify):[†]	1	1%
Choose not to report	10	6%
Respondent Occupation (n = 165)		
Teacher	112	68%
Other school staff	3	2%
University educator	14	8%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	7	5%
Scientist, Engineer, or Mathematics professional	14	8%
Other, (specify)[‡]	15	9%
Respondent Role in JSHS (n = 165)		
Research Mentor	54	33%
Competition advisor	11	67%
Other, (specify)[§]	25	15%
Teacher	98	59%
Invited Speaker	4	2%
Judge	23	14%

[†] No responses provided.

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.

Table 14 details the frequency with which students reported engaging in STEM Practices while in school. Table 15 shows students' responses for participating in the same STEM Practices in JSHS. Participants indicated that they participated in most STEM Practices more frequently in JSHS than in school. For example, 55% of participants reported having worked with a STEM researcher or company on a real-world STEM project at least once in JSHS while only 42% of respondents indicated having the same experience in school. Similarly, half (50%) of R-JSHS respondents indicated they engaged in solving real world problems at least monthly in JSHS while fewer (45%) reported the same in school. At the same time, respondents indicated they worked collaboratively as part of a team significantly more often in school (85% at least once) as compared to JSHS (69% at least once).

Table 14. Nature of Student STEM Practices in School for R-JSHS Respondent (n = 423-427)

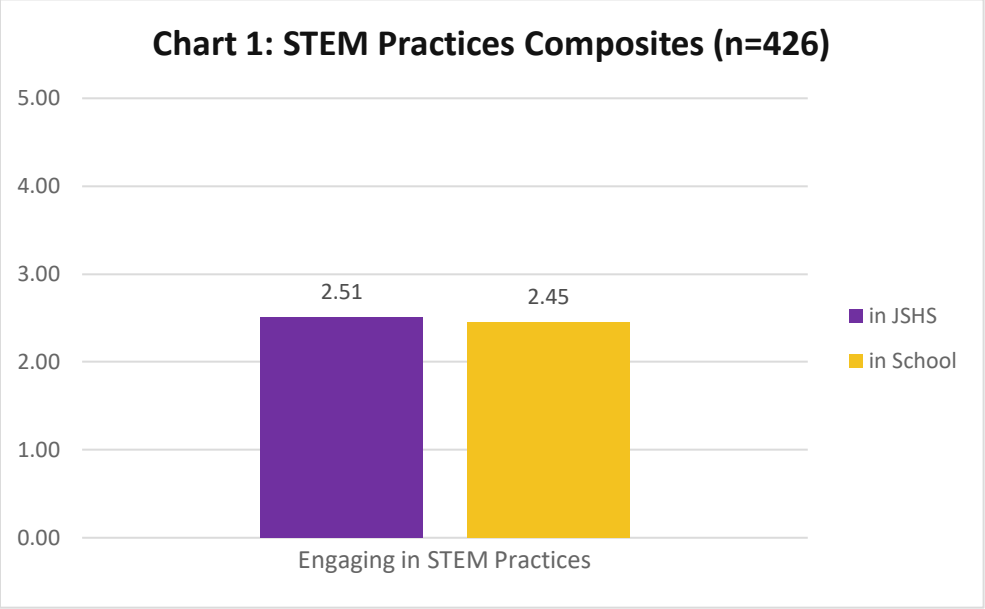
	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project.	57.7%	19.0%	4.5%	12.9%	5.9%	
	246	81	19	55	25	**426**
Work with a STEM researcher on a research project topic assigned by my teacher.	63.6%	20.6%	5.2%	6.9%	3.8%	
	269	87	22	29	16	**423**
Design my own research or investigation based on my own question(s).	21.4%	40.4%	13.5%	13.3%	11.4%	
	90	170	57	56	48	**421**
Present my STEM research to a panel of judges from industry or the military.	52.9%	39.8%	5.6%	1.4%	0.2%	
	225	169	24	6	1	**425**
Interact with STEM researchers.	35.8%	34.7%	14.6%	9.2%	5.7%	
	152	147	62	39	24	**424**
Use laboratory procedures and tools	15.0%	22.8%	22.5%	29.6%	10.1%	
	64	97	96	126	43	**426**
Identify questions or problems to investigate	12.8%	24.6%	22.9%	22.2%	17.5%	
	54	104	97	94	74	**423**
Design and carry out an investigation	13.6%	30.2%	24.4%	20.6%	11.2%	
	58	129	104	88	48	**427**
Analyze data or information and draw conclusions	11.0%	21.3%	24.4%	29.5%	13.8%	
	47	91	104	126	59	**427**
Work collaboratively as part of a team	15.3%	18.3%	16.7%	25.1%	24.6%	
	65	78	71	107	105	**426**
Build or make a computer model	64.8%	20.6%	6.1%	5.2%	3.3%	
	274	87	26	22	14	**423**
Solve real world problems	22.8%	32.2%	14.3%	14.3%	16.4%	
	97	137	61	61	70	**426**

Table 15. Nature of Student STEM Practices in JSHS for R-JSHS Respondents (n = 420-427)

	Not at all	At least once	Monthly	Weekly	Every day	Response Total
Work with a STEM researcher or company on a real world STEM research project.	45.0%	18.5%	9.8%	17.3%	9.4%	
	192	79	42	74	40	**427**
Work with a STEM researcher on a research project topic assigned by my teacher.	66.3%	15.8%	4.7%	8.5%	4.7%	
	281	67	20	36	20	**424**
Design my own research or investigation based on my own question(s).	16.8%	38.9%	8.8%	17.5%	18.0%	
	71	164	37	74	76	**422**
Present my STEM research to a panel of judges from industry or the military.	42.1%	44.9%	6.9%	3.5%	2.6%	
	178	190	29	15	11	**423**
Interact with STEM researchers.	27.3%	30.3%	16.8%	16.6%	9.0%	
	115	128	71	70	38	**422**
Use laboratory procedures and tools	23.7%	21.8%	12.8%	24.4%	17.3%	
	100	92	54	103	73	**422**
Identify questions or problems to investigate	14.7%	28.4%	14.9%	23.6%	18.4%	
	62	120	63	100	78	**423**
Design and carry out an investigation	15.2%	31.6%	12.4%	22.6%	18.3%	
	64	133	52	95	77	**421**
Analyze data or information and draw conclusions	14.0%	24.8%	17.1%	25.5%	18.6%	
	59	104	72	107	78	**420**
Work collaboratively as part of a team	30.7%	24.6%	10.4%	16.1%	18.2%	
	130	104	44	68	77	**423**
Build or make a computer model	66.5%	15.9%	6.2%	6.2%	5.2%	
	280	67	26	26	22	**421**
Solve real world problems	24.1%	25.5%	12.3%	16.5%	21.5%	
	102	108	52	70	91	**423**

A composite score was calculated for this set of items, titled "STEM Practices."[3] Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and the average across all items in the scale was calculated. The composite score was used to test whether there were differences in student experiences by overall U2 status and each individual component of U2 (gender, race/ethnicity group, FARMS, ELL, school location, college first generation). No significant group differences found in terms of STEM Practices in JSHS by U2 status, but there was a significant difference found by FARMS with those receiving FRL reporting less engagement with STEM Practices than those who do not receive FRL[4] (small effect of d = 0.243 standard deviations). No other demographics related to U2 status showed significant differences in terms of STEM Practices in JSHS.

To compare how students perceived their JSHS STEM Practice experiences to their typical school experiences, students' responses to the item about how often they engaged in the same STEM Practice activities in school were combined into composites[5] that are parallel to the ones asking about JSHS. Students reported slightly greater "STEM Practices" in JSHS than in school but the difference was not statistically significant (see Chart 1). It is important to note, however, that these data may not entirely 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 therefore not conceptualize STEM practices in JSHS and STEM practices in school as separate phenomena.



[3] The Cronbach's alpha reliability for these 12 Engaging in STEM in JSHS items was 0.911.
[4] Two-tailed independent samples t-test: $t(316) = 2.16$, $p = 0.032$.
[5] The Cronbach's alpha reliability for the 12 Engaging in STEM in School items was 0.894.

N-JSHS students who participated in the focus group cited several differences in their engagement in STEM in JSHS versus their engagement in STEM in school. In particular, N-JSHS students cited the opportunity to apply their STEM knowledge, the research skills they gained, the exposure to a cohort of like—minded peers, the rigor of expectations, and the expertise of the judge feedback as unique elements of JSHS as compared to typical school experiences. For example,

> "I think there's no comparison between my experiences at JSHS and at school…[At school] they don't tell you what to do with that knowledge and they don't teach you how to explore. JSHS actually takes people that have [experience in these] fields and use that knowledge and apply it…and puts them in front of you." (N-JSHS Student)

> "I love coming here and participating…you get to be with people who are passionate about what you're passionate about, and you're not excluded like you normally are at school. You're with people who are excited about what you're excited about. You can all speak the same language, and it's just a great place to make friends." (N-JSHS Student)

> "I'm actually in a research class at my school. Even so, I think that here my project is definitely held to a higher standard. It's expected that I'm doing work in the conditions that are standard for my field…Even being involved in rigorous science classes at school, there is another layer here, I think." (N-JSHS Student)

> "It's nice that JSHS a lot of times has professionals who are working in your field, so that they can actually give you useful feedback to better your presentation." (N-JSHS Student)

STEM Knowledge and Skills

To measure to what extent students build STEM knowledge and skills while engaging in in JSHS activities, the questionnaire asked participants to report on gains in knowledge and specific skills related to STEM. A majority (70% or more) of R-JSHS students reported medium or large gains in all areas of STEM knowledge due to their participation in the JSHS program (see Table 16). Nearly all (90% or more) students reported at least some gain in all areas. For example, 95% of students reported gains in knowledge of research conducted in a STEM topic or field; 94% in in-depth knowledge of a STEM topic; and 93% in knowledge of how scientists and engineers work on real problems in STEM as well as knowledge of what everyday research work is like in STEM.

Questionnaire items assessing the impact of participating in JSHS on STEM Knowledge were combined into a composite variable[6] to test for differences between U2 status and subgroups of students. No significant differences between any subgroups or overall U2 status were found in terms of student reported STEM Knowledge.

Table 16. R-JSHS Participant Reports of Impact on STEM Knowledge (n = 421-423)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	6.2%	22.3%	35.8%	35.8%	
	26	94	151	151	**422**
Knowledge of research conducted in a STEM topic or field	5.0%	17.0%	32.4%	45.6%	
	21	72	137	193	**423**
Knowledge of research processes, ethics, and rules for conduct in STEM	7.8%	22.6%	31.6%	38.0%	
	33	95	133	160	**421**
Knowledge of how scientists and engineers work on real problems in STEM	6.6%	19.4%	34.3%	39.7%	
	28	82	145	168	**423**
Knowledge of what everyday research work is like in STEM	6.6%	22.3%	30.8%	40.3%	
	28	94	130	170	**422**

Students were also asked to rate their gains in skills related to science and engineering practices, or STEM Competencies (see Table 17). A majority (55% or more) of students reported medium or large gains in all but one area (using computer models, 46%) of STEM Competencies. Further, a large majority (80% or more) reported at least some gain in all areas except for using computer models (68%). For example, 93% of students reported gains in using knowledge and creativity to suggest a solution to a problem; 92% identifying limitations of the methods and tools used for data collection; and 92% in asking questions that can be answered with one or more scientific experiment.

[6] The Cronbach's alpha reliability for these 5 items was 0.935.

Table 17. R-JSHS Participant Gains in their STEM Competencies – Science and Engineering Practices (n = 418-422)

	No gain	Small gain	Medium gain	Large gain	Response Total
Asking a question that can be answered with one or more scientific experiments	8.5%	21.1%	38.4%	32.0%	
	36	89	162	135	**422**
Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation	6.6%	20.9%	36.0%	36.5%	
	28	88	152	154	**422**
Using knowledge and creativity to suggest a solution to a problem	6.5%	17.9%	36.8%	38.8%	
	27	75	154	162	**418**
Making a model of an object or system showing its parts and how they work	20.4%	23.2%	28.2%	28.2%	
	86	98	119	119	**422**
Designing procedures for an experiment that are appropriate for the question to be answered	9.7%	21.1%	32.9%	36.3%	
	41	89	139	153	**422**
Identifying the limitations of the methods and tools used for data collection	8.1%	21.6%	33.9%	36.5%	
	34	91	143	154	**422**
Carrying out procedures for an experiment and recording data accurately	10.0%	19.0%	31.1%	39.9%	
	42	80	131	168	**421**
Using computer models of objects or systems to test cause and effect relationships	31.7%	22.6%	21.2%	24.5%	
	133	95	89	103	**420**
Organizing data in charts or graphs to find patterns and relationships	10.9%	23.7%	28.4%	37.0%	
	46	100	120	156	**422**
Considering different interpretations of data to decide if a solution to a problem works as intended	10.0%	25.2%	31.0%	33.8%	
	42	106	130	142	**420**
Considering different interpretations of data when deciding how the data answer a question	11.2%	23.3%	30.9%	34.7%	
	47	98	130	146	**421**
Supporting an explanation for an observation with data from experiments	8.6%	20.7%	30.2%	40.6%	
	36	87	127	171	**421**

Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge	9.0%	20.9%	33.0%	37.1%	
	38	88	139	156	**421**
Supporting a solution for a problem with data	8.4%	19.3%	31.3%	41.1%	
	35	81	131	172	**419**
Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations	8.3%	20.9%	34.0%	36.8%	
	35	88	143	155	**421**
Defending an argument that conveys how an explanation best describes an observation	9.3%	23.5%	31.6%	35.6%	
	39	99	133	150	**421**
Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts	9.5%	23.0%	32.7%	34.8%	
	40	97	138	147	**422**
Identifying the strengths and limitations of solutions in terms of how well they meet design criteria	12.1%	20.9%	34.4%	32.5%	
	51	88	145	137	**421**
Integrating information from technical or scientific texts and other media to support your explanation of an observation	9.8%	23.1%	31.2%	36.0%	
	41	97	131	151	**420**
Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)	8.3%	16.6%	29.7%	45.4%	
	35	70	125	191	**421**
Integrating information from technical or scientific texts and other media to support your solution to a problem	11.2%	23.8%	31.1%	34.0%	
	47	100	131	143	**421**

Composite scores were calculated for student STEM Competency gains.[7] Using these composites to look for differential programmatic impacts on overall U2 status and student subgroups, no significant difference in STEM Competency skills were found.

Table 18 provides student responses about the impact of JSHS on their 21st Century Skills. Approximately two-thirds or more of respondents reported medium or large gains in all areas, and large majorities (85% or more) of students reported at least small gains in all areas. Some areas with largest reported 21st Century Skills gains included setting goals and reflecting on performance (92%); sticking with a task until

[7] The STEM Competencies composite (21 items) has a Cronbach's alpha reliability of 0.977.

it is finished (92%); and making changes when things do not go as planned (92%). A 21st Century Skills[8] composite variable was formed from the corresponding items on the questionnaire. No significant differences in 21st Century Skills were found by gender, race/ethnicity, or free/reduced-lunch status.

Table 18. R-JSHS Participant Reports of Impacts on 21st Century Skills (n = 415-418)

	No gain	Small gain	Medium gain	Large gain	Response Total
Learning to work independently	11.7%	16.0%	22.0%	50.2%	
	49	67	92	210	**418**
Setting goals and reflecting on performance	7.9%	16.3%	24.6%	51.2%	
	33	68	103	214	**418**
Sticking with a task until it is finished	8.4%	15.6%	21.3%	54.7%	
	35	65	89	228	**417**
Making changes when things do not go as planned	8.4%	12.8%	23.6%	55.2%	
	35	53	98	229	**415**
Working well with people from all backgrounds	14.9%	21.6%	21.6%	41.8%	
	62	90	90	174	**416**
Including others' perspectives when making decisions	13.4%	19.1%	27.3%	40.2%	
	56	80	114	168	**418**
Communicating effectively with others	10.3%	15.6%	24.8%	49.3%	
	43	65	103	205	**416**
Viewing failure as an opportunity to learn	9.4%	14.6%	22.8%	53.2%	
	39	61	95	222	**417**

[8] The 21st Century Skills composite (8 items) had a Cronbach's alpha reliability of .941.

STEM Identity and Confidence

Because students are unlikely to pursue STEM further in their education and/or careers if they do not see themselves as capable of succeeding in STEM[9], deepening students' STEM identities and confidence is important for increasing the likelihood of students pursuing STEM careers. Table 19 displays student responses to a series of questionnaire items intended to measure the impact of JSHS on students' STEM identities. Large majorities (more than 80%) of students reported at least some gain in all areas of STEM identity, and nearly two-thirds or more indicated medium to large gains. Areas of particularly large reported gains included confidence to try out new ideas or procedures on their own in STEM projects (92%); desire to build relationships with mentors who work in STEM (91%); and connecting a STEM topic or field to personal values (90%).

Table 19. R-JSHS Participant Reports on JSHS Impacts on STEM Identity (n = 415-417)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	12.7%	19.7%	27.1%	40.5%	
	53	82	113	169	**417**
Deciding on a path to pursue a STEM career	17.8%	21.4%	24.6%	36.1%	
	74	89	102	150	**415**
Sense of accomplishing something in STEM	11.5%	18.5%	23.7%	46.3%	
	48	77	99	193	**417**
Feeling prepared for more challenging STEM activities	10.6%	14.5%	27.7%	47.2%	
	44	60	115	196	**415**
Confidence to try out new ideas or procedures on my own in a STEM project	7.7%	15.1%	26.9%	50.2%	
	32	63	112	209	**416**
Patience for the slow pace of STEM research	11.5%	21.1%	27.8%	39.6%	
	48	88	116	165	**417**
Desire to build relationships with mentors who work in STEM	9.1%	15.3%	27.3%	48.2%	
	38	64	114	201	**417**

[9] 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.

Connecting a STEM topic or field to my personal values	9.9%	15.6%	23.6%	51.0%	
	41	65	98	212	**416**

Composite scores created for the STEM Identity[10] items were used to investigate potential differential impacts of JSHS participation on subgroups of students. Statistical differences were not found in STEM Identity by participant U2 status or any subgroup used to identify AEOP underrepresented students.

[10] The Cronbach's alpha reliability for these 8 STEM Identity items was 0.941.

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, and generally serve as STEM role models for JSHS students. Over half (58%) of mentors responding to the mentor questionnaire reported working with 5 or fewer students, while 19% of mentors reported working with 6-10 students. The remaining 23% 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: [11]

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.

More than half of responding mentors reportedly used each strategy on the questionnaire to establish the relevance of learning activities to students (Table 20). Strategies with particularly high reported use

[11] 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.

by mentors (approximately three-quarters or more) are becoming familiar with their students' backgrounds and interests at the beginning of JSHS (82%); encouraging students to suggest new readings, activities, or projects (75%); and helping students become aware of the role(s) that STEM plays in their everyday lives (73%).

Table 20. Mentor Strategies to Establish the Relevance of Learning Activities (n = 149-151)

	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	81.5%	18.5%	**151**
	123	28	
Giving students real-life problems to investigate or solve	67.8%	32.2%	**149**
	101	48	
Selecting readings or activities that relate to students' backgrounds	58.0%	42.0%	**150**
	87	63	
Encouraging students to suggest new readings, activities, or projects	74.7%	25.3%	**150**
	112	38	
Helping students become aware of the role(s) that STEM plays in their everyday lives	73.2%	26.8%	**149**
	109	40	
Helping students understand how STEM can help them improve their own community	71.1%	28.9%	**149**
	106	43	
Asking students to relate real-life events or activities to topics covered in JSHS	71.1%	28.9%	**149**
	106	43	

A majority (more than 50%) of mentors reported using each strategy associated with supporting the diverse needs of learners (see Table 21). Strategies that more than three-quarters of mentors reported using included using a variety of teaching and/or mentoring activities to meet the needs of all students (83%); interacting with students and other personnel the same way regardless of their background (76%); and directing students to other individuals or programs for support as needed (76%).

Table 21. Mentor Strategies to Support the Diverse Needs of Learners (n = 143-147)

	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	55.9%	44.1%	
	81	64	**145**
Interact with students and other personnel the same way regardless of their background	76.2%	23.8%	
	112	35	**147**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	83.3%	16.7%	
	120	24	**144**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	52.8%	47.2%	
	76	68	**144**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	67.3%	32.7%	
	99	48	**147**
Directing students to other individuals or programs for additional support as needed	75.9%	24.1%	
	110	35	**145**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	54.5%	45.5%	
	78	65	**143**

JSHS mentors reported using all strategies to support students' development of collaboration and interpersonal skills (see Table 22). Large majorities of mentors reported using strategies such as having participant(s) listen to the ideas of others with an open mind (87%); having participant(s) explain difficult ideas to others (84%); and having participant(s) exchange ideas with others whose backgrounds or viewpoints are different from their own (77%).

Table 22. Mentor Strategies to Support Participant Development of Collaboration and Interpersonal Skills (n = 144-145)

	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	71.0%	29.0%	
	103	42	**145**

Having participant(s) explain difficult ideas to others	84.1%	15.9%	
	122	23	**145**
Having participant(s) listen to the ideas of others with an open mind	86.8%	13.2%	
	125	19	**144**
Having participant(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	77.1%	22.9%	
	111	33	**144**
Having participant(s) give and receive constructive feedback with others	71.0%	29.0%	
	103	42	**145**

Nearly two-thirds of mentors reported using each of the various strategies to support students' engagement in "authentic" STEM activities (Table 23). Strategies that more than three-quarters of JSHS mentors reported using were allowing participant(s) to work independently to improve their self-management abilities (83%); providing participant(s) with constructive feedback to improve their STEM competencies (83%); and having participant(s) search for and review technical research to support their work (79%).

Table 23. Mentor Strategies to Support Participant Engagement in "Authentic" STEM Activities (n = 142-144)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	61.8%	38.2%	
	89	55	**144**
Having participant(s) search for and review technical research to support their work	78.5%	21.5%	
	113	31	**144**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	74.3%	25.7%	
	107	37	**144**
Supervising participant(s) while they practice STEM research skills	72.9%	27.1%	
	105	39	**144**
Providing participant(s) with constructive feedback to improve their STEM competencies	82.5%	17.5%	
	118	25	**143**

Allowing participant(s) to work independently to improve their self-management abilities	83.1%	16.9%	
	118	24	**142**

Mentors discussing different AEOPs with their students is one way to ensure students are aware of the program pipeline and are able to continue to grow in their STEM abilities, interest, and confidence. Unfortunately, Table 24 shows few mentors reported speaking with their students about AEOPs other than JSHS (60%) and UNITE (25%). Less than 10% of mentors reported discussing any other AEOP with their students, although 21% indicated they discussed AEOP with their students in general but without reference to any specific program.

Table 24. Mentors Discussing Other AEOPs with Participants (n = 141-146)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
UNITE	25.3%	74.7%	
	37	109	**146**
Junior Science & Humanities Symposium (JSHS)	59.6%	40.4%	
	87	59	**146**
Science & Engineering Apprenticeship Program (SEAP)	7.0%	93.0%	
	10	132	**142**
Research & Engineering Apprenticeship Program (REAP)	7.1%	92.9%	
	10	131	**141**
High School Apprenticeship Program (HSAP)	7.0%	93.0%	
	10	132	**142**
College Qualified Leaders (CQL)	2.1%	97.9%	
	3	139	**142**
GEMS Near Peer Mentor Program	4.2%	95.8%	
	6	136	**142**
Undergraduate Research Apprenticeship Program (URAP)	5.7%	94.3%	
	8	133	**141**

Science Mathematics, and Research for Transformation (SMART) College Scholarship	9.9%	90.1%	
	14	127	**141**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	2.8%	97.2%	
	4	138	**142**
I discussed AEOP with participant(s) but did not discuss any specific program	21.7%	78.3%	
	31	112	**143**
eCybermission	9.1%	90.9%	
	13	130	**143**

R-JSHS students were asked to report on their mentor's primary position (Table 25) and availability (Table 26). Most students indicated their mentor was either a teacher (49%) or STEM researcher (34%). In terms of mentor availability, nearly two-thirds of students reported their mentor was available to them at least half of the time (73%). Fewer students reported their mentor was available less than half of the time (10%) or never available (2%), while 15% of students indicated they did not have a mentor at all.

Table 25. R-JSHS Participant Reports of their Mentor's Primary Position (n=428)

	Response Percent	Response Total
I did not have a research mentor	12.62 %	54
Teacher	48.60 %	208
Coach	0.00 %	0
Parent	2.80 %	12
Club or activity leader (School club, Boy/Girl Scouts, etc.)	0.70 %	3
STEM researcher (industry, university, or DoD/government employee, etc.)	34.11 %	146
Other, (specify):	1.17 %	5

Table 26. R-JSHS Participant Reports of Availability of Mentors (n = 429)

	Response Percent	Response Total
I did not have a mentor	15.38 %	66
The mentor was never available	1.63 %	7

The mentor was available less than half of the time	10.02 %	43
The mentor was available about half of the time of my project	8.39 %	36
The mentor was available more than half of the time	24.01 %	103
The mentor was always available	40.56 %	174

N-JSHS participants were also asked to describe the nature of the mentoring support they were provided for JSHS (n = 24). More specifically, participants were asked if they had a mentor and, if so, whether their JSHS project was part of a class (in school). More than three-quarters (78%) of respondents indicated their project work was not part of a class in school, and only 18% reported their JSHS work was part of a class in school. However, 43% indicated they worked with a teacher in some capacity even if it was not part of formal classwork. Another 26% mentioned working with a university or industry mentor, and 22% said they had not formal mentor and relied on various adult support (e.g., family, teachers, university professors).

Program Features and Feedback/Satisfaction

Students were asked to respond to several questionnaire items about the nature of their experiences in JSHS. When asked what field their JSHS experience focused on, a majority of students indicated science (65%). Fewer students reported that their experiences focused on integrated STEM (more than one content area) (17%), engineering (13%), technology (3%), or mathematics (2%).

In terms of project design, more than a third of students reported designing their entire project on their own (39%) (Table 27). Nearly a quarter (22%) of regional JSHS students indicated that they worked with their mentor to design a project. Remaining students reported working with their mentor and research team to design a project (15%); having a choice among various projects suggested by their mentor (9%); being assigned a project by their mentor (3%); or not having a project (13%).

Table 27. Participant Input on the Design of Their Project (n = 424)

	Response Percent	Response Total
I did not have a project	12.74 %	54
I was assigned a project by my mentor	2.83 %	12
I worked with my mentor to design a project	22.17 %	94
I had a choice among various projects suggested by my mentor	8.96 %	38
I worked with my mentor and members of a research team to design a project	14.62 %	62

I designed the entire project on my own	38.68 %	164

N-JSHS participants were also asked about the nature of the mentoring support they were provided for JSHS (n = 65). Participants were asked if they had a mentor and, if so, whether their JSHS project was part of a class (in school) or if they worked after school with a teacher, or if they worked with a university or industry mentor. Nearly a quarter (23%) of respondents indicated their project work was part of a class in school. Another 38% worked outside of school with a university or industry mentor while 28% of N-JSHS respondents indicated that they worked both in and out of the classroom with either mentors and/or university or industry experts.

Students were asked about their participation in research groups in JSHS. It was most common for students to work alone (or alone with their research mentor) (62%) (Table 28). However, some reported working with others through a shared laboratory/space, but on different projects (17%) or with a group on the same project (11%). Fewer students indicated that they worked alone on their project but met with others regularly for reporting and discussion (7%), or worked alone on a project closely connected with projects of others in a group (4%).

Table 28. Student Participation in Research Groups (n = 429)

	Response Percent	Response Total
I worked alone (or alone with my research mentor)	61.54 %	264
I worked with others in a shared laboratory or other space, but we work on different projects	17.02 %	73
I worked alone on my project and I met with others regularly for general reporting or discussion	6.53 %	28
I worked alone on a project that was closely connected with projects of others in my group	3.50 %	15
I work with a group who all worked on the same project	11.42 %	49

JSHS students were actively engaged in scholarly research dissemination activities (Table 29). Most R-JSHS students (81%) reported they had attended a symposium or conference. Similarly, a majority of R-JSHS participants reported presenting a talk or poster to other students or faculty (66%) or presenting a talk or poster at a professional symposium or conference (54%). Several students reported plans to disseminate their research through research journals (11%) or through technical paper or patents (6%), while others had already published their work in research journals (11%) or through technical papers or patents (11%). Some participants also reported winning an award or scholarship based on their research (20%).

Table 29. Students Engagement with Research Dissemination Activities During R-JSHS (n = 429)

	Response Percent	Response Total
I presented a talk or poster to other students or faculty	66.20 %	284
I presented a talk or poster at a professional symposium or conference	53.85 %	231
I attended a symposium or conference	80.89 %	347
I wrote or co-wrote a paper that was/will be published in a research journal	11.19 %	48
I wrote or co-wrote a technical paper or patent	10.72 %	46
I will present a talk or poster to other students or faculty	27.04 %	116
I will present a talk or poster at a professional symposium or conference	20.51 %	88
I will attend a symposium or conference	27.97 %	120
I will write or co-write a paper that was/will be published in a research journal	11.19 %	48
I will write or co-write a technical paper or patent	5.83 %	25
I won an award or scholarship based on my research	19.58 %	84

R-JSHS students and mentors were both asked to rate their satisfaction with a number of features of the JSHS program. Regional students' responses to a questionnaire item asking about their experiences at the R-JSHS event they attended are provided in Table 30. Overall, FY18 students reported being less satisfied with event features compared to FY17 students. More than half of responding regional students were somewhat or very much satisfied with JSHS features related to presentations: student oral presentations (FY18, 82%; FY17, 88%); student poster presentations (FY18, 57%; FY17, 60%); and invited speaker presentations (FY18, 61%; FY17, 70%). Students reported being reasonably satisfied with JSHS judging and feedback, although again, students were somewhat less satisfied overall in FY18 compared to FY17. Half or more of students reported that they were somewhat or very much satisfied in the following areas: judging process (FY18, 62%; FY17, 69%); feedback from judges (FY18, 51%; FY17, 60%); feedback from VIPs and peers (FY18, 50%; FY17, 57%). For activities and social events, approximately half of the students were somewhat or very much satisfied with tours or field trips (55%) and social events (54%). Fewer

students were somewhat or very much satisfied with team building activities (38%), and many reported not experiencing these activities (43%). Few students expressed dissatisfaction with any R-JSHS features, although it is noteworthy that 11% expressed dissatisfaction with the judging process and with feedback from judges.

Table 30. Student Satisfaction with R-JSHS Event Features (n = 424-428)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Student Oral Presentations	5.6%	2.3%	10.5%	25.0%	56.5%	
	24	10	45	107	242	**428**
Student Poster Presentations	28.8%	3.5%	11.0%	19.7%	37.0%	
	123	15	47	84	158	**427**
Judging Process	12.2%	10.5%	15.2%	26.2%	35.8%	
	52	45	65	112	153	**427**
Feedback from Judges	25.4%	10.6%	13.2%	17.9%	32.9%	
	108	45	56	76	140	**425**
Feedback from VIPs and Peers	25.6%	5.6%	19.0%	18.1%	31.7%	
	109	24	81	77	135	**426**
Invited Speaker Presentations	12.3%	9.0%	17.7%	25.0%	36.1%	
	52	38	75	106	153	**424**
Tours or Field Trips	21.5%	5.6%	17.8%	17.6%	37.5%	
	92	24	76	75	160	**427**
Team Building Activities	43.0%	7.5%	11.5%	13.8%	24.2%	
	183	32	49	59	103	**426**
Social Events	24.0%	4.9%	16.7%	19.5%	34.8%	
	102	21	71	83	148	**425**

N-JSHS students were also asked to share their impressions of the judging process at regional competitions in an open-ended questionnaire item. Of the 25 students who provided a response, 15 provided positive comments about regional judging. For example, one student responded by saying, "My overall impressions with the regional judging process was quite what I expected. Everything was well organized." The other 10 students made suggestions for improving regional judging focusing on providing judges representing a greater diversity of disciplines, providing more judges, and providing feedback from judges. For example, students commented:

> "The regional judging process was pretty good. They asked really good questions primarily about the content. The one improvement I foresee is having judges that represent most of the categories so having someone good with like computer science."
>
> "The regional judging process could be improved by allowing the judges to give feedback on the projects after judging is over."
>
> "As with any science fair, it's difficult when the judges do not specialize in your topic. I am in life sciences, and three of my judges were in astronomy and physics."

Most of the 23 national participants who provided feedback about how well their regional competitions helped to prepare them for JSHS nationals affirmed that their experience in regional events prepared them for the national competition. Comments focused on the experience of giving oral presentations and support for communicating their research. For example,

> "[The regional competition] gave me the experience doing an oral presentation (unlike posters, which I usually do at science fairs) and gave me more confidence (first time I ever qualified for a national science competition)." (N-JSHS student)
>
> "The regional competition carried out very helpful and informative orientation sessions that helped me to format my presentation and become a better communicator." (N-JSHS Student)

Two of the responding students indicated that the regional event did not prepare them for national competition. One student noted that the lack of feedback on his project contributed to this, saying "I do not feel like my regional competition helped me prepare for JSHS, because we did not receive any feedback on how to improve our projects in order to be competitive."

R-JSHS students were asked to rate the usefulness of various JSHS resources (Table 31). The most beneficial resources (those selected most frequently as "very much" useful) were deadlines for paper submissions and competition (43%) and participation guidelines (37%). Resources accessed least were the selected articles about conducting research (47% did not use), sample papers (44% did not use), and oral presentation tips (41% did not use). In general, FY18 student respondents felt JSHS resources were less useful and reported using less resources than FY17 participants. However, similar patterns in terms of recourse benefit and use were found between student cohorts.

Table 31. Usefulness of R-JSHS Resources for Participants (n = 423-425)

	I did not use this resource	Not at all	A little	Somewhat	Very much	Response Total
JSHS Groundrules for Student Presentations	23.3%	5.2%	17.7%	20.0%	33.7%	
	99	22	75	85	143	**424**
Paper Submissions and Competition Deadlines	18.0%	4.3%	13.9%	20.8%	43.0%	
	76	18	59	88	182	**423**
Sample Papers	44.2%	7.3%	12.0%	14.6%	21.9%	
	188	31	51	62	93	**425**
Oral Presentation Tips	41.4%	5.7%	13.9%	15.8%	23.2%	
	175	24	59	67	98	**423**
Selected Articles – Conducting Research	47.4%	7.3%	14.9%	13.0%	17.5%	
	201	31	63	55	74	**424**
Poster Guidelines	40.9%	4.5%	12.2%	14.6%	27.8%	
	174	19	52	62	118	**425**
Participation Guidelines	19.8%	3.8%	18.1%	20.5%	37.9%	
	84	16	77	87	161	**425**

Most R-JSHS students (80% or more) indicated that they were satisfied with various features of their overall JSHS research experiences (Table 32). Student reports of the research experience overall were particularly positive (88% somewhat or very satisfied). Additionally, large majority of students reported being satisfied (somewhat or very satisfied) with the amount of time they spent doing meaningful research (87%); their working relationship with their mentor (83%); and the amount of time they spent with their mentors (82%). Again, FY18 student's satisfaction responses were lower than those of FY17 participants.

Table 32. R-JSHS Participant Satisfaction with their JSHS Research Experience (n=420-422)

	Did not experience	Not satisfied	Somewhat satisfied	Very satisfied	Response Total
My working relationship with my mentor	14.5%	2.1%	15.2%	68.1%	
	61	9	64	286	**420**
The amount of time I spent doing meaningful research	11.2%	2.1%	23.5%	63.2%	
	47	9	99	266	**421**
The amount of time I spent with my research mentor	15.0%	3.3%	21.7%	60.0%	
	63	14	91	252	**420**
The research experience overall	10.7%	1.7%	20.6%	67.1%	
	45	7	87	283	**422**

To test for group differences in student reported satisfaction with their JSHS experience between groups of students (gender, racial/ethnic, free/reduced-lunch status) four satisfaction items were combined into a composite variable[12]. Statistical differences in student satisfaction with their JSHS experiences were not found by U2 status or any grouping variables tested.

An open-ended item on the questionnaire asked students to comment on their overall satisfaction with their JSHS experience. In a sample of 110 of the regional student responses, 79% commented only on positive aspects of the program. Many students provided simple affirmations of their program experiences such as "I was very satisfied with JSHS - I will definitely participate next year." Among students who provided more detailed feedback about the positive aspects of their JSHS experiences, many focused on the opportunity to gain experience in presenting their work, learning about others' research, and connecting with other young researchers. For example:

> "I enjoyed JSHS a lot. It was extremely interesting to get to see other students' research, as well as inspiring. It strengthened my drive to continue research and gave me more confidence in what I am doing as a high school student." (R-JSHS Student)

> "Overall, my JSHS experience has been fun and interesting. I enjoyed being able to spend time with peers and mentors who have helped me and each other on diverse research projects. I think being able to present this research [was] a good opportunity." (R-JSHS Student)

[12] The Cronbach's alpha reliability for these 4 items was 0.943.

> "The JSHS was a phenomenal experience for me to share both my independent research and get to meet new people that share my same passion for science. Being able to present to many people of diverse backgrounds was an eye-opening experience." (R-JSHS Student)

Nineteen (17%) of the R-JSHS student respondents made positive comments about the program but also offered caveats, and three students did not have anything positive to say about their R-JSHS experience. The negative comments were most frequently focused on organizational and/or communication issues (6 comments) and on judging (4 comments). Student comments about judges included observations that judges seemed unfamiliar with students' areas of research, concerns about inconsistent judging, insufficient judge feedback, or negative or insulting judge feedback and questioning. Examples of these caveats include:

> "With my JSHS experience, the coordinator was disorganized. Due dates for things were given extremely late in comparison to how they have been in the past." (R-JSHS Student)

> "I was very pleased with JSHS overall. Accommodations were extremely nice, excellent food and hotel, but I do wish that poster judging was unbiased and not volunteered. Many of the judges were associated with one school in particular." (R-JSHS Student)

> "I disliked how we knew nothing about our fair until a few weeks prior to it, how we were limited in participants, how our director was unorganized, how there were not many prizes, the lectures we had to attend, and how the judges seemed biased." (R-JSHS Student)

Students participating in the national JSHS event were also asked in an open-ended questionnaire item to reflect on their overall satisfaction with their experiences at the national event. Of the 26 students who provided responses, 19 (73%) had only positive things to say about the event. These responses included general comments such as "It was honestly amazing!" as well as more specific comments focusing on the opportunity to present research to expert judges and networking with professionals in STEM fields and other young researchers. For example,

> "I really enjoyed participating in the national JSHS event; I not only liked presenting and receiving feedback from qualified judges but also seeing the potential pathways in STEM from going to the lab tours and hearing the general sessions." (N-JSHS Student)

> "I was very impressed with the schedule and tours and events. I loved meeting smart people of all ages and the food was stellar. " (N-JSHS Student)

> "It's very fun and it's an interesting experience being with military personnel. talking with my academic peers is fascinating, and somewhat of a new experience for me, which I thoroughly enjoyed." (N-JSHS Student)

Four other N-JSHS students had generally positive things to say but offered caveats, and one student had nothing positive to say about the event. Students who provided detailed caveats focused on judging and event scheduling and logistics. For example,

> "The event was extremely well organized and the events were held on time. I was able to learn a lot about the other participants, as well as make new connections. However, I did feel that my poster judging was a bit negative with one of the judges having absolutely no knowledge about Biology. Hence, I do believe that if we want the results to be an accurate representation of the students' work, the judges need to be aware of scientific fields at their end." (N-JSHS Student)

> "It was great. The only complaint I have is that app did not have the correct time for the buses for R&D tours, this resulted in myself and my roommate missing our tours." (N-JSHS Student)

N-JSHS students were also asked to share their impressions of judging at the national event and ways that it could be improved. Of the 27 students who commented, 6 (22%) offered simple affirmations of the judging such as, "Great! Super smart judges." Four other comments (15%) focused on providing judges with expertise in a variety of disciplines and another 4 (15%) suggested allowing more time for poster judging and providing more judges for posters. Two students (7%) indicated that they felt that judges were biased toward mentored projects, and another 2 students expressed a desire for more feedback from judges. Students' comments included the following:

> "I also thought the national judging process was effective and chose the best students. However, my category combined both behavioral and biomedical/bioengineering, two fields that I didn't think weren't similar enough to be in the same category. None of the judges were familiar with behavioral sciences either which I felt put me at a disadvantage." (N-JSHS Student)

> "The national judging process worked well. I received enough information on the rubric and types of questions asked to be prepared for questioning." (N-JSHS Student)

> "The national judging should have judges that have a greater understanding of the categories that they are judging. With the short time frame it is very hard to start explaining the very basics of Biology as it cut into time that I could have used to explain the details of my research. One of the judges seemed extremely irritable at the start of the judging itself." (N-JSHS Student)

> "They need to take mentorship into account. Kids won who received a project from someone." (N-JSHS Student)

> "Great, very specialized judges (for oral). Poster presenters felt rushed and the judges seemed uninterested; judging to judge not to learn or enjoy." (N-JSHS Student)

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, forty-eight comments (48%) focused on scheduling issues, either ensuring that the event adheres to the public schedule or suggesting schedule modifications such as more time between presentations, less time between activities, longer presentation times, a shorter day, or more free time. Another 34 comments (34%) suggested having more or more interesting speakers and/or activities during events as improvements. Food and beverage improvements were suggested in 14 comments (14%), while 13% included suggestions to broaden the scope of JSHS by engaging more presenters at events and/or increasing publicity efforts. Another 13% of comments focused on poster sessions, suggesting that poster presenters be given equal priority to oral presenters, increasing the time for poster judging and the number of poster judges, and providing time for students to view posters. Eleven (11%) suggested providing more time and opportunity for students to network with other students. Ten comments (10%) suggested improvements in communication. Other suggested improvements, mentioned by fewer than 10% students included:

- Better organization
- Providing more career information
- Providing more information about the DoD and/or AEOP
- Providing practice sessions for presenters
- Providing sample papers and projects on the website
- Providing students with assistance in identifying mentors
- Changes in event location
- More awards

Students presenting at the national event were also asked for their suggestions for improving the JSHS program overall. Of the 21 N-JSHS students who offered suggestions, there were 3 suggestions (14%) for allowing more time for students to connect with one another, 3 suggestions (14%) for a change in location, and 2 (10%) focusing on poster judging and logistics of the poster session. For example,

> "I would suggest that they give time and make activities for the students to get to know other students and make new friends, maybe a mixer or something like that. " (N-JSHS Student)

> "I was pretty satisfied with the event. I would, however, like more time during the poster presentations, but I understand that judges are busy and there are time constraints. Thank you so much for hosting and planning JSHS! This was my first year and I enjoyed it immensely." (N-JSHS Student)

"For the poster competition I was never told when to take down my poster, and as a result it was taken down for me and treated really poorly. More directions like that would improve the program." (N-JSHS Student)

Other improvements mentioned by 1 student each included:

- improving the selection of judges
- conducting more program outreach
- scheduling the keynote speaker before instead of after dinner
- improvements in travel logistics
- improvements in the availability and/or choices of food

When asked about program improvements, students participating in the focus group emphasized improvements in food, noting that insufficient information and food options were provided for students with food allergies and special dietary requirements.

Mentors were also asked about their satisfaction with features of JSHS (Table 34). More than half (57% - 90%)of mentors reported being somewhat or very much satisfied with all program features they experienced except for communication with AAS (37% were somewhat or very much satisfied; 61% had not experienced). Additionally, a quarter of the mentors (25%) reported having not experienced support for instruction or mentorship during JSHS activities. Very few mentors expressed dissatisfaction with any feature of JSHS.

Table 33. Mentor Satisfaction with JSHS Program Features (n = 162-164)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	11.0%	1.8%	7.4%	28.2%	51.5%	
	18	3	12	46	84	**163**
Communicating with Academy of Applied Science (AAS)	61.3%	0.0%	1.2%	6.7%	30.7%	
	100	0	2	11	50	**163**
Communicating with your JSHS site's organizers	6.7%	1.8%	4.3%	12.8%	74.4%	
	11	3	7	21	122	**164**
Support for instruction or mentorship during program activities	31.5%	3.7%	6.2%	14.8%	43.8%	
	51	6	10	24	71	**162**
Support for instruction or mentorship during JSHS activities	25.2%	4.3%	6.1%	15.3%	49.1%	
	41	7	10	25	80	**163**

Research abstract preparation requirements	31.3%	2.5%	2.5%	16.6%	47.2%	
	51	4	4	27	77	**163**
The physical location(s) of JSHS activities	4.9%	1.2%	3.7%	18.3%	72.0%	
	8	2	6	30	118	**164**

The mentor questionnaire included open-ended items asking mentors for their opinions about the program. Mentors were asked to identify the three most important strengths of JSHS. Of the 119 mentors who responded, the most often cited strength of JSHS, mentioned 48 times (40%), was the opportunity for students to present their research. Another 41 (34%) noted the opportunity for students to connect with other like-minded young researchers, 34 (29%) mentioned the benefits of students interacting with judges, 31 (26%) cited student research skills as a strength, and 28 (24%) expressed that the opportunity for students to see peers' research and be exposed to a variety of research topics was a strength of JSHS. Other strengths mentioned in 12 or fewer comments (<10%) included the program's organization; JSHS's support for student research; students' exposure to real-world research; and the opportunity for students to develop skills such as problem-solving, patience, time management, and the ability to work independently (8% of comments).

Mentors participating in the focus group emphasized the value of JSHS in encouraging students to conduct and present research and that the program "really makes the students feel much more special than some of the other competitions."

Mentors participating in the focus group also cited the support teachers receive in engaging students in research as a benefit of JSHS. Mentors said,

> "Being able to encourage students to pursue good scientific methodologies and use what we see here as examples is very valuable. Especially with statistical analysis and that sort of stuff. You tell them, but when they see their peers, students their age doing the high level stats analysis, that's powerful." (JSHS Mentor)

> "The networking too helps, and there's other teachers doing research. Even…today, there were some resources about possibly coming up with partnerships to help give the kids [places] to do research." (JSHS Mentor)

Mentors were also asked to respond to an open-ended item asked them to describe three ways JSHS could be improved for future participants. Among the comments made by the 108 mentors who responded to this item, 57 comments (53%) included suggestions for improvements in JSHS program-level features such as improving communication (16 comments), increasing publicity (15 comments), focusing more on poster

presentations (9 comments), judging mentored and unmentored projects separately (8 comments), and providing more funding (5 comments), improving registration procedures (2 comments), and providing more AEOP information (2 comments). Another 48 comments (44%) included suggested improvements for event logistics, including suggestions for more interactive activities and tours (12 comments), more or better speakers (9 comments), increased opportunities for students to socialize with one another and network with professionals (8 comments), limiting events to one day rather than two (6 comments), and better organization of events (5 comments). Other event-related improvements mentioned in fewer than 5 comments included: providing opportunities for JSHS students to connect with undergraduate students and learn about their research, shortening the length of event days, and improvements to food. Twenty-seven (25%) comments focused on improvements in judging, emphasizing the need for judges to provide feedback (14 comments), to ensure that judges' areas of expertise are related to students' projects (6 comments), and general suggestions to improve judging (7 comments).

The mentors who participated in the focus group also offered suggestions for improvements to JSHS, focusing on ways to expand the program's reach. Mentors' suggestions included pairing schools and teachers with active research programs with schools serving students who are underserved or underrepresented in STEM, encouraging schools with AP research courses to have students participate in JSHS, and getting more teachers involved by engaging the support of district level leadership and providing support and training for research. Mentors suggested that providing examples of schools that had been successful at forging mentor partnerships for JSHS might be a useful means to engaging district leadership support for JSHS involvement. Mentors said, for example

> "Getting buy-in form our local district leadership, that's key. If they buy in and are willing to provide for teachers to get involved and get in-service training to improve the connections and the research capabilities, that's key…for local district leadership to see that success…they jump." (JSHS Mentor)

> "I wonder if somehow JSHS directors could reach out to schools that are putting in [AP research courses] and say, 'This may be a great place for your students to showcase their work and get some feedback prior to having to submit that portfolio to the AP board.' That might be a good partnership." (JSHS Mentor)

Mentors were also asked to comment on their overall satisfaction with their JSHS experience in an open-ended questionnaire item. Of the 112 mentors who responded, nearly all (106, or 95%) included positive comments about the program. Many focused on the high quality of the student research presented and the opportunities for students to present their research and receive feedback from professionals. For example:

"I was highly satisfied with this process. The director of the event was amazing and responded to my myriad of questions in a timely manner and was highly accommodating. The presentations were strictly moderated and the judges asked [appropriate] questions." (JSHS Mentor)

"JSHS is always a great experience for my kids. They, especially the kids new to science research, get to see exactly what is expected out of them. I love the collaboration with the kids from varying school. I also really enjoy the 'college' experience the [students get]." (JSHS Mentor)

"I've been involved in JSHS for the last 34 years in education and have seen how it captures the interest of students and gives them a vehicle to answer questions about the world in which they live." (JSHS Mentor)

"I could not be more pleased with the JSHS experience, both for myself and my students. My students were so inspired that they were already discussing plans for next year's research on the ride home!" (JSHS Mentor)

Thirteen of the mentors (12%) made positive comments but also offered some caveats, while 8 respondents (7%) offered no positive comments. These respondents' caveats most often focused on organizational or administrative issues, perceived advantages of students presenting mentored research, and judging. For example,

"Overall, it was good. However, it is difficult to maintain student motivation to participate when it is apparent that students who work with STEM professionals in their off-site lab settings have a distinct advantage with respect to winning." (JSHS Mentor)

"I feel like I could have benefited from meeting ahead of time to get an idea of what the experience was going to be and knowing all of the different roles. Feel like panels should be geared towards students' interests." (JSHS Mentor)

"I was happy with the JSHS experience but was unhappy to find that it starts at the Junior level in high school. The experiences need to begin far much earlier in their academic and research high school years. " (JSHS Mentor)

"My students and I had a good experience at the JSHS event, but things could have gone more smoothly. Communication with me (the teacher) was delayed and infrequent. It was also not clear what activities the students were going to be in." (JSHS Mentor)

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 reported on how they learned about AEOP (Table 34). Approximately half (52%) of participants indicated they learned about JSHS/AEOP from someone who works at the school or university they attend. The next highest reported means of learning about JSHS was a school or university newsletter, email, or website (26%), followed by a past participant of the program (17%), and friend (13%). All other response options were selected by less than 10% of students.

Table 34. How R-JSHS Participants Learned About AEOP (n = 317)

	Response Percentage	Response Total
Army Educational Outreach Program (AEOP) Website	3.79%	12
AEOP on Facebook, Twitter, Instagram, or other social media	0.63%	2
School or university newsletter, email, or website	25.87%	82
Past participant of program	16.72%	53
Friend	12.93%	41
Family Member	7.26%	23
Someone who works at the school or university I attend	51.74%	164
Someone who works with the program	4.10%	13
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	0.63%	2
Community group or program	3.47%	11
Choose Not to Report	6.31%	20

Mentors were also asked how they learned about JSHS (Table 35). The most frequently chosen responses were personal contacts, including a past JSHS participant (33%), a colleague (32%), or a JSHS site host of director (18%).

Table 35. How JSHS Mentors Learned about JSHS/AEOP (n = 165)

	Response Percentage	Response Total
Academy of Applied Science (AAS) website	2.42 %	4
Army Educational Outreach Program (AEOP) website	5.45 %	9
AEOP on Facebook, Twitter, Pinterest, or other social media	0.61 %	1
A STEM conference or STEM education conference	5.45 %	9
An email or newsletter from school, university, or a professional organization	11.52 %	19
Past JSHS participant	32.73 %	54
A student	10.30 %	17
A colleague	32.12 %	53
My supervisor or superior	10.91 %	18
A JSHS site host or director	18.18 %	30
Workplace communications	6.67 %	11
Someone who works with the Department of Defense (Army, Navy, Air Force)	0.00 %	0
Other, (specify):	8.48 %	14

When asked why they chose to participate in the program, R-JSHS students reported a variety of factors (Table 36). The top two motivating factors were interest in STEM (78%) and the desire to learn something new (74%). These were followed closely by having fun (65%) and teacher encouragement (64%). Note – participants could select more than one response on this item.

Table 36. Factors Motivating Student Participation in R-JSHS (n = 317)

	Response Percentage	Response Total
Teacher or professor encouragement	63.72%	202
An academic requirement or school grade	13.88%	44
Desire to learn something new or interesting	74.45%	236
The mentor(s)	18.93%	60
Building college application or résumé	49.84%	158
Networking opportunities	40.06%	127
Interest in STEM	77.60%	246
Interest in STEM careers with the Army	14.51%	46
Having fun	65.30%	207
Earning stipends or awards for doing STEM	32.81%	104
Opportunity to do something with friends	28.39%	90
Opportunity to use advanced laboratory technology	35.33%	112
Desire to expand laboratory or research skills	54.57%	173
Learning in ways that are not possible in school	55.52%	176
Serving the community or country	31.55%	100
Exploring a unique work environment	39.75%	126
Figuring out education or career goals	48.26%	153
Seeing how school learning applies to real life	39.75%	126
Recommendations of past participants	22.08%	70
Choose Not to Report	2.21%	7

N-JSHS participants in the focus group report similar motivating factors and sources of information about AEOP. Students said, for example,

> "I came to the regional [JSHS] because my science teacher had heard about it through one of her contacts and it sounded really interesting" (N-JSHS Student)

> "I'm in AP Research, so I took advantage of my love for research" (N-JSHS Student)

"One of my school seniors went to JSHS and I learned about it my junior year…My school doesn't really know about it. It was just that student." (N-JSHS Student)

"I'm part of the research program at my school. We have a year-long research class. Every year part of the class is entering competitions like JSHS." (N-JSHS Student)

Previous Program Participation and Future Interest

R-JSHS questionnaire respondents were asked to report on their past participation in other AEOPs (Table 37). Approximately a quarter (26%) of respondents indicated they had participated in JSHS before. Other AEOPs for which students reported past participation were Camp Invention (5%), eCybermission (2%), JSS (1%), GEMS (<1%), UNITE (<1%), SEAP (<1%), REAP (<1%), and HSAP (<1%). While 18% indicated they had participated in other STEM programs, more than half (58%) of respondents reported having never participated in any other AEOP.

Table 37. R-JSHS Participant Past AEOP Participation (n = 317)

AEOP Programs	Response Percent	Response Total
Camp Invention	5.05%	16
eCYBERMISSION	1.58%	5
Junior Solar Sprint (JSS)	1.26%	4
Gains in the Education of Mathematics and Science (GEMS)	0.63%	2
UNITE	0.32%	1
Junior Science & Humanities Symposium (JSHS)	25.87%	82
Science & Engineering Apprenticeship Program (SEAP)	0.63%	2
Research & Engineering Apprenticeship Program (REAP)	0.32%	1
High School Apprenticeship Program (HSAP)	0.32%	1
College Qualified Leaders (CQL)	0.00%	0
Undergraduate Research Apprenticeship Program (URAP)	0.00%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0.00%	0
I've never participated in any AEOP programs	57.73%	183
Other STEM Program	17.98%	57

R-JSHS students were asked to report on their level of interest in participating in future AEOP programs (Table 38). Few students expressed that they were "not at all" interested in future programs (6%-8%). However, the majority of students (56%-74%) had not heard of programs other than JSHS. Although students reported limited awareness of other AEOPs, between 20% and 36% of students expressed at least somewhat future interest in all programs other than JSHS (88%). These findings are similar to FY17.

Table 38. R-JSHS Participant Interest in Future AEOP Programs (n = 415-420)

	I've never heard of this program	Not at all	Somewhat interested	Very interested	Response Total
Unite	74.2%	5.8%	12.5%	7.5%	
	308	24	52	31	**415**
Junior Science & Humanities Symposium (JSHS)	3.8%	8.1%	33.6%	54.5%	
	16	34	141	229	**420**
Science & Engineering Apprenticeship Program (SEAP)	59.4%	7.2%	20.5%	12.9%	
	249	30	86	54	**419**
Research & Engineering Apprenticeship Program (REAP)	61.3%	5.7%	20.8%	12.2%	
	257	24	87	51	**419**
High School Apprenticeship Program (HSAP)	62.1%	7.4%	17.9%	12.6%	
	260	31	75	53	**419**
College Qualified Leaders (CQL)	67.3%	6.4%	16.2%	10.0%	
	282	27	68	42	**419**
GEMS Near Peer Mentor Program	69.9%	6.2%	16.0%	7.9%	
	292	26	67	33	**418**
Undergraduate Research Apprenticeship Program (URAP)	64.3%	6.0%	17.6%	12.1%	
	270	25	74	51	**420**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	56.3%	7.9%	19.6%	16.2%	
	236	33	82	68	**419**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	66.0%	7.2%	17.0%	9.8%	
	276	30	71	41	**418**

N-JSHS students were also asked about their interest future AEOP participation (Table 39). Compared to R-JSHS students, N-JSHS participants had slightly greater knowledge of and interest in participating in other AEOPs with the exception of Unite (82% of N-JSHS students reported never hearing of this program). Aside from Unite, fewer N-JSHS students than R-JSHS students reported having never heard of the other AEOPs (15%-56%). Between 33% and 78% of N-JSHS students indicated being at least somewhat interested in all programs other than Unite (11%), and nearly all expressed interest in participating in JSHS in the future (96%).

Table 39. N-JSHS Participant Interest in Future AEOP Programs (n = 27)

	I've never heard of this program	Not at all	Somewhat interested	Very interested	Response Total
Unite	81.5%	7.4%	7.4%	3.7%	
	22	2	2	1	**27**
JSHS	0.0%	3.7%	25.9%	70.4%	
	0	1	7	19	**27**
SEAP	14.8%	7.4%	63.0%	14.8%	
	4	2	17	4	**27**
REAP	37.0%	7.4%	44.4%	11.1%	
	10	2	12	3	**27**
HSAP	40.7%	14.8%	37.0%	7.4%	
	11	4	10	2	**27**
CQL	44.4%	11.1%	29.6%	14.8%	
	12	3	8	4	**27**
GEMS Near Peer Mentor Program	37.0%	18.5%	40.7%	3.7%	
	10	5	11	1	**27**
URAP	40.7%	11.1%	37.0%	11.1%	
	11	3	10	3	**27**
SMART College Scholarship	44.4%	7.4%	25.9%	22.2%	
	12	2	7	6	**27**
NDSEG Fellowship	55.6%	11.1%	25.9%	7.4%	

	15	3	7	2	**27**

Awareness of STEM Careers and DoD STEM Careers and Research

A goal of the AEOP is to increase both the number and diversity of students who pursue STEM careers. As such, the questionnaire included items to assess students' exposure to STEM careers in general and STEM careers within the DoD more specifically. Results from FY18 are similar to those from FY17. Nearly all (84%) R-JSHS students reported learning about at least one STEM job/career during JSHS, with 28% indicating they had learned about five or more (Table 40). Again, similar to FY17 findings, FY18 R-JSHS participants reported less knowledge of DoD STEM jobs/careers with 53% having heard of at least one and only 10% having learned about five or more during JSHS (Table 41).

Table 40. Number of STEM Jobs/Careers Students Learned About During R-JSHS (n =421)

Number of STEM Jobs/Careers	Response Percent	Response Total
None	15.91 %	67
One job	9.26 %	39
Two jobs	20.67 %	87
Three jobs	20.43 %	86
Four jobs	5.94 %	25
Five or more	27.79 %	117

Table 41. Number of Department of Defense (DoD) STEM Jobs/Careers Learned About During R-JSHS (n = 429)

Number of DoD STEM Jobs/Careers	Response Percent	Response Total
None	46.85 %	201
One job	13.75 %	59
Two jobs	14.69 %	63
Three jobs	10.96 %	47
Four jobs	4.20 %	18
Five or more	9.56 %	41

N-JSHS student were asked the same questions regarding the numbers of STEM jobs/careers in general and within the DoD they learned about during their N-JSHS experience (Tables 42 and 43). Nearly all N-JSHS participants (96%) reported learning about one or more STEM jobs/careers in general, and all (100%)

indicated they learned about one or more DoD STEM job/career. Additionally, more than half of N-JSHS students indicated they learned about five or more STEM jobs/careers in general (56%) and DoD STEM jobs/careers (63%).

Table 42. Number of STEM Jobs/Careers Students Learned About During N-JSHS (n =27)

Number of STEM Jobs/Careers	Response Percent	Response Total
None	3.70%	1
One job	0.00%	0
Two jobs	11.11%	3
Three jobs	18.52%	5
Four jobs	11.11%	3
Five or more	55.56%	15

Table 43. Number of Department of Defense (DoD) STEM Jobs/Careers Learned About During N-JSHS (n = 27)

Number of DoD STEM Jobs/Careers	Response Percent	Response Total
None	0.00%	0
One job	7.41%	2
Two jobs	7.41%	2
Three jobs	14.81%	4
Four jobs	7.41%	2
Five or more	62.96%	17

To further explore students' exposure to STEM career opportunities in the DoD, N-JSHS participants in the focus group were asked whether and how they had learned about STEM career opportunities in the DoD during JSHS. Students' responses indicated that their exposure to DoD STEM career opportunities was primarily at the N-JSHS event rather than at regional competitions. They reported hearing about these careers through speakers and tours, and some had suggestions for additional ways to expose students to DoD STEM careers. For example,

> "I learned a lot just from the speakers in the general sessions. I think something even more effective would be like a career fair where different representatives from different fields in the DoD could be there and we could talk to each of them about their research and what they're doing." (N-JSHS Student)

"I think it was just great – the former JSHS delegates and members and showing how they were following this trajectory…Their whole path, that was really interesting to see because that's going to be us in a couple of years." (N-JSHS Student)

"Touring the Army research lab was also really helpful because that was a bit of a smaller group, so you could talk to the scientists more individually and see what they actually do on a day-to-day basis and what the labs are like." (N-JSHS Student)

"It was nice to have a lot of professionals here, but…the only time when you get to talk individually with them was when we were in the [roundtables]…That was really nice, but it would be nice if we could switch around and maybe have more people here that we could just talk to about different things, because when…there's only four people for 200 kids it's hard to have a nice conversation." (N-JSHS Student)

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. Thus, R-JSHS participants were asked about their opinions regarding DoD researchers and research (Table 44). Nearly three-quarters of students selected "strongly agree" or "agree" for each item, including that DoD researchers solve real-world problems (74%); DoD research is valuable to society (73%); advance science and engineering fields (73%); and develop new technologies (72%). FY18 positive results are similar to those of FY17.

Table 44. R-JSHS Participant Opinions about DoD Researchers and Research (n = 419-421)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	2.6%	1.2%	23.5%	41.6%	31.1%	
	11	5	99	175	131	**421**
DoD researchers develop new, cutting edge technologies	2.9%	0.2%	24.6%	40.6%	31.7%	
	12	1	103	170	133	**419**
DoD researchers solve real-world problems	2.9%	0.7%	22.4%	39.3%	34.8%	
	12	3	94	165	146	**420**
DoD research is valuable to society	3.1%	0.7%	23.4%	37.7%	35.1%	
	13	3	98	158	147	**419**

Interest and Future Engagement in STEM

Developing a STEM-literate citizenry is a key goal of AEOP. In order to gauge the impact of JSHS on students outside of their required school coursework, students were asked to rate the impact of JSHS on their likelihood to engage in various STEM activities (Table 45). R-JSHS students reported that after participating in JSHS they were more likely to engage in activities such as working on a STEM project or experiment in a university or professional setting (69%); helping with a community service project related to STEM (67%); talking with friends or family about STEM (62%); and mentor or teach other students about STEM (62%).

A composite score[13] was generated from these items to test for differences among subgroups of students. No significant differences in Intent to Engage in STEM Out of School were found by overall U2 status, race/ethnicity, gender, ELL status, or first generation status. However, there was a significant difference by FARMS with lower socio-economic status students reporting significantly lower likelihood of engaging[14] (small effect of $d = 0.327$ standard deviations) and school location with students indicating they belong to an underrepresented school location reporting significantly lower likelihood of engaging[15] (small effect of $d = 0.222$ standard deviations).

Table 45. R-JSHS Impact on Participants' Intent to Engage in STEM Out of School (n = 415-419)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	3.1%	2.9%	47.5%	29.8%	16.7%	
	13	12	199	125	70	**419**
Tinker (play) with a mechanical or electrical device	2.9%	4.8%	50.8%	26.7%	14.8%	
	12	20	213	112	62	**419**
Work on solving mathematical or scientific puzzles	2.9%	3.3%	45.2%	30.9%	17.7%	
	12	14	189	129	74	**418**
Use a computer to design or program something	3.6%	5.5%	45.2%	28.7%	17.0%	
	15	23	189	120	71	**418**
	2.6%	3.1%	32.1%	33.0%	29.2%	

[13] These 10 items had a Cronbach's alpha reliability of 0.934.
[14] Two-tailed independent samples t-test: $t(308) = 2.87$, $p = 0.004$.
[15] Two-tailed independent samples t-test: $t(350) = 2.08$, $p = 0.039$.

Talk with friends or family about STEM	11	13	134	138	122	**418**
Mentor or teach other students about STEM	2.6%	3.3%	32.3%	38.3%	23.4%	
	11	14	135	160	98	**418**
Help with a community service project related to STEM	2.4%	2.9%	28.1%	38.2%	28.4%	
	10	12	117	159	118	**416**
Participate in a STEM camp, club, or competition	2.4%	3.6%	33.7%	30.6%	29.7%	
	10	15	141	128	124	**418**
Take an elective (not required) STEM class	2.2%	1.9%	40.0%	26.9%	29.0%	
	9	8	167	112	121	**417**
Work on a STEM project or experiment in a university or professional setting	3.1%	1.9%	25.5%	30.6%	38.8%	
	13	8	106	127	161	**415**

R-JSHS students were asked about their education aspirations after participating in JSHS (Table 46). Almost all students (96%) reported that they planned to, at minimum, earn a Bachelor's degree. In terms of graduate education, 78% indicated that they plan to complete a master's degree or higher, and 59% reported that they intend to earn a terminal degree (doctorate, medical degree, professional law or business degree).

Table 46. After R-JSHS - Participant Education Aspirations (n = 429)

After JSHS Aspirations	Response Percent	Response Total
Graduate from high school	2.56 %	11
Go to a trade or vocational school	0.70 %	3
Go to college for a little while	1.17 %	5
Finish college (get a Bachelor's degree)	11.89 %	51
Get more education after college	5.36 %	23
Get a master's degree	19.35 %	83
Get a Ph.D.	23.54 %	101
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	16.78 %	72
Get a combined masters/ Ph.D.	12.82 %	55
Get another professional degree (law, business, etc.)	5.83 %	25

N-JSHS students were asked the same question about their education aspirations after participating in JSHS (Table 47). N-JSHS student educational aspirations were higher than R-JSHS students', with all N-JSHS participants (100%) reporting that they planned to at least earn a Bachelor's degree. Further, 89% indicated they plan to complete a master's degree or higher, and 71% reported that they intend to earn a terminal degree (doctorate, medical degree, professional law or business degree). N-JSHS students were also asked about their interest in STEM higher education (Table 48). Respondents reported highly favorable responses about their future post-secondary plans in STEM education with 96% indicating that they intend to pursue a Bachelor's degree in a STEM field and 89% reporting that they plan to earn an advanced STEM degree.

Table 47. After N-JSHS - Participant Education Aspirations (n=28)

After Aspirations	Response Percent	Response Total
Graduate from high school	0.00%	0
Go to a trade or vocational school	0.00%	0
Go to college for a little while	0.00%	0
Finish college (get a Bachelor's degree)	3.57%	1
Get more education after college	7.14%	2
Get a master's degree	17.86%	5
Get a Ph.D.	28.57%	8

Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	14.29%	4
Get a combined masters/Ph.D.	25.00%	7
Get another professional degree (law, business, etc.)	3.57%	1

Table 48. After N-JSHS - Participant Education Aspirations (n=28)

STEM Degree Type	Yes	No
Bachelor's degree in a STEM field	27 (96.4%)	1 (3.57%)
Advanced degree (beyond a bachelor's degree) in a STEM field	25 (89.29%)	3 (10.71%)

Resources

R-JSHS survey participants were asked which resources impacted their awareness of the various AEOPs (Table 49). Resources that more than half of students reported as having at least a little impact on their awareness of AEOPs were similar to the resources that impacted their learning about DoD jobs/careers: participation in JSHS (74%); presentations or information shared at the competition (63%); and invited speakers (60%). Again, JSHS mentors had less of an impact, with less than half of R-JSHS students (47%) reporting that mentors helped them learn about AEOPs. Likewise, AEOP electronic efforts had the least impact of the resources with three-quarters or more indicating they did not experience the AEOP website (74%) or AEOP social media (83%) with regards to their AEOP awareness.

Table 49. Impact of Resources on R-JSHS Participant Awareness of AEOPs (n = 421-427)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	74.0%	7.3%	9.8%	4.2%	4.7%	
	316	31	42	18	20	**427**
AEOP on Facebook, Twitter, Pinterest or other social media	83.1%	7.3%	4.7%	2.1%	2.8%	
	354	31	20	9	12	**426**
My JSHS mentor(s)	43.4%	10.1%	18.8%	12.4%	15.3%	
	185	43	80	53	65	**426**

Presentations or information shared at the JSHS competition	25.7%	11.2%	23.3%	17.6%	22.3%	
	108	47	98	74	94	**421**
Participation in JSHS	19.6%	6.4%	27.1%	20.5%	26.4%	
	83	27	115	87	112	**424**
Invited speakers at JSHS	26.8%	13.2%	21.9%	19.3%	18.8%	
	114	56	93	82	80	**425**

R-JSHS students' reports about the usefulness of various AEOP resources for learning about DoD STEM careers are found in Table 50. Resources rated by more than half of students as having at least a little impact on their learning about DoD STEM careers were participation in JSHS (63%); presentations or information shared at the competition (62%); and invited speakers (57%). JSHS mentors had less of an impact with 39% of R-JSHS students reporting that mentors impacted their learning about DoD STEM careers. AEOP electronic efforts had the least impact of the resources with nearly three-quarters or more indicating they did not experience the AEOP website (73%) or AEOP social media (80%).

Table 50. Impact of Resources on R-JSHS Student Awareness of DoD STEM Careers (n = 421-425)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	73.4%	5.6%	12.0%	4.5%	4.5%	
	312	24	51	19	19	**425**
AEOP on Facebook, Twitter, Pinterest or other social media	80.2%	7.5%	7.8%	2.1%	2.4%	
	340	32	33	9	10	**424**
My JSHS mentor(s)	45.0%	15.9%	18.5%	8.8%	11.8%	
	190	67	78	37	50	**422**
Presentations or information shared at the JSHS competition	25.8%	12.3%	26.5%	15.4%	20.1%	
	109	52	112	65	85	**423**
Participation in JSHS	23.8%	13.1%	23.0%	20.2%	20.0%	
	100	55	97	85	84	**421**
Invited speakers at JSHS	29.6%	13.3%	22.5%	14.9%	19.7%	
	125	56	95	63	83	**422**

Mentors reported, similarly to students, that the most useful resources for exposing students to AEOPs was participation in JSHS (84%) (Table 51). For mentors, the second most useful resource was JSHS program administrators or site coordinators (73%). Also similar to students, mentors reported having little experience with AEOP electronic and print efforts with more than three-quarters indicating they did not experience AEOP social media (93%); AAS website (85%); AEOP brochure (77%); and the AEOP website (76%).

Table 51. Mentor Responses about Usefulness of Resources for Exposing Students to AEOPs (n = 153-157)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Academy of Applied Science (AAS) website	85.3%	0.6%	3.2%	3.8%	7.1%	
	133	1	5	6	11	**156**
Army Educational Outreach Program (AEOP) website	75.6%	0.0%	9.0%	7.1%	8.3%	
	118	0	14	11	13	**156**
AEOP on Facebook, Twitter, Pinterest or other social media	92.9%	0.0%	3.8%	1.9%	1.3%	
	145	0	6	3	2	**156**
AEOP brochure	77.4%	0.0%	7.7%	7.1%	7.7%	
	120	0	12	11	12	**155**
JSHS Program administrator or site coordinator	26.8%	0.0%	8.5%	16.3%	48.4%	
	41	0	13	25	74	**153**
Invited speakers or "career" events	56.8%	2.6%	6.5%	10.3%	23.9%	
	88	4	10	16	37	**155**
Participation in JSHS	14.6%	1.3%	3.8%	7.0%	73.2%	
	23	2	6	11	115	**157**

Table 52 shows that mentors' responses followed a similar pattern for an item asking about the usefulness of resources for exposing students to DoD STEM careers. Again, mentors indicated that participation in JSHS (74%) and JSHS program administrators or site coordinators (60%) were the most useful resources. For all AEOP electronic and print resources, a large majority of mentors (78%-96%) reported not experiencing these for the purpose of exposing students to DoD STEM careers.

Table 52. Usefulness of Resources for Exposing Students to DoD STEM Careers (n = 155-157)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Academy of Applied Science (AAS) website	88.5%	0.0%	2.6%	4.5%	4.5%	
	138	0	4	7	7	**156**
Army Educational Outreach Program (AEOP) website	81.9%	0.0%	6.5%	5.2%	6.5%	
	127	0	10	8	10	**155**
AEOP on Facebook, Twitter, Pinterest or other social media	93.6%	0.6%	1.9%	2.6%	1.3%	
	146	1	3	4	2	**156**
AEOP brochure	78.2%	1.3%	5.1%	8.3%	7.1%	
	122	2	8	13	11	**156**
It Starts Here! Magazine	95.5%	1.3%	0.6%	1.3%	1.3%	
	149	2	1	2	2	**156**
JSHS Program administrator or site coordinator	39.7%	0.6%	5.1%	12.8%	41.7%	
	62	1	8	20	65	**156**
Invited speakers or "career" events	57.1%	3.2%	5.8%	10.9%	23.1%	
	89	5	9	17	36	**156**
Participation in JSHS	24.8%	1.3%	7.0%	6.4%	60.5%	
	39	2	11	10	95	**157**

Overall Impact

The overall impact of participating in JSHS was evaluated by questionnaire items asking students to report on their awareness of and interest in STEM opportunities; their perceptions of the impact on JSHS on their skills, confidence, and knowledge; and their knowledge of and appreciation for STEM research and careers in the DoD. More than half of R-JSHS students (51%-83%) agreed that JSHS contributed to or was primarily responsible for their growth in all areas (Table 53). For example, students strongly agreed that JSHS contributed to an increase in their confidence in their STEM knowledge, skills, and abilities (83%); their interest in participating in STEM activities outside of school requirements (78%); and their interest in taking STEM classes in school (68%). While more than half of students indicated agreement with all items, there were a substantial number of participants who indicated that JSHS did not impact them for AEOP-

related items such as pursuing a STEM career with the DoD (49%); being more interested in participating in other AEOPs (45%); and being more aware of other AEOPs (40%).

Questionnaire items for Overall Impact of participating in JSHS on regional students were combined into a composite variable[16] to assess for differences between student subgroups. There was a significant difference in reported Overall Impact by U2 status with AEOP defined underrepresented students reporting significantly lower impact compared to those who were not identified as underrepresented[17] (small effect of d = 0.219 standard deviations). However, no significant subgroup differences were found.

Table 53. R-JSHS Participant Opinion of JSHS Impacts (n = 128-132)

	Disagree - This did not happen	Disagree - This happened but not because of JSHS	Agree - JSHS contributed	Agree - JSHS was primary reason	Response Total
More confident in STEM knowledge, skills, and abilities	2.3%	14.4%	63.6%	19.7%	
	3	19	84	26	**132**
More interested in participating in STEM activities outside of school requirements	3.9%	18.6%	57.4%	20.2%	
	5	24	74	26	**129**
More aware of other AEOPs	28.1%	11.7%	43.8%	16.4%	
	36	15	56	21	**128**
More interested in participating in other AEOPs	32.8%	11.7%	39.1%	16.4%	
	42	15	50	21	**128**
More interested in taking STEM classes in school	5.4%	27.1%	48.1%	19.4%	
	7	35	62	25	**129**
More interested in earning a STEM degree	7.8%	26.4%	47.3%	18.6%	
	10	34	61	24	**129**
More interested in pursuing a career in STEM	8.5%	24.8%	46.5%	20.2%	
	11	32	60	26	**129**
	22.7%	14.8%	46.9%	15.6%	

[16] The Cronbach's alpha reliability for these 10 items was 0.921.
[17] Two-tailed independent samples t-test: $t(356) = 2.07$, $p = 0.039$.

More aware of DoD STEM research and careers	29	19	60	20	**128**
Greater appreciation of DoD STEM research	24.0%	10.9%	48.8%	16.3%	
	31	14	63	21	**129**
More interested in pursuing a STEM career with the DoD	35.2%	14.1%	37.5%	13.3%	
	45	18	48	17	**128**

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. In the 100 responses sampled, students noted a variety of benefits of JSHS participation. The most frequently mentioned benefit, cited by in nearly half (47%) of responses, was presentation skills. About a third of responses cited STEM learning (34%), research skills (32%), increasing their interest in and/or motivation for STEM (31%) and interacting with others who have similar interests (30%). Other benefits included learning about others' research and research topics (29%), gaining career information (23%) networking with professionals (16%), and improving communication skills generally (14%). Other benefits, mentioned in fewer than 10% of responses included:

- Getting information about other AEOPs
- Collaboration skills
- Confidence
- Feedback on projects,
- Patience and/or perseverance
- Leadership
- Creativity
- Feeling of accomplishment about making a contribution to STEM research

N-JSHS students were also asked about the overall impact of participating in JSHS (Table 54). Compared to R-JSHS participants, N-JSHS students reported stronger impacts for all items except one (more interest in taking STEM classes in school for which 44% reported an impact). More than three-quarters of N-JSHS students agreed that JSHS impacted their confidence in their STEM knowledge, skills, and abilities (89%) and their interest in participating in STEM activities outside of school requirements (82%). N-JSHS students reported particularly strong impacts for specific AEOP and DoD-related items, with most indicating they were more aware of other AEOPs (100%); had greater appreciation of the Army or DoD STEM research (93%); were more aware of army or DoD STEM research and careers (89%); were more interested in participating in other AEOPs (78%); and were more interested in pursuing a STEM career with the Army or DoD.

Table 54. N-JSHS Participant Opinion of JSHS Impacts (n = 26-27)

	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	0.0%	11.1%	81.5%	7.4%	
	0	3	22	2	**27**
I am more interested in participating in STEM activities outside of school requirements	0.0%	18.5%	66.7%	14.8%	
	0	5	18	4	**27**
I am more aware of other AEOPs	0.0%	0.0%	34.6%	65.4%	
	0	0	9	17	**27**
I am more interested in participating in other AEOPs	14.8%	7.4%	37.0%	40.7%	
	4	2	10	11	**26**
I am more interested in taking STEM classes in school	48.1%	7.4%	40.7%	3.7%	
	13	2	11	1	**27**
I am more interested in earning a STEM degree	3.7%	37.0%	55.6%	3.7%	
	1	10	15	1	**27**
I am more interested in pursuing a career in STEM	0.0%	33.3%	66.7%	0.0%	
	0	9	18	0	**27**
I am more aware of Army or DoD STEM research and careers	7.4%	3.7%	25.9%	63.0%	
	2	1	7	17	**27**
I have a greater appreciation of Army or DoD STEM research	7.4%	0.0%	33.3%	59.3%	
	2	0	9	16	**27**
I am more interested in pursuing a STEM career with the Army or DoD	29.6%	0.0%	40.7%	29.6%	
	8	0	11	8	**27**

Students presenting at the national event were also asked in an open-ended questionnaire item to reflect on the benefits of participating in JSHS. Of the 24 students who responded to the item, half (12, or 50%) cited the benefits of interacting with like-minded peers. Other benefits mentioned included the opportunity to communicate about their research (7, or 29%), get career information (5, or 21%), and the

exposure to a variety of research projects (5, or 21%). Other benefits, mentioned by 1 student each, included receiving judge feedback, increasing confidence, and the lab tours. For example,

> "I really enjoyed meeting people from different places with similar passions as mine, and it helped me understand possible future paths I could take." (N-JSHS Student)

> "I think meeting new people and DOD scientists opened my eyes to the level of research being done. I had a newfound appreciation for what the DOD does and the career, life advice were mostly helpful." (N-JSHS Student)

Students participating in the focus group at the national event also emphasized the value of the personal connections, the opportunities to learn about STEM careers, and the opportunity to present research as benefits. For example,

> "I enjoyed the networking socials that we had, like the ice cream social…It was nice because we got to talk with our fellow peers. You definitely get to get a broader view of the whole entire country and to see other people that are passionate about science like myself." (N-JSHS Student)

> "I really liked yesterday when we had the groups where we signed up to meet different professionals and we were in small groups talking…That was one of the most valuable things I've done while I've been here." (N-JSHS Student)

> "There aren't that many venues for high school students to really share research. In the area that I'm in, a lot of people know that I do research, but it's weird because no one else does research, so I don't have anything to compare myself to. JSHS was a really unique opportunity that gave me a lot of connections to people that actually do research in my field" (N-JSHS Student)

8 | Findings and Recommendations

Summary of Findings

The FY18 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 55.

Table 55. 2018 JSHS Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
There is a substantial downward trend in interest and participation when viewed over a multi-year period.	In FY18, interest in JSHS declined slightly to 4,279 initial registrations. This continues a downward trend in registrations since 2015: in FY17 there were 8,663; in FY16, 8,947; in FY15, 9,347.
	In FY18, JSHS had 3,069 students who completed their project and participated in the competition. However, this represents a 45% decrease from FY17, and continual decrease from prior years. In FY17 5,577 students were served; in FY16, 5,629; and in FY15, 5,829.
Collection of required demographic data for JSHS participants continued to be a challenge.	As in FY17, JSHS continued to struggle with gathering necessary demographic data from regional sites. In fact, data were missing for over 50% of enrolled students. There were 12 of the 46 JSHS regions that did not use Cvent for registration. Using Cvent data, the overall U2 population for R-JSHS in FY18 was 37%. By comparison, the N-JSHS U2 population was 38%.
JSHS continued a trend of enrolling a majority of female participants.	For the R-JSHS students for whom demographic data were available, slightly more than half (58%) were female and 40% were male. A majority of N-JSHS participants (59%) were female.
The ethnic/racial diversity of JSHS remains relatively constant compared to previous program years.	As in previous years, students identifying themselves as White were the largest racial/ethnic group among R-JSHS and N-JSHS participants (57% and 54% respectively). Students identifying themselves as Asian were the second largest racial/ethnic group of participants (20% for R-JSHS and 30% for N-JSHS). As in FY17, only 6% of R-JSHS students identified themselves as Black or African American (2% for N-JSHS). The proportion of Hispanic or Latino students in R-JSHS decreased slightly (5% in FY18, 7% in FY17). Among N-JSHS students, 4% identified themselves as Hispanic or Latino.

	Mentors participating in a focus group suggested ways to broaden the reach of JSHS through providing teacher supports. In particular, they suggested pairing schools and teachers with active research programs with schools serving students who are underserved or underrepresented in STEM, encouraging schools with AP research courses to have students participate in JSHS, and getting more teachers involved by engaging the support of district level leadership and providing support and training for research. Mentors suggested that providing examples of schools that had been successful at forging mentor partnerships for JSHS might be a useful means to engaging district leadership support for JSHS involvement.
Students reported that they actively engaged in STEM practices in JSHS but 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 R-JSHS experiences. For example, 55% of students reported having worked with a STEM researcher or company on a real-world STEM project at least once in JSHS while only 42% of respondents indicated having the same experience in school. Similarly, half (50%) of R-JSHS respondents indicated they engaged in solving real world problems at least monthly in JSHS while fewer (45%) reported this type and frequency of engagement in school.
	Although there was no significant difference in engagement in STEM practices by U2 status, low SES students were significantly less engaged in STEM practices than non-SES students (small effect size).
	N-JSHS students in focus groups reported that JSHS provides more active engagement than their typical school experiences because of the opportunities to apply their STEM knowledge, gain research skills, experience a cohort of like—minded peers, the rigor of expectations, and the expertise of the judge feedback.
	There was no statistically significant difference overall, however, in students' engagement in STEM practices in R-JSHS as compared to school. It is important to note, however, that these data may not entirely 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 therefore not conceptualize STEM practices in JSHS and STEM practices in school as separate phenomena.
Students reported gains in their STEM knowledge and STEM competencies (skills in science and engineering practices) as a result of participating in JSHS.	A majority (70% or more) of R-JSHS students reported medium or large gains in all areas of STEM knowledge due to their participation in the JSHS program.
	A majority (55% or more) of R-JSHS students reported medium or large gains in all but one area (slightly less than half [46%] reported at least medium gains in using computer models) of STEM Competencies.

Students reported gains in their 21st Century Skills as a result of participating in JSHS.	Approximately two-thirds or more of respondents reported medium or large gains in all areas, and large majorities (85% or more) of students reported at least small gains in all areas of 21st Century Skills. These included skills such as setting goals and reflecting on performance, sticking with a task until it is finished, and making changes when things do not go as planned.
Students reported gains in their STEM identities as a result of participating in JSHS.	Large majorities (more than 80%) of students reported at least some gain in all areas of STEM identity, or their feelings of confidence in their ability to succeed in STEM, and nearly two-thirds or more indicated medium to large gains in each area.
Priority #2: *Support and empower educators with unique Army research and technology resources.*	
While most mentors used a variety of effective mentoring strategies with their students, few discussed AEOPs other than JSHS with their students.	More than half of responding mentors (53%-87%) 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.
	Few mentors (2%-25%) reported speaking with students about AEOPs other than JSHS. Less than a quarter (21%) discussed AEOPs with participants without referencing any specific program.
Students reported high levels of satisfaction with JSHS program components, although satisfaction ratings were somewhat lower than in FY17. Judging and feedback were areas of somewhat less satisfaction for participants.	Most R-JSHS (80% or more) students were somewhat or very much satisfied with nearly all JSHS features that they had experienced, although satisfaction levels for elements associated with presentations and judging and feedback were somewhat lower than in FY17.
	Qualitative data from both R-JSHS and N-JSHS students suggest that students particularly value the opportunity to present their research, learn about others' research, and connect with like-minded peers.
	Although few R-JSHS students expressed dissatisfaction with any R-JSHS features on the questionnaire, it is noteworthy that 11% expressed dissatisfaction with the judging process and with feedback from judges.
	Qualitative data from students regarding judging and judge feedback indicate that some participants feel that there is a lack of judges representing diverse specialties at the regional level, and that poster judging at both the regional and national level could be improved by providing more, and more specialized, judges. In addition, students valued

	the feedback they received from judges although R-JSHS student comments suggest that feedback may not be provided consistently across regional events.
	Qualitative data from R-JSHS students regarding program improvements focused on improvements in scheduling and organization of events and providing more speakers and interactive activities at events.
Mentors reported high levels of satisfaction with JSHS, and suggested various program improvements.	More than half of mentors (57%-90%) reported being somewhat or very much satisfied with all program features they experienced. Over half (61%) had not experienced communication with AAS.
	Qualitative data from mentors indicates that mentors particularly value the opportunity for students to present their research, to connect with like-minded peers, network with STEM professionals, develop research skills, and learn about others' research.
	Qualitative data from mentors suggests that mentors believe that JSHS could be improved by measures such as improving communication, increasing publicity, improving judge feedback and diversity of judges' areas of expertise, and providing more interactive activities at events.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Schools and school-based communication continue to be the primary means of student information about AEOP. Mentors learned about AEOP primarily through personal or professional contacts.	About three-quarters of R-JSHS students learned about AEOP either through their schools (52%) or through a school or university newsletter, email, or website (26%). Over half of mentors learned about JSHS either through personal contacts, including a past JSHS participant (33%) or a colleague (32%).
R-JSHS students had less knowledge of other AEOPs than N-JSHS student. Program participation and personally conveyed information were the most impactful resources for both mentors and students to learn about other AEOPs.	Few R-JSHS students expressed that they were "not at all" interested in future programs (6%-8%). However, the majority of R-JSHS students (56%-74%) had not heard of programs other than JSHS. Some (20%-36%) R-JSHS students were interested in participating in other JSHS. Fewer N-JSHS were unfamiliar with other AEOPs (15%-56%), and many N-JSHS students (33% - 78%) expressed interest in participating in most other AEOPs. Very few mentors reported speaking with their students about AEOPs other than JSHS (60%) and UNITE (25%). Less than 10% of mentors reported discussing any other AEOP with their students, although 21% indicated they discussed AEOP with their students in general but without reference to any specific program.

	The most useful resources for R-JSHS students for AEOP information were participation in JSHS (74%); presentations or information shared at the competition (63%); and invited speakers (60%). Slightly over half of R-JSHS students reported that they had not experienced AEOP information from their mentors (43%) or that their mentors were not a useful resource for this information (10%).
	Mentors reported that the most useful resources of AEOP information were JSHS participation (84%) and program administrators or site coordinators (73%).
	Few students and mentors reported that electronic resources were impactful for learning about AEOPs and most had not experienced resources such as the AEOP website, AEOP social media, and the AAS website.
JSHS participants learned about STEM careers both generally and within the DoD had positive perceptions of DoD research and researchers.	A large majority (84%) of R-JSHS students had learned about at least one STEM job or career during JSHS although fewer (53%) had learned about at least one STEM job or career within the DoD. Nearly all (96%) of N-JSHS students had learned about at least one STEM job or career during JSHS and all had learned about at least one STEM job or career within the DoD.
	R-JSHS students reported that the most impactful resources for learning about STEM careers in the Army or DoD were participation in JSHS (63%); presentations or information shared at the competition (62%); and invited speakers (57%).
	Of the R-JSHS students who had opinions about DoD research and researchers, large majorities of R-JSHS agreed or strongly agreed that DoD researchers solve real-world problems (74%); DoD research is valuable to society (73%); advance science and engineering fields (73%); and develop new technologies.
R-JSHS students reported being more likely to engage in STEM activities outside of required school courses in the future.	Most R-JSHS students (62%-69%) reported that after participating in JSHS they were more likely to engage in several activities including working on a STEM project or experiment in a university or professional setting, helping with a community service project related to STEM (67%); talking with friends or family about STEM, and mentoring or teaching other students about STEM.
	While there were no differences in likelihood of future engagement in STEM by U2 status, low SES students reported significantly lower likelihood of participating in STEM activities in the future (small effect size).

Most JSHS participants had educational aspirations beyond earning an undergraduate degree after participating in JSHS.	Almost all R-JSHS students (96%) reported that they planned to, at minimum, earn a Bachelor's degree. Most R-JSHS students (78%) indicated that they plan to earn a graduate degree. All N-JSHS students planned to earn a Bachelor's degree (96% of these in a STEM field), and most (89%) indicated they plan to earn a graduate degree.
Both R-JSHS and N-JSHS students reported positive impacts from their JSHS participation, although many reported that JSHS had not impacted their knowledge of other AEOPs and DoD STEM careers. There was a significant difference in impact by U2 status.	More than half of all R-JSHS students (51%-83%) indicated that their JSHS participation had positive impacts on their awareness of and interest in STEM opportunities; their perceptions of the impact on JSHS on their skills, confidence, and knowledge; and their knowledge of and appreciation for STEM research and careers in the DoD.
	Over a quarter of R-JSHS students reported that JSHS had not impacted their interest in participating in other AEOPs (33%), their awareness of other AEOPs (28%), and their interest in STEM careers with the DoD (35%).
	U2 R-JSHS students reported overall lower impacts than other students (small effect size).
	Most N-JSHS students reported that JSHS had positively impacted their awareness of and interest in STEM opportunities; their perceptions of the impact on JSHS on their skills, confidence, and knowledge; and their knowledge of and appreciation for STEM research and careers in the DoD.
	All N-JSHS students reported that JSHS positively impacted their awareness of other AEOPs. And over three-quarters (78%) indicated that JSHS impacted their interest in participating in other AEOPs.

Responsiveness to FY17 Evaluation Recommendations

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

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

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

FY17 Finding: JSHS continued to experience a decrease in applications and participation in the program overall – which represents a three-year downward trend of 8%. For FY17 there were 8,663 applications and 5,577 students were supported to participate. In FY16 there were 8,900 applications and 5,300 participants – compared to 9,347 and 5,829 respectively in FY15. This is an area that is in need of focus again in FY18. We suggest three strategies for addressing enrollment concerns: 1) work with regions to expand their recruitment efforts beyond the local area utilizing websites, social media, and other marketing efforts of the consortium, 2) grow capacity for stronger regions to accept more participants, 3) asking FY17 alumni to recruit two new participants for the program.

JSHS FY18 Efforts and Outcomes: The AAS has encouraged JSHS regional symposia to feature a Poster Session to allow more students the opportunity to participate and present their STEM research at the symposium. Approximately 2/3 of the regions have implemented Poster Sessions as part of their symposium programming. Secondly, two regions – Wyoming and California – host virtual competitions for students to allow access despite geographic barriers. Virtual competition may be an approach to investigate to increase infrastructure for a limited investment. Lastly, approximately three regions work with their Conference Services Office and charge a university established fee for each regional symposium participant. There is a direct relationship between the number of participants served and the cost per participant not just in those regions but in other regions as well.

Factor impacting Placement Rate due to Competitive Nature of JSHS (i.e. competing for scholarships)– Regions do have to be concerned about domination of a resource rich school district and have established quotas to limit participation from any one school in many cases, but not all. Virginia provides an example through their annual report feedback. “We (James Madison University) have to limit the number of students who can apply from a school (especially the Governor’s schools which typically have 50 or more students doing research projects), but we give every student who is selected by the school a chance to speak in the competition.”

FY17 Finding: Though JSHS has steadily had participation from female students (59% in FY17), the diversity of other groups in JSHS has continued to decline. 55% of participants in FY17 were White and 24% Asian. Only 6% of participants identified as Black/African American and 7% Hispanic or Latino. Geographical representation was predominantly suburban (52%) as well, as the urban school representation declined to 3%. Recruitment and marketing strategies in FY17 should intensively focus on working with regions to expand their reach into communities with more diversity. JSHS should also work with strategic outreach partners to address recruiting challenges as well.

JSHS FY18 Efforts and Outcomes: The AAS has worked with Strategic Outreach Partners in Ohio, North Carolina, Michigan, and Montana to broaden successful participation in JSHS by U2 populations. The AAS has also identified Upward Bound Programs (Project Trio) at 29 of the 47 universities that host regional symposia. Upward Bound students are U2 populations and successfully participated in four regional symposia in FY ’18. FY ’19 plans will look at expansion of the partnership with Upward Bound to increase participation in JSHS. Lastly, the AAS and NSTA have reached out to all JSHS Regional Symposia to introduce eCYBERMISSION Team

Advisors and encourage participation in JSHS. We are looking forward to increased participation in JSHS FY '19 by eCybermission students and Apprentices.

FY17 Finding: Program provided/collected demographic data on participants was incomplete, as in FY15 and FY16. Our recommendation from FY16 is repeated this year. It is strongly suggested that JSHS require regional sites to collect full demographic data on all participants in FY18 and beyond.

JSHS FY18 Efforts and Outcomes: In FY18, CVENT was used by a total of 34 of 46 JSHS Regional Symposia and the National JSHS. AEOP common questions and demographic data collection were consistently accessed through those regions who implemented CVENT as their registration tool. A total 12 Regional Symposium did not use CVENT due to timing, availability of staff, or internal university procedures which prohibit adding CVENT links on host institutional networks. Concerns also arise around confidentiality, or the fact that some regions do not want to collect or share email addresses for students. Those regions which did not use CVENT were requested to incorporate into their existing practices, the AEOP common questions and demographic questions with the exact language and response choices to match those in CVENT.

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

FY17 Finding: In FY17 JSHS participants continued to report dissatisfaction with judging practices and judging feedback at regional competitions – a finding that has been reported in FY14, FY15, and FY16 as well. There were several data points that reinforced this finding, from the R-JSHS survey to N-JSHS focus group sessions and the N-JSHS survey. Participants reported not being satisfied with the quality of and amount of feedback provided from judges – including receiving no written feedback from judges. Further, participants felt that the judges were not content experts and that they were judged primarily for their presentation skills rather than the actual content and focus of their research project. As has been recommended in previous years, JSHS should develop and implement guidelines for judging that include templates for providing feedback (written and oral) to participants. Further, regional sites should make every effort to have judges that reflect the breadth and depth of STEM content that participants may focus on as much as possible. STEM experts as well as Army/DoD STEM experts should be sought to engage in R-JSHS events. Virtual judging processes that may enable more qualified STEM judges to participate is a strategy that should be considered, given the concerns in this area that have been prevalent the last three years of the program.

JSHS FY18 Efforts and Outcomes: JSHS implemented a judging feedback process in FY18.

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

FY17 Finding: As in FY17, 59% of R-JSHS participants agreed that JSHS made them more aware of other AEOPs and 55% were interested in participating in other AEOPs. These percentages are slightly improved from FY16 (50% and 46% respectively). However, most mentors did not discuss AEOPs with participants

and the percentages decreased in FY17 – as only 21% discussed Unite (compared to 23% in FY16), 14% SMART (compared to 7% in FY16), 12% eCybermission (compared to 8% in FY16), 11% SEAP (compared to 9% in FY16), 10% URAP (compared 4% in FY16), 10% REAP (compared to 8% in FY16), 9% HSAP (compared to 6% in FY16), 5% CQL (compared to 2% in FY16), and 6% NDSEG Fellowship (compared to 3% in FY16). These findings are concerning, primarily because these are areas that AAS could address through collective and organized marketing efforts for JSHS. Widmeyer developed slide decks and other materials should be better utilized by programs to expose participants to other important components of the AEOP pipeline. Promotion of the AEOPs should be collective responsibility of each and every program within the consortium.

JSHS FY18 Efforts and Outcomes: JSHS distributed AEOP brochures to regions in FY18.

FY17 Finding: The majority of participants in R-JSHS (85%) in FY17 (similar to FY16 78%) reported learning about STEM careers during JSHS. There was also growth in the percentage of participants that learned about at least one Army/DoD STEM career in FY17 (51% compared to 40% FY16). Conversely, a large majority of N-JSHS (80%) students indicated that invited speakers or career events were a key resource for learning about DoD STEM careers. The difference in growth of learning about STEM careers overall and DoD STEM careers specifically may be attributed to mentor level of discussion of each during the program. Mentors (78%) reported discussing STEM careers with participants. However, only 35% discussed Army/DoD STEM careers. Mentors (78%) reported discussing STEM careers with participants. However, only 35% discussed Army/DoD STEM careers. In FY17 JSHS should address this area through development of a toolkit for regional sites to use (i.e. slideshow, handouts, social media posts) and also an inventory of potential regional Army/DoD STEM career people who could be engaged to participate in person or by video in the programming.

JSHS FY18 Efforts and Outcomes: JSHS provided some targeted support to selected regions to try and engage DoD researchers in regional programs.

Recommendations for FY19 Program Improvement/Growth

Evaluation findings indicate that JSHS experienced success as in previous years. Notable successes for the year include continual impacts on STEM skills, STEM knowledge, STEM identity, and 21st Century Skills. While these successes are commendable, there are some areas that remain with potential for growth and/or improvement. The evaluation team therefore offers the following recommendations for FY19 and beyond:

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

1. As in the previous three years, JSHS participation continued to decrease in FY18. There were 3,069 participants in FY18, compared to 5,577 in FY17, representing a 45% decrease. Since FY15, the enrollent has dropped over 50%, from 9,347 to 4,600. As in FY17, we recommend that the for FY19 the new IPA (National Science Teachers Association) take a serious approach to reversing this trend. As in FY17, we suggest three strategies for addressing enrollment concerns: 1) work with regions to expand their recruitment efforts beyond the local area utilizing websites, social media, and other marketing efforts of the consortium, 2) grow capacity for stronger regions to accept more participants, 3) asking FY18 alumni to recruit new participants for the program.

2. In FY18, JSHS did not secure 100% participation in the use of Cvent for registration for regions. Only 34 of the 46 regions were fully integrated. As a result, the program failed to collect important demographic data on all participants. For the purposes of this evaluation, we calculated the percentage of underserved students using only data from Cvent (n = 2,955). The overall U2 percentage for JSHS in FY18 was 37%. There are two recommendations in regards to this area of concern. First, all JSHS sites should be required to use Cvent for registration in FY19. Second, JSHS should work to engage and grow the percentage of underserved students by at least 5% for FY19 and also develop a plan to continue to grow this percentage over the next five years.

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

1. JSHS mentors reported only 53% to 87% usage of the effective mentoring strategies. This reveals that mentors are either choosing not to implement best-practice or are not equipped with the appropriate training to utilize the strategies with their participants. It is recommended that JSHS develop and implement a required training for mentors (delivered virtually) that is completed at least once when beginning to work with the program in FY19 and beyond.
2. As in previous years, JSHS participants and mentors indicated the need for securing judges from more diverse backgrounds who were also representative of STEM content area specialties. It is recommended that JSHS continue to have formal efforts to address the lack of diverse populations and STEM content expertise in their judging volunteers.

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

In FY18, JSHS participants reported (56% to 74% depending on program) not having any knowledge of the other AEOP programs. Few mentors reported speaking with their students about AEOPs other than JSHS (60%) and UNITE (25%). Less than 10% of mentors reported discussing any other AEOP with their students, although 21% indicated they discussed AEOP with their students in general but without reference to any specific program.

This finding has been prevalent across evaluations from FY15 to present without improvement despite some efforts to encourage regional sites to promote AEOPs. Due to the significance and importance of making participants aware of the other AEOPs and resources in the pipeline, we strongly encourage NSTA to take this finding very seriously and develop and implement a formal strategy to address this in FY19 and beyond.