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ARMY EDUCATIONAL OUTREACH PROGRAM

JSHS

2019 Annual Program Evaluation Report
Findings

July 2020

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ARMY EDUCATIONAL OUTREACH PROGRAM

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3 | Introduction

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

AEOP Priorities

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

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

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

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

Program Overview

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

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

In regional (R-JSHS) and national (N-JSHS) symposia, students present their research in a forum of peer researchers and practicing researchers from 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 47 university campus sites nationwide in 2019. 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. In 2019, 93 students made oral presentations and 128 students made poster presentations at the N-JSHS competition in Albuquerque, New Mexico. NSTA has established guidelines and "Ground rules" for the student research paper competition and provides these guidelines to JSHS regional symposia and other cooperating organizations. These resources allow for a general consistency in student experience and outcome, while still allowing sites the flexibility to design the details of their program to meet the unique needs of their students. All JSHS programs are designed to meet the following objectives:

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

6. Expose students to STEM careers in the Army and/or DoD laboratories; and
7. Increase the future pool of talent capable of contributing to the nation's scientific and technological workforce.

The 47 R-JSHS sites reported that they received applications from 4,493 students; 2,651 (59%) of these students competed in regional competitions. This represents a 5% increase in applicants as compared to FY18 when 4,279 students applied and begins to reverse a downward trend in the number of JSHS applicants (8,663 applicants in FY17; 8,947 in FY16; 9,347 in FY15). The 16% decrease in participation as compared to FY18 (when 3,069 students participated) continues the downward trend in participation, with fewer applicants participating each year since FY15 (5,577 participants in FY 17; 5,620 in FY16; and 5,829 in FY15). Table 1 summarizes applicants and final selection as reported by the sites.

Table 1. 2019 JSHS Site Reports of Applicants and Selection

Region	Students Applied	Students Selected	Teachers Selected
Alabama	48	37	15
Alaska	13	13	3
Arizona	44	44	5
Arkansas	45	45	6
California Northern & Western Nevada	63	54	Not reported
California Southern	30	27	Not reported
Connecticut	236	236	37
Europe DoDEA	55	29	12
Florida	74	45	35
Georgia	119	59	6
Hawaii	121	72	23
Illinois	43	43	13
Illinois - Chicago	45	16	Not reported
Indiana	24	24	3
Intermountain	83	58	18
Iowa	239	15	33
Kansas-Nebraska-Oklahoma	35	31	Not reported
Kentucky	18	18	5
Louisiana	102	94	18
Maryland	59	59	3
Michigan Southeastern	41	35	20

Missouri	85	85	Not reported
New England Northern	71	71	9
New England Southern	47	47	23
New Jersey Rutgers	152	93	35
New Jersey Shore	81	48	15
New York Long Island	193	109	54
New York Metro	191	91	40
New York Upstate	778	84	75
North Carolina	76	76	11
North Central	77	76	Not reported
Ohio	117	74	12
Oregon	17	17	7
Pacific DoDEA	195	126	17
Pennsylvania	32	32	18
Philadelphia	52	21	1
Puerto Rico	130	50	10
South Carolina	170	34	21
Southwest	25	23	14
Tennessee	50	35	16
Texas	68	66	22
Virginia	114	104	17
Washington	45	45	9
Washington D.C.	123	123	20
West Virginia	6	6	2
Wisconsin & Upper Michigan	45	45	12
Wyoming & Eastern Colorado	16	16	Not reported
Totals	**4,493**	**2,651**	**715**

In addition to students, JSHS engaged approximately 2,636 adult teachers, faculty, graduate students, and other adults who served in various roles, including 252 DoD scientists and engineers (S&Es). This is a 24% increase in adult participation overall compared to FY18 when 2,015 adults participated and a 44% increase in S&E participation compared to FY18 when 139 DoD S&Es participated. There were a total of 34 Army/DoD research laboratories and centers that collaborated with JSHS. A total of 1,110 adults were registered in Cvent. Table 2 provides an overview of students, teachers, college and university faculty and staff, and DoD S&Es who participated in JSHS in 2019.

Table 2. 2019 NSTA Reports of JSHS Participation	
Participant Group	**No. of Participants**
High school students (grades 9-12)	2,651
K-12 teachers	715
College/university faculty or other personnel	705
Army/DoD Scientists & Engineers	252
Total	**4,323**

Table 3 displays demographic information for student participants who registered in Cvent. In FY19, Cvent reflected enrollment of 2,970 students while site reports reflected enrollment of 2,651 students. Cvent data indicate that slightly more than half (59%) of R-JSHS students were female and 40% were male, a distribution similar to FY18 when 58% of R-JSHS participants were female and 40% were male. Half (50%) of students identified themselves as White (compared to 57% in FY18), with another 27% identifying themselves as Asian (20% in FY18). While 1% of students chose not to report their race/ethnicity, 5% identified themselves as Black or African American (6% in FY18) and 7% as Hispanic or Latino (5% in FY18). Over a third of R-JSHS students (41%) met the AEOP criteria for U2 (37% in FY18). The demographic make-up of students participating in N-JSHS was similar to that of the overall population of R-JSHS students although somewhat fewer N-JSHS participants were female (54%) and White (36%) and more were Asian (36%) as compared to the overall R-JSHS population. It should be noted, however, that 11% of N-JSHS students chose not to report their race or ethnicity.

Table 3. 2019 JSHS Student Profile (Cvent)				
Demographic Category	**R-JSHS Participants (n=2,970)**		**N-JSHS Participants* (n=229)**	
Participant Gender				
Female	1,737	58.6%	122	53.3%
Male	1,197	40.4%	107	46.7%
Choose not to report	32	1.1%	0	0%
Participant Race/Ethnicity				
Asian	785	26.5%	82	35.8%
Black or African American	149	5.0%	10	4.4%
Hispanic or Latino	215	7.2%	14	6.1%
Native American or Alaska Native	14	<1%	2	<1%
Native Hawaiian or Other Pacific Islander	14	<1%	2	<1%
White	1,483	50.0%	82	35.8%
Other race or ethnicity	116	3.9%	12	5.2%
Choose not to report	190	6.4%	25	10.9%
School Location				
Urban (city)	618	20.9%	59	25.8%
Suburban	1,703	57.5%	128	55.9%
Rural (country)	519	17.5%	22	9.6%
DoDDS/DoDEA School	100	3.4%	7	3.1%
Home school	7	<1%	1	<1%
Online school	6	<1%	0	0%
Frontier or Tribal school	0	0%	0	0%
Choose not to report	8	<1%	12	5.2%
Free or Reduced Price Lunch Recipient				
Yes	387	13.1%	17	8.7%
No	2,362	79.7%	192	83.8%
Choose not to report	213	7.2%	20	8.7%
English is a first language				
Yes	2,557	86.4%	201	78.6%
No	334	11.3%	16	16.2%
Choose not to report	69	2.3%	12	5.2%
First Generation Status				
Yes	320	10.8%	16	7.0%
No	2,528	85.5%	201	87.8%
Choose not to report	110	3.7%	12	5.2%
U2 Classification				
Yes	1,216	40.9%	90	39.3%
No	1,754	59.1%	139	60.7%

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

Table 4 outlines costs of the JSHS program for 2019. The total cost was $1,943,752. The cost per student participant for FY19 was $733.

Table 4. 2019 JSHS Program Costs	
Total Cost	$1,943,752
Army Cost	$30,924
IPA Cost	$1,912,829
Total Travel	$402,055
Army Travel	$30,924
IPA Travel	$4,646
Participant Travel	$366,485
Total Awards	$428,800
Student Awards/Stipends	$403,500
Adult/Teacher/Mentor Awards	$25,300
Cost Per Student	$733

4 | Evaluation At-A-Glance

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

Inputs	Activities	Outputs	Outcomes (Short term)	Impact (Long Term)
• Tri-service sponsorship • NSTA providing oversight of regional and national programs • Operations conducted by university and DoD partners • Students participating in regional and national programs • STEM professionals and educators serving as research mentors, judges, personnel and volunteers of regional and national programs • Awards for student competitors, and recognition for STEM professionals and educators in support roles • Centralized branding and comprehensive marketing • Centralized evaluation	• Students conduct "authentic" STEM and humanities research, often mentored by STEM professionals and educators • Students present their research in poster or oral presentations at 47 regional symposia • STEM professionals judge presentations and select regional winners • Regional winners advance to N-JSHS (Albuquerque, NM). • Program activities that expose students to AEOP programs and/or STEM careers in the Army or DoD	• Number and diversity of student participants engaged in programs • Number and diversity of STEM professionals and educators serving as research mentors, judges, personnel and volunteers of regional and national programs • Number and diversity of DoD scientists and engineers and other military personnel engaged in programs • Number and Title 1 status of high schools served through participant engagement • Students, regional directors, national judges, and NSTA contributing to evaluation	• Increased participant knowledge, skills and abilities, and confidence in STEM • Increased student interest in future STEM engagement • Increased participant awareness of and interest in other AEOP opportunities • Increased participant awareness of and interest in DoD STEM research and careers • Implementation of evidence-based recommendations to improve JSHS regional and national programs	• Increased student participation in other AEOP and DoD-sponsored programs • Increased student pursuit of STEM coursework in secondary and post-secondary schooling • Increased student pursuit of STEM degrees • Increased student pursuit of STEM careers • Increased student pursuit of DoD STEM careers • Continuous improvement and sustainability of JSHS

The JSHS evaluation gathered information from multiple participant groups about JSHS processes, resources, activities, and their potential effects in order to address key evaluation questions related to program strengths and challenges, benefits to participants, and overall effectiveness in meeting AEOP and JSHS program objectives.

Key Evaluation Questions

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

Table 5. 2019 Student Questionnaires

Category	Description
Profile	**Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators
	Education Intentions: Degree level, confidence to achieve educational goals
AEOP Goal 1	**Capturing the Student Experience:** In-school vs. In-program experience; 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 6. 2019 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 AEOPs; efforts to expose students to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing student AEOP metrics
	Army/DoD STEM: attitudes toward Army/DoD STEM research and careers, efforts to expose students to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing student Army/DoD career metrics
AEOP Goal 2 and 3	**Mentor Capacity:** Perceptions of mentor/teaching strategies
	Comprehensive Marketing Strategy: How mentors learn about AEOP, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers
	Program Specific Online Resources: Usefulness of online resources for supporting students in participating in AEOP

Table 7. 2019 Student Focus Groups	
Category	**Description**
Profile	Gender, grade level, past participation in JSHS, past participation in other AEOPs
Satisfaction & Suggestions	Motivating factors for participation, satisfaction with and suggestions for improving JSHS programs, benefits to participants
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Extent to which students were exposed to other AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Extent to which students were exposed to STEM and Army/DoD STEM jobs

Table 8. 2019 Mentor Focus Groups	
Category	**Description**
Profile	Gender, occupation, role in JSHS, past participation in JSHS, past participation in other AEOPs
Satisfaction & Suggestions	Perceived value of JSHS, benefits to participants suggestions for improving JSHS programs
AEOP Goal 1 and 2 Program Efforts	**Army STEM: AEOP Opportunities –** Efforts to expose students to AEOP opportunities
	Army STEM: Army/DoD STEM Careers – Efforts to expose students to STEM and Army/DoD STEM jobs
	Mentor Capacity: Local Educators – Strategies used to increase diversity/support diversity in JSHS

Table 9. 2019 Program Information Provided by NSTA	
Category	**Description**
Program	Description of symposia categories and activities
AEOP Goal 1 and 2 Program Efforts	**Underserved Populations:** mechanisms for marketing to and recruitment of students from underserved populations
	Army STEM: Army/DoD STEM Careers – Exposure to Army STEM research and careers (varies by regional, national event); Participation of Army S&Es and/or Army research facilities in event activities (varies by regional, national event)
	Mentor Capacity: Local Educators - University faculty and student involvement, teacher involvement

The JSHS evaluation included examination of participant outcomes and other areas that inform program continuous improvement. A focus of the evaluation is on efforts toward the long-term goal of JSHS and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technological progress. Thus, it is important to consider the factors that motivate students to participate in JSHS, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. The evaluation also collected data about participant perspectives on program processes, resources, and activities for the purpose of recommending improvements as the program moves forward.

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

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

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

STEM-literate citizenry and include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are important for those engaging in STEM enterprises, but also for all members of society as critical consumers of information and effective decision makers in a world that is heavily reliant on STEM. The evaluation of JSHS measured students' self-reported gains in STEM competencies and engagement in opportunities intended to develop what are considered to be critical STEM skills in the 21st Century—collaboration and teamwork.

Detailed information about methods and instrumentation, sampling and data collection, and analysis are described in Appendix A, the evaluation plan. The reader is strongly encouraged to review Appendix A to clarify how data are summarized, analyzed, and reported in this document. Findings of statistical and/or practical significance are noted in the report narrative, with tables and footnotes providing results from tests for significance. Focus group protocols are provided in Appendix B (students) and Appendix C (mentors); questionnaires are provided in Appendices D & E (N-JSHS and R-JSHS 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 regional competitions, and mentors from 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.

Student and mentor JSHS questionnaire participation, response rates, and margins of error at the 95% confidence level (a measure of how representative the sample is of the population) are provided in Table 10. The margin of error is larger than generally acceptable for N-JSHS students, indicating that this sample may not be representative of the population.

Table 10. 2019 JSHS Questionnaire Participation				
Participant Group	**Respondents (Sample)**	**Total Participants* (Population)**	**Participation Rate**	**Margin of Error @ 95% Confidence[2]**
R-JSHS Students	554	2,970	18.65%	±3.76%
N-JSHS Students	91	229	39.73%	± 7.99%
Adult Volunteers/Mentors	332	1,110	29.91%	± 4.50%

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

Focus groups were conducted at the national JSHS event in Albuquerque, New Mexico. The two student focus group included 15 students (eight females and seven males). Thirteen of these students were first-time participants in JSHS. Ten participants were oral presenters and five were poster presenters. The mentor focus group included three female mentors, all of whom were teachers. One of the teachers was a first-time participant while the others had five years or more of experience with JSHS. 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 11 shows demographic information provided by FY19 R-JSHS questionnaire respondents. For FY19, gender composition (61% female, 39% male) remained similar to FY18 (63% female, 37% male), with nearly two-thirds of respondents being female. Also similar to FY18, more R-JSHS student respondents identified with the race/ethnicity of White 50% (compared to 56% in FY18) than any other single race/ethnicity. Over a third of respondents (36%) identified themselves as Asian. Most respondents were rising 11th graders (37%) or 12th graders (34%). Very few students indicated they received free or reduced lunch in school (FARMS) (12%), that they would be first generation college students (5%), or were English language learners (ELL) (3%). Slightly more than half of students reported attending suburban schools (54%) (Table 12). Students were identified as meeting AEOP's definition of underrepresented status (U2) if they possessed two or more of the following demographics: female, non-White and non-Asian in

[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.

race/ethnicity, urban/rural/frontier school location, FARMS, ELL status, or college first generation. Less than half (40%) of the R-JSHS survey participants met the AEOP's U2 criteria. The demographic data for R-JSHS questionnaire respondents is similar to that of the overall population of R-JSHS student participants.

Table 11. 2019 R-JSHS Student Respondent Profile

Demographic Category	R-JSHS Questionnaire Respondents	
Respondent Gender (n = 554)		
Female	339	61.2%
Male	215	38.8%
Choose Not to Report	0	0%
Respondent Race/Ethnicity (n = 554)		
Asian	198	35.7%
Black or African American	14	2.5%
Hispanic or Latino	28	5.1%
Native American or Alaska Native	5	1.0%
Native Hawaiian or Other Pacific Islander	12	2.2%
White	275	49.6%
Other race or ethnicity (specify):[†]	22	4.0%
Respondent Grade Level (n = 554)		
9th	43	7.8%
10th	113	20.4%
11th	203	36.6%
12th	190	34.3%
1st Year College Student	1	<1%
Other	4	<1%
Free and Reduced Lunch Status (FARMS) (n = 554)		
Yes	64	11.6%
No	472	85.2%
Choose Not to Report	18	3.2%
English Language Leaner (ELL) Status (n = 554)		
Yes	16	2.9%
No	538	97.1%
Choose Not to Report	0	0%
College First Generation (n = 511)		
Yes	25	4.9%
No	481	94.1%
Choose Not to Report	5	1.0%
U2 Status (2 or more underrepresented indicators) (n = 554)		
Yes	222	40.1%
No	332	59.9%
Choose Not to Report	0	0%

[†]Other = Arab (2), Asian American, Asian/Native Hawaiian/White, Bangladeshi, Caribbean American, Egyptian/Trinidadian, Ethiopian, Filipino/White, Middle Eastern, Hawaiian/Chinese/Japanese/White, Mixed (black and white), Mixed (African

American, white, and pacific islander), Multiracial (Asian and Caucasian), Multiracial (Latino and African), Native American/White, White/Filipino, and White/Asian

Table 12. 2019 R-JSHS Student Respondent School Information

Demographic Category	R-JSHS Questionnaire Respondents	
Respondent School Location (n=554)		
Suburban	301	54.3%
Urban (city)	136	24.5%
Rural (country)	100	18.1%
Frontier or tribal school	0	0%
Department of Defense school (DoDDS or DoDEA)	0	0%
Home school	0	0%
Online school	0	0%
Choose Not to Report	17	3.1%

Student respondents are broken down by their highest level of JSHS competition in Table 13. Almost a quarter of R-JSHS respondents (22%) reported participating in non-presenting roles (student delegate/observer), while no responding N-JSHS students reported participating in non-presenting roles, although 10% indicated they had participated in "other" ways (which may have included some of the invited Presidential Scholar candidates who attended JSHS but were not competitors). 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 13. 2019 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	55%	30%
Poster presenter	23%	60%
Non-presenting participant	16%	0%
Non-competitive poster presenter	6%	0%
Other	0%	10%

Mentor Demographics

Table 14 presents FY19 mentor questionnaire respondent demographics. More than half of mentors responding to the questionnaire were female (62%) and White (68%). Most mentors identified their occupation as teacher (57%), while just over a tenth indicated they were professional scientists, engineers, or mathematicians (13%).

Table 14. 2019 JSHS Mentor Respondent Profile		
Demographic Category	**Questionnaire Respondents**	
Respondent Gender (n = 332)		
Female	206	62%
Male	123	37%
Choose not to report	3	1%
Respondent Race/Ethnicity (n = 332)		
Asian	53	16%
Black or African American	9	3%
Hispanic or Latino	17	5%
Native American or Alaska Native	1	<1%
Native Hawaiian or Other Pacific Islander	4	1%
White	227	68%
Other race or ethnicity, (specify):[†]	8	2%
Choose not to report	13	4%
Respondent Occupation (n = 332)		
Teacher	189	57%
Other school staff	9	3%
University educator	23	7%
Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.)	16	5%
Scientist, Engineer, or Mathematics professional	43	13%
Other, (specify)[‡]	52	15%
Respondent Role in JSHS (n = 331)		
Research Mentor	74	22%
Competition advisor	26	8%
Other, (specify)[§]	78	24%
Teacher	181	55%
Invited Speaker	0	0%
Judge	54	16%

[†] 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.

Tables 15 and 16 provide student-reported frequencies for engaging in STEM practices in school and JSHS respectively. For all items except three (using laboratory procedures, identifying questions or problems to investigate, and working collaboratively), JSHS participants indicated performing each STEM practice more often (weekly or every day) in JSHS than in school. Some examples of STEM practices students reported doing most often (weekly or every day) in JSHS were designing and carrying out an investigation (40% in JSHS compared to 33% in school); interacting with STEM researchers (29% in JSHS compared to 23% in school); and designing their own research based on their own questions (37% in JSHS compared to 32% in school).

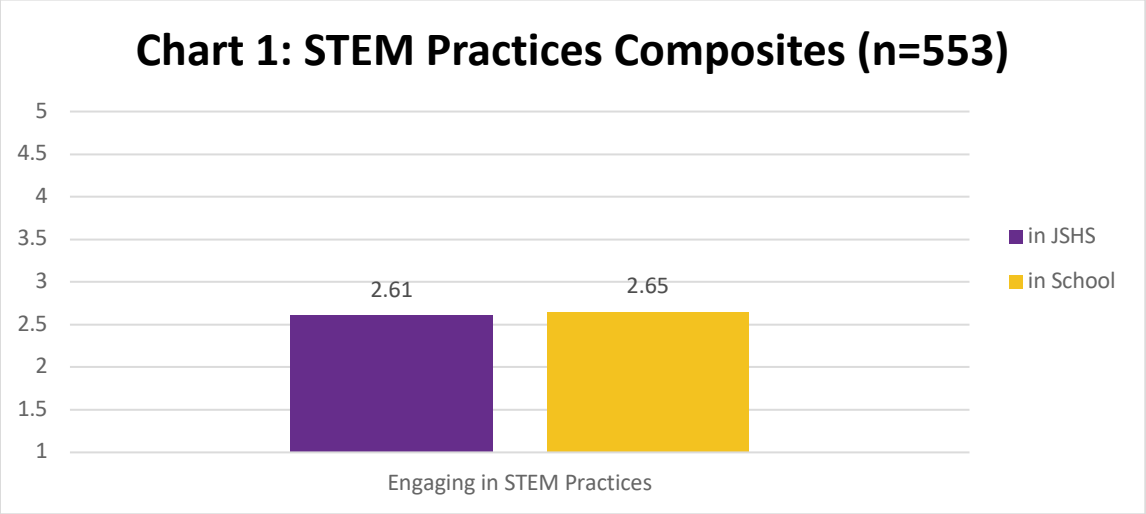
Table 15. Nature of Student STEM Practices in School for R-JSHS Respondent (n = 554)

	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.	46.6%	20.8%	9.4%	15.7%	7.6%	
	258	115	52	87	42	**554**
Work with a STEM researcher on a research project topic assigned by my teacher.	66.6%	19.0%	4.7%	6.0%	3.8%	
	369	105	26	33	21	**554**
Design my own research or investigation based on my own question(s).	13.9%	41.2%	13.4%	17.0%	14.6%	
	77	228	74	94	81	**554**
Present my STEM research to a panel of judges from industry or the military.	37.4%	52.0%	8.7%	1.1%	0.9%	
	207	288	48	6	5	**554**
Interact with STEM researchers.	22.9%	35.4%	18.2%	14.4%	9.0%	
	127	196	101	80	50	**554**
Use laboratory procedures and tools	10.5%	23.1%	24.0%	31.4%	11.0%	
	58	128	133	174	61	**554**
Identify questions or problems to investigate	5.2%	24.5%	21.7%	27.1%	21.5%	
	29	136	120	150	119	**554**
Design and carry out an investigation	9.4%	33.2%	24.4%	20.6%	12.5%	
	52	184	135	114	69	**554**
Analyze data or information and draw conclusions	4.5%	23.5%	26.5%	29.2%	16.2%	
	25	130	147	162	90	**554**
Work collaboratively as part of a team	10.5%	17.5%	16.2%	31.9%	23.8%	
	58	97	90	177	132	**554**
Build or make a computer model	55.2%	24.9%	7.6%	6.5%	5.8%	
	306	138	42	36	32	**554**
Solve real world problems	11.2%	35.0%	15.0%	16.1%	22.7%	
	62	194	83	89	126	**554**

Table 16. Nature of Student STEM Practices in JSHS for R-JSHS Respondents (n = 553)

	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.	41.6%	23.5%	9.8%	16.6%	8.5%	
	230	130	54	92	47	**553**
Work with a STEM researcher on a research project topic assigned by my teacher.	67.6%	15.6%	5.1%	7.8%	4.0%	
	374	86	28	43	22	**553**
Design my own research or investigation based on my own question(s).	12.5%	37.6%	12.7%	17.2%	20.1%	
	69	208	70	95	111	**553**
Present my STEM research to a panel of judges from industry or the military.	36.0%	49.4%	10.1%	3.3%	1.3%	
	199	273	56	18	7	**553**
Interact with STEM researchers.	22.4%	32.2%	16.3%	18.4%	10.7%	
	124	178	90	102	59	**553**
Use laboratory procedures and tools	17.2%	24.2%	17.9%	25.1%	15.6%	
	95	134	99	139	86	**553**
Identify questions or problems to investigate	7.6%	31.3%	17.4%	24.1%	19.7%	
	42	173	96	133	109	**553**
Design and carry out an investigation	10.3%	33.6%	16.3%	19.9%	19.9%	
	57	186	90	110	110	**553**
Analyze data or information and draw conclusions	7.2%	29.3%	15.9%	27.8%	19.7%	
	40	162	88	154	109	**553**
Work collaboratively as part of a team	28.8%	21.9%	11.4%	19.9%	18.1%	
	159	121	63	110	100	**553**
Build or make a computer model	61.1%	18.4%	5.8%	8.5%	6.1%	
	338	102	32	47	34	**553**
Solve real world problems	14.1%	36.3%	11.2%	17.5%	20.8%	
	78	201	62	97	115	**553**

A composite score was calculated for each set of items: "STEM Practices in School" and "STEM Practices in JSHS".[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. Composite scores were compared and no significant difference was found between students' perceived STEM practice engagement in school compared to in JSHS (see Chart 1). It is important to note, however, that these data may not 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.



Composite scores for STEM Practices in JSHS were 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). There were no significant differences in JSHS STEM practices engagement by overall U2 status or any of the individual demographics. This suggests that all students (regardless of demographics) were engaging in JSHS STEM practices similarly.

N-JSHS students participating in focus groups cited several differences in their engagement in STEM in JSHS versus their engagement in STEM in school. These students noted that in school as compared to in JSHS they have fewer opportunities for research, fewer opportunities to present, more limited access to equipment, and a more limited span of STEM disciplines available to them. Students also noted that in

[3] The Cronbach's alpha reliability for Engaging in STEM in JSHS items was 0.909 and for Engaging in STEM in School was 0.879.

JSHS they received career information that they do not receive in school and feel more supported in their research efforts in JSHS. Students said, for example,

> *"Our high school doesn't have the best lab equipment, especially [since] I did bio acoustical research, so that's something that most of the STEM personnel at my school had no idea about. It was really interesting to be able to come here, learn more from the judges and also network with professionals in the field."* (N-JSHS Student)

> *"We don't have anything in school…that's guided us towards working for the military or like any government affiliated research."*(N-JSHS Student)

> *"[In] my AP bio class, we talk about super cool things. We got to learn about the CRISPR gene and we got to make bacteria glow in the dark which is all super awesome, but it's only in the classroom and the teacher sets up the labs and we do the lab…Being able to do this competition, we actually got to come up with the question and figure out how to do it ourselves."* (N-JSHS Student)

STEM Knowledge and Skills

The questionnaire asked participants to report on how their gains in STEM Knowledge were impacted by participating in JSHS (Table 17). As a result of participating in JSHS, a majority (70% or more) of R-JSHS students reported medium or large gains in all STEM knowledge areas. For example, 79% of students reported medium to large gains in knowledge of research conducted in a STEM topic or field and for in-depth knowledge of a STEM topic.

STEM knowledge items were combined into a composite variable[4] to test for differences between U2 status and subgroups of students. No significant differences between any demographic subgroups or overall U2 status were found for STEM knowledge.

[4] The Cronbach's alpha reliability for STEM Knowledge items was 0.903.

Table 17. R-JSHS Participant Reports of Impact on STEM Knowledge (n = 553)

	No gain	Small gain	Medium gain	Large gain	Response Total
In depth knowledge of a STEM topic(s)	2.2%	19.3%	39.4%	39.1%	
	12	107	218	216	**553**
Knowledge of research conducted in a STEM topic or field	1.8%	18.6%	35.4%	44.1%	
	10	103	196	244	**553**
Knowledge of research processes, ethics, and rules for conduct in STEM	4.9%	25.1%	33.5%	36.5%	
	27	139	185	202	**553**
Knowledge of how scientists and engineers work on real problems in STEM	3.1%	20.6%	36.2%	40.1%	
	17	114	200	222	**553**
Knowledge of what everyday research work is like in STEM	5.4%	22.6%	32.0%	40.0%	
	30	125	177	221	**553**

R-JSHS students were asked to rate their gains in STEM competencies as a result of participating in JSHS (see Table 18). More than half of students (58%-80%) reported medium or large gains in all STEM competencies. Three-quarters or more of students reported medium to large gains in multiple STEM competencies, including using knowledge and creativity to suggest a solution to a problem (75%), supporting an explanation with STEM knowledge or data from experiments (75%), defending an argument based upon findings from an experiment or other data, and presenting an argument that uses data and/or findings from an experiment (78%).

Table 18. R-JSHS Participant Gains in STEM Competencies-Science and Engineering Practices (n = 553)

	No gain	Small gain	Medium gain	Large gain	Response Total
Defining a problem that can be solved by developing a new or improved product or process	7.1%	22.2%	38.9%	31.8%	
	39	123	215	176	**553**
Creating a hypothesis or question that can be tested in an experiment	7.6%	22.8%	33.8%	35.8%	
	42	126	187	198	**553**
Using my knowledge and creativity to suggest a solution to a problem	4.7%	20.8%	34.7%	39.8%	
	26	115	192	220	**553**
Making a model to show how something works	16.3%	26.2%	27.8%	29.7%	
	90	145	154	164	**553**
Designing procedures or steps for an experiment that work	6.0%	22.1%	34.5%	37.4%	
	33	122	191	207	**553**
Identifying the limitations of the methods and tools used for collecting data	4.7%	22.4%	33.8%	39.1%	
	26	124	187	216	**553**
Carrying out an experiment and recording data accurately	6.3%	20.1%	31.8%	41.8%	
	35	111	176	231	**553**
Creating charts or graphs to display data and find patterns	6.3%	21.3%	32.7%	39.6%	
	35	118	181	219	**553**
Considering multiple interpretations of data to decide if something works as intended	5.6%	21.9%	34.9%	37.6%	
	31	121	193	208	**553**
Supporting an explanation with my STEM knowledge or data from experiments	4.2%	20.4%	36.7%	38.7%	
	23	113	203	214	**553**
Identifying the strengths and limitations of data or arguments presented in technical or scientific texts	5.1%	21.7%	36.7%	36.5%	
	28	120	203	202	**553**
Presenting an argument that uses data and/or findings from an experiment	4.5%	17.5%	34.9%	43.0%	
	25	97	193	238	**553**
Defending an argument based upon findings from an experiment or other data	5.2%	19.9%	32.9%	42.0%	
	29	110	182	232	**553**
Integrating information from technical or scientific texts and other media to support your explanation of an experiment or solution to a problem	6.9%	22.4%	30.6%	40.1%	
	38	124	169	222	**553**

Composite scores were computed for student STEM competency items[5] and investigated for differential programmatic impacts. No significant differences by overall U2 status or any individual demographic were found for participants' STEM competency gains.

Students' reports of the impact of JSHS on their 21st Century skills are displayed in Table 19. More than half of students (52%-85%) reported at least medium gains in all 21st Century skills except for creating media products (34%) and leading/guiding others in a team/group (49%). Areas with largest reported 21st Century skills gains (medium to high) included solving problems (77%); evaluating others' evidence, arguments, and beliefs (78%); incorporating feedback on personal work (78%); and communicating clearly with others (85%).

A 21st Century skills[6] composite variable was created from these items. A significant difference in 21st Century skills was found by FARMS status with FARMS students reporting significantly higher gains in 21st Century skills (effect size is small, d=0.218).[7] Significant differences in 21st Century skills gains were not found by overall U2 status or any other demographic variables examined.

Table 19. R-JSHS Participant Reports of Impacts on 21st Century Skills (n = 553)

	No gain	Small gain	Medium gain	Large gain	Response Total
Thinking creatively	4.3%	18.8%	38.9%	38.0%	
	24	104	215	210	**553**
Working creatively with others	14.8%	23.3%	33.3%	28.6%	
	82	129	184	158	**553**
Using my creative ideas to make a product	12.8%	23.1%	31.5%	32.5%	
	71	128	174	180	**553**
Thinking about how systems work and how parts interact with each other	10.3%	21.5%	32.5%	35.6%	
	57	119	180	197	**553**
Evaluating others' evidence, arguments and beliefs	4.0%	18.1%	38.5%	39.4%	
	22	100	213	218	**553**
Solving problems	4.2%	18.8%	36.0%	41.0%	

[5] The STEM Competencies composite had a Cronbach's alpha reliability of 0.963.
[6] The 21st Century Skills composite had a Cronbach's alpha reliability of 0.967.
[7] Independent samples t-test results for 21st Century Skills by FARMS: $t(399)=2.18$, $p=0.030$

	23	104	199	227	**553**
Communicating clearly (written and oral) with others	2.4%	12.8%	35.3%	49.5%	
	13	71	195	274	**553**
Collaborating with others effectively and respectfully in diverse teams	14.6%	23.3%	30.6%	31.5%	
	81	129	169	174	**553**
Interacting effectively with others in a respectful and professional manner	4.5%	18.8%	35.4%	41.2%	
	25	104	196	228	**553**
Accessing and evaluating information efficiently (time) and critically (evaluates sources)	4.7%	23.0%	36.5%	35.8%	
	26	127	202	198	**553**
Using and managing data accurately, creatively, and ethically	5.4%	20.3%	37.3%	37.1%	
	30	112	206	205	**553**
Analyzing media (news) - understanding points of view in the media	24.1%	24.4%	26.0%	25.5%	
	133	135	144	141	**553**
Creating media products like videos, blogs, social media	43.4%	22.2%	17.4%	17.0%	
	240	123	96	94	**553**
Use technology as a tool to research, organize, evaluate, and communicate information	8.1%	25.0%	32.0%	34.9%	
	45	138	177	193	**553**
Adapting to change when things do not go as planned	6.0%	17.5%	33.6%	42.9%	
	33	97	186	237	**553**
Incorporating feedback on my work effectively	5.8%	16.5%	33.6%	44.1%	
	32	91	186	244	**553**
Setting goals and utilizing time wisely	6.5%	22.8%	32.9%	37.8%	
	36	126	182	209	**553**
Working independently and completing tasks on time	6.3%	20.1%	30.6%	43.0%	
	35	111	169	238	**553**
Taking initiative and doing work without being told to	6.1%	20.4%	30.6%	42.9%	
	34	113	169	237	**553**
	6.1%	19.2%	33.6%	41.0%	

Prioritizing, planning, and managing projects to achieve completion	34	106	186	227	**553**
Producing results - sticking with a task until it is finished	5.8%	19.2%	29.8%	45.2%	
	32	106	165	250	**553**
Leading and guiding others in a team or group	25.3%	25.7%	23.1%	25.9%	
	140	142	128	143	**553**
Being responsible to others - thinking about the larger community	9.8%	22.2%	33.6%	34.4%	
	54	123	186	190	**553**

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[8], deepening students' STEM identities and confidence is important for increasing the likelihood of students pursuing STEM careers. Students were therefore asked a series of questionnaire items to measure the impact of JSHS on their STEM identities (Table 20). More than 70% of students reported medium to large gains across all areas of STEM identity. Areas of the greatest reported (medium/large) gains were confidence to try out new ideas or procedures on STEM projects (78%), the desire to build relationships with mentors who work in STEM (79%), and being better prepared for more challenging STEM activities (80%).

Composite scores for STEM identity[9] items were used to investigate potential differential impacts of JSHS participation on subgroups of students. Statistical differences were found in STEM identity gains by FARMS status (FARMS students reporting higher gains) and school location (suburban students reporting higher gains)[10]. Both FARMS status and school location differences had small effect sizes (d=0.249 and d=0.209 respectively). No statistical differences were found in STEM identity by overall U2 status or any other demographic variables assessed.

[8] 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.
[9] The Cronbach's alpha reliability for STEM Identity items was 0.922.
[10] Independent samples t-test results for STEM Identity by FARMS: $t(399)=2.49$, $p=0.013$; and by School Location: $t(534)=2.41$, $p=0.016$

Table 20. R-JSHS Participant Reports on JSHS Impacts on STEM Identity (n = 553)

	No gain	Small gain	Medium gain	Large gain	Response Total
Interest in a new STEM topic	8.0%	21.3%	29.5%	41.2%	
	44	118	163	228	**553**
Interest in pursuing a STEM career	9.4%	16.3%	30.4%	43.9%	
	52	90	168	243	**553**
Sense of accomplishment from my work in the program	6.9%	16.3%	26.6%	50.3%	
	38	90	147	278	**553**
Better prepared for more challenging STEM activities	6.0%	13.9%	32.7%	47.4%	
	33	77	181	262	**553**
Confidence to try out new ideas or procedures on my own in a STEM project	5.8%	15.9%	28.8%	49.5%	
	32	88	159	274	**553**
Desire to build relationships with mentors who work in STEM	5.2%	16.1%	26.2%	52.4%	
	29	89	145	290	**553**

6 | Priority #2 Findings

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

Mentor Strategies and Support

Mentors play a critical role in the JSHS program. Mentors provide one-on-one support to students, chaperone students, advise students on educational and career paths, may provide opportunities for students to use laboratory space and/or equipment, or generally serve as STEM role models for JSHS students. About two-thirds (66%) of mentors responding to the mentor questionnaire reported working with 5 or fewer students, while 9% of mentors reported working with 6-10 students. The remaining 25% 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.

[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.

Table 21 shows mentor responses to items related to establishing the relevance of learning activities. More than 60% of responding mentors reportedly used each strategy with students. Strategies which three-quarters or more reported using were becoming familiar with students' backgrounds and interests at the beginning of JSHS (80%), helping students understand how STEM can help them improve their own community (76%), and helping students become aware of the role(s) STEM plays in their everyday lives (75%).

Table 21. Mentor Strategies to Establish the Relevance of Learning Activities (n = 268-271)

	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	80.2%	19.8%	**268**
	215	53	
Giving students real-life problems to investigate or solve	70.4%	29.6%	**270**
	190	80	
Selecting readings or activities that relate to students' backgrounds	61.0%	39.0%	**267**
	163	104	
Encouraging students to suggest new readings, activities, or projects	73.6%	26.4%	**269**
	198	71	
Helping students become aware of the role(s) that STEM plays in their everyday lives	74.8%	25.2%	**270**
	202	68	
Helping students understand how STEM can help them improve their own community	75.6%	24.4%	**271**
	205	66	
Asking students to relate real-life events or activities to topics covered in JSHS	74.3%	25.7%	**268**
	199	69	

More than half of mentors reported using each strategy associated with supporting the diverse needs of learners (Table 22). Strategies that approximately three-quarters or more of mentors reported using were interacting with students and other personnel the same way regardless of their background (76%), using a variety of teaching and/or mentoring activities to meet the needs of all students (75%), and directing students to other individuals or programs for additional support as needed (74%).

Table 22. Mentor Strategies to Support the Diverse Needs of Learners (n = 261-265)

	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	59.2%	40.8%	
	157	108	**265**
Interact with students and other personnel the same way regardless of their background	76.2%	23.8%	
	202	63	**265**
Use a variety of teaching and/or mentoring activities to meet the needs of all students	74.7%	25.3%	
	195	66	**261**
Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM	60.0%	40.0%	
	159	106	**265**
Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills	63.2%	36.8%	
	168	98	**266**
Directing students to other individuals or programs for additional support as needed	74.1%	25.9%	
	197	69	**266**
Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM	55.1%	44.9%	
	146	119	**265**

Approximately 70% or more of JSHS mentors reported using all strategies to support students' development of collaboration and interpersonal skills (Table 23). More than three-quarters of mentors reported having participants give and receive constructive feedback with others (78%) and having participants listen to the ideas of others with an open mind (80%).

Table 23. Mentor Strategies to Support Participant Development of Collaboration and Interpersonal Skills (n = 266-267)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Having participant(s) tell other people about their backgrounds and interests	69.2%	30.8%	
	184	82	**266**
Having participant(s) explain difficult ideas to others	74.2%	25.8%	
	198	69	**267**
Having participant(s) listen to the ideas of others with an open mind	80.1%	19.9%	
	214	53	**267**
Having participant(s) exchange ideas with others whose backgrounds or viewpoints are different from their own	72.2%	27.8%	
	192	74	**266**
Having participant(s) give and receive constructive feedback with others	77.8%	22.2%	
	207	59	**266**

For strategies related to engaging students in "authentic" STEM activities, two-thirds or more of mentors reported using each strategy listed (Table 24). Strategies implemented by more than three-quarters of JSHS mentors were having participant(s) search for and review technical research to support their work (76%), providing participants with constructive feedback to improve their STEM competencies (81%), and allowing participants to work independently to improve their self-management strategies (83%).

Table 24. Mentor Strategies to Support Participant Engagement in "Authentic" STEM Activities (n = 264)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Teaching (or assigning readings) about specific STEM subject matter	67.8%	32.2%	
	179	85	**264**
Having participant(s) search for and review technical research to support their work	75.8%	24.2%	
	200	64	**264**
Demonstrating laboratory/field techniques, procedures, and tools for my student(s)	67.0%	33.0%	
	177	87	**264**
Supervising participant(s) while they practice STEM research skills	73.0%	27.0%	
	192	71	**263**
Providing participant(s) with constructive feedback to improve their STEM competencies	80.5%	19.5%	
	214	52	**266**
Allowing participant(s) to work independently to improve their self-management abilities	83.3%	16.7%	
	220	44	**264**

Mentors were also asked to report on strategies they used to support students' STEM education and career pathways (Table 25). The most frequently used strategies in this area included asking students about their educational and/or career goals (85%), providing guidance about educational pathways that will prepare students for STEM careers (71%), and recommending extracurricular programs that align with the students' goals (70%). Mentors were more likely to discuss STEM careers and opportunities that were not related to AEOP or the DoD with their students than those opportunities related to AEOP or DoD. For example, more than two-thirds of mentors reported discussing STEM career opportunities in industry or academia (68%) with their students while only 35% of mentors report discussing STEM career opportunities within the DoD or other government agencies with their students.

Table 25. Mentors Using Strategies to Support Student STEM Education and Career Pathways (n=264-266)

	Yes - I used this strategy	No - I did not use this strategy	Response Total
Asking my student(s) about their educational and/or career goals	85.3%	14.7%	
	227	39	**266**
Recommending extracurricular programs that align with students' goals	70.2%	29.8%	
	186	79	**265**
Recommending Army Educational Outreach Programs that align with students' goals	30.9%	69.1%	
	82	183	**265**
Providing guidance about educational pathways that will prepare my students for a STEM career	71.3%	28.7%	
	189	76	**265**
Discussing STEM career opportunities within the DoD or other government agencies	34.6%	65.4%	
	92	174	**266**
Discussing STEM career opportunities in private industry or academia	68.4%	31.6%	
	182	84	**266**
Discussing the economic, political, ethical, and/or social context of a STEM career	58.5%	41.5%	
	155	110	**265**
Recommending student and professional organizations in STEM to my students	56.8%	43.2%	
	150	114	**264**
Helping students build a professional network in a STEM field	54.1%	45.9%	
	144	122	**266**
Helping my students with their resume, application, personal statement, and/or interview preparations	57.7%	42.3%	
	153	112	**265**

Mentors discussing the range of 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. Less than 10% of mentors reported speaking with students about AEOPs other than JSHS (67%), UNITE (26%), SEAP (14%), and SMART (11%). Less than 20% indicated they discussed AEOPs in general, without reference to any specific program, with their students.

Table 26. Mentors Discussing Other AEOPs with Participants (n = 280-287)

	Yes - I discussed this program with my student(s)	No - I did not discuss this program with my student(s)	Response Total
UNITE	25.8%	74.2%	
	74	213	**287**
Junior Science & Humanities Symposium (JSHS)	66.9%	33.1%	
	192	95	**287**
Science & Engineering Apprenticeship Program (SEAP)	14.4%	85.6%	
	41	244	**285**
Research & Engineering Apprenticeship Program (REAP)	9.5%	90.5%	
	27	256	**283**
High School Apprenticeship Program (HSAP)	8.1%	91.9%	
	23	260	**283**
College Qualified Leaders (CQL)	3.2%	96.8%	
	9	274	**283**
GEMS Near Peer Mentor Program	2.8%	97.2%	
	8	274	**282**
Undergraduate Research Apprenticeship Program (URAP)	5.4%	94.6%	
	15	265	**280**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	11.3%	88.7%	
	32	252	**284**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	3.6%	96.4%	
	10	271	**281**
I discussed AEOP with participant(s) but did not discuss any specific program	17.9%	82.1%	
	50	230	**280**
eCYBERMISSION	6.8%	93.2%	
	19	262	**281**

Students participating in JSHS were asked to report on their mentor's primary position (Table 27) and availability (Table 28). Most students said their mentor was either a teacher (40%) or STEM researcher (38%). More than half of students indicated their mentor was available at least half of the time (61%). Fewer students reported their mentor was available less than half of the time (8%) or never available (3%), while 15% of students reported they did not have a mentor at all.

Table 27. R-JSHS Participant Reports of their Mentor's Primary Position (n=553)

	Response Percent	Response Total
I did not have a research mentor	15.19%	84
Teacher	39.60%	219
Coach	0.36%	2
Parent	4.16%	23
Club or activity leader (School club, Boy/Girl Scouts, etc.)	0.18%	1
STEM researcher (industry, university, or DoD/government employee, etc.)	38.16%	211
Other, (specify):	2.35%	13

Table 28. R-JSHS Participant Reports of Availability of Mentors (n = 553)

	Response Percent	Response Total
I did not have a mentor	15.38%	66
The mentor was never available	2.53%	14
The mentor was available less than half of the time	7.96%	44
The mentor was available about half of the time of my project	13.74%	76
The mentor was available more than half of the time	19.17%	106
The mentor was always available	41.77%	231

N-JSHS participants were asked in an open-ended questionnaire item about the nature of the mentoring support they received in JSHS. A total of 82 N-JSHS students provided responses. Responses indicated that 20 of these (24%) had received in-school mentoring only, while 28 (34%) received mentoring outside of school only. Another 20 (24%) responded that they had received mentoring both in school, from their teachers, and out of school, from a university professor or other STEM professional. Fourteen respondents (17%) indicated that they received no substantial mentoring and completed their projects independently, while four (5%) provided responses for which it was not possible to ascertain the nature of the mentoring they received. These responses suggest that students' mentoring takes a variety of forms, often combining support both from their teachers and from outside mentors, as illustrated by the following descriptions of mentoring provided by N-JSHS students:

> *"My science teacher in my high school lab was my mentor. "*
>
> *"My mentoring occurred as part of a mathematics research class, but did not extend beyond simple details on the formatting of my work."*
>
> *"Research is a class at my school. Our school connects students who are interested in research and apply for the program with mentors. My partner and I worked with a mentor in a lab throughout the summer (~40 hours/week). When we come back to school after the summer, we spent class time learning how to write papers, improve our presentation skills, and provide feedback to our classmates."*
>
> *"I received feedback from my science teachers at school and received help from my mentor. My teacher helped revised my board and paper. My mentor discussed ideas with me, helped my run and understand my statistical analysis, and reviewed my methods. I wrote my paper, created my board, and drew conclusions by myself."*
>
> *"I worked individually and emailed experts when I needed guidance."*
>
> *"My mentor was someone I met who worked in the materials processing industries as an engineer. He simply answered questions I had about industry and offered a few suggestions."*

Program Features and Feedback/Satisfaction

Students were asked to respond to several questionnaire items about the nature of their experiences in JSHS. In terms of project design input, more than three-quarters reported having some degree of participation in designing their projects. Specifically, 39% independently designed their entire project, while another 22% reported working with their mentor to design their project, and 16% designed their project with their mentor and members of a research team (Table 29). Approximately 11% of students reported not having a project.

Table 29. Participant Input on the Design of Their Project (n = 553)

	Response Percent	Response Total
I did not have a project	10.67%	59
I was assigned a project by my mentor	5.61%	31
I worked with my mentor to design a project	21.70%	120
I had a choice among various projects suggested by my mentor	7.05%	39
I worked with my mentor and members of a research team to design a project	16.09%	89
I designed the entire project on my own	38.88%	215

Most JSHS students actively participated in scholarly discourse through research dissemination (Table 30). Two-thirds of R-JSHS students (76%) indicated they had attended a symposium or conference. More than half of R-JSHS participants reported presenting either a talk/poster to other students or faculty (69%) or presenting a talk/poster at a professional symposium/conference (55%). Fewer students noted future plans to share their research through research journals (12%), or had already published their work in research journals (15%) or through technical papers/patents (12%). Approximately a quarter (24%) of participants indicated they had won an award or scholarship based on their research.

Table 30. Students' Engagement with Research Dissemination Activities During R-JSHS (n = 553)

	Response Percent	Response Total
I presented a talk or poster to other students or faculty	69.26%	383
I presented a talk or poster at a professional symposium or conference	55.33%	306
I attended a symposium or conference	76.13%	421
I wrote or co-wrote a paper that was/will be published in a research journal	14.83%	82
I wrote or co-wrote a technical paper or patent	12.48%	69
I will present a talk or poster to other students or faculty	27.67%	153
I will present a talk or poster at a professional symposium or conference	22.06%	122
I will attend a symposium or conference	30.56%	169
I will write or co-write a paper that was/will be published in a research journal	11.93%	66
I will write or co-write a technical paper or patent	4.34%	24
I won an award or scholarship based on my research	23.87%	132

R-JSHS students and mentors were both asked to rate their satisfaction with a number of features of the JSHS program. Table 31 shows regional students' responses to items asking them about their experiences at the R-JSHS event they attended. More than half of students (54%-85%) reported being at least somewhat satisfied with all event features except for team building activities (37% somewhat or very much satisfied, 46% did not experience). Event features with high frequencies of satisfaction (somewhat or very much satisfied reported by approximately two-thirds or more of students) were student oral presentations (85%), judging process (69%), and Invited speakers (64%). Less than 10% of students expressed dissatisfaction with any of the R-JSHS features.

Table 31. Student Satisfaction with R-JSHS Event Features (n = 553)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Student Oral Presentations	4.9%	1.1%	9.4%	25.7%	59.0%	
	27	6	52	142	326	**553**
Student Poster Presentations	30.6%	2.7%	9.0%	21.2%	36.5%	
	169	15	50	117	202	**553**
Judging Process	9.2%	7.6%	13.9%	30.7%	38.5%	
	51	42	77	170	213	**553**
Feedback from Judges	18.1%	8.3%	13.2%	22.8%	37.6%	
	100	46	73	126	208	**553**
Feedback from VIPs and Peers	25.3%	4.9%	11.4%	25.7%	32.7%	
	140	27	63	142	181	**553**
Invited Speaker Presentations	21.2%	3.8%	11.0%	22.6%	41.4%	
	117	21	61	125	229	**553**
Tours or Field Trips	31.8%	5.1%	8.9%	18.6%	35.6%	
	176	28	49	103	197	**553**
Team Building Activities	45.8%	5.8%	11.8%	14.1%	22.6%	
	253	32	65	78	125	**553**
Social Events	26.8%	4.2%	10.7%	21.5%	36.9%	
	148	23	59	119	204	**553**

An open-ended item on the R-JSHS questionnaire asked students to comment on their overall satisfaction with their JSHS experience. In a sample of 115 of the regional student responses, nearly all (112, or 97%) had something positive to say about JSHS, and a large majority (87, or 76%) commented only on positive aspects of the program. Many students provided simple affirmations of their program experiences such as "I loved it, thank you so much for the experience and for having me!" Among students who provided more detailed feedback about the positive aspects of their JSHS experiences, many focused on the experience they gained in conducting and presenting research, their exposure to others' research, the value of the feedback they received, and the opportunity to connect with like-minded peers. For example:

> *"It was a great experience and I was very thankful for the chance to present the research I created. I liked that we got support and questions from judges and the audience because it really boosted my confidence about possible pursuing research as a career. I found the importance of sharing research verbally because of this program."* (R-JSHS Student)

> *I really had a blast, this was my first JSHS and I thought it was informative, entertaining, and enjoyable…As a freshman heading into a Science and Engineering Cohort I found it incredibly inspirational to see students just a few years older than me accomplishing all of this. I hope to take part in this competition in the future."* (R-JSHS Student)

> *"I was able to network and meet with other people, many of which I would likely see again in future STEM competitions. The program also gave me a chance to present and gain recognition for my research, which is incredibly important to me."* (R-JSHS Student)

Twenty-five (22%) of the R-JSHS student respondents made positive comments about the program but also offered caveats, and two students did not have anything positive to say about their R-JSHS experience. These comments were most frequently focused on dissatisfaction with judging, including lack of feedback; suggestions for more specific project categories; the lack of recognition of research teams; a desire for more social interaction time; a desire for more information about other programs; and comments about event logistics (e.g., event was too long, comments about lack of organization and logistical difficulties). For example,

> *"I enjoyed my experience at JSHS because I was able to learn from other young STEM researchers and had experience presenting my project under a limited timeframe and answering questions. JSHS also motivated me in writing an abstract and paper for my project, and I appreciate that with the paper being before the talk, JSHS models the research procedure that we would encounter later on in STEM careers. However, I was very limited by the project categories JSHS offers, as my project is in the Earth Sciences or geosciences and those projects counted in the Chemistry category even though my project has nothing to do with Chemistry."* (R-JSHS Student)

> *"I am glad that I had the opportunity to participate in JSHS, although I feel as though by the time I got to present the judges were tired of listening to presentations and were not engaged. I could*

not tell if the judges did not have any genuine questions or were too tired to be fully attentive in my presentation. " (R-JSHS Student)

"Overall, I was very satisfied with JSHS. Being my first time here, it exceeded my expectations of what was going to happen. I would like more opportunities to interact with students from other schools and I would like to see more activities students can do in the future. I will hope to attend JSHS in the future." (R-JSHS Student)

"Overall, I am not satisfied with JSHS experience. I am part of a research group and the program does not allow groups to present. Additionally, it was not listed on any of the JSHS websites that I would be required to attend the full 3 days and stay at the designated spots or risk disqualification." (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 86 students who provided responses, nearly all (80, or 93%) had something positive to say about the event. These responses included general comments such as "Amazing!" and "I thought it was great!" as well as more specific comments focusing on the opportunity to hear about others' research, the opportunity to connect with like-minded peers, learning about careers, the quality of the speakers, and the opportunity to network with STEM professionals. For example,

"I had an amazing time at JSHS. The biggest takeaway for me is that I want to look into research opportunities for the DoD. Meeting the judges and researchers at the competition inspired me to potentially pursue going into STEM research to help defend our country." (N-JSHS Student)

"The JSHS National Event was incredible. I had an amazing experience and really enjoyed meeting other students who were also interested in research. I felt that the environment was very collaborative and everyone was excited to learn about each other's research. I listened to several paper presentations and learned a lot. I also really enjoyed having time to visit Albuquerque with my delegation during the cultural excursion. " (N-JSHS Student)

"I was impressed by the number of students with outstanding projects as well as the fantastic keynote speakers that presented their research and involvement with the STEM fields in their professional careers." (N-JSHS Student)

About a third (33%) of N-JSHS respondents responded positively about their experience at the national competition but also offered caveats, and six respondents (7%) had nothing positive to say about the event. Students' comments focused on organizational issues, the food choices, speakers, activities and opportunities for socialization, and the primary focus of the event on hard sciences and secondary focus on behavioral sciences and humanities. For example,

"Very nicely organized and lovely setting. However food especially for vegetarians like me, needed more options." (N-JSHS Student)

"It was amazing to meet so many different people, but I felt like the schedule could have had a few extra activities." (N-JSHS Student)

"I thought it was fairly disorganized...I enjoyed the opportunities we had, but the food was very bad and the keynote speakers were a bit too long." (N-JSHS Student)

"Positive. I only question why it's called the science and humanities symposium, when elements of the humanities were infrequent if present at all." (N-JSHS Student)

"Everything within JSHS Nationals was unorganized. In addition, the speakers brought in to speak to the presenters had very similar overall messages in their talks and spoke to the presenters instead of trying to get them engaged." (N-JSHS Student)

N-JSHS students were also asked to share their impressions of the judging process at both the regional and national level competitions, and to share their suggestions for improvements at each level in open-ended questionnaire items. A total of 80 students provided responses regarding regional judging and 82 provided responses regarding the national judging.

Over three-quarters (76%) of N-JSHS respondents made positive comments about regional judging. These comments focused on the value of the feedback they received from judges in improving their work and the preparation for national competition provided by the similarity of the regional judging to that at the national level. A third (26, or 33%) of the 80 respondents made positive comments about regional judging and also provided suggestions for improvement, and 17 respondents (21%) made no positive comments about regional judging but provided suggestions for improvement. Suggested improvements to regional judging included:

- Providing more judges or more female judges
- Ensuring that judges are knowledgeable about the categories they judge
- Ensuring that judges ask relevant and meaningful questions
- Providing more detailed feedback from judges
- Allowing more time for questions, both from judges and from the audience
- Providing participants with the judging rubrics in advance
- Instructing judges to consider the type of mentorship students received

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

"The [R-JSHS] judging was fair and generally helpful. It could be improved by having more specialized judges who could give specific feedback about procedures and content." (N-JSHS Student)

"Feedback is plentiful and helpful. However, the majority of [R-JSHS] judges were older men with degrees in physics or chemistry. There was only one female judge. I felt like I was only receiving one point of view." (N-JSHS Student)

Over half (48, or 59%) of the 82 N-JSHS questionnaire respondents made positive comments about the national level judging. These comments focused on the interest and support judges showed to projects and the opportunity to receive feedback on projects. Twenty-five (30%) of respondents made positive comments about N-JSHS judging and provided suggestions for improvement, and 27 (33%) made no positive comments but provided suggestions for improvement. Suggestions for improving judging at the national level included:

- Providing more judges (particularly for poster judging)
- Providing more time for judging (particularly for poster judging)
- Providing more judge feedback
- Ensuring that judges are knowledgeable about the categories they judge
- Ensuring that judges ask relevant and meaningful questions
- Providing more specific categories for projects and separating categories (e.g., separating mathematics from computer science, and behavioral science from medical science)
- Ensuring consistency in judging
- Improving judges' attentiveness or communication with presenters

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

"Similar to my experience at the regionals, the [N-JSHS] judges asked good questions and had many good ideas for how our research could be continued next year. However, I did not feel that there was enough time during the poster presentation rotations to fully explain my project. If possible, it would be helpful to extend the judging rotation time to 15 minutes." (N-JSHS Student)

"The national judging process was good. Some of the judges didn't ask any questions at all, and I would have liked a bit more feedback from the experts." (N-JSHS Student)

"Overall, it was very successful. I learned a lot from my [N-JSHS] judges. The only thing that was difficult was that my category (behavioral science) was combined with medicine and health." (N-JSHS Student)

N-JSHS students were also asked to respond to an open-ended item asking whether regional competition prepared them for national competition. A large majority (86%) of the 81 students who provided a response answered that regional competition prepared them for the N-JSHS competition. Students focused on the similarity of the judging and questions the judges asked at regional and national levels, the similarity of the format of the competitions, and the presentation experience they received at the regional level. Six (7%) of these students responded that while the regional competition prepared them for the

national competition, there were differences between their experiences, and another nine (11%) indicated that the regional competition had not prepared them for the N-JSHS competition. These students noted the following differences between regional and national level competitions:

- No or little feedback provided at the regional event as compared to the national event
- Questioning at the regional level was less intense or comprehensive
- Differences between presenting orally at regional level and poster presenting at national level
- Different levels of organization and communication for regional competition versus national competition
- Inconsistent application of rules across competition levels

For example, N-JSHS students made the following comments about how their regional competition prepared them for national level competition:

> *"I feel that the regional competition helped me prepare for JSHS Nationals because the judges at the regional competition asked a lot of good questions that helped me consider new aspects of our project and better articulate different aspects of our presentation."* (N-JSHS Student)

> *"I think my regional competition did help in the sense that it was conducted in the same format as the national competition, but I was not given any feedback from it so I wasn't able to fix any possible mistakes."* (N-JSHS Student)

> *"My regional competition was an oral presentation while Nationals was a poster presentation. Though it gave me some insight on my presentation skills, the differences in the competitions made me a little less prepared."* (N-JSHS Student)

N-JSHS focus group participants also commented about differences between their R-JSHS and N-JSHS experiences. Students made the following observations about the differences in regional and national events:

- There is more information about the Army and DoD at N-JSHS
- Judges were more closely matched to categories at N-JSHS or judges were "better" at N-JSHS
- The organization of N-JSHS was better than at some students' R-JSHS events
- There was a greater diversity of projects at N-JSHS
- There was a greater diversity of students at N-JSHS
- There were higher standards for projects at N-JSHS

R-JSHS students were asked to rate the usefulness of various JSHS resources (Table 32). Resources fell into one of two categories, some with more than two-thirds of students indicating they were at least somewhat useful and others with more than a third of students reporting they did not use the resources. Resources used and considered at least somewhat useful by participants were paper submission and

completion deadlines (77%), participation guidelines (68%), and JSHS groundrules for student presentations (67%). Resources not used by more than a third of participants were oral presentation tips (39%), poster guidelines (44%), selected articles – conducting research (49%),and sample papers (50%).

Table 32. Usefulness of R-JSHS Resources for Participants (n = 538-553)

	I did not use this resource	Not at all	A little	Somewhat	Very much	Response Total
JSHS Groundrules for Student Presentations	22.1%	1.9%	8.7%	23.4%	43.9%	
	119	10	47	126	236	**538**
Paper Submissions and Competition Deadlines	13.7%	1.4%	8.1%	21.0%	55.7%	
	76	8	45	116	308	**553**
Sample Papers	49.5%	3.1%	7.8%	13.0%	26.6%	
	274	17	43	72	147	**553**
Oral Presentation Tips	39.1%	1.6%	8.3%	17.4%	33.6%	
	216	9	46	96	186	**553**
Selected Articles – Conducting Research	48.8%	2.0%	9.0%	12.7%	27.5%	
	270	11	50	70	152	**553**
Poster Guidelines	43.9%	1.3%	5.1%	13.9%	35.8%	
	243	7	28	77	198	**553**
Participation Guidelines	21.9%	0.9%	9.1%	23.4%	44.6%	
	118	5	49	126	240	**538**

More than 80% of R-JSHS students (82%-88%) reported that they were at least somewhat satisfied with all features of their overall JSHS research experience items (Table 33). Students were particularly satisfied with the research experience overall (88% somewhat or very satisfied) and the amount of time they spend doing meaningful research in JSHS (87% somewhat or very satisfied).

Table 33. 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**

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 115 responses analyzed, issues related to event logistics were mentioned the most frequently (104 times). These comments included students' requests for more time for social interaction (20); requests for more activities or trips/tours (15); comments about food (14), requests for more, better, or more diverse speakers (13); and various comments about program scheduling such as requests for shorter or longer events and for shorter or longer breaks. Fifty comments focused on improving judging, including requests for more interaction or feedback (18), more judges (8), and better judges/judges representing a wider range of disciplines (7). Another 39 comments focused on the JSHS program as a whole, including suggestions to engage more participants and/or more diverse schools (10), requests that more awards be given (7), and suggestions that students be required to disclose the type of mentorship they received for their projects. Twenty-four comments focused on improvements in program communication, including providing clearer guidelines and deadlines for presenters (11) and for registration/application procedures (4).

Students presenting at the national event were also asked for their suggestions for improving the JSHS program overall. Of the 79 N-JSHS students who offered suggestions, the most frequently mentioned improvements (14 students, or 17%) focused on the organization, scheduling, and communication associated with the national event. Another 13 students (16%) suggested improvements to the N-JSHS speakers, including requests for more diverse or more interactive or interesting speakers. Improvements to food choices at N-JSHS were mentioned by 12 students (15%), including offering a greater variety of foods, more vegetarian options, and more breakfast choices). Other suggestions, mentioned by seven students or fewer, included requests for more social or networking events for students, different or more tours, improvements in judging, more project categories, a different location, more interactive activities,

a shorter event, a larger room for poster judging, more opportunities for networking with STEM professionals, and less bias toward the hard sciences. N-JSHS students commented, for example,

> *"It was disappointing that all but one of the keynote speakers listed in the program are white males. Given the diversity of the student presenters, I feel it's imperative to have speakers that better represent the audience they're speaking to. I realize the pool of potential speakers is likely dominated by white males, but there must be individuals out there that could help diversify the keynote speakers. Thank you for the excellent symposium!"* (N-JSHS Student)

> *"I think that organization and communication needs to be improved. Before and during the symposium, I was very confused with what was happening. I would ask my regional chaperone questions, and she would not know the answer either due to lack of communication…I think there should be more activities, in general, and they should be interesting to students."* (N-JSHS Student)

> *"Though the program generally had respect for many areas of study, I felt that contestants in pure mathematics were bombarded with questions about applications before the mathematical value of the work was even considered. Pure mathematics also deserves as much respect as other fields of study. It should not be placed in the same category as computer science, where applications are much more evident and appealing to the judges at first glance, and should also not be compared to artificial intelligence and other fields, which are clearly a world apart from pure mathematics. I understand very well that there are few, if any projects in pure mathematics every year, but with the motivation and encouragement of the program this could be turned around. It would be wonderful for me to see a true mathematics category in the program in further years, with judges in high level abstract topics capable of evaluating students results for their true value."* (N-JSHS Student)

> *"Curb the bias towards the hard sciences. There are less opportunities for participants in the Behavioral and Social Sciences. Have a fun event (a dance maybe) in which everyone can have fun and make connections with other students."* (N-JSHS Student)

When asked to suggest improvements to JSHS, N-JSHS students participating in focus groups also offered several suggestions. Many of these suggestions mirrored the responses on the questionnaire, but provided additional nuance to comments about the diversity of speakers, the poster judging, and time to connect with peers. Students said, for example,

> *"Since it is a competition where there are kids studying in such diverse fields, it would be interesting if we also had [as a speaker] maybe like a bio person or chem person who shows that you don't only have to be an engineer to be in the Army or the government."* (N-JSHS Student)

"[Poster judges] only got to ask just a couple of questions and then they had to move on. I noticed too that part of the judges in the other sections across from us had spent 18 minutes at one project and then had less time at other projects." (N-JSHS Student)

"One of the most valuable parts of this program is that you're with other kids, and that these other kids all have these amazing projects that we all want to hear about…The time that you do that is more informal and in conversation. You do that when you're on excursions and things like that." (N-JSHS Student)

N-JSHS students mentioned several other possible improvements to JSHS in focus groups also. These suggestions included improvements to the poster session, including providing chairs for presenters, more space for posters, and providing ice cream at the open poster session. Other suggestions focused on N-JSHS event features included providing more interactive content on tours, more DoD-focused tours, more cultural excursions, and more diversity in food choices. Students also suggested some organizational improvements including better communication between the program and students, better coordination and communication of travel arrangements, providing more information about lab tours before students register, and improvements to the JSHS app. Students noted that the app was "not user-friendly or intuitive" and that "Cvent on my phone just keeps crashing."

Mentors were also asked about their satisfaction with features of JSHS (Table 34). More than half (60% - 92%) of mentors reported being somewhat or very much satisfied with all program features except for communicating with NSTA (36% were somewhat or very much satisfied; 62% had not experienced). Additionally, 28% of mentors reported having not experienced support for instruction or mentorship during JSHS activities. Very few mentors expressed dissatisfaction with any feature of JSHS.

Table 34. Mentor Satisfaction with JSHS Program Features (n = 324-328)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Application or registration process	10.7%	2.7%	1.2%	21.6%	63.7%	
	35	9	4	71	209	**328**
Communicating with NSTA	62.2%	0.6%	1.5%	9.8%	25.8%	
	202	2	5	32	84	**325**
Communicating with your JSHS site's organizers	7.4%	1.5%	2.5%	11.3%	77.3%	
	24	5	8	37	252	**326**
Support for instruction or mentorship during JSHS activities	28.4%	0.6%	5.9%	12.3%	52.8%	
	92	2	19	40	171	**324**
Research abstract preparation requirements	34.6%	1.9%	2.2%	16.0%	45.4%	
	112	6	7	52	147	**324**
The physical location(s) of JSHS activities	4.3%	0.6%	3.3%	11.9%	79.9%	
	14	2	11	39	263	**329**

Mentors were also asked to comment on their overall satisfaction with JSHS in an open-ended questionnaire item. Of the 70 responses sampled, nearly all (65, or 93%) included positive comments about the program. Mentors remarked on the value of students' research and presentation experiences, the quality of the judging, and the professionalism and organization of the JSHS program and events. For example:

> *"I greatly appreciate JSHS as an educator. It provides an important venue for students to think and interact like professional scientists."* (JSHS Mentor)

> *"Excellent!! Becoming one of the more important STEM activities in the region w/ increasing continued participation. Also, important exposure to positive perception of the military and its contribution to STEM."* (JSHS Mentor)

> *"This was my students first experience with JSHS…[I] thought it was a very positive experience as well as beneficial in learning to present research in a different way...[The event] was well organized and well thought out. The judges asked good questions of the kids and gave good feedback. This was a great experience and my student will apply again next year!"* (JSHS Mentor)

Ten mentors (7%) made positive comments but also offered some caveats, while five respondents (7%) offered no positive comments. These respondents' remarks focused on organizational or administrative issues, judging, inconsistency of rules, and the diversity of students attending events. For example,

> *"Thanks for the organizers' hard work [to] make this a fantastic experience…as a parent and a scientist myself, I did attend one session of presentations, and went through all the poster session. I also talked to several presenters. What I want to emphasize is that the judges should be the scientists from the field of that particular session or poster session. Several students complained [that] the judges did not understand what they were talking about."* (JSHS Mentor)

> *"My biggest concern was the rules that were posted on our rules page were the ones I followed. Another school did not follow posted rules and was allowed to go against them. When I contacted the director, his response was to remove said rules from the website. Allowing one school to run the competition should not be allowed. It happens all the time in the region I am located. Not having a limit on the number of student papers a school can submit makes it extremely difficult for us smaller schools to compete."* (JSHS Mentor)

> *"Considerations need to be made to encourage more involvement by students in rural, poorer areas."* (JSHS Mentor)

In another open-ended questionnaire item, mentors were asked to identify the three most important strengths of JSHS. Of the 70 mentor responses sampled, the most often cited strength of JSHS, mentioned by 31 mentors (44%), was the opportunity for students to develop professional communication and presentation skills. Another 28 mentors (40%) cited as a program strength the opportunity for students to connect with like-minded peers, and 21 (30%) mentioned the research experience and skills students gain. Exposure to others' research was also a strength of the program noted by 15 (21%) of mentors and 13 (19%) cited the judging and feedback students receive as program strengths. Other strengths mentioned included the opportunity for students to network with professionals (12, or 17%), program management (10, or 14%), and the effect JSHS has on increasing student interest and/or motivation in STEM (8, or 11%).

Mentors participating in the focus group also commented upon the benefits of JSHS. These mentors cited students' opportunity to learn research skills, the opportunity to present their research and improve their communication skills, the feedback they receive about their projects, the opportunity to see authentic science in diverse fields, and the opportunity for students to connect with like-minded peers.

Mentors in the focus group also cited benefits to themselves as educators. The mentors valued the opportunity to connect with other educators and learn about research in other high schools, the opportunity to network with researchers, the information they gained from tours, and the information they gained from judges' feedback.

Mentors were also asked to respond to an open-ended item asked them to describe three ways in which JSHS could be improved. There were a wide variety of suggestions made in the 70 responses sampled. The most frequently mentioned suggestions, made by 18 mentors (26%) focused on event scheduling, including the location of competitions, the length of the event, and the number and length of the breaks. Fourteen mentors (20%) suggested improvements to judging, including increasing the amount of feedback or providing written feedback and recruiting judges with a wider variety of disciplinary backgrounds. Another 13 mentors (19%) suggested having more or better speakers and tours. Eleven (16%) of mentors suggested providing more social interaction time for students, and 16% suggested recruiting more, or more diverse, students. Nine (13%) suggested providing more resources for students such as examples of papers. Other suggestions, mentioned by less than 10% of mentors, included providing more information about the AEOP and DoD, more opportunities to visit the poster sessions, more opportunities for students to connect to alumnae (e.g., inviting alumnae to speak at events), providing a list of available mentors, and providing more incremental deadlines.

The mentors who participated in the focus group also offered suggestions for improvements to JSHS. These mentors mentioned several broad programmatic improvements including recognizing differences in accessibility to research mentors and resources between schools, sending JSHS alumni to regional events in order to expose students to STEM careers, and providing professional development opportunities (e.g., in statistics) for teachers. Mentors, for example, suggested providing a separate category for "in house" or unmentored projects, saying

> *"My high school is very rural, and we compete against very urban [schools]. The big debate is do you have separate categories, because we go to the grocery store and buy our lab supplies [while] they go to the National Institute of Health on a six-week trip with their dad who works there and works with STEM cells in a Petri dish, and we titrated orange juice."* (JSHS Mentor)

> *"When our kids who spent all this time working on a project that…in their world, is very good, [then they] come and compete with someone who has the resources that Johns Hopkins does, or National Institute of Health, or even the UW Hospital or whatever… then they don't want to come back."* (JSHS Mentor)

Mentors in the focus group also suggested some event-specific improvements such as providing more diverse speakers, improving communication about travel and lodging arrangements, the timing of the N-JSHS (the event was held near Easter when travel was relatively expensive), allowing participants to choose tours on the app, and organizing the printed schedule by topic.

When asked about ways that the program could engage more students from underserved or under-represented populations, mentors made several suggestions. The most discussed suggestion, as referenced above, was to provide separate categories for unmentored projects. Mentors also noted the need to pay teachers for their time and suggested providing scholarships for students to attend N-JSHS as observers and funding an effort in which scientists would come to schools to train teachers in research.

7 | Priority #3 Findings

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

How Participants Found out About AEOP

R-JSHS participants were asked how they learned about AEOP; results are shown in Table 35. Two-thirds (66%) of students said they learned about AEOP from someone who works at the school or university they attend. This was followed by school or university newsletters, emails, or websites (34%); past participants of the program (30%); and friends (22%). All other response options were selected by approximately 10% or fewer students.

Table 35. How R-JSHS Participants Learned About AEOP (n = 317)

	Response Percentage	Response Total
Army Educational Outreach Program (AEOP) Website	8.20%	26
AEOP on Facebook, Twitter, Instagram, or other social media	0.95%	3
School or university newsletter, email, or website	33.75%	107
Past participant of program	29.65%	94
Friend	22.08%	70
Family Member	10.41%	33
Someone who works at the school or university I attend	65.93%	209
Someone who works with the program	4.10%	13
Someone who works with the Department of Defense (Army, Navy, Air Force, etc.)	2.21%	7
Community group or program	4.42%	14
Choose Not to Report	11.04%	35

Table 36 shows mentors' responses to how they learned about JSHS. The most common responses were related to some form of personal contact including past participation in JSHS (30%), a colleague (24%), or a JSHS site host or director (22%).

Table 36. How JSHS Mentors Learned about AEOP (n = 329)

	Response Percentage	Response Total
National Science Teaching Association (NSTA) website	2.74 %	9
Army Educational Outreach Program (AEOP) website	5.78 %	19
AEOP on Facebook, Twitter, Pinterest, or other social media	1.22 %	4
A STEM conference or STEM education conference	4.86 %	16
An email or newsletter from school, university, or a professional organization	14.59 %	48
Past JSHS participant	30.09 %	99
A student	8.81 %	29
A colleague	24.01 %	79
My supervisor or superior	7.90 %	26
A JSHS site host or director	22.49 %	74
Workplace communications	7.29 %	24
Someone who works with the Department of Defense (Army, Navy, Air Force)	3.04 %	10
Other, (specify):	8.51 %	28

JSHS students reported a variety of factors for why they choose to participate in the program (Table 37). The top two motivating factors were interest in STEM (81%) and the desire to learn something new (75%). These were followed by having fun (61%), a desire to expand laboratory or research skills (59%), and teacher encouragement (58%).

Table 37. Factors Motivating Student Participation in R-JSHS (n = 446)

	Response Percentage	Response Total
Teacher or professor encouragement	58.30%	260
An academic requirement or school grade	15.70%	70
Desire to learn something new or interesting	74.89%	334
The mentor(s)	21.30%	95
Building college application or résumé	46.41%	207
Networking opportunities	40.81%	182
Interest in STEM	80.94%	361
Interest in STEM careers with the Army	15.02%	67
Having fun	61.21%	273
Earning stipends or awards for doing STEM	34.30%	153
Opportunity to do something with friends	23.99%	107
Opportunity to use advanced laboratory technology	38.79%	173
Desire to expand laboratory or research skills	59.19%	264
Learning in ways that are not possible in school	56.28%	251
Serving the community or country	31.39%	140
Exploring a unique work environment	36.32%	162
Figuring out education or career goals	47.31%	211
Seeing how school learning applies to real life	37.89%	169
Recommendations of past participants	21.08%	94
Choose Not to Report	2.91%	13

N-JSHS participants in focus groups reported learning about JSHS primarily through their schools, either from teachers or science fair advisors. These students reported various motivations for participating. Many of the participants indicated that they had participated as part of research courses in their schools. Others valued the opportunity to share their research, meet new people, or continue existing lines of research. One student said, for example,

> *"I spent over 160 hours this summer in my lab, and I also spent many hours during the week at my lab. I feel like this is a great opportunity to bring the work that I've been doing on my own and my professor into the public and get some recognition for it, which is really fulfilling."* (N-JSHS Student)

Previous Program Participation and Future Interest

Table 38 shows R-JSHS participant responses to a question on past participation in AEOPs. Slightly less than a quarter (23%) of respondents reported they had participated in JSHS before. Other AEOPs students reported past participation in were Camp Invention (3%), eCYBERMISSION (1%), JSS (<1%), UNITE (<1%), SEAP (<1%), REAP (<1%), and HSAP (<1%). Although 21% noted they had participated in other STEM programs, nearly two-thirds (65%) indicated they had not participated previously in AEOPs.

Table 38. R-JSHS Participant Past AEOP Participation (n = 446)

AEOP Programs	Response Percent	Response Total
Camp Invention	2.69%	12
eCYBERMISSION	1.35%	6
Junior Solar Sprint (JSS)	0.22%	1
Gains in the Education of Mathematics and Science (GEMS)	0%	0
UNITE	0.22%	1
Junior Science & Humanities Symposium (JSHS)	22.87%	102
Science & Engineering Apprenticeship Program (SEAP)	0.22%	1
Research & Engineering Apprenticeship Program (REAP)	0.22%	1
High School Apprenticeship Program (HSAP)	0.22%	1
College Qualified Leaders (CQL)	0%	0
Undergraduate Research Apprenticeship Program (URAP)	0%	0
Science Mathematics & Research for Transformation (SMART) College Scholarship	0%	0
I've never participated in any AEOP programs	64.80%	289
Other STEM Program	20.63%	92

R-JSHS students reported on their interest in participating in future AEOP programs (Table 39). Few students expressed that they were “not at all” interested in future programs (4%-7%). However, more than half of students (58%-73%) reported they had not heard of programs other than JSHS. Similar to FY18 findings, students reported limited awareness of other AEOPs, although between 22% and 38% of students expressed at least some future interest in all programs other than JSHS (88% expressed interest in participating again in the future).

Table 39. R-JSHS Participant Interest in Future AEOP Programs (n = 553)

	I've never heard of this program	Not at all	Somewhat interested	Very interested	Response Total
Unite	73.2%	4.3%	9.6%	12.8%	
	405	24	53	71	**553**
Junior Science & Humanities Symposium (JSHS)	2.2%	7.1%	27.7%	63.1%	
	12	39	153	349	**553**
Science & Engineering Apprenticeship Program (SEAP)	59.5%	5.4%	13.4%	21.7%	
	329	30	74	120	**553**
Research & Engineering Apprenticeship Program (REAP)	61.1%	6.1%	12.3%	20.4%	
	338	34	68	113	**553**
High School Apprenticeship Program (HSAP)	62.0%	5.2%	13.7%	19.0%	
	343	29	76	105	**553**
College Qualified Leaders (CQL)	68.5%	5.2%	12.3%	13.9%	
	379	29	68	77	**553**
GEMS Near Peer Mentor Program	68.7%	6.7%	12.8%	11.8%	
	380	37	71	65	**553**
Undergraduate Research Apprenticeship Program (URAP)	62.9%	3.4%	13.6%	20.1%	
	348	19	75	111	**553**
Science Mathematics, and Research for Transformation (SMART) College Scholarship	57.9%	3.8%	15.6%	22.8%	
	320	21	86	126	**553**
National Defense Science & Engineering Graduate (NDSEG) Fellowship	65.6%	6.7%	11.9%	15.7%	
	363	37	66	87	**553**

N-JSHS students were also asked about their interest future AEOP participation (Table 40). N-JSHS participants had similar knowledge of and interest in participating in other AEOPs as R-JSHS students. Between 21% and 59% of N-JSHS students indicated being at least somewhat interested in all programs other than Unite (16%), and nearly all expressed interest in participating in JSHS in the future (92%).

Table 40. N-JSHS Participant Interest in Future AEOP Programs (n = 87-88)

	I've never heard of this program	Not at all	Somewhat interested	Very interested	Response Total
Unite	83.0%	1.1%	5.7%	10.2%	
	73	1	5	9	88
JSHS	0.0%	8.0%	17.0%	75.0%	
	0	7	15	66	88
SEAP	52.9%	6.9%	19.5%	20.7%	
	46	6	17	18	87
REAP	58.0%	3.4%	19.3%	19.3%	
	51	3	17	17	88
HSAP	61.4%	9.1%	15.9%	13.6%	
	54	8	14	12	88
CQL	71.3%	2.3%	11.5%	14.9%	
	62	2	10	13	87
GEMS Near Peer Mentor Program	74.7%	4.6%	8.0%	12.6%	
	65	4	7	11	87
URAP	59.1%	2.3%	15.9%	22.7%	
	52	2	14	20	88
SMART College Scholarship	35.2%	5.7%	26.1%	33.0%	
	31	5	23	29	88
NDSEG Fellowship	63.6%	3.4%	19.3%	13.6%	
	56	3	17	12	88

Awareness of STEM Careers and DoD STEM Careers and Research

A goal of AEOP is to increase both the number and diversity of students who pursue STEM careers. As such, the questionnaire included items to assess students' exposure to STEM careers in general and STEM careers within the DoD more specifically. A large majority (82%) of R-JSHS students reported learning about at least one STEM job/career during JSHS, and 27% expressed they had learned about five or more (Table 41). These students had learned about fewer DoD STEM jobs/careers, with less than half (46%) reporting having heard of at least one and only 7% having learned about five or more during JSHS (Table 42). These findings are similar to those from FY18.

Table 41. Number of STEM Jobs/Careers Students Learned About During R-JSHS (n =553)

Number of STEM Jobs/Careers	Response Percent	Response Total
None	17.72%	98
One job	10.13%	56
Two jobs	18.44%	102
Three jobs	19.71%	109
Four jobs	7.05%	39
Five or more	26.94%	149

Table 42. Number of Department of Defense (DoD) STEM Jobs/Careers Learned About During R-JSHS (n = 553)

Number of DoD STEM Jobs/Careers	Response Percent	Response Total
None	53.53%	296
One job	18.81%	104
Two jobs	13.56%	75
Three jobs	5.06%	28
Four jobs	1.99%	11
Five or more	7.05%	39

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 43 and 44). Nearly all N-JSHS participants (91%) reported learning about one or more STEM jobs/careers in general, and nearly all (94%) indicated they learned about one or more DoD STEM job/career. Additionally, approximately half or more of N-JSHS students reported they learned about five or more STEM jobs/careers in general (58%) and DoD STEM jobs/careers (48%).

Table 43. Number of STEM Jobs/Careers Students Learned About During N-JSHS (n=82)

Number of STEM Jobs/Careers	Response Percent	Response Total
None	8.54%	7
One job	0%	0
Two jobs	8.53%	7
Three jobs	22.23%	18
Four jobs	9.76%	8
Five or more	58.54%	48

Table 44. Number of Department of Defense (DoD) STEM Jobs/Careers Learned About During N-JSHS (n = 88)

Number of DoD STEM Jobs/Careers	Response Percent	Response Total
None	5.62%	5
One job	4.49%	4
Two jobs	13.48%	12
Three jobs	16.85%	15
Four jobs	11.24%	10
Five or more	48.31%	43

To further explore students' exposure to STEM career opportunities in the DoD, N-JSHS focus group participants were asked whether and how they had learned about STEM career opportunities in the DoD during JSHS. Students responded that their exposure to DoD STEM career opportunities occurred primarily at the N-JSHS event rather than at regional competitions. For example, one focus group participant noted,

> *"If you went to [the regional event], you wouldn't have known that it was the DoD."* (N-JSHS Student)

All students in the focus groups reported learning about DoD STEM careers at N-JSHS. Their exposure to STEM careers was through speakers, round table discussions, and lab tours. Students said, for example,

> *"[I learned about DoD STEM careers] especially through the lab tours and the presentations where they talk about their work. You see there's a really wide variety of job opportunities and paths you can take in the Army."* (N-JSHS Student)

> *"I don't think I've ever really considered [a STEM career in the DoD] before, but then [at N-JSHS] you see like all these incredible people and the opportunities. They show you different perspectives.*

I don't know if I going to go into the Army to do research, but I definitely want to do STEM." (N-JSHS Student)

Students participating in focus group also offered some suggestions for ways to expose students to DoD STEM careers. In particular, students suggested emphasizing the career opportunities for civilians versus active duty military personnel and offering more DoD-specific tours at N-JSHS. For example,

"What would have been helpful is if [on tours] they outlined if they're doing civilian, or if they're doing active duty, whenever they're doing these research opportunities." (N-JSHS Student)

Mentors participating in the focus group at N-JSHS also emphasized the value of first-hand information and personal connections to STEM professionals via speakers, round table discussions, and field trips to expose their students to DoD STEM careers. As one mentor said,

"I think when they meet a professional that captivates them that has passion for what they do, I see my students immediately lock eyes with them. Now, all of a sudden, they're with them, and they're paying attention. Then they discuss their route and their path." (JSHS Mentor)

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, Table 45 shows survey results of R-JSHS participants' opinions regarding DoD researchers and research. More than three-quarters of students selected "strongly agree" or "agree" for each item, including that DoD researchers solve real-world problems (81%) and develop new cutting edge technologies (80%).

Table 45. R-JSHS Participant Opinions about DoD Researchers and Research (n = 553)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Response Total
DoD researchers advance science and engineering fields	1.3%	0.7%	18.6%	44.7%	34.7%	
	7	4	103	247	192	**553**
DoD researchers develop new, cutting edge technologies	1.1%	0.4%	18.6%	43.4%	36.5%	
	6	2	103	240	202	**553**
DoD researchers solve real-world problems	1.4%	0.9%	17.0%	38.7%	42.0%	
	8	5	94	214	232	**553**
DoD research is valuable to society	1.6%	1.3%	19.7%	33.6%	43.8%	
	9	7	109	186	242	**553**

Interest and Future Engagement in STEM

Developing a STEM-literate citizenry is a key goal of AEOP. To assess the impact of JSHS on student interests and likelihood of future engagement in STEM outside of their required school coursework, students rated a series of items (Table 46). Approximately half or more of R-JSHS students reported they were more likely or much more likely to participate in all STEM activities after JSHS. STEM activities in which two-thirds or more of respondents reported increased likelihood of participation were helping with a community service project related to STEM (66%), talking with friends or family about STEM (68%), and working on a STEM project/experiment in a university or professional setting (69%).

A composite score[12] was generated from these future STEM engagement items to test for differences among subgroups of students. No significant differences in students' intent to engage in STEM out of school were found by overall U2 status, gender, ELL status, school location, or first generation status. However, there was a significant difference by FARMS with lower socio-economic status students reporting significantly higher likelihood of engaging[13] (small effect of $d = 0.299$), and by race/ethnicity with minority students indicating significantly higher likelihood of engaging[14] (small effect of $d = 0.214$).

Table 47 shows R-JSHS students' education aspirations after participating in JSHS. Nearly all students (98%) reported planning to earn a Bachelor's degree, at a minimum. Further, 80% indicated they intend to earn a master's degree or higher, and 63% reported that they plan to earn a terminal degree (doctorate, medical degree, professional law or business degree).

N-JSHS students were asked the same question about their education aspirations after participating in JSHS (Table 48). N-JSHS student educational aspirations were similar to those of R-JSHS students', with all N-JSHS participants (100%) reporting that they plan to at least earn a Bachelor's degree, 80% planning to earn at least a master's degree, and 65% intending to earn a terminal degree. N-JSHS students were also asked about their interest in STEM higher education specifically (Table 49). More than 80% of N-JSHS participants reported planning to earn STEM bachelor's degree (89%) or advanced degree in STEM (85%).

[12] The Likely to Engage composite had a Cronbach's alpha reliability of 0.938.
[13] Two-tailed independent samples t-test for FARMS and STEM Identity: $t(399) = 2.99$, $p = 0.003$.
[14] Two-tailed independent samples t-test for race/ethnicity and STEM Identity: $t(403) = 2.15$, $p = 0.032$.

Table 46. R-JSHS Impact on Participants' Intent to Engage in STEM Out of School (n = 553)

	Much less likely	Less likely	About the same before and after	More likely	Much more likely	Response Total
Watch or read non-fiction STEM	1.1%	1.4%	44.7%	31.1%	21.7%	
	6	8	247	172	120	**553**
Tinker (play) with a mechanical or electrical device	1.3%	1.6%	46.7%	29.8%	20.6%	
	7	9	258	165	114	**553**
Work on solving mathematical or scientific puzzles	1.1%	1.1%	43.9%	30.9%	23.0%	
	6	6	243	171	127	**553**
Use a computer to design or program something	0.9%	2.2%	49.5%	23.1%	24.2%	
	5	12	274	128	134	**553**
Talk with friends or family about STEM	0.2%	0.9%	30.7%	35.3%	32.9%	
	1	5	170	195	182	**553**
Mentor or teach other students about STEM	0.5%	1.6%	34.0%	32.2%	31.6%	
	3	9	188	178	175	**553**
Help with a community service project related to STEM	0.4%	1.4%	31.8%	33.6%	32.7%	
	2	8	176	186	181	**553**
Participate in a STEM camp, club, or competition	0.5%	1.3%	33.5%	28.9%	35.8%	
	3	7	185	160	198	**553**
Take an elective (not required) STEM class	0.5%	1.4%	38.2%	27.7%	32.2%	
	3	8	211	153	178	**553**
Work on a STEM project or experiment in a university or professional setting	0.4%	1.1%	29.1%	28.4%	41.0%	
	2	6	161	157	227	**553**

Table 47. After R-JSHS - Participant Education Aspirations (n = 553)

After JSHS Aspirations	Response Percent	Response Total
Graduate from high school	<1%	3
Go to a trade or vocational school	<1%	4
Go to college for a little while	<1%	4
Finish college (get a Bachelor's degree)	11.39%	63
Get more education after college	6.69%	37
Get a master's degree	17.00%	94
Get a Ph.D.	21.16%	117
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	20.25%	112
Get a combined masters/ Ph.D.	15.91%	88
Get another professional degree (law, business, etc.)	5.61%	31

Table 48. After N-JSHS - Participant Education Aspirations (n=86)

After Aspirations	Response Percent	Response Total
Graduate from high school	0%	0
Go to a trade or vocational school	0%	0
Go to college for a little while	0%	0
Finish college (get a Bachelor's degree)	8.14%	7
Get more education after college	11.63%	10
Get a master's degree	15.12%	13
Get a Ph.D.	27.91%	24
Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S)	22.09%	19
Get a combined masters/Ph.D.	10.47%	9
Get another professional degree (law, business, etc.)	4.65%	4

Table 49. After N-JSHS - Participant STEM Education Aspirations (n=85-86)

STEM Degree Type	Yes	No
Bachelor's degree in a STEM field	76 (89.41%)	9 (10.59%)
Advanced degree (beyond a bachelor's degree) in a STEM field	73 (84.88%)	13 (15.12%)

Resources

R-JSHS survey participants were asked which resources impacted their awareness of AEOPs (Table 50). Resources that more than half of students reported as having at least a little impact on their awareness of AEOPs were JSHS program staff or site coordinators (67%), presentations or information shared at the competition (64%), and invited speakers (60%). JSHS mentors had less of an impact, with less than half of R-JSHS students (40%) reporting that mentors helped them learn about AEOPs. AEOP electronic efforts had the least impact of the resources with nearly two-thirds or more indicating they did not experience the AEOP website (60%) or AEOP social media (72%).

Table 50. Impact of Resources on R-JSHS Participant Awareness of AEOPs (n = 553)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	60.2%	5.6%	11.6%	11.4%	11.2%	
	333	31	64	63	62	**553**
AEOP on Facebook, Twitter, Pinterest or other social media	72.2%	6.9%	9.6%	5.8%	5.6%	
	399	38	53	32	31	**553**
AEOP printed materials	55.5%	5.8%	16.3%	11.4%	11.0%	
	307	32	90	63	61	**553**
JSHS program staff or site coordinator	25.5%	6.9%	23.7%	21.2%	22.8%	
	141	38	131	117	126	**553**
Invited speakers at JSHS	31.3%	8.9%	17.2%	18.3%	24.4%	
	173	49	95	101	135	**553**
Presentations or information shared at the JSHS competition	26.0%	10.5%	17.4%	20.3%	25.9%	
	144	58	96	112	143	**553**
My JSHS mentor(s)	46.3%	13.0%	9.6%	12.1%	19.0%	
	256	72	53	67	105	**553**

R-JSHS students' reports about the usefulness of various AEOP resources for learning about DoD STEM careers are found in Table 51. Resources rated by more than half of students as having at least a little impact on their learning about DoD STEM careers were presentations or information shared at the competition (58%), invited speakers (56%), and JSHS program staff or site coordinators (60%). JSHS mentors had less of an impact with 35% 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 two-thirds or more indicating they did not experience AEOP social media (73%) or the AEOP website (63%).

Table 51. Impact of Resources on R-JSHS Student Awareness of DoD STEM Careers (n = 538-553)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	62.6%	5.8%	11.2%	9.9%	10.5%	
	346	32	62	55	58	**553**
AEOP on Facebook, Twitter, Pinterest or other social media	72.7%	6.5%	8.7%	8.0%	4.2%	
	402	36	48	44	23	**553**
AEOP printed materials	56.8%	6.7%	15.7%	12.1%	8.7%	
	314	37	87	67	48	**553**
JSHS program staff or site coordinator	34.4%	9.9%	19.2%	17.9%	18.6%	
	190	55	106	99	103	**553**
Invited speakers or career events	35.1%	9.1%	17.7%	16.9%	21.2%	
	189	49	95	91	114	**538**
Presentations or information shared at the JSHS competition	31.1%	10.8%	17.9%	19.5%	20.6%	
	172	60	99	108	114	**553**
My JSHS mentor(s)	49.5%	15.4%	10.1%	10.8%	14.1%	
	274	85	56	60	78	**553**

Tables 52 and 53 show mentor responses to the same usefulness of resources items. Mentors felt somewhat more strongly than students about the usefulness of resources related to exposing students to AEOPs compared to DoD STEM careers. Resources mentors supported as most useful (somewhat or very much) were JSHS program staff of site coordinators (75% AEOPs, 66% DoD STEM careers), presentations or information shared at the JSHS competitions (71% AEOPs, 63% DoD STEM careers), and invited speakers or "career" events (50% AEOPs, 50% DoD STEM careers).

Table 52. Mentor Responses about Usefulness of Resources for Exposing Students to AEOPs (n = 332)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	71.4%	2.4%	6.3%	10.8%	9.0%	
	237	8	21	36	30	**332**
AEOP on Facebook, Twitter, Pinterest or other social media	88.0%	4.2%	3.0%	3.9%	0.9%	
	292	14	10	13	3	**332**
AEOP printed materials	64.8%	3.0%	6.6%	14.2%	11.4%	
	215	10	22	47	38	**332**
JSHS program staff or site coordinator	22.9%	1.8%	5.7%	16.6%	53.0%	
	76	6	19	55	176	**332**
Invited speakers or "career" events	48.2%	1.8%	6.9%	15.1%	28.0%	
	160	6	23	50	93	**332**
Presentations or information shared at the JSHS competition	28.0%	1.5%	4.8%	20.2%	45.5%	
	93	5	16	67	151	**332**

Table 53. Usefulness of Resources for Exposing Students to DoD STEM Careers (n = 332)

	Did not experience	Not at all	A little	Somewhat	Very much	Response Total
Army Educational Outreach Program (AEOP) website	75.3%	3.0%	4.5%	10.2%	6.9%	
	250	10	15	34	23	**332**
AEOP on Facebook, Twitter, Pinterest or other social media	88.9%	4.2%	3.0%	2.4%	1.5%	
	295	14	10	8	5	**332**
AEOP printed materials	65.4%	2.4%	6.6%	13.6%	12.0%	
	217	8	22	45	40	**332**
JSHS program staff or site coordinator	30.4%	3.6%	5.1%	17.8%	43.1%	
	101	12	17	59	143	**332**
Invited speakers or "career" events	47.3%	2.4%	6.6%	16.0%	27.7%	
	157	8	22	53	92	**332**
Presentations or information shared at the JSHS competition	35.5%	1.5%	4.8%	19.3%	38.9%	
	118	5	16	64	129	**332**

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. Table 54 shows that close to half or more of R-JSHS students (43%-83%) agreed that JSHS contributed to or was primarily responsible for their growth in all areas. Items for which two-thirds or more of participants reported impact were appreciation of DoD research (65%); interest in participating in STEM activities outside of school requirements (74%); and confidence in STEM knowledge, skills, and abilities (83%).

Overall impact of JSHS items were combined into a composite variable[15] to assess for differences between student subgroups. While there were no significant differences in overall impact were found by U2 status, there were significant differences found by FARMS, ELL status, and School Location, with FARMS students, ELL students, and students attending suburban schools reporting more impacts from their JSHS participation.[16] Effect sizes were small for all differences (FARMS d=0.247; ELL Status d=0.220; School Location d=0.272).

[15] The Cronbach's alpha reliability for Overall Impact items was 0.913.

[16] Independent samples t-test results for Overall Impact by FARMS: $t(399)=2.47$, $p=0.014$; ELL Status: $t(443)=2.31$, $p=0.022$; and School Location: $t(534)=3.14$, $p=0.002$.

Table 54. R-JSHS Participant Opinion of JSHS Impacts (n = 553)

	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	2.9%	14.1%	66.7%	16.3%	
	16	78	369	90	**553**
More interested in participating in STEM activities outside of school requirements	4.5%	21.2%	57.1%	17.2%	
	25	117	316	95	**553**
More aware of other AEOPs	32.7%	5.4%	37.3%	24.6%	
	181	30	206	136	**553**
More interested in participating in other AEOPs	32.9%	7.1%	40.1%	19.9%	
	182	39	222	110	**553**
More interested in taking STEM classes in school	6.0%	32.5%	49.4%	12.1%	
	33	180	273	67	**553**
More interested in earning a STEM degree	8.5%	29.8%	50.8%	10.8%	
	47	165	281	60	**553**
More interested in pursuing a career in STEM	8.3%	28.9%	50.5%	12.3%	
	46	160	279	68	**553**
More aware of DoD STEM research and careers	32.7%	8.5%	36.0%	22.8%	
	181	47	199	126	**553**
Greater appreciation of DoD STEM research	26.0%	8.7%	41.6%	23.7%	
	144	48	230	131	**553**
More interested in pursuing a STEM career with the DoD	46.3%	10.3%	28.2%	15.2%	
	256	57	156	84	**553**

In order to further understand the impact of regional participation in JSHS on students, an open-ended item on the questionnaire asked R-JSHS students to list the three most important ways they benefited from JSHS. Among the 115 responses sampled, students noted a variety of benefits of JSHS participation. The most frequently mentioned benefit, cited by 76 respondents (67%) was the opportunity to develop presentation and communication skills followed by exposure to others' research (40, or 35%). Over a

quarter of respondents remarked on the opportunity to gain research experience and develop STEM skills (35, or 30%). Nearly a quarter of student responses (27, or 23%) cited connecting with like-minded peers as a benefit, and the same proportion of respondents cited STEM knowledge and learning as a benefit of participation. Another 25 students (22%) remarked on the value of the career information they received, while 23 students (20%) identified interacting with others who have similar interests as a benefit. The same number of students noted that increasing motivation or interest in STEM is a benefit of participating in JSHS. Other benefits included networking with professionals (17%), increasing students' confidence (16%), receiving feedback on their projects (16%), and receiving information about other opportunities (12%).

N-JSHS students were also asked about the overall impact of participating in JSHS (Table 55). Items for which N-JSHS participants were most likely to indicate that JSHS had an impact were awareness of Army/DoD STEM researcher and careers (92%); appreciation of Army/DoD STEM research (89%); awareness of other AEOPs (82%); and confidence in STEM knowledge, skills, and abilities (81%). N-JSHS students were more likely to report a greater knowledge of and appreciation for AEOPs and DoD STEM research/careers compared to R-JSHS students. However, R-JSHS students were more likely to report impacts on their interest in taking more STEM classes in school, earning a STEM degree, and pursuing careers in STEM due to their participation in JSHS than N-JSHS students.

Table 55. N-JSHS Participant Opinion of JSHS Impacts (n = 85)

	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	4.7%	14.1%	70.6%	10.6%	
	4	12	60	9	**85**
I am more interested in participating in STEM activities outside of school requirements	7.1%	15.3%	68.2%	9.4%	
	6	13	58	8	**85**
I am more aware of other AEOPs	15.3%	2.4%	37.6%	44.7%	
	13	2	32	38	**85**
I am more interested in participating in other AEOPs	28.2%	4.7%	32.9%	32.9%	
	24	4	28	28	**85**
I am more interested in taking STEM classes in school	10.6%	38.8%	44.7%	5.9%	
	9	33	38	5	**85**
I am more interested in earning a STEM degree	9.4%	32.9%	50.6%	5.9%	
	8	28	43	5	**85**
I am more interested in pursuing a career in STEM	9.4%	31.8%	51.8%	5.9%	
	8	27	44	5	**85**
I am more aware of Army or DoD STEM research and careers	4.7%	3.5%	37.6%	54.1%	
	4	3	32	46	**85**
I have a greater appreciation of Army or DoD STEM research	8.2%	2.4%	37.6%	51.8%	
	7	2	32	44	**85**
I am more interested in pursuing a STEM career with the Army or DoD	31.8%	8.2%	34.1%	24.7%	
	27	7	29	21	**85**

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 80 students who responded to the item, nearly half (37, or 46%) cited the benefits of interacting with like-minded peers. Additional comments focused on the

benefits of networking with professionals (20%) or networking generally (20%). Other benefits mentioned included gaining career information (14%), exposure to others' research (13%), and the opportunity to develop presentation and communication skills (10%). For example,

> *"I really enjoyed meeting and having conversations with other students who are passionate about research. I was really amazed and inspired by the other projects that I learned about and the research that other students conducted. Additionally, the lab tour was incredible. I learned about specific projects, which opened my eyes to many different possibilities and avenues for careers within STEM related fields. I also really enjoyed the round table and panel discussions with scientists and enjoyed learning about the experiences and programs that helped each scientist reach the point where they are today as well as their research projects."* (N-JSHS Student)

> *"I was able to bring my research to a wider audience. I felt motivated to continue research. I certainly improved my ability to present and my public speaking skills have improved because of JSHS."* (N-JSHS Student)

N-JSHS students participating in focus groups cited similar benefits. These students emphasized the value of presentation experience, the value of the career information they received, being able to network with other student participants, being inspired by their exposure to research and STEM professionals, and the value of the feedback they received on their projects. For example,

> *"I learned about a lot of science careers that I didn't really know."* (N-JSHS Student)

> *"I got inspired. I was watching all of the presentations in my category, and I was like, 'There is so much really cool science going on here.' Now I have all these other ideas for things I want to try."* (N-JSHS Student)

> *"This competition gives us a lot of free time to be able to talk with everyone…Everyone was extremely open to get to know each other. That's my favorite thing about [N-JSHS] hands down."* (N-JSHS Student)

8 | Findings and Recommendations

Summary of Findings

The FY19 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 56.

Table 56. 2019 JSHS Evaluation Findings	
Priority #1: *Broaden, deepen, and diversify the pool of STEM talent in support of our Defense Industry Base*	
There was a slight increase in JSHS applicants in FY19 compared to FY18, however a substantial downward trend in participation over a multi-year period continues.	In FY 19, R-JSHS sites received applications from 4,493 students, a 5% increase as compared to FY18 when 4,279 students applied. This represents a slight reversal in the downward trend in applications since 2015 (8,663 applicants in FY17; 8,947 in FY16; and 9,347 in FY15).
	In FY19, 2,651 students competed in regional competitions. This is a 16% decrease in participation as compared to FY18 (3,069 participants) and continues the downward trend in participation (5,577 participants in FY 17; 5,620 in FY16; and 5,829 in FY15).
Collection of required demographic data for JSHS improved for 2019.	In FY19, Cvent reflected enrollment of 2,970 students while site reports reflected enrollment of 2,651 students.
JSHS continues a trend of enrolling a majority of female participants.	Slightly more than half (59%) of FY19 R-JSHS students were female and 40% were male, a distribution similar to FY18 when 58% of R-JSHS participants were female and 40% were male.
The ethnic/racial diversity of JSHS remains relatively constant compared to previous program years , with White and Asian being the most frequently reported races or ethnicities.	Half (50%) of R-JSHS students identified themselves as White (compared to 57% in FY18), with another 27% identifying themselves as Asian (20% in FY18). The proportion of Hispanic or Latino students in R-JSHS increased slightly (7% in FY19, 5% in FY18), and the proportion of Black or African American students decreased slightly (5% in FY19, 6% in FY18).
Students reported that they actively engaged in STEM practices in JSHS but that this	Students reported engaging in a wide variety of STEM practices in their R-JSHS experiences and indicated that they performed each STEM Practice more often (weekly or every day) during JSHS than in school.

engagement was not significantly more frequent than in their typical school experiences.	For example, students engaged in the following more frequently in JSHS than in school: designing and carrying out an investigation (40% in JSHS compared to 33% in school); interacting with STEM researchers (29% in JSHS compared to 23% in school); and designing their own research based on their own questions (37% in JSHS compared to 32% in school).
	There was no significant difference in engagement in STEM practices by U2 status or by any individual demographic component of U2 status.
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 JSHS.
	More than half of students (58%-80%) reported medium or large gains in all STEM competencies. Three-quarters or more of students reported medium to large gains in multiple STEM competencies, including using knowledge and creativity to suggest a solution to a problem (75%), supporting an explanation with STEM knowledge or data from experiments (75%), defending an argument based upon findings from an experiment or other data, and presenting an argument that uses data and/or findings from an experiment (78%).
	There was no significant difference in gains in STEM knowledge or STEM competencies by U2 status or by any individual demographic component of U2 status.
Students reported gains in their 21st Century skills as a result of participating in JSHS; FARMS students reported larger gains than their peers.	More than half of students (52%-85%) reported at least medium gains in all 21st Century skills except for creating media products (34%) and leading/guiding others in a team/group (49%). Areas with largest reported 21st Century skills gains (medium to high) included solving problems (77%); evaluating others' evidence, arguments, and beliefs (78%); incorporating feedback on personal work (78%); and communicating clearly with others (85%).
	There was no significant difference in gains in 21st Century skills by overall U2 status, however FARMS students reported larger gains than their peers (small effect size).
Students reported gains in their STEM identities as a result of participating in JSHS; FARMS students and students who attended suburban schools reported larger gains than their peers.	More than 70% of students reported medium to large gains across all areas of STEM identity. Areas of the greatest reported medium/large gains were confidence to try out new ideas or procedures on STEM projects (78%), the desire to build relationships with mentors who work in STEM (79%), and being better prepared for more challenging STEM activities (80%).
	There was no significant difference in gains in STEM identity by overall U2 status, however FARMS students and those who attended suburban schools reported larger gains than their peers (small effect sizes).
Priority #2: *Support and empower educators with unique Army research and technology resources.*	

Most JSHS students had worked with mentors, and these mentors were primarily teachers or STEM researchers.	Most R-JSHS students reported their mentor was either a teacher (40%) or STEM researcher (38%). More than half of students indicated their mentor was available at least half of the time (61%).
Students most frequently worked with their mentors to design their projects, however many students also reported designing their projects on their own.	More than three-quarters of students reported having some degree of participation in designing their projects. Specifically, 39% independently designed their entire project, while 22% reported working with their mentor to design their project, 16% designed their project with their mentor and members of a research team, and 7% were given a choice among various projects suggested by their mentors.
Most mentors used a variety of effective mentoring strategies with their students, however few discussed AEOPs other than JSHS with their students.	Most responding mentors (55%-83%) reported using strategies associated with establishing the relevance of learning activities to students, supporting the diverse needs of learners, supporting students' development of collaboration and interpersonal skills, and supporting students' engagement in "authentic" STEM activities.
	Although about two-thirds (67%) of mentors discussed JSHS with students and slightly over a quarter (26%) discussed Unite, few mentors (3%-18%) reported speaking with students about other AEOPs specifically or about AEOPs generally.
Students reported high levels of satisfaction with JSHS program components, and were somewhat more satisfied with the judging and feedback from judges as compared to FY18.	Most R-JSHS (54%-85%) students were somewhat or very much satisfied with nearly all JSHS features that they had experienced. Students were most satisfied with oral presentations (85%), judging (69%), and speakers. Nearly half (46%) of R-JSHS students had not experienced team-building activities.
	Qualitative data from both R-JSHS and N-JSHS students suggest that students particularly valued the research experience they gained, the opportunity to present their research and learn about others' research, the feedback they received, and connecting with like-minded peers.
	Few R-JSHS students expressed dissatisfaction with any R-JSHS features on the questionnaire, although 8% expressed dissatisfaction with the judging process and with feedback from judges, a decrease from the 11% who expressed dissatisfaction with these features in FY18. Over three-quarters of N-JSHS questionnaire respondents made positive comments about regional judging and over half made positive comments about the national judging.
R-JSHS and N-JSHS students made a number of suggestions for program improvement	N-JSHS students made the following suggestions for improvements to the regional judging process: • Providing more judges or more female judges • Ensuring that judges are knowledgeable about the categories they judge • Ensuring that judges ask relevant and meaningful questions • Providing more detailed feedback from judges

	• Allowing more time for questions, both from judges and from the audience • Providing participants with the judging rubrics in advance • Instructing judges to consider the type of mentorship students received
	N-JSHS students made the following suggestions for improvements to the national judging process: • Providing more judges (particularly for poster judging) • Providing more time for judging (particularly for poster judging) • Providing more judge feedback • Ensuring that judges are knowledgeable about the categories they judge • Ensuring that judges ask relevant and meaningful questions • Providing more specific categories for projects and separating categories (e.g., separating mathematics from computer science, and behavioral science from medical science) • Ensuring consistency in judging • Improving judges' attentiveness or communication with presenters
	R-JSHS students recommended program improvements focusing on event logistics such as providing more time for social interaction; more activities, trips, or tours; and different or better speakers. Those suggesting overall program improvements suggested providing clearer guidelines and deadlines for presenters and clearer registration or application procedures.
	N-JSHS students recommended program improvements to the organization, scheduling, and communication associated with the national event. Students also suggested more diverse, interactive, or interesting speakers; improvements to poster judging (e.g., provide chairs, provide more judges, provide more time); more or better tours; and more food choices.
Mentors reported high levels of satisfaction with JSHS, and suggested various program improvements.	More than half of mentors (60%-92%) reported being somewhat or very much satisfied with all program features they experienced. Over a third (35%) had not experienced support for instruction or mentorship and had not experienced research abstract preparation.
	Qualitative data from mentors indicates that mentors particularly value the opportunity for students to experience authentic research, present their research, connect with like-minded peers, and receive feedback on their projects. Mentors also valued the opportunity to connect with other educators, network with researchers, and the information they gained from tours and judges' feedback on students' projects.
	Mentors suggested that JSHS could be improved by improving event logistics and scheduling, improving judging (e.g., judges from a wider variety of disciplines, more written feedback), having more or better

	speakers or tours, and providing more social interaction time for students.
	Mentors participating in a focus group suggested ways to broaden the reach of JSHS, stressing the need to provide separate categories for unmentored projects. Mentors also noted that paying teachers for their time could broaden participation, and suggested providing scholarships for students to attend N-JSHS as observers and funding an effort in which scientists would come to schools to train teachers in research.
Priority #3: *Develop and implement a cohesive, coordinated and sustainable STEM education outreach infrastructure across the Army*	
Students' primary source of Information about AEOP is communication through their schools, and they are motivated to participate by their interest in STEM and desire to learn. Mentors learned about AEOP primarily through personal or professional contacts.	Two-thirds (66%) of students learned about AEOP from someone who works at the school or university they attend, 34% from school or university newsletters, emails, or websites; 30% from past participants of the program; and 22% from friends.
	The top two factors motivating students to participate in JSHS were interest in STEM (81%) and the desire to learn something new (75%). Other motivators included having fun (61%), a desire to expand laboratory or research skills (59%), and teacher encouragement (58%)
	The most common ways mentors learned about AEOP were from being a past JSHS participant (30%), from a colleague (24%), or from a JSHS site host or director (22%).
Most students had not heard of most AEOPs other than JSHS although many expressed interest in participating in other AEOPs in the future. 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 (3%-7%) and few N-JSHS students (1%-8%) indicated that they were "not at all" interested in participating in other AEOPs. However, the majority of R-JSHS students (58%-73%) had not heard of AEOPs other than JSHS. Likewise, most N-JSHS students (53%-83%) had not heard of AEOPs with the exception of the SMART scholarship (35% had not heard of this).
	Between 22% and 38% of R-JSHS students expressed at least some future interest in participating in all programs other than JSHS (88% were interested in future participation). Between 21% and 59% of N-JSHS students indicated being at least somewhat interested in all programs other than Unite (16%), and nearly all expressed interest in participating in JSHS in the future (92%).
	Resources that more than half of students reported as having at least a little impact on their awareness of AEOPs were JSHS program staff or site coordinators (67%), presentations or information shared at the competition (64%), and invited speakers (60%). Nearly half (46%) had not received AEOP information from their mentors and another 13% indicated that AEOP information from mentors was not helpful.

	Mentors reported that the most useful resources of AEOP information were JSHS program staff of site coordinator (75%), presentations or information shared at the JSHS competitions (71%), and invited speakers or "career" events (50%).
JSHS participants learned about STEM careers both generally and within the DoD, and had positive perceptions of DoD research and researchers.	A large majority (82%) of R-JSHS students reported learning about at least one STEM job/career during JSHS, and 27% expressed they had learned about five or more. Less than half (46%) of R-JSHS students reported having heard of at least one DoD STEM job/career, and only 7% having learned about five or more during JSHS.
	Nearly all N-JSHS participants (91%) reported learning about one or more STEM jobs/careers in general, and nearly all (94%) indicated they learned about one or more DoD STEM job/career. Additionally, approximately half or more of N-JSHS students reported they learned about five or more STEM jobs/careers in general (58%) and DoD STEM jobs/careers (48%).
	N-JSHS students noted that their exposure to DoD STEM career opportunities was primarily at the N-JSHS event rather than at regional competitions.
	Of the R-JSHS students who had opinions about DoD research and researchers, more than three-quarters selected "strongly agree" or "agree" for each item about which they were asked, including that DoD researchers solve real-world problems (81%) and develop new cutting edge technologies (80%).
R-JSHS students reported being more likely to engage in STEM activities outside of required school courses in the future; FARMS and minority students were more likely to report intentions to engage in STEM in the future than their peers.	Most R-JSHS students (51%-68%) reported they were more likely or much more likely to participate in STEM activities after JSHS. STEM activities in which two-thirds or more of respondents reported increased likelihood of participation were helping with a community service project related to STEM (66%), talking with friends or family about STEM (68%), and working on a STEM project/experiment in a university or professional setting (69%)
	While there were no differences in likelihood of future engagement in STEM by overall U2 status, FARMS students and minority students reported significantly higher likelihood of participating in STEM activities in the future (small effect sizes).
Most JSHS participants had educational aspirations beyond earning an undergraduate degree after participating in JSHS.	Nearly all R-JSHS students (98%) reported planning to earn a Bachelor's degree, at a minimum, and 80% indicated they intend to earn a master's degree or higher, while 63% reported plans to earn a terminal degree. All N-JSHS participants (100%) reported that they plan to at least earn a Bachelor's degree, and 80% indicated planning to earn at least a master's degree, while 65% reported that they plan to earn a terminal 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; FARMS students, ELL students, and students attending suburban schools reported larger impacts than their peers.	Close to half or more of R-JSHS students (43%-83%) agreed that JSHS contributed to or was primarily responsible for their growth in all areas of program impact. Items for which two-thirds or more of participants reported impact were appreciation of DoD research (65%); interest in participating in STEM activities outside of school requirements (74%); and confidence in STEM knowledge, skills, and abilities (83%).
	Nearly half of R-JSHS students (46%) reported that JSHS had not increased their interest in pursuing a STEM career with the DoD. A third (33%) of R-JSHS students reported that JSHS had not impacted their interest in participating in other AEOPs, their awareness of other AEOPs, and their awareness of DoD STEM research and careers.
	There was no significant difference in impact of JSHS by overall U2 status, however FARMS students, ELL students, and students attending suburban schools reported larger impacts than their peers (small effect sizes).
	Over half of N-JSHS students (51%-92%) reported that JSHS had impacted them in each area about which they were asked. Items for which N-JSHS participants were most likely to indicate that JSHS had an impact were awareness of Army/DoD STEM researcher and careers (92%); appreciation of Army/DoD STEM research (89%); awareness of other AEOPs (82%); and confidence in STEM knowledge, skills, and abilities (81%).

Recommendations for FY20 Program Improvement/Growth

The primary purpose of the AEOP program evaluation is to serve as a vehicle to inform future programming and continuous improvement efforts with the goal of making progress toward the AEOP priorities. 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 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 FY20 and beyond:

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

As in the previous four years, JSHS participation continued to decrease in FY19, declining 16% from FY18 (2,592 compared to 3,069 participants). Previous year participation numbers were 5,577 in FY17, 5,620 in FY16, and 5,829 in FY15. As in FY17 and FY18, we again suggest considering 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.

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

Findings in FY19 indicated slightly more than half of JSHS mentors reported using some of the effective mentoring strategies including attending to different learning styles and highlighting individuals from underserved backgrounds in STEM careers. All other strategies were utilized by more than 60% of mentors, an improvement from FY18. However, it is recommended that JSHS utilize the mentoring strategies toolkit that has been developed for use in the AEOP in FY20.

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

As in FY18, JSHS participants in FY19 reported (58% to 73% depending on program) not having any knowledge of the other AEOPs. Few mentors reported speaking with their students about other AEOPs (3-18% depending on 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 implement a plan of how to better grow mentor and participant awareness of other AEOPs in FY20.