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# Army Educational Outreach Program

Junior Science and Humanities Symposium (JSHS)

# 2017 Annual Program Evaluation Report

## PART 2: Evaluation Findings

May 2018

aeop
ARMY EDUCATIONAL OUTREACH PROGRAM

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# 2 | Table of Contents


| | |
|---|---|
| AEOP Consortium Contacts | Page 1 |
| Table of Contents | Page 2 |
| Introduction | Page 3 |
| Evidence-Based Program Change | Page 9 |
| FY17 Evaluation At-A-Glance | Page 11 |
| Actionable Program Evaluation | Page 21 |
| Outcomes Evaluation | Page 53 |
| Findings & Recommendations | Page 72 |

# 3 | Introduction

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

**AEOP Priorities**

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

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

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

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

## Program Overview

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

1. Chemistry (including geochemistry, energy-alternative fuels, materials science);
2. Engineering;

3. Environmental sciences;
4. Life sciences (including natural sciences, microbiology, molecular/cellular, biochemistry);
5. Mathematics and computer sciences;
6. Medicine & health (including behavioral sciences, neurobiology, biomedical, physiology); and
7. Physics and astronomy.

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 2017. 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 as part of the national competition; the third-place student was invited to display a poster of his/her research in a competitive poster session; and the fourth and fifth place students were invited to attend as student delegates with the option to showcase their research in a non-competitive poster session. The AAS has established guidelines and "Ground rules" for the student research paper competition and provides these guidelines to JSHS regional symposia and other cooperating organizations. These resources allow for a general consistency in student experience and outcome, while still allowing sites the flexibility to design the details of their program to meet the unique needs of their students. All JSHS programs are designed to meet the following objectives:

1. Promote research and experimentation in STEM at the high school level;
2. Recognize the significance of research in human affairs and the importance of humane and ethical principles in the application of research results;
3. Search out talented youth and their teachers, recognize their accomplishments at symposia, and encourage their continued interest and participation in the sciences, mathematics, and engineering;
4. Recognize innovative and independent research projects of youth in regional and national symposia;
5. Expose students to academic and career opportunities in STEM and to the skills required for successful pursuit of STEM;
6. Expose students to STEM careers in the Army and/or DoD laboratories; and
7. Increase the future pool of talent capable of contributing to the national's scientific and technological workforce.

The 47 R-JSHS sites received applications from 8,663 students and were able to accommodate 64% of these (5,577). In FY17, 34 of the 47 R-JSHS used AEOP's centralized application portal to capture 2,435 of its participants. The rest were self-reported by the remaining regions. This represents a 3% decrease in

student applicants since FY16 when 8,947 students applied and a 7% decrease in participants since FY15 when 9,347 students applied. Slightly fewer applicants were selected in FY17 than in FY16, representing a .8% decrease as compared to the 5,620 selected in FY16 and a 4% decrease from the 5,829 selected in FY15. Table 1 summarizes interest and final selection by site.

| Table 1. 2017 JSHS Site Applicant and Selection Numbers | | | |
|---|---|---|---|
| **2017 JSHS Site** | **No. of Student Applicants** | **No. of Selected Students** | **No. of Selected Teachers** |
| Alabama | 220 | 124 | 24 |
| Alaska | 31 | 102 | 2 |
| Arizona | 120 | 112 | 12 |
| Arkansas | 110 | 89 | 11 |
| California No. & W. Nevada | 140 | 27 | 14 |
| California Southern | 200 | 35 | 20 |
| Connecticut | 510 | 419 | 56 |
| Europe | 132 | 64 | 13 |
| Florida | 400 | 347 | 77 |
| Georgia | 170 | 120 | 9 |
| Hawaii | 180 | 88 | 17 |
| Illinois | 49 | 56 | 7 |
| Illinois-Chicago | 120 | 66 | 20 |
| Indiana | 44 | 48 | 4 |
| Intermountain | 110 | 112 | 19 |
| Iowa | 130 | 164 | 31 |
| Kansas-Nebraska-Oklahoma | 100 | 66 | 23 |
| Kentucky | 30 | 29 | 1 |
| Louisiana | 150 | 81 | 15 |
| Maryland | 110 | 56 | 9 |
| Michigan Southeastern | 70 | 25 | 10 |
| Missouri | 120 | 100 | 19 |
| New England Northern | 150 | 76 | 20 |
| New England Southern | 250 | 191 | 14 |
| New Jersey Monmouth | 240 | 191 | 14 |
| New Jersey Rutgers | 300 | 157 | 37 |
| New York Long Island | 370 | 217 | 41 |
| New York Metro | 140 | 206 | 34 |
| New York Upstate | 527 | 501 | 61 |
| North Carolina | 170 | 100 | 19 |
| North Central | 220 | 182 | 22 |
| Ohio | 240 | 156 | 19 |
| Oregon | 24 | 32 | 8 |
| Pacific | 170 | 94 | 14 |
| Pennsylvania | 50 | 53 | 18 |
| Puerto Rico | 150 | 47 | 12 |

| | | | |
|---|---|---|---|
| Philadelphia | 400 | 167 | 17 |
| South Carolina | 426 | 291 | 40 |
| Southwest | 250 | 43 | 20 |
| Tennessee | 110 | 37 | 11 |
| Texas | 260 | 95 | 33 |
| Virginia | 500 | 125 | 13 |
| Washington | 120 | 63 | 8 |
| Washington D.C. | 230 | 145 | 23 |
| West Virginia | 40 | 13 | 3 |
| Wisconsin | 60 | 54 | 8 |
| Wyoming-Eastern Colorado | 20 | 11 | 2 |
| **Total** | **8,663** | **5,577** | **924** |
| National Symposium | | 226 | 74 |

In addition to students, JSHS engaged approximately 3,309 teachers, faculty, graduate students, and support personnel in conducting the symposia including approximately 246 DoD STEM scientists and engineers (S&Es). Table 2 provides an overview of participants by category.

**Table 2. 2017 JSHS Participation**

| Participant Group | No. of Participants |
|---|---|
| High school students (grades 9-12) | 5,577 |
| K-12 teachers | 998 |
| College/university faculty or other personnel | 2,311 |
| Army/DoD Scientists & Engineers | 246 |
| **Total** | **9,132** |

Fourteen regions of the 47 regional symposia provided incomplete demographic information about participants (demographic data missing for 3,108 student participants – 44% of the total population). In the regions that reported gender data, 58% of participants were female and 41% were male. Over half (53%) of students identified themselves as White with another 24% identifying themselves as Asian. While 5% of students chose not to report their race/ethnicity, 6% identified themselves as Black or African American and 7% as Hispanic or Latino. Native American or Alaskan students comprised 2% of student participants and less than 1% of students were Native Hawaiian or Pacific Islanders.

The total cost of the 2017 JSHS program was $2,019,112, including $421,000 provided in scholarships and awards (Table 3). Undergraduate tuition scholarships to winners at the R-JSHS and N-JSHS events are payable to the students' college of enrollment upon matriculation. The average cost per student participant for 2017 JSHS was $362.

| **Table 3. 2017 JSHS Program Costs** | |
|---|---|
| **2017 JSHS – Summative Cost Breakdown** | |
| Administrative Costs (salaries, fringe, indirect, cost share) | $299,732 |
| Regional Site Awards | $747,987 |
| National Program | $497,265 |
| Scholarships and Awards (includes Teacher Awards) | $421,000 |
| Other Operational Costs | $53,129 |
| **Total Cost** | **$2,019,112** |
| **Cost Per Student Participant** | **$362** |

# 4 | Evidence - Based Program Change

The three key priorities for AEOP programs in FY17 were: (1) increase outreach to populations that are historically underserved and underrepresented in STEM; (2) increase participants' awareness of Army/DoD STEM careers; and (3) increase participants' awareness of other AEOP opportunities. AAS took the following actions in the FY17 administration of the JSHS program in light of programmatic recommendations from the Army and LO, the key AEOP priorities, site visits conducted by AAS and the LO, and the FY16 JSHS evaluation study:

**I. Encourage and reward increased student participation in STEM (Priorities 1 and 2)**

a. Continued to grow and expand student participation in JSHS by leveraging the reach of JSHS regional sites to encourage and invite student participation in STEM. R-JSHS used a variety of techniques to reach out to high schools within the geographic area served and invite participation in R-JSHS.
b. Targeted outreach and marketing efforts to high schools, statewide teacher associations, regional and state science fairs, STEM affinity groups, internal and external apprenticeship programs, and collaboration with the network of high schools represented in AEOP programs and among the Consortium partners.
c. AAS developed messaging, webinars, and Outreach Toolkit for regional symposia to communicate best practices, recruitment strategies and timelines.

**II. Expand the participation of underserved populations in STEM (Priority 1)**

a. Coordinated with LO to integrate strategic partners from underserved groups.
b. Shared best practices employed by regions to reach and engage underserved students through routine messaging to Regions, conduct of webinars and resource materials on building partnerships.
c. Encouraged JSHS Regional Symposia to collaborate with internal and external partners which prepare underserved students for success in STEM. Partners included underserved school districts, internal and external programs such as Project Trio, Upward Bound, US 2020, Society for Black Engineers, American Chemical Society's Project SEED, other internship programs.
d. Developed JSHS nominee criteria under the Presidential Scholarship Program to recognize students who achieved high academic success despite challenges or hurdles to success.

**III. Expose students to AEOP/Army STEM careers (Priorities 1 and 3)**

a. Recruited and identified a diverse pool of DoD STEM mentors to participate in Regional and National Symposia and showcase experience in pursuit of a DoD STEM career.
b. Collaborated with the CAM and tri-service sponsors to develop materials which showcase critical areas of STEM of interest to DoD.
c. Collaborated with the AEOP Marketing team to obtain AEOP printed materials and collateral to distribute at regional and national levels.
d. Collaborated with the AEOP Alumni team to create profiles on JSHS Alumni and share their experiences with JSHS and DoD STEM careers. Distributed DoD STEM career brochure to R-JSHS.

**IV. Expand cross-marketing and outreach for JSHS to include other AEOPs. (Priorities 2 and 3)**

a. Collaborated with the Apprenticeship Program to inform apprentices and invite participation in JSHS.
b. Incentivized students through publicizing JSHS scholarship opportunities and other benefits available to participating students.
c. Collaborated with Widmeyer, CAM and IPA's to distribute a call to JSHS constituents to apply or volunteer across AEOP programs.

V. **Market JSHS to teachers and high schools to effectively communicate relationship to science standards that prepare students for 21st century skills. (Priority 2)**

a. Developed and distributed an Outreach Toolkit to support regions in recruiting participation by high schools and teachers.
b. Identified innovative strategies employed by JSHS Regional Symposia to increase participation.
c. Developed a new interactive JSHS website to publicize products, instructional tools and workshops at R-JSHS level to assist teachers in the implementation of STEM research in the classroom and out-of-school activities.

# 5 | Evaluation At-A-Glance

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

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

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

**Key Evaluation Questions**

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

| Table 4. 2017 Student Questionnaires | |
|---|---|
| **Category** | **Description** |
| Profile | **Demographics:** Participant gender, age, grade level, race/ethnicity, and socioeconomic status indicators |
| | **Education Intentions:** Degree level, confidence to achieve educational goals, field sought |
| AEOP Goal 1 | **Capturing the Student Experience:** In-school vs. In-program experience; mentored research experience and products (students) |
| | **STEM Competencies:** Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP |
| | **Transferrable Competencies:** Gains in 21st Century Skills |
| | **STEM Identity:** Gains in STEM identity, intentions to participate in STEM, and STEM-oriented education and career aspirations; contribution of AEOP |
| | **Future STEM Engagement:** Gains in interest/intent for future STEM engagement (informal activities, education, career) |
| | **AEOP Opportunities:** Past participation, awareness of, and interest in participating in other AEOP programs; contribution of AEOP, impact of AEOP resources |
| | **Army/DoD STEM:** Exposure to Army/DoD STEM jobs, attitudes toward Army/DoD STEM research and careers, change in interest for STEM and Army/DoD STEM jobs; contribution of AEOP, impact of AEOP resources |
| AEOP Goal 2 and 3 | **Mentor Capacity:** Perceptions of mentor/teaching strategies (students respond to a subset) |
| | **Comprehensive Marketing Strategy:** How students learn about AEOP, motivating factors for participation, impact of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers |
| | **Program Specific Online Resources:** Usefulness of online resources for participating in AEOP |
| Satisfaction & Suggestions | Benefits to participants, suggestions for improving programs, overall satisfaction |

| Table 5. 2017 Mentor Questionnaires | |
|---|---|
| **Category** | **Description** |
| Profile | **Demographics:** Participant gender, race/ethnicity, occupation, past participation |
| Satisfaction & Suggestions | Awareness of JSHS, motivating factors for participation, satisfaction with and suggestions for improving JSHS programs, benefits to participants |
| AEOP Goal 1 | **Capturing the Student Experience:** In-program experience |
| | **STEM Competencies:** Gains in Knowledge of STEM, Science & Engineering Practices; contribution of AEOP |
| | **Transferrable Competencies:** Gains in 21st Century Skills |
| | **AEOP Opportunities:** Past participation, awareness of other AEOP programs; efforts to expose students to AEOPs, impact of AEOP resources on efforts; contribution of AEOP in changing student AEOP metrics |
| | **Army/DoD STEM:** attitudes toward Army/DoD STEM research and careers, efforts to expose students to Army/DoD STEM research/careers, impact of AEOP resources on efforts; contribution of AEOP in changing student Army/DoD career metrics |
| AEOP Goal 2 and 3 | **Mentor Capacity:** Perceptions of mentor/teaching strategies |
| | **Comprehensive Marketing Strategy:** How mentors learn about AEOP, usefulness of AEOP resources on awareness of AEOPs and Army/DoD STEM research and careers |
| | **Program Specific Online Resources:** Usefulness of online resources for supporting students in participating in AEOP |

| Table 6. 2017 Student Focus Groups | |
|---|---|
| **Category** | **Description** |
| Profile | Gender, race/ethnicity, grade level, past participation in JSHS, past participation in other AEOP programs |
| Satisfaction & Suggestions | Motivating factors for participation, satisfaction with and suggestions for improving JSHS programs, benefits to participants |
| AEOP Goal 1 and 2 Program Efforts | **Army STEM: AEOP Opportunities –** Extent to which students were exposed to other AEOP opportunities |
| | **Army STEM: Army/DoD STEM Careers –** Extent to which students were exposed to STEM and Army/DoD STEM jobs |

| Table 7. 2017 Mentor Focus Groups | |
|---|---|
| **Category** | **Description** |
| Profile | Gender, race/ethnicity, occupation, organization, role in JSHS, past participation in JSHS, past participation in other AEOP programs |
| Satisfaction & Suggestions | Perceived value of JSHS, benefits to participants suggestions for improving JSHS programs |
| AEOP Goal 1 and 2 Program Efforts | **Army STEM: AEOP Opportunities –** Efforts to expose students to AEOP opportunities |
| | **Army STEM: Army/DoD STEM Careers –** Efforts to expose students to STEM and Army/DoD STEM jobs |
| | **Mentor Capacity: Local Educators –** Strategies used to increase diversity/support diversity in JSHS |

| Table 8. 2017 Annual Program Report | |
|---|---|
| **Category** | **Description** |
| Program | Description of symposia categories and activities |
| AEOP Goal 1 and 2 Program Efforts | **Underserved Populations:** mechanisms for marketing to and recruitment of students from underserved populations |
| | **Army STEM: Army/DoD STEM Careers –** Exposure to Army STEM research and careers (varies by regional, national event); Participation of Army engineers and/or Army research facilities in event activities (varies by regional, national event) |
| | **Mentor Capacity: Local Educators -** University faculty and student involvement, teacher involvement |

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

## Study Sample

Questionnaire responses were received from students participating in the national competition, students from 40 of the 47 regional competitions, and mentors from 34 of the 47 regional sites. Mentors completed the mentor questionnaire once for all students they mentored, whether the students advanced to N-JSHS or not, and therefore their responses do not distinguish between R-JSHS and N-JSHS. Table 9 shows the number of student and mentor respondents by site.

| Table 9. JSHS Participants and Respondents by Site | | | | | | |
|---|---|---|---|---|---|---|
| **2017 JSHS Site** | **R-JSHS Students** | | **N-JSHS Students** | | **Mentors (Teachers & Other Adults)** | |
| | **No. of Participants** | **No. of Survey Respondents†** | **No. of Participants** | **No. of Survey Respondents** | **No. of Participants** | **No. of Survey Respondents†** |
| Alabama | 124 | 5 | 5 | 1 | 54 | 3 |
| Alaska | 102 | 11 | 5 | 2 | 73 | 12 |
| Arizona | 112 | 0 | 5 | 1 | 36 | 0 |
| Arkansas | 89 | 4 | 5 | 2 | 37 | 3 |
| California No. & W. Nevada | 27 | 3 | 5 | 1 | 33 | 0 |
| California Southern | 35 | 4 | 3 | 2 | 40 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Connecticut | 419 | 19 | 5 | 2 | 161 | 14 |
| Europe | 64 | 18 | 5 | 2 | 20 | 0 |
| Florida | 347 | 0 | 5 | 1 | 397 | 0 |
| Georgia | 120 | 18 | 4 | 2 | 99 | 4 |
| Hawaii | 88 | 0 | 5 | 2 | 54 | 32 |
| Illinois | 56 | 1 | 5 | 1 | 41 | 0 |
| Illinois-Chicago | 66 | 8 | 5 | 1 | 25 | 3 |
| Indiana | 48 | 28 | 5 | 1 | 13 | 4 |
| Intermountain | 112 | 50 | 3 | 1 | 156 | 4 |
| Iowa | 164 | 9 | 1 | 1 | 48 | 10 |
| Kansas-Nebraska-Oklahoma | 66 | 11 | 5 | 1 | 88 | 2 |
| Kentucky | 29 | 19 | 6 | 2 | 12 | 6 |
| Louisiana | 81 | 1 | 5 | 2 | 27 | 5 |
| Maryland | 56 | 30 | 4 | 2 | 81 | 4 |
| Michigan | 25 | 0 | 5 | 2 | 47 | 1 |
| Missouri | 100 | 10 | 5 | 2 | 63 | 7 |
| New England Northern | 76 | 17 | 3 | 1 | 40 | 2 |
| New England Southern | 191 | 31 | 0 | 0 | 34 | 12 |
| New Jersey Southern | 191 | 11 | 0 | 0 | 30 | 1 |
| New Jersey Rutgers | 157 | 14 | 5 | 6 | 119 | 10 |
| New York Long Island | 217 | 13 | 5 | 3 | 169 | 4 |
| New York Metro | 206 | 3 | 5 | 2 | 160 | 2 |
| New York Upstate | 501 | 8 | 5 | 2 | 133 | 4 |
| North Carolina | 100 | 7 | 5 | 1 | 68 | 5 |
| North Central | 182 | 7 | 4 | 0 | 94 | 3 |
| Ohio | 156 | 79 | 5 | 3 | 96 | 12 |
| Oregon | 32 | 1 | 5 | 1 | 18 | 0 |
| Pacific | 94 | 0 | 6 | 2 | 34 | 0 |
| Pennsylvania | 53 | 14 | 5 | 2 | 73 | 5 |
| Philadelphia | 47 | 6 | 6 | 0 | 44 | 7 |
| Puerto Rico | 167 | 32 | 5 | 2 | 42 | 4 |
| South Carolina | 291 | 1 | 5 | 1 | 158 | 8 |
| Southwest | 43 | 2 | 6 | 2 | 40 | 4 |
| Tennessee | 37 | 0 | 5 | 2 | 25 | 0 |
| Texas | 95 | 2 | 4 | 1 | 74 | 10 |
| Virginia | 125 | 28 | 5 | 2 | 56 | 8 |
| Washington | 63 | 1 | 5 | 0 | 47 | 1 |
| Washington D.C. | 145 | 18 | 5 | 2 | 67 | 6 |
| West Virginia | 13 | 1 | 5 | 1 | 13 | 0 |
| Wisconsin | 54 | 0 | 4 | 1 | 18 | 9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Wyoming-Eastern Colorado | 11 | 6 | 0 | 0 | 14 | 3 |
| **Total** | **5,577** | **559** | **226** | **65** | **3,271** | **234** |

† Large numbers of respondents (over 50%) did not provide a response to the survey item asking them to indicate their JSHS region.

Table 10 provides an analysis of student and mentor participation in the JSHS questionnaires, the response rate, and the margin of error at the 95% confidence level (a measure of how representative the sample is of the population). The margin of error for the regional student survey is within an acceptable range although the margins of error for mentor surveys and for national student surveys are larger than generally acceptable, indicating that the samples may not be representative of these populations.

**Table 10. 2017 JSHS Questionnaire Participation**

| Participant Group | Respondents (Sample) | Total Participants (Population) | Participation Rate | Margin of Error @ 95% Confidence[1] |
|---|---|---|---|---|
| R-JSHS Students | 559 | 5,577 | 9.63% | ±3.94% |
| N-JSHS Students | 65 | 226 | 28.76% | ±10.28% |
| Mentors | 262 | 3301 | 7.94% | ±5.81% |

Focus groups were conducted at Ohio R-JSHS and at N-JSHS. Two student focus groups were conducted at R-JSHS and two student focus groups were also completed at the N-JSHS. The four student focus groups included 36 students (19 females, 17 males). One mentor focus group was conducted at R-JSHS and one was conducted at N-JSHS. The mentor focus groups included 14 mentors (12 females, 2 males). 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 illustrates the demographic information provided by FY17 JSHS questionnaire respondents. More females than males completed the questionnaire in FY17 (59% female, 41% male), with gender

[1] "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.

distribution for respondents similar to that in FY16 (female 60%; male 40%). Also, similar to FY16, among R-JSHS respondents, more students identified with the race/ethnicity category of White 55% (compared to 54% in FY16) than any other single race/ethnicity category. However, there continued to be substantial representation of Asian (29%) and Hispanic or Latino (9%) populations. Over a third of respondents (35%) were rising 12th graders in FY17 (up from 31% in 2016). Rising college freshmen were the second largest R-JSHS group (33% of respondents). Table 12 shows that a majority of respondents at regionals attended public schools (82%). Finally, more than half of the participants in the survey attended schools in suburban areas (52%).

Since 14 of the 47 regional symposia provided incomplete demographic information for participants JSHS demographic data, it is difficult to make any strong comparisons between the survey respondent group and actual program participation. Available data suggests, however, that survey respondents who provided demographic information are similar to the overall population of enrolled students for whom data is available in terms of gender and racial ethnicity, although the survey sample data varied somewhat from the demographic data for the overall population of enrolled students. For example, the survey sample contained slightly more females (60% of respondents as compared 58% of enrolled students), White students (55% of respondents as compared to 53% of enrolled students), and Asian students (29% of respondents as compared to 24% of enrolled students), and slightly fewer Black or African American students (3% of respondents as compared to 6% of enrolled students).

†Other = Trinidadian; Arab; Hispanic and African American; Mixed (black and white); Black and white

**Table 11. 2017 R-JSHS Student Respondent Profile**

| Demographic Category | R-JSHS Questionnaire Respondents | |
|---|---|---|
| Female | 324 | 59% |
| Male | 227 | 41% |
| Asian | 158 | 29% |
| Black or African American | 18 | 3% |
| Hispanic or Latino | 48 | 9% |
| Native American or Alaska Native | 2 | 0% |
| Native Hawaiian or Other Pacific Islander | 1 | 0% |
| White | 304 | 55% |
| Other race or ethnicity (specify):† | 20 | 4% |
| 9th | 41 | 7% |
| 10th | 121 | 22% |
| 11th | 195 | 35% |
| 12th | 182 | 33% |
| 1st Year College Student | 1 | 0% |

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

**Table 12. 2017 R-JSHS Student Respondent School Information**

| Demographic Category | R-JSHS Questionnaire Respondents | |
|---|---|---|
| Suburban | 195 | 52% |
| Urban (city) | 125 | 33% |
| Rural (country) | 48 | 13% |
| Frontier or tribal school | 0 | 0% |
| Public school | 450 | 82% |
| Private school | 78 | 14% |
| Department of Defense school (DoDDS or DoDEA) | 18 | 3% |

The highest level of competition students reported achieving in 2017 is illustrated in Table 13. 21% of responding R-JSHS students participated in non-presenting roles (student delegate/observer), whereas 100% of responding N-JSHS students participated in presenting roles. The distribution of respondents' participation at R-JSHS and N-JSHS are aligned with the focus of each level of competition. In particular, 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. 2017 JSHS Student Respondent Roles | | |
|---|---|---|
| **Highest Level of Competition Achieved in 2016** | **R-JSHS Questionnaire Respondents (n = 550)** | **N-JSHS Questionnaire Respondents (n = 65)** |
| Oral presenter | 50% | 60% |
| Poster presenter | 29% | 40% |
| Non-presenting participant | 16% | 0% |
| Non-competitive poster presenter | 5% | 0% |

### *Past Program Participation*

R-JSHS participants were asked to report on their past participation in other AEOPs in the participant questionnaire (Table 14). Over a quarter (27%) of respondents indicated that they had previously participated in JSHS while 2% had participated in eCybermission, 4% in Camp Invention, 15% in other STEM programs. Slightly over half (51%) reported that they had never participating in any other AEOP initiatives other than JSHS. One student reported having participated in GEMS and one in SEAP previously (0.24%). Similarly, N-JSHS participants were asked to report their past participation. Three had participated in eCybermission (3%) and one in Camp Invention (1%).

**Table 14. R-JSHS Participant Past AEOP Participation (n = 393)**

| | Response Percent | Response Total |
|---|---|---|
| Camp Invention | 4.00 % | 17 |
| eCYBERMISSION | 2.12 % | 9 |
| Junior Solar Sprint (JSS) | 0.24 % | 1 |
| Gains in the Education of Mathematics and Science (GEMS) | 0.24 % | 1 |
| UNITE | 0.00 % | 0 |
| Junior Science & Humanities Symposium (JSHS) | 26.59 % | 113 |
| Science & Engineering Apprenticeship Program (SEAP) | 0.24 % | 1 |
| Research & Engineering Apprenticeship Program (REAP) | 0.24 % | 1 |
| High School Apprenticeship Program (HSAP) | 0.00 % | 0 |
| College Qualified Leaders (CQL) | 0.00 % | 0 |
| Undergraduate Research Apprenticeship Program (URAP) | 0.00 % | 0 |
| Science Mathematics & Research for Transformation (SMART) College Scholarship | 0.00 % | 0 |
| I've never participated in any AEOP programs | 51.06 % | 217 |
| Other STEM Program | 15.29 % | 65 |

## Mentor Demographics

Table 15 summarizes demographics for mentors responding to the FY17 mentor questionnaire. In regard to gender and survey participation, JSHS experienced a slight decrease in the percentage of female mentors for FY17 (60%) compared to FY16 (63%). Accordingly, the percentage of male mentors responding to the questionnaire increased in FY17 to 39%. Responding mentors were predominantly White (70%), although 7 (3%) Black or African American mentors and 18 (7%) Hispanic or Latino mentors responded, a significant increase over FY16 participation by these groups. Likewise, 14% of mentor respondents were Asian in FY17, up from 12% in FY16. Most of the mentors identified as teachers (63%) or research mentors (31%). There were 79 mentor respondents who identified themselves as professionals in science, engineering, or mathematics, compared to 5 in FY16.

| Table 15. 2017 JSHS Mentor Respondent Profile | | |
|---|---|---|
| **Demographic Category** | **Questionnaire Respondents** | |
| **Respondent Gender (n = 258)** | | |
| Female | 154 | 60% |
| Male | 100 | 39% |
| Choose not to report | 4 | 2% |
| **Respondent Race/Ethnicity (n = 258)** | | |
| Asian | 35 | 14% |
| Black or African American | 7 | 3% |
| Hispanic or Latino | 18 | 7% |
| Native American or Alaska Native | 1 | 1% |
| Native Hawaiian or Other Pacific Islander | 1 | 1% |
| White | 180 | 70% |
| Other race or ethnicity, (specify):[†] | 5 | 2% |
| Choose not to report | 11 | 4% |
| **Respondent Occupation (n = 258)** | | |
| Teacher | 163 | 63% |
| Other school staff | 6 | 2% |
| University educator | 19 | 7% |
| Scientist, Engineer, or Mathematician in training (undergraduate or graduate student, etc.) | 6 | 2% |
| Scientist, Engineer, or Mathematics professional | 33 | 13% |
| Other, (specify)[‡] | 31 | 12% |
| **Respondent Role in JSHS (n = 254)** | | |
| Research Mentor | 79 | 31% |
| Competition advisor | 21 | 8% |
| Other, (specify)[§] | 43 | 17% |
| Teacher | 152 | 60% |
| Invited Speaker | 5 | 2% |
| Judge | 41 | 16% |

[†] No responses provided.

# 6 | Actionable Program Evaluation

Actionable Program Evaluation is intended to provide assessment and evaluation of program processes, resources, and activities for the purpose of recommending improvements as the program moves forward. This section highlights information outlined in the Satisfaction & Suggestions sections of Tables 4-9. A focus of the Actionable Program Evaluation is efforts toward the long-term goal of JSHS and all of the AEOP to increase and diversify the future pool of talent capable of contributing to the nation's scientific and technology progress. JSHS regional symposia are engaged in outreach efforts to identify underrepresented populations who are capable of succeeding in JSHS. Thus, it is important to consider how JSHS is marketed and ultimately recruits student participants, the factors that motivate students to participate in JSHS, participants' perceptions of and satisfaction with activities, what value participants place on program activities, and what recommendations participants have for program improvement. The following sections report student and mentor perceptions that pertain to current programmatic efforts and recommend evidence-based improvements to help JSHS achieve outcomes related to AEOP programs and objectives—specifically, to help JSHS continue to expand participation from and support STEM education for students from underrepresented groups.

## Marketing and Recruiting Underrepresented and Underserved Populations

JSHS regional symposia engage in outreach activities specifically targeted to recruiting populations underrepresented in STEM careers. These efforts are largely developed and implemented at a local level. Strategies that JSHS employed in FY17 included:

- Coordinated with LO to integrate strategic partners from underrepresented groups.
- Shared best practices employed by regions to reach and engage underrepresented students through routine messaging to Regions, conduct of webinars and resource materials on building partnerships.
- Encouraged JSHS Regional Symposia to collaborate with internal and external partners which prepare underrepresented students for success in STEM. Partners included underrepresented school districts, internal and external programs such as Project Trio, Upward Bound, US 2020, Society for Black Engineers, American Chemical Society's Project SEED, other internship programs.

R-JSHS participants were asked how they learned about JSHS (Table 16). More than a third (35%) of participants indicated they learned about JSHS/AEOP from someone who works at the school or university they attend. The second highest reported means of learning about JSHS was a school or university newsletter, email, or website (22%) followed by a past participant of the program (14%). From 4-7% of respondents learned about the program through the AEOP website (3%), a friend (6%), or a family member (5%). These findings suggest that disseminating information to teachers and schools

continues to be the most effective means of recruiting students. Note – participants and mentors could select more than one response on this item.

**Table 16. How R-JSHS Participants Learned About JSHS/AEOP (n = 393)**

| | Response Percentage | Response Total (508) |
|---|---|---|
| Army Educational Outreach Program (AEOP) Website | 4.13 % | 21 |
| AEOP on Facebook, Twitter, Instagram, or other social media | 0.59 % | 3 |
| School or university newsletter, email, or website | 21.85 % | 111 |
| Past participant of program | 14.37 % | 73 |
| Friend | 6.10 % | 31 |
| Family Member | 5.12 % | 26 |
| Someone who works at the school or university I attend | 34.84 % | 177 |
| Someone who works with the program | 1.57 % | 8 |
| Someone who works with the Department of Defense (Army, Navy, Air Force, etc.) | 0.39 % | 2 |
| Community group or program | 1.18 % | 6 |
| Choose Not to Report | 9.84 % | 50 |

Mentors were also asked how they learned about JSHS (Table 17). The most frequently chosen responses were personal contacts, including a past JSHS participant (35%), someone who works at their school or university (18%), or a school or university newsletter, email, or website (16%).

**Table 17. How JSHS Mentors Learned about JSHS/AEOP (n = 143)**

| | Response Percentage | Response Total (172) |
|---|---|---|
| Army Educational Outreach Program (AEOP) Website | 2.91 % | 5 |
| AEOP on Facebook, Twitter, Instagram, or other social media | 0.00 % | 0 |
| School or university newsletter, email, or website | 16.28 % | 28 |
| Past participant of program | 34.88 % | 60 |
| Friend | 4.07 % | 7 |
| Family Member | 1.16 % | 2 |
| Someone who works at the school or university I attend | 18.02 % | 31 |
| Someone who works with the program | 10.47 % | 18 |
| Someone who works with the Department of Defense (Army, Navy, Air Force, etc.) | 1.16 % | 2 |
| Community group or program | 0.58 % | 1 |
| Choose Not to Report | 10.47 % | 18 |

## Factors Motivating Student Participation

When asked about their motivations for participating in JSHS, students indicated that they chose to participate for a variety of reasons. Table 18 shows that the top two motivating factors were interest in STEM (11%) and the desire to learn something new (9%) followed closely by the encouragement of a teacher (8%). Note – participants could select more than one response on this item.

**Table 18. Factors Motivating Student Participation in R-JSHS (n = 393)**

| | Response Percentage | Response Total (2,873) |
|---|---|---|
| Teacher or professor encouragement | 8.32 % | 239 |
| An academic requirement or school grade | 2.51 % | 72 |
| Desire to learn something new or interesting | 9.47 % | 272 |
| The mentor(s) | 1.88 % | 54 |
| Building college application or résumé | 5.81 % | 167 |
| Networking opportunities | 4.42 % | 127 |
| Interest in STEM | 10.62 % | 305 |
| Interest in STEM careers with the Army | 1.74 % | 50 |
| Having fun | 7.69 % | 221 |
| Earning stipends or awards for doing STEM | 3.69 % | 106 |
| Opportunity to do something with friends | 3.03 % | 87 |
| Opportunity to use advanced laboratory technology | 4.59 % | 132 |
| Desire to expand laboratory or research skills | 7.21 % | 207 |
| Learning in ways that are not possible in school | 6.79 % | 195 |
| Serving the community or country | 3.83 % | 110 |
| Exploring a unique work environment | 4.77 % | 137 |
| Figuring out education or career goals | 5.85 % | 168 |
| Seeing how school learning applies to real life | 4.87 % | 140 |
| Recommendations of past participants | 2.47 % | 71 |
| Choose Not to Report | 0.45 % | 13 |

N-JSHS participants indicated very similar reasons for participating in JSHS. Responses included, for example:

- I felt participating in JSHS would be a great opportunity to present my research to experienced individuals in research fields and to receive feedback.
- I found an ad for this on Google and thought it would be a great way to learn more about science.
- I learned about JSHS from the science teacher at my school. I decided to participate because I thought it would be a good resume builder.

- I learned about JSHS through my high school research program, and wanted to be exposed to ideas and science research at a national level. I loved the opportunity to listen to people's projects, and present my own as well.
- I learned about JSHS through my science research course, and I participated for the experience and opportunity.

## The JSHS Experience

R-JSHS students were asked to respond to several questionnaire items asking about the nature of their experiences in JSHS and how those experiences compared to their STEM learning opportunities in school. When asked what field their JSHS experience focused on, a majority of students selected science (62%); engineering (13%) was the next most frequently chosen focus, followed by integrated STEM (more than one content area) (9%), engineering (13%), technology (4%), and mathematics (2%).

As Table 19 indicates, 42% of regional students indicated that they designed their entire project on their own. Slightly over a quarter (26%) of regional students indicated that they worked with their mentor to design a project. The remaining students reported working with their mentor and research team to design a project (12%), having a choice among various projects suggested by their mentor (7%) or being assigned a project by their mentor (5%).

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

**Table 19. Participant Input on the Design of Their Project (n = 545)**

| | Response Percent | Response Total |
|---|---|---|
| I did not have a project | 7.71 % | 42 |
| I was assigned a project by my mentor | 5.14 % | 28 |
| I worked with my mentor to design a project | 26.06 % | 142 |
| I had a choice among various projects suggested by my mentor | 6.79 % | 37 |
| I worked with my mentor and members of a research team to design a project | 12.11 % | 66 |
| I designed the entire project on my own | 42.20 % | 230 |

Table 20 provides R-JSHS student responses about their participation in research groups. Most students worked alone (or alone with their research mentor) on their projects (60%). Very few students (7%) reported working with a group on the same project or working on a project alone that was closely related to projects of others in their group (3%). Some reported working in a shared laboratory/space with others, but on different projects (19%), or worked alone but met with others regularly to discuss their projects (10%).

**Table 20. Student Participation in Research Groups (n = 439)**

| | Response Percent | Response Total |
|---|---|---|
| I worked alone (or alone with my research mentor) | 60.36 % | 332 |
| I worked with others in a shared laboratory or other space, but we work on different projects | 19.27 % | 106 |
| I worked alone on my project and I met with others regularly for general reporting or discussion | 9.82 % | 54 |
| I worked alone on a project that was closely connected with projects of others in my group | 3.45 % | 19 |
| I work with a group who all worked on the same project | 7.09 % | 39 |

Table 21 illustrates how students disseminated their research during their JSHS experience. A large majority (80%) of R-JSHS students reported that they had attended a symposium or conference. Likewise, most R-JSHS participants reported presenting a talk or poster to other students or faculty (72%). Additionally, 56% reported presenting a talk or poster at a professional symposium or conference (compared to 23% in FY16). It should be noted that students may have selected any of these three responses to indicate their participation in regional JSHS symposia. Some participants also reported winning an award or scholarship based on their research (28%). Several reported plans to disseminate their research through research journals (11%), through technical paper or patents (5%), while others had already published their work in research journals (11%) and through technical papers or patents (9%).

**Table 21. Students Engagement with Research Dissemination Activities During R-JSHS (n = 441)**

| | Response Percent | Response Total |
|---|---|---|
| I presented a talk or poster to other students or faculty | 71.82 % | 395 |
| I presented a talk or poster at a professional symposium or conference | 55.82 % | 307 |
| I attended a symposium or conference | 79.64 % | 438 |
| I wrote or co-wrote a paper that was/will be published in a research journal | 10.55 % | 58 |
| I wrote or co-wrote a technical paper or patent | 8.91 % | 49 |
| I will present a talk or poster to other students or faculty | 27.82 % | 153 |
| I will present a talk or poster at a professional symposium or conference | 21.82 % | 120 |
| I will attend a symposium or conference | 26.55 % | 146 |
| I will write or co-write a paper that was/will be published in a research journal | 11.09 % | 61 |
| I will write or co-write a technical paper or patent | 4.55 % | 25 |
| I won an award or scholarship based on my research | 28.36 % | 156 |

Increasing both the number and diversity of students who pursue STEM careers is one goal of the AEOP, and therefore, the questionnaire included an item that measured students' exposure to these careers. In particular, the R-JSHS student questionnaire asked participants to report how many STEM jobs/careers in general as well as DoD STEM jobs/careers they learned about during their R-JSHS experience. Table 22 illustrates that nearly 85% of R-JSHS students had learned about at least one STEM job or career in JSHS (an increase from FY16 when 78% had learned about one STEM job or career), with 27% reporting learning about five or more (up from 21% in FY16). In contrast, many fewer participants learned about DoD STEM jobs/careers overall (Table 23). Slightly over half (51%) of participants reported that they learned about at least one DoD STEM job/career, while 49% had not learned about even one (a decrease from FY16 when 60% had not learned about any DoD STEM jobs or careers). Only 12% of respondents reported learning about five or more jobs. This is an area in which JSHS should continue to invest. FY17 showed noticeable increases in students learning about both general STEM and DoD-specific STEM jobs and careers, suggesting that JSHS efforts in previous years have been somewhat successful in increasing students' exposure to DoD STEM jobs and careers.

**Table 22. Number of STEM Jobs/Careers Students Learned About During R-JSHS (n =540)**

| Number of STEM Jobs/Careers | Response Percent | Response Total |
|---|---|---|
| None | 15.37 % | 83 |
| One job | 10.37 % | 56 |
| Two jobs | 18.33 % | 99 |
| Three jobs | 20.00 % | 108 |
| Four jobs | 9.07 % | 49 |
| Five or more | 26.85 % | 145 |

**Table 23. Number of Department of Defense (DoD) STEM Jobs/Careers Learned About During R-JSHS (n = 550)**

| Number of DoD STEM Jobs/Careers | Response Percent | Response Total |
|---|---|---|
| None | 49.27 % | 271 |
| One job | 13.45 % | 74 |
| Two jobs | 13.45 % | 74 |
| Three jobs | 9.64 % | 53 |
| Four jobs | 2.55 % | 14 |
| Five or more | 11.64 % | 64 |

The N-JSHS student questionnaire also asked participants to report how many STEM jobs/careers in general as well as DoD STEM jobs/careers they learned about during their N-JSHS experience. Tables 24 and 25 show the responses. Most notable is that over 60% of students learned about 5 or more jobs/careers in both STEM and DoD-specific STEM. All N-JSHS reported learning about at least one DoD STEM job or career, while only three students (5%) reported learning about no general STEM jobs or careers.

**Table 24. Number of STEM Jobs/Careers Students Learned About During N-JSHS (n =63)**

| Number of STEM Jobs/Careers | Response Percent | Response Total |
|---|---|---|
| None | 4.8 % | 3 |
| One job | 3.2 % | 2 |
| Two jobs | 9.5 % | 6 |
| Three jobs | 9.5 % | 6 |
| Four jobs | 11.1 % | 7 |
| Five or more | 61.9 % | 39 |

**Table 25. Number of Department of Defense (DoD) STEM Jobs/Careers Learned About During N-JSHS (n = 64)**

| Number of DoD STEM Jobs/Careers | Response Percent | Response Total |
|---|---|---|
| None | 0.0 % | 0 |
| One job | 3.1 % | 2 |
| Two jobs | 10.9 % | 7 |
| Three jobs | 20.3 % | 13 |
| Four jobs | 4.7 % | 3 |
| Five or more | 60.9 % | 39 |

Table 26 summarizes the reported impact of resources on R-JSHS student awareness of DoD STEM Careers. The resource that had the most reported impact was actual participation in JSHS (17% of responses). The JSHS mentors and invited speakers (9% of responses for each) were also reported as influencing awareness of STEM. AEOP electronic and print efforts (websites, social media, brochure, magazine) had the least impact of all resources, with large percentages of students reporting that they had not experienced resources such as the AEOP website (87%), AEOP on social media (89%), or the It Starts Here! magazine (92%).

**Table 26. Impact of Resources on R-JSHS Student Awareness of DoD STEM Careers (n=548)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Army Educational Outreach Program (AEOP) website** | 70.6% | 6.4% | 7.2% | 6.1% | 9.7% | |
| | 384 | 35 | 39 | 33 | 53 | **544** |
| **AEOP on Facebook, Twitter, Pinterest or other social media** | 79.8% | 6.5% | 3.9% | 3.0% | 6.9% | |
| | 430 | 35 | 21 | 16 | 37 | **539** |
| **AEOP brochure** | 66.7% | 6.3% | 13.1% | 5.3% | 8.7% | |
| | 362 | 34 | 71 | 29 | 47 | **543** |
| **My JSHS mentor(s)** | 43.1% | 16.0% | 16.2% | 9.4% | 15.3% | |
| | 234 | 87 | 88 | 51 | 83 | **543** |
| **Presentations or information shared at the JSHS competition** | 28.3% | 10.7% | 23.0% | 17.3% | 20.8% | |
| | 154 | 58 | 125 | 94 | 113 | **544** |
| **Participation in JSHS** | 23.3% | 11.6% | 23.0% | 18.6% | 23.5% | |
| | 127 | 63 | 125 | 101 | 128 | **544** |
| **Invited speakers at JSHS** | 29.4% | 14.1% | 20.2% | 14.6% | 21.7% | |
| | 159 | 76 | 109 | 79 | 117 | **540** |

To further explore students' exposure to STEM career opportunities in the DoD, student participants in the focus groups were asked whether they had learned about these opportunities during JSHS. R-JSHS students responded that that they had not learned about STEM jobs/careers with the DoD in R-JSHS. One respondent noted that "advertising and emphasizing more of the army's hand in this might be a little bit better" (R-JSHS student). N-JSHS focus group responses indicated that these students had more exposure to STEM career opportunities at N-JSHS. They reported hearing about these careers in part through tours, lunch, dinners, reverse science fair, keynote speakers, and exhibits. For instance:

- "To us, our tour guide was a photographer for the Navy. That was really cool."
- "There was information at the AOP booth. The Army Outreach Program."
- "I didn't realize there were so many science and STEM opportunities in the Navy or Army or Air Force."
- "Honestly, my favorite part, outside the presenting part itself, was when we got to see all the boards in the room, wherever that is, down there, from the different people involved with the DOD."

- “I also had no idea about all of these positions for research inside the DoD because when you think of defense you think of active military. “
- “We all assume certain things of the Army, Navy, Air Force and forget about the technical, the brain power that has to go into making all that happen. I learned a lot about that from a lot of the keynote speakers. The guy today was a cognitive scientist, and he worked for the Air Force. What? That doesn't even make sense, but it certainly does make a lot more sense now, and I learned a lot from the keynote speakers, and also why the Department of Defense budget is so big. That makes a little bit more sense now too. In terms of being interested in a position, more than anything it gives me a bit of reassurance that you don't have to just do lab work or be a professor if you want to do science.”
- “I definitely didn't know there were as many lab positions. I knew there were more technical engineering positions in the Army, military and all the branches but definitely not as much of the biological and chemical sciences.”

Table 27 shows students’ responses when asked about the frequency with which they participate in STEM activities while in school and Table 28 reports on students’ reports of participating in the same activities in JSHS. Participants indicated that they participated in STEM activities more frequently in JSHS than in school in nearly all areas. For example, 61% of participants indicated that they worked with a STEM researcher or company on a real-world STEM project at least once in JSHS while only 49% of respondents indicated having this experience in school. Likewise, over half (54%) of respondents reported solving real world problems at least monthly while in JSHS while fewer (48%) reported having this experience regularly in school. It is important to note, however, that these data may not entirely reflect the impact of JSHS as compared to typical school experiences since R-JSHS students may have participated in JSHS as a part of a school class. The fact that nearly a quarter of N-JSHS students participated in this way suggests that it may be useful to ask a similar question of R-JSHS participants or to rephrase the questionnaire item to better reflect students’ school experiences outside of their JSHS participation.

**Table 27. Nature of Student Activities in School for R-JSHS Respondent (n= 546)**

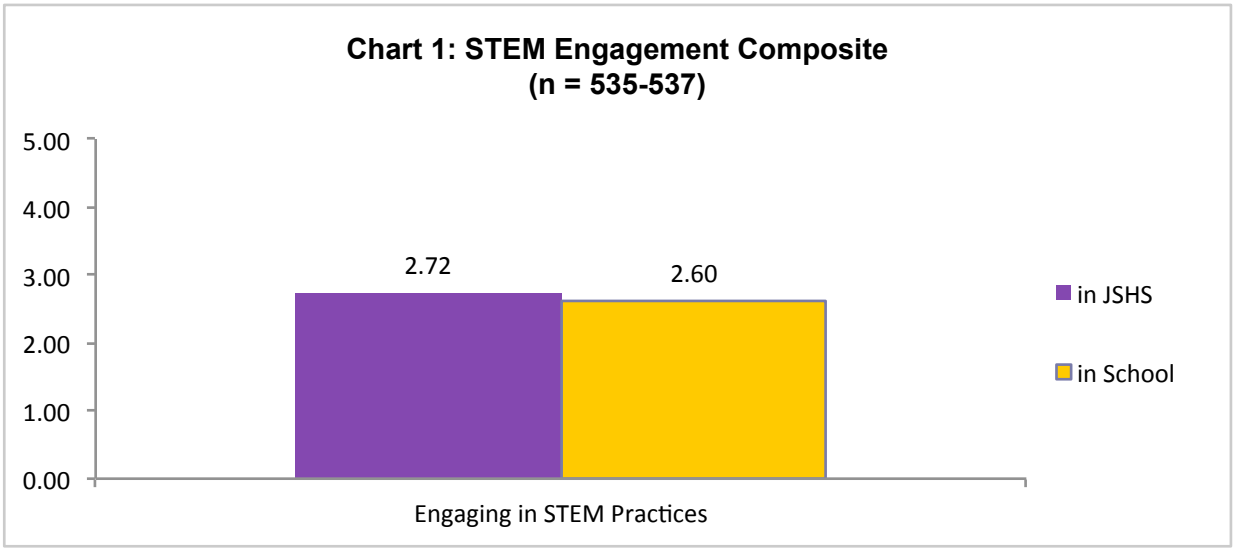
| | Not at all | At least once | Monthly | Weekly | Every day | Response Total |
|---|---|---|---|---|---|---|
| Work with a STEM researcher or company on a real-world STEM research project. | 51.3% | 23.7% | 6.6% | 10.5% | 7.9% | |
| | 279 | 129 | 36 | 57 | 43 | **544** |
| Work with a STEM researcher on a research project topic assigned by my teacher. | 58.9% | 23.1% | 6.9% | 7.4% | 3.7% | |
| | 318 | 125 | 37 | 40 | 20 | **540** |
| Design my own research or investigation based on my own question(s). | 16.4% | 43.8% | 13.4% | 12.2% | 14.2% | |
| | 89 | 238 | 73 | 66 | 77 | **543** |
| Present my STEM research to a panel of judges from industry or the military. | 48.4% | 44.1% | 5.8% | 1.1% | 0.6% | |
| | 260 | 237 | 31 | 6 | 3 | **537** |
| Interact with STEM researchers. | 28.9% | 36.5% | 16.2% | 10.9% | 7.5% | |
| | 154 | 194 | 86 | 58 | 40 | **532** |
| Use laboratory procedures and tools | 11.9% | 21.0% | 21.6% | 30.5% | 14.9% | |
| | 64 | 113 | 116 | 164 | 80 | **537** |
| Identify questions or problems to investigate | 8.0% | 23.4% | 19.4% | 26.2% | 23.0% | |
| | 43 | 125 | 104 | 140 | 123 | **535** |
| Design and carry out an investigation | 9.9% | 30.7% | 24.4% | 21.6% | 13.4% | |
| | 53 | 165 | 131 | 116 | 72 | **537** |
| Analyze data or information and draw conclusions | 7.6% | 21.9% | 19.9% | 29.7% | 21.0% | |
| | 41 | 118 | 107 | 160 | 113 | **539** |
| Work collaboratively as part of a team | 10.7% | 18.9% | 17.6% | 25.8% | 27.0% | **534** |
| | 57 | 101 | 94 | 138 | 144 | |
| Build or make a computer model | 51.9% | 27.1% | 10.6% | 7.1% | 3.4% | **536** |
| | 278 | 145 | 57 | 38 | 18 | |
| Solve real world problems | 19.3% | 32.2% | 15.4% | 12.0% | 21.2% | **540** |
| | 103 | 172 | 82 | 64 | 113 | |

**Table 28. Nature of Student Activities in JSHS for R-JSHS Respondents (n = 543)**

| | 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.** | 39.1% | 21.0% | 8.5% | 16.9% | 14.5% | |
| | 211 | 113 | 46 | 91 | 78 | **539** |
| **Work with a STEM researcher on a research project topic assigned by my teacher.** | 60.8% | 21.6% | 5.0% | 8.6% | 4.1% | |
| | 327 | 116 | 27 | 46 | 22 | **538** |
| **Design my own research or investigation based on my own question(s).** | 11.2% | 38.7% | 12.6% | 17.5% | 20.1% | |
| | 60 | 208 | 68 | 94 | 108 | **538** |
| **Present my STEM research to a panel of judges from industry or the military.** | 36.9% | 48.5% | 8.1% | 3.2% | 3.4% | |
| | 197 | 259 | 43 | 17 | 18 | **534** |
| **Interact with STEM researchers.** | 21.7% | 30.8% | 14.3% | 15.7% | 17.5% | |
| | 115 | 163 | 76 | 83 | 93 | **530** |
| **Use laboratory procedures and tools** | 18.8% | 21.4% | 14.3% | 22.2% | 23.3% | |
| | 100 | 114 | 76 | 118 | 124 | **532** |
| **Identify questions or problems to investigate** | 7.8% | 25.6% | 16.9% | 22.9% | 26.9% | |
| | 41 | 135 | 89 | 121 | 142 | **528** |
| **Design and carry out an investigation** | 9.2% | 29.8% | 14.6% | 21.2% | 25.3% | |
| | 49 | 159 | 78 | 113 | 135 | **534** |
| **Analyze data or information and draw conclusions** | 7.9% | 24.6% | 16.3% | 24.4% | 26.8% | |
| | 42 | 130 | 86 | 129 | 142 | **529** |
| **Work collaboratively as part of a team** | 28.9% | 21.0% | 11.8% | 18.0% | 20.3% | |
| | 154 | 112 | 63 | 96 | 108 | **533** |
| **Build or make a computer model** | 54.5% | 21.8% | 7.9% | 7.5% | 8.3% | |
| | 290 | 116 | 42 | 40 | 44 | **532** |
| **Solve real world problems** | 17.3% | 28.4% | 9.0% | 16.9% | 28.2% | |
| | 92 | 151 | 48 | 90 | 150 | **531** |

A composite score was calculated for this set of items, titled "Engaging in STEM Practices in JSHS."[2] Response categories were converted to a scale of 1 = "Not at all" to 5 = "Every day" and the average across all items in the scale was calculated. The composite score was used to test whether there were differences in student experiences by gender and race/ethnicity group (minority vs. non-minority students). No significant group differences found in terms of Engaging with STEM Practices in JSHS by race/ethnicity, but there was a significant difference found by gender with females reporting more engagement than males[3] (small effect of d = 0.301 standard deviations).

To examine how the JSHS experience compares to their typical school experience, students' responses to the item about how often they engaged in the same activities in school were combined into composites[4] that are parallel to the ones asking about JSHS. Students reported significantly greater "Engagement in STEM" in JSHS than in school[5] (small effect of d = 0.293 standard deviations) (see Chart 1). These data indicate that JSHS provides students with more intensive STEM engagement experiences than students receive in school.




[2] The Cronbach's alpha reliability for these 12 Engaging in STEM in JSHS items was 0.910
[3] Two-tailed independent samples t-test: $t(360) = 2.86$, $p < 0.001$
[4] The Cronbach's alpha reliability for the 12 Engaging in STEM in School items was 0.882.
[5] Two-tailed dependent samples t-test: $t(537) = 7.88$, $p < 0.001$.

## The Role of Mentors

Mentors play a critical role in the JSHS program. Mentors provide one-on-one support to students, chaperone students, advise students on educational and career paths, may provide opportunities for students to use laboratory space and/or equipment, and generally serve as STEM role models for JSHS students. Nearly half (46%) of mentors responding to the mentor questionnaire reported working with 5 or fewer students, while 27% of mentors reported working with 6-10 students. The remaining 27% 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:[6]

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.

Table 30 indicates that a majority of responding mentors used multiple strategies to establish the relevance of learning activities to students. For example, a large majority tried to learn about the students and their interests at the beginning of the program (81%) and encouraged students to suggest new reading, activities, or projects (82%). Many also helped students become aware of the roles STEM plays in their everyday lives (77%); helped students see how STEM can affect them or their communities (74%); asked students to relate outside events or activities to topics covered in the program (71%), gave students real-life problems to investigate or solve (72%); or selected readings or activities related to students' backgrounds (64%). FY17 data indicate that JSHS mentors increased the use of all of these strategies as compared to FY16.

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[6] 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 30. Mentor Strategies to Establish the Relevance of Learning Activities (n = 240)**

| | 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** | 80.9% | 19.1% | |
| | 191 | 45 | **236** |
| **Giving students real-life problems to investigate or solve** | 72.0% | 28.0% | |
| | 170 | 66 | **236** |
| **Selecting readings or activities that relate to students' backgrounds** | 63.5% | 36.5% | |
| | 148 | 85 | **233** |
| **Encouraging students to suggest new readings, activities, or projects** | 81.6% | 18.4% | |
| | 191 | 43 | **234** |
| **Helping students become aware of the role(s) that STEM plays in their everyday lives** | 76.8% | 23.2% | |
| | 182 | 55 | **237** |
| **Helping students understand how STEM can help them improve their own community** | 74.4% | 25.6% | |
| | 174 | 60 | **234** |
| **Asking students to relate real-life events or activities to topics covered in JSHS** | 71.4% | 28.6% | |
| | 167 | 67 | **234** |

Although a majority of mentors reported using strategies to support the needs of diverse learners, there was a slight downward trend in the use of these strategies in FY17 compared to FY16. As can be seen in Table 31, 79% of mentors reported using a variety of teaching and/or mentoring activities to meet the needs of students (compared to 91% in FY16). While 78% interacted with students and other personnel the same way regardless of their backgrounds this is a decrease compared to 85% reporting the use of this strategy in FY16. Eighty-one percent of mentors reported directing students to other individuals or programs for additional support. Most of responding mentors also reported using strategies such as identifying different learning styles students may have at the beginning of their JSHS experience (56%) and providing extra readings, activities, or learning support for students who lacked essential background skills (68%).

**Table 31. Mentor Strategies to Support the Diverse Needs of Learners (n = 240)**

| | 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** | 56.1% | 43.9% | |
| | 129 | 101 | **230** |
| **Interact with students and other personnel the same way regardless of their background** | 78.4% | 21.6% | |
| | 185 | 51 | **236** |
| **Use a variety of teaching and/or mentoring activities to meet the needs of all students** | 79.1% | 20.9% | |
| | 186 | 49 | **236** |
| **Integrating ideas from education literature to teach/mentor students from groups underrepresented in STEM** | 60.7% | 39.3% | |
| | 142 | 92 | **234** |
| **Providing extra readings, activities, or learning support for students who lack essential background knowledge or skills** | 68.3% | 31.7% | |
| | 157 | 73 | **230** |
| **Directing students to other individuals or programs for additional support as needed** | 81.1% | 18.9% | |
| | 189 | 44 | **233** |
| **Highlighting under-representation of women and racial and ethnic minority populations in STEM and/or their contributions in STEM** | 56.6% | 43.4% | |
| | 129 | 99 | **228** |

Mentor use of strategies to support students' development of collaboration and interpersonal skills decreased slightly in FY17 (see Table 32) as compared to FY16. For example, while over three-quarters (80%) of responding mentors reported having students listen to the ideas of others with an open mind, this is lower than the 92% who reported using this strategy in FY16). Likewise, 78% of mentors reported having students explain difficult ideas to others while 90% of mentors reported using this strategy in FY16.

**Table 32. Mentor Strategies to Support Participant Development of Collaboration and Interpersonal Skills (n = 237)**

| | 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** | 64.5% | 35.5% | |
| | 147 | 81 | **228** |
| **Having participant(s) explain difficult ideas to others** | 78.4% | 21.6% | |
| | 182 | 50 | **232** |
| **Having participant(s) listen to the ideas of others with an open mind** | 79.5% | 20.5% | |
| | 182 | 47 | **229** |
| **Having participant(s) exchange ideas with others whose backgrounds or viewpoints are different from their own** | 74.7% | 25.3% | |
| | 171 | 58 | **229** |
| **Having participant(s) give and receive constructive feedback with others** | 83.5% | 16.5% | |
| | 193 | 38 | **231** |

Mentor use of strategies to support student engagement in authentic STEM activities (Table 33) also decreased compared to FY16 reports. For example, although more than three quarters (84%) of all respondents indicated that they allowed students to work independently to improve their self-management skills, this is a decrease as compared to the 98% of mentors reporting using this strategy in FY16. Similarly, 73% of mentors indicated that they supervised students while they practiced STEM research skills and that they demonstrated laboratory/field techniques, procedures, and tools for students, compared to 84% in FY16. In spite of these decreases, the majority of mentors reported using all strategies including providing students with constructive feedback to improve their STEM competencies (88%) and having students search for and review technical research to support their work (81%).

**Table 35. Mentors Discussing Other AEOPs with Participants (n = 245)**

| | Yes - I discussed this program with my student(s) | No - I did not discuss this program with my student(s) | Response Total |
|---|---|---|---|
| **Unite** | 21.3% | 78.7% | |
| | 49 | 181 | **230** |
| **JSHS** | 63.6% | 36.4% | |
| | 152 | 87 | **239** |
| **SEAP** | 8.7% | 91.3% | |
| | 20 | 209 | **229** |
| **REAP** | 7.5% | 92.5% | |
| | 17 | 211 | **228** |
| **HSAP** | 5.7% | 94.3% | |
| | 13 | 215 | **228** |
| **CQL** | 1.8% | 98.2% | |
| | 4 | 224 | **228** |
| **GEMS Near Peer Mentor Program** | 1.8% | 98.2% | |
| | 4 | 224 | **228** |
| **URAP** | 4.4% | 95.6% | |
| | 10 | 218 | **228** |
| **SMART College Scholarship** | 6.6% | 93.4% | |
| | 15 | 214 | **229** |
| **NDSEG Fellowship** | 3.1% | 96.9% | |
| | 7 | 222 | **229** |
| **I discussed AEOP with participant(s) but did not discuss any specific** | 16.2% | 83.8% | |
| | 37 | 192 | **229** |
| **eCybermission** | 8.3% | 91.7% | |
| | 19 | 209 | **229** |

**Table 36. Usefulness of Resources for Exposing Students to AEOPs (n = 247)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Academy of Applied Science (AAS) website** | 76.1% | 2.9% | 2.9% | 8.8% | 9.2% | |
| | 181 | 7 | 7 | 21 | 22 | **238** |
| **AEOP website** | 75.0% | 3.8% | 2.5% | 8.8% | 10.0% | |
| | 180 | 9 | 6 | 21 | 24 | **240** |
| **AEOP on Facebook, Twitter, Pinterest or other social media** | 90.6% | 3.4% | 1.3% | 3.0% | 1.7% | |
| | 212 | 8 | 3 | 7 | 4 | **234** |
| **AEOP brochure** | 76.8% | 2.5% | 3.4% | 7.6% | 9.7% | |
| | 182 | 6 | 8 | 18 | 23 | **237** |
| **JSHS Program administrator or site coordinator** | 22.6% | 2.9% | 5.8% | 18.1% | 50.6% | |
| | 55 | 7 | 14 | 44 | 123 | **243** |
| **Invited speakers or "career" events** | 49.2% | 2.1% | 7.6% | 15.5% | 25.6% | |
| | 117 | 5 | 18 | 37 | 61 | **238** |
| **Participation in JSHS** | 12.1% | 2.1% | 5.9% | 14.6% | 65.3% | |
| | 29 | 5 | 14 | 35 | 156 | **239** |

Likewise, mentors reported little familiarity with AEOP print and electronic resources for use in exposing students to DoD STEM careers. Table 37 illustrates that program participation and program administrators continue to be the most useful resources for mentors in exposing students to these careers.

**Table 37. Usefulness of Resources for Exposing Students to DoD STEM Careers (n = 246)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Academy of Applied Science (AAS) website** | 78.7% | 1.3% | 5.5% | 6.4% | 8.1% | |
| | 185 | 3 | 13 | 15 | 19 | **235** |
| **AEOP website** | 80.2% | 2.1% | 3.4% | 6.3% | 8.0% | |
| | 190 | 5 | 8 | 15 | 19 | **237** |
| **AEOP on Facebook, Twitter, Pinterest or other social media** | 91.7% | 3.1% | 1.3% | 2.2% | 1.7% | |
| | 210 | 7 | 3 | 5 | 4 | **229** |
| **AEOP brochure** | 77.2% | 2.5% | 3.8% | 6.8% | 9.7% | |
| | 183 | 6 | 9 | 16 | 23 | **237** |
| **It Starts Here! Magazine** | 92.2% | 2.2% | 1.3% | 1.3% | 3.0% | |
| | 214 | 5 | 3 | 3 | 7 | **232** |
| **JSHS Program administrator or site coordinator** | 33.1% | 3.3% | 5.4% | 20.1% | 38.1% | |
| | 79 | 8 | 13 | 48 | 91 | **239** |
| **Invited speakers or "career" events** | 49.8% | 1.7% | 6.9% | 15.2% | 26.4% | |
| | 115 | 4 | 16 | 35 | 61 | **231** |
| **Participation in JSHS** | 19.8% | 2.1% | 6.3% | 13.1% | 58.6% | |
| | 47 | 5 | 15 | 31 | 139 | **237** |

## Satisfaction with JSHS

Both R-JSHS students and mentors were asked to rate their satisfaction with a number of features of the JSHS program. Table 38 displays regional students' responses to an item asking them about their experience at the R-JSHS event they attended. Over half of responding regional students were somewhat or very much satisfied with the student oral presentations (88%) while over half (60%) were somewhat or very satisfied with student poster presentations and invited speaker presentations (70%). Half (50%) were somewhat or very satisfied with social events while 57% reported being somewhat or very satisfied with features such as feedback from VIPs and peers, tours of field trips (44%), and the judging process (69%). Another 60% of students indicated being satisfied with feedback from judges. Student satisfaction (being somewhat or very satisfied) in all of these categories increased from FY16 to FY17. Over half of respondents had not experienced team-building activities (58%) while a third or more had not experienced social events (33%) or tours or field trips (37%).

N-JSHS students were also asked about their satisfaction with features of the judging process at regional competitions. Most participants (58%) said that they were very satisfied with the judging at regionals. Several students mentioned that they would like to see judges who were more diverse in their knowledge and a wider variety of STEM fields represented (14%). A sampling of responses to the open-ended item "what are your overall impressions of the regional judging process" is listed below.

- "The regional judges that I met with were very pleasant. However, I got the impression that the judges were not familiar with the field that I was discussing. This made it more difficult for me to receive the level of questions and feedback that I needed to prepare for the national competition."
- "The oral presentation at my regional worked much like the judging at nationals and was very effective. The judges had plenty of time to ask questions and I had plenty of time to answer. I also had time to personally talk with the judges about their thoughts on my project after I presented; they told me what I did well, what I could have improved on. This dialogue was very beneficial."
- "The questions were top-notch quality. The judges read my research paper thoroughly and asked me very pointed questions regarding various phrases there. No silly questions. I gathered that almost all judges were professors from local universities and colleges, and a small number from local army research lab. Superb for both first round and final round."
- "It seemed similar to the National structure. One improvement could be to have a more diverse set of judges for each category."
- "Regional judging was one of my favorite experiences. I think the main reason I enjoyed it so much, is that it never felt like a 'competition', more like a conference where you and peers were sharing research. Judges would share thoughts and ask questions and it discussions would bounce back and forth between judges and student. I also really enjoyed that students and audience were allowed to ask questions as well."
- "The judges were very enthusiastic although some were not professionals in my field. They were very encouraging and excited to learn my research."
- "There weren't too many judges for certain categories, which made it harder for some students to find a receptive and understanding audience."

**Table 38. Satisfaction with R-JSHS Event Features (n = 547)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Student Oral Presentations** | 3.8% | 2.4% | 6.6% | 25.6% | 61.5% | |
| | 21 | 13 | 36 | 140 | 336 | **546** |
| **Student Poster Presentations** | 28.2% | 3.1% | 9.1% | 18.1% | 41.5% | |
| | 154 | 17 | 50 | 99 | 227 | **547** |
| **Judging Process** | 9.4% | 8.6% | 13.4% | 27.0% | 41.7% | |
| | 51 | 47 | 73 | 147 | 227 | **545** |
| **Feedback from Judges** | 19.0% | 8.6% | 12.5% | 19.7% | 40.3% | |
| | 102 | 46 | 67 | 106 | 217 | **538** |
| **Feedback from VIPs and Peers** | 26.1% | 4.5% | 13.0% | 21.6% | 34.8% | |
| | 138 | 24 | 69 | 114 | 184 | **529** |
| **Invited Speaker Presentations** | 12.7% | 3.2% | 13.9% | 21.1% | 49.0% | |
| | 67 | 17 | 73 | 111 | 258 | **526** |
| **Tours or Field Trips** | 37.0% | 6.0% | 12.6% | 17.2% | 27.1% | |
| | 191 | 31 | 65 | 89 | 140 | **516** |
| **Team Building Activities** | 58.0% | 4.3% | 6.9% | 9.7% | 21.1% | |
| | 311 | 23 | 37 | 52 | 113 | **536** |
| **Social Events** | 33.1% | 2.9% | 14.3% | 18.1% | 31.6% | |
| | 172 | 15 | 74 | 94 | 164 | **519** |

R-JSHS students were asked to rate the usefulness of JSHS resources available to them (Table 39). The most beneficial resources (those selected most frequently as “very much” useful) were the deadlines for paper submissions and competition (53%) and participation guidelines (42%). The least accessed resources were the selected articles about conducting research (45% did not use), sample papers (36% did not use), and oral presentation tips (36% did not use).

**Table 39. Usefulness of R-JSHS Resources for Participants (n = 548)**

| | I did not use this resource | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **JSHS Groundrules for Student Presentations** | 25.5% | 2.2% | 12.8% | 20.5% | 39.0% | |
| | 139 | 12 | 70 | 112 | 213 | **546** |
| **Paper Submissions and Competition Deadlines** | 13.5% | 3.0% | 11.6% | 19.0% | 53.0% | |
| | 73 | 16 | 63 | 103 | 287 | **542** |
| **Sample Papers** | 36.1% | 3.7% | 12.5% | 18.2% | 29.5% | |
| | 196 | 20 | 68 | 99 | 160 | **543** |
| **Oral Presentation Tips** | 36.1% | 4.6% | 15.6% | 16.3% | 27.5% | |
| | 197 | 25 | 85 | 89 | 150 | **546** |
| **Selected Articles – Conducting Research** | 44.9% | 6.3% | 12.4% | 14.2% | 22.2% | |
| | 243 | 34 | 67 | 77 | 120 | **541** |
| **Poster Guidelines** | 32.2% | 4.4% | 10.4% | 14.8% | 38.2% | |
| | 176 | 24 | 57 | 81 | 209 | **547** |
| **Participation Guidelines** | 18.0% | 2.4% | 14.1% | 23.7% | 41.8% | |
| | 98 | 13 | 77 | 129 | 228 | **545** |

Most N-JSHS participants reported that participation in the R-JSHS competition helped to prepare them for the N-JSHS. However, some shared that they received little constructive feedback to help them learn how to improve their work in the future.

R-JSHS students were also asked to report on the availability of their mentors. Table 40 indicates that less than half (44%) of responding students indicated their mentor was always available, although only 7% reported that their mentor was available less than half the time and 3% that their mentor was never available.

**Table 40. R-JSHS Participant Reports of Availability of Mentors (n = 550)**

| | Response Percent | Response Total |
|---|---|---|
| I did not have a mentor | 13.82 % | 76 |
| The mentor was never available | 2.91 % | 16 |
| The mentor was available less than half of the time | 7.09 % | 39 |
| The mentor was available about half of the time of my project | 9.82 % | 54 |
| The mentor was available more than half of the time | 22.36 % | 123 |
| The mentor was always available | 44.00 % | 242 |

R-JSHS students also responded to a questionnaire item asking them about their satisfaction with various features of their overall JSHS experiences. The research experience overall ranked as the experiences with which the most students were satisfied (91% were somewhat or very satisfied). A large majority of students were also satisfied with features such as the amount of time spent doing meaningful research (89% were somewhat or very satisfied) and their working relationships with their mentors (84% were somewhat or very satisfied).

**Table 41. R-JSHS Participant Satisfaction with Their JSHS Experience (n=550)**

| | Did not experience | Not satisfied | Somewhat satisfied | Very satisfied | Response Total |
|---|---|---|---|---|---|
| **My working relationship with my mentor** | 14.5% | 1.8% | 15.6% | 68.0% | |
| | 79 | 10 | 85 | 370 | **544** |
| **The amount of time I spent doing meaningful research** | 6.6% | 4.8% | 21.7% | 66.9% | |
| | 36 | 26 | 118 | 364 | **544** |
| **The amount of time I spent with my research mentor** | 13.9% | 4.6% | 22.0% | 59.4% | |
| | 76 | 25 | 120 | 324 | **545** |
| **The research experience overall** | 6.6% | 2.2% | 18.2% | 72.9% | |
| | 36 | 12 | 99 | 396 | **543** |

In order to test for differences in satisfaction with the JSHS experience between groups of students (gender and racial/ethnic groups) satisfaction items were combined into a composite variable[7]. No

[7] The Cronbach's alpha reliability for these 4 items was 0.898.

statistical differences were found by gender or race/ethnicity in terms of student satisfaction with JSHS experiences.

An open-ended item on the questionnaire asked students to comment on their overall satisfaction with their JSHS experience. Of the 190 regional student responses sampled (a 33% sample was taken of the 442 responses available), 68% commented only on positive aspects of the program. Many students provided simple affirmations of their program experiences such as "I am very satisfied with my experience and I thought it was very valuable." Other students provided more detail about what they enjoyed about the program, and many focused on the opportunity to present their work and learning about others' research and about STEM more generally. For example:

> "It was a very eye-opening experience, as I did not realize how advanced science had become or how advanced my peers are. Overall, I was satisfied with my JSHS experience and hope to participate in JSHS again next year." (R-JSHS Student)

> "I am very satisfied with this experience. I had a great time and was very engaged by the interesting activities. I learned a lot about STEM topics. I felt it was very educational and beneficial." (R-JSHS Student)

Thirty R-JSHS students responded with positive comments about the program but also offered caveats, and eight students offered negative comments about their R-JSHS experience. The negative comments were most frequently focused on the judging (12 comments). Student comments included observations that judges seemed unfamiliar with students' areas of research, concerns about inconsistent judging, insufficient judge feedback, or negative or insulting judge feedback and questioning. For example:

> "My experience at JSHS was unsatisfactory. I felt as though the judging process is unfair. I do not understand how presentations are judged or evaluated, but the fact that different presentations are judged by different people leaves room for subjectivity. One judge's 'good' may be another judge's 'average'." (R-JSHS Student)

> "JSHS was a very enjoyable experience overall, however perhaps changing the judging criteria in terms of having awards for a broader scope of research and not just water and water ecology projects would be really nice. It was rather frustrating for me to have put hours of time into my poster project to receive absolutely no awards because of my research field." (R-JSHS Student)

> "The judges were very discouraging and made me feel like I had a horrible presentation and that my information was wrong. The judges basically said that my project was terrible and that I didn't actually accomplish what I did. I was very proud of my project until I got to JSHS. I would rethink the judges for next year. Overall, it was a good experience for me but I felt very discouraged by the judges.." (R-JSHS Student)

Other caveats offered (1 or 2 comments each) by R-JSHS included comments on event organization and communication, too narrow a focus for fields being judged, limited assistance from mentors, and food and logistical issues during events. Twenty-two respondents in the sample did not provide a response to this question.

Students participating in the national JSHS event were asked to reflect on their overall satisfaction with their experiences at the national event. Of the 61 responses received, 82% had only positive things to say about the event. These responses ranged from general comments such as "I thought it was very impressive and organized" to more specific comments about event organization, opportunities for networking, and appreciation for the keynote speakers. Students particularly appreciated having time to socialize and network with professionals and other students at the event. For example,

> "I enjoyed the event very much and thought I learned a lot and had a lot of new experiences. I appreciated meeting peers and professionals." (N-JSHS Student)
>
> "JSHS was an amazing, eye-opening event. I was able to meet people from across the United States and be exposed to fields of science that are glanced over in the traditional high school setting. " (N-JSHS Student)

Eleven students who presented at the national event had generally positive things to say but offered caveats, however there were no completely negative comments. The most frequently mentioned caveat focused on the poster presenters (4 students believed that the poster presentations did not receive enough emphasis or focus). Students also expressed a desire for more time to socialize with other students (mentioned in 4 comments), expressed concerns that judging was not appropriate or fair to poster presenters (2 responses), and that there was not enough free time at the event (3 responses).

Students were also asked to respond to an open-ended questionnaire item asking how the program could be improved. Five of the 190 regional student responses sampled (33% of the 442 available responses were sampled) replied that no improvements were necessary. Of the respondents who offered suggestions for improvements, judging was an area of focus, with 41 students (22%) commenting on judging. Another 39 students (21%) indicated that event organization and scheduling could be improved. Students particularly indicated that they would like more focus on recruiting judges that are knowledgeable about students' areas of research, more feedback from judges, and more judges overall. Students who participated in regional events also indicated that providing more activities and more opportunities for students to interact would improve the program (25 responses or 13%). Another 27 students (14%) felt that providing more lab tours and field trips would improve the R-JSHS experience, and bout 17% of students felt that better communication, more speakers, and more publicity/greater participation would improve the JSHS experience. Other suggested improvements, mentioned by fewer

than 10% of students included:

- Increasing the number of categories available
- Improving the website
- Earlier registration and/or student notification
- Less free time
- Longer event
- Shorter/better timed event (consider AP exam schedule)
- More opportunities to network with professionals
- More specific guidelines and/or sample presentations
- More interactive tours/opportunities
- More opportunity to listen to talks in other disciplines and visit poster sessions
- Improving the choices and/or quality of food provided
- Improve the technology available for presenting
- More information about the DoD
- More STEM career information

Students presenting at the national event were also asked for their suggestions for improving the JSHS program overall. The 56 N-JSHS students who responded offered a wide variety of improvements, however the most frequently mentioned were more opportunities to visit the area surrounding the competition site and other offsite venues (13%) and more downtime during the event (11%). Students also commented that they felt speakers lacked diversity in their demographics and fields of interest (5%) and commented that the food quality and meal logistics could be improved (9%). Other improvements mentioned by 6 or fewer students included:

- Improving organization and scheduling (in particular, not scheduling the event during AP exams)
- Improving judging
- Advertising JSHS in order to expand regional participation
- Decreasing the downtime during the national event
- Giving awards for poster participants
- Increasing the time available to visit the expo
- Making additional categories available/not combining categories
- Providing presentation guidelines early in the process
- Shorten speaker times to increase engagement
- Improving communication

Concerns and suggestions mentioned by N-JSHS participants included:

- Long length of speeches and lack of diversity of topics of speeches
- More guidelines for poster presentation
- Detailed rubric for judging so competitors know what they need to add in their presentation
    - More specialized judges

- More cultural excursions and icebreaker events to help students from different areas of the nation meet and collaborate
- Try to match students with tours that relate to their research interests
- More diverse speakers; as one respondent said, “Every single speaker was white, and all but one was male. The theme was ‘Diversify Solutions’, but we really didn't see any diversity. One speaker even talked about minority groups not seeing themselves in STEM occupations, but didn't address the issue: they never see anyone like them in STEM occupations”
- Include recent projects on the website
- Fewer lectures
- Providing better awards to poster presenters
- Ensuring that judges are supportive of and interested in presenters when asking questions

Mentors were also asked about their satisfaction with features of JSHS. Table 42 summarizes mentor satisfaction with a variety of program features. Most mentors reported being “very much” or “somewhat” satisfied with the program features they experienced, although 62% of mentors had not communicated with the AAS and 21% indicated that they had not experienced support for instruction or mentorship during JSHS activities.

The mentor questionnaire also included open-ended items asking mentors for their opinions about the program. Mentors were asked to identify the three most important strengths of JSHS. Of the 86 mentor responses sampled (a 33% sample was taken of the 262 responses available), 38 mentors recognized the value of student opportunities to develop presenting and communication skills (44%). Thirty-two mentors also recognized the value of students meeting and networking with like-minded peers and professionals (37%). About a quarter of responses focused on students having the opportunity to conduct research (30%) and the opportunity for students to learn about others’ research (23%). A smaller number of mentors (8%) commented that the judging and feedback students receive is a strength of JSHS. Other, less frequently mentioned, strengths mentioned by mentors included providing opportunities for recognition of student research and competition, building student confidence, providing career information, increasing student motivation and interest in STEM, and JSHS speakers. These themes were echoed in focus groups with the following strengths cited by mentors in focus groups:

- Encouraging STEM awareness
- Increasing presentation skills
- Developing writing skills
- Opportunities to interact with scientists/ researchers
- The opportunity to develop a community of students who are passionate about STEM education
- Opportunities for students to have their work recognized and appreciated by others
- The potential for JSHS to serve as motivation for students to move forward in STEM careers
- Exposure to career professionals
- Engagement with PhD researchers and programs at university

- Seeing and being inspired by other students' research

**Table 42. Mentor Satisfaction with JSHS Program Features (n = 255)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Application or registration process** | 12.2% | 1.6% | 5.5% | 25.6% | 55.1% | |
| | 31 | 4 | 14 | 65 | 140 | **254** |
| **Communicating with Academy of Applied Science (AAS)** | 61.7% | 0.0% | 2.1% | 9.1% | 27.2% | |
| | 150 | 0 | 5 | 22 | 66 | **243** |
| **Communicating with your JSHS site's organizers** | 5.9% | 1.2% | 2.7% | 11.0% | 79.2% | |
| | 15 | 3 | 7 | 28 | 202 | **255** |
| **The physical location(s) of JSHS activities** | 21.7% | 0.4% | 5.5% | 14.6% | 57.9% | |
| | 55 | 1 | 14 | 37 | 147 | **254** |
| **Support for instruction or mentorship during JSHS activities** | 20.9% | 0.0% | 4.7% | 19.4% | 54.9% | |
| | 53 | 0 | 12 | 49 | 139 | **253** |
| **Research abstract preparation requirements** | 27.0% | 2.8% | 4.0% | 20.2% | 46.0% | |
| | 68 | 7 | 10 | 51 | 116 | **252** |

Mentors were also asked to respond to an open-ended item asked them to describe three ways JSHS could be improved for future participants. Of the 86 mentor responses sampled (a 33% sample was taken of the 262 responses available), 68 mentors provided at least one suggestion for improvement. There were a wide variety of improvements suggested. The most frequently mentioned improvements focused on increasing recruiting and advertising to increase JSHS participation (19%). Judging was also frequently identified as an area for improvement (18% of responses), with suggestions including providing more judges, more judge feedback, and improving the quality and consistency of judging. Other relatively frequently mentioned improvements included providing a model presentation or rubric prior to the competition, more or different activities, especially icebreakers and team building, better scheduling and organization, and more lab visits or field trips (10% of responses for each). Other suggestions (mentioned by 10% or less of mentors) included:

- Providing more opportunities for students to interact with each other
- Providing more emphasis on and information about DoD research, careers, and program
- Better communication

- Improving access to mentors
- Providing more awards
- Providing more funding for teachers and/or students
- Increasing the opportunity to view more student presentations
- Ensure students have an understanding of ethics

Mentors participating in focus groups were also asked to share ideas for ways that JSHS could be improved. Suggestions included:

- Communicating the availability of the JSHS app prior to the national event
- Engaging teachers to reach diverse student populations
- Providing workshops for teachers before the competition
- Providing virtual preparation for students
- Fewer speakers at the event
- More diverse speakers at the event
- Allowing students to work in teams for some projects
- Monetary resources, such as mini-grants, to help get teachers started

Mentors were also asked to comment on their overall satisfaction with their JSHS experience. Of the 86 mentor responses sampled (a 33% sample was taken of the 262 responses available), nearly all who provided a response (70, or 95%) included positive comment about the program. Many focused on the opportunities for students to present their research, network with peers, and receive feedback from professionals. For example:

> "It was a good experience for students and adults. I have taken students to JSHS for many years and will continue to do so. Thank you for providing this program." (JSHS Mentor)

> "I do enjoy the JSHS experience. It gives the students an opportunity to speak in front of an audience of people they of whom they are not acquainted. I enjoy watching the students giving it their all even though they are scared to death. They are learning how to speak in front of others." (JSHS Mentor)

> "I appreciated that they considered that all schools do not have access to research facilities and had different categories for competition. I also loved the fact that students were allowed and encouraged to ask questions. Judges did a good job of motivating the presenters." (JSHS Mentor)

> "JSHS is a wonderful competition and symposium. It is worthwhile for all students that participate; regardless if chosen to present or move on to national level." (JSHS Mentor)

Ten of the mentors offered positive comments but also some caveats, while four respondents offered no positive comments. These respondents' caveats most often focused on the disparity in resources available to competitors, judges' topical knowledge, and food options.

> "I just hope that next year, there are judges that are knowledgeable in the appropriate areas to be judged." (JSHS Mentor)

> "We enjoyed the experience; however, coming in to it we did not really know the details on how students would be judged. Also, it appears as though many of the projects were completed in professional research labs while others were completed in the classroom. There is a drastic difference in the amount of resources available to students in each of these settings which in my opinion needs to be recognized by the judges. Perhaps projects from the classroom can be judged against other projects from classrooms as opposed to being judged against projects from professional research labs." (JSHS Mentor)

> "I am very satisfied with [JSHS]. We do over 50 STEM competition events annually and this is always one of the highlights. More vegetarian food would have been desirable for participants. This year's closing keynote speaker was not as strong as previous years. My students commented several times on the lack of relevance of his slideware and presentation." (JSHS Mentor)

Some respondents to the mentor survey shared concerns and suggestions when asked about their overall satisfaction with the program:

> "There needs to be a way to sort out districts with rural, low income students and small research opportunities from those who go to high income districts in largely populated urban areas. Districts with high 'free and reduced' lunch counts that are located in remote areas are competing with students who take research classes for credit and work with higher ed. institutions to do their research. It is very difficult for our 'kitchen' science to compete with stem cell labs or university level research labs." (JSHS Mentor)

> "Awesome competition. In our case, as part of the AEOP grant, we were not part of the completion and received no score. I did not object to this at the time, but in retrospect I should have. Students who are not allowed to compete because they are 'poor Public Schools' kids is not how life works. The students (and indirectly us teachers) should have been made to stand up and be judged with everyone else so that we all could learn where we stand and what would have to be done in the future to be competitive. Also, by not being judged, and by being segregated from the rest of the competition, students could infer that their projects didn't matter." (JSHS Mentor)

# 7 | Outcomes Evaluation

The evaluation of JSHS included measurement of several outcomes relating 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.[8] STEM competencies are necessary for a STEM-literate citizenry and include foundational knowledge, skills, and abilities in STEM, as well as the confidence to apply them appropriately. STEM competencies are important 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.

## STEM Knowledge and Skills

Over three-quarters of R-JSHS students reported medium or large gains in all areas of STEM knowledge as a result of their participation in the JSHS program (see Table 43). The vast majority of students reported at least some gain in all areas. For example, 96% of students reported gains in knowledge of research

[8] 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.

conducted in a STEM topic or field, 95% in in-depth knowledge of a STEM topic, and 93% in knowledge of how scientists and engineers work on real problems in STEM.

The Impacts on STEM Knowledge student questionnaire items were combined into a composite variable[9] to test for differences between subgroups of students. There were no significant differences between genders or racial/ethnic groups in terms of reported STEM Knowledge.

Students were also asked to rate their gains in STEM competencies, or science and engineering practices (see Table 44). Large majorities of students reported medium or large gains in all areas of STEM competencies, and most reported at least some gain in all areas. For example, 93% of students reported gains in using knowledge and creativity to suggest a solution to a problem, 92% in designing procedures for an experiment that are appropriate for the question to be answered, and 92% in supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge.

**Table 43. R-JSHS Participant Reports of Impact on STEM Knowledge (n = 545)**

| | No gain | Small gain | Medium gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **In depth knowledge of a STEM topic(s)** | 4.6% | 15.4% | 32.2% | 47.8% | |
| | 25 | 84 | 175 | 260 | **544** |
| **Knowledge of research conducted in a STEM topic or field** | 4.2% | 12.7% | 32.7% | 50.4% | |
| | 23 | 69 | 177 | 273 | **542** |
| **Knowledge of research processes, ethics, and rules for conduct in STEM** | 9.0% | 15.1% | 30.7% | 45.2% | |
| | 49 | 82 | 167 | 246 | **544** |
| **Knowledge of how scientists and engineers work on real problems in STEM** | 6.8% | 14.4% | 28.4% | 50.5% | |
| | 37 | 78 | 154 | 274 | **543** |
| **Knowledge of what everyday research work is like in STEM** | 7.4% | 17.0% | 25.6% | 50.0% | |
| | 40 | 92 | 139 | 271 | **542** |

[9] The Cronbach's alpha reliability for these 5 items was 0.924.

**Table 44. R-JSHS Participant Gains in their STEM Competencies – Science and Engineering Practices (n = 538)**

| | No gain | Small gain | Medium gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **Asking a question that can be answered with one or more scientific experiments** | 9.1% | 17.5% | 33.1% | 40.2% | |
| | 49 | 94 | 178 | 216 | **537** |
| **Using knowledge and creativity to suggest a testable explanation (hypothesis) for an observation** | 6.7% | 15.9% | 30.4% | 47.0% | |
| | 36 | 85 | 163 | 252 | **536** |
| **Using knowledge and creativity to suggest a solution to a problem** | 6.9% | 13.1% | 31.0% | 49.1% | |
| | 37 | 70 | 166 | 263 | **536** |
| **Making a model of an object or system showing its parts and how they work** | 20.9% | 16.6% | 26.3% | 36.2% | |
| | 112 | 89 | 141 | 194 | **536** |
| **Designing procedures for an experiment that are appropriate for the question to be answered** | 7.7% | 15.1% | 30.8% | 46.4% | |
| | 41 | 81 | 165 | 248 | **535** |
| **Identifying the limitations of the methods and tools used for data collection** | 7.8% | 14.2% | 30.4% | 47.6% | |
| | 42 | 76 | 163 | 255 | **536** |
| **Carrying out procedures for an experiment and recording data accurately** | 8.6% | 13.6% | 29.1% | 48.7% | |
| | 46 | 73 | 156 | 261 | **536** |
| **Using computer models of objects or systems to test cause and effect relationships** | 32.6% | 19.1% | 19.5% | 28.8% | |
| | 174 | 102 | 104 | 154 | **534** |
| **Organizing data in charts or graphs to find patterns and relationships** | 9.3% | 16.6% | 28.0% | 46.1% | |
| | 50 | 89 | 150 | 247 | **536** |
| **Considering different interpretations of data to decide if a solution to a problem works as intended** | 8.6% | 18.5% | 28.0% | 45.0% | |
| | 46 | 99 | 150 | 241 | **536** |
| **Considering different interpretations of data when deciding how the data answer a question** | 8.0% | 16.1% | 31.0% | 44.9% | |
| | 43 | 86 | 166 | 240 | **535** |
| **Supporting an explanation for an observation with data from experiments** | 7.9% | 14.4% | 29.3% | 48.4% | |
| | 42 | 77 | 157 | 259 | **535** |

| | No gain | Small gain | Medium gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **Supporting an explanation with relevant scientific, mathematical, and/or engineering knowledge** | 7.5% | 14.8% | 28.4% | 49.3% | |
| | 40 | 79 | 152 | 264 | **535** |
| **Supporting a solution for a problem with data** | 8.3% | 14.3% | 27.2% | 50.2% | |
| | 44 | 76 | 144 | 266 | **530** |
| **Identifying the strengths and limitations of explanations in terms of how well they describe or predict observations** | 6.6% | 16.4% | 30.6% | 46.4% | |
| | 35 | 87 | 163 | 247 | **532** |
| **Defending an argument that conveys how an explanation best describes an observation** | 9.0% | 15.7% | 31.3% | 44.0% | |
| | 48 | 84 | 167 | 235 | **534** |
| **Identifying the strengths and limitations of data, interpretations, or arguments presented in technical or scientific texts** | 7.9% | 17.0% | 29.8% | 45.3% | |
| | 42 | 91 | 159 | 242 | **534** |
| **Identifying the strengths and limitations of solutions in terms of how well they meet design criteria** | 10.4% | 17.2% | 28.7% | 43.7% | |
| | 56 | 92 | 154 | 234 | **536** |
| **Integrating information from technical or scientific texts and other media to support your explanation of an observation** | 9.3% | 15.5% | 28.9% | 46.3% | |
| | 50 | 83 | 155 | 248 | **536** |
| **Communicating about your experiments and explanations in different ways (through talking, writing, graphics, or mathematics)** | 5.4% | 13.8% | 29.1% | 51.7% | |
| | 29 | 74 | 156 | 277 | **536** |
| **Integrating information from technical or scientific texts and other media to support your solution to a problem** | 9.9% | 18.3% | 26.0% | 45.8% | |
| | 53 | 98 | 139 | 245 | **535** |

Composite scores were also calculated for gains in STEM competencies in Science and Engineering.[10] These composites were used to assess if the JSHS program had differential impacts on student groups. There was no significant difference in STEM Competency skills by gender or race/ethnicity.

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

The student questionnaire asked students about the impact of JSHS on their 21st Century Skills (see Table 45). About half or more of all respondents reported large gains in all areas, and large majorities of students reported at least small gains in all areas including setting goals and reflecting on performance (93%), communicating effectively with others (91%), and viewing failure as an opportunity to learn (91%). A composite variable of the 8 items focusing on 21st Century Skills[11] was created to test for differences between student subgroups. There were no significant differences in 21st Century Skills by gender or race/ethnicity.

**Table 45. R-JSHS Participant Reports of Impacts on 21st Century Skills (n = 537)**

| | No gain | Small gain | Medium gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **Learning to work independently** | 10.7% | 10.8% | 23.4% | 55.1% | |
| | 57 | 58 | 125 | 295 | **535** |
| **Setting goals and reflecting on performance** | 7.5% | 10.5% | 27.3% | 54.8% | |
| | 40 | 56 | 146 | 293 | **535** |
| **Sticking with a task until it is finished** | 9.0% | 7.9% | 22.9% | 60.2% | |
| | 48 | 42 | 122 | 320 | **532** |
| **Making changes when things do not go as planned** | 8.4% | 7.7% | 24.6% | 59.3% | |
| | 45 | 41 | 131 | 316 | **533** |
| **Working well with people from all backgrounds** | 16.1% | 15.0% | 20.8% | 48.1% | |
| | 86 | 80 | 111 | 257 | **534** |
| **Including others' perspectives when making decisions** | 13.7% | 17.2% | 23.4% | 45.7% | |
| | 73 | 92 | 125 | 244 | **534** |
| **Communicating effectively with others** | 8.8% | 9.9% | 26.5% | 54.9% | |
| | 47 | 53 | 142 | 294 | **536** |
| **Viewing failure as an opportunity to learn** | 8.4% | 10.3% | 24.2% | 57.0% | |
| | 45 | 55 | 129 | 304 | **533** |

## STEM Identity and Confidence

[11] The 21st Century Skills composite (8 items) had a Cronbach's alpha reliability of .940.

The student questionnaire included a series of items intended to measure the impact of JSHS on students' STEM identities. 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[12], deepening students' STEM knowledge and skills is important for increasing the likelihood of students pursuing STEM careers. Table 46 displays student responses to these items, which illustrate that JSHS has substantial impacts on participants' STEM identities. Large majorities of students reported at least some gain in all areas of STEM identity including a sense of accomplishing something in STEM (92%), confidence to try out new ideas or procedures on their own in STEM projects (92%), and interest in new STEM topics (88%).

**Table 46. R-JSHS Participant Reports on JSHS Impacts on STEM Identity (n = 540)**

| | No gain | Small gain | Medium gain | Large gain | Response Total |
|---|---|---|---|---|---|
| **Interest in a new STEM topic** | 12.1% | 16.5% | 25.2% | 46.2% | |
| | 65 | 89 | 136 | 249 | **539** |
| **Deciding on a path to pursue a STEM career** | 16.2% | 17.3% | 25.3% | 41.2% | |
| | 87 | 93 | 136 | 221 | **537** |
| **Sense of accomplishing something in STEM** | 8.6% | 13.8% | 25.0% | 52.5% | |
| | 46 | 74 | 134 | 281 | **535** |
| **Feeling prepared for more challenging STEM activities** | 8.2% | 12.3% | 26.5% | 52.9% | |
| | 44 | 66 | 142 | 283 | **535** |
| **Confidence to try out new ideas or procedures on my own in a STEM project** | 7.9% | 12.9% | 25.8% | 53.4% | |
| | 42 | 69 | 138 | 285 | **534** |
| **Patience for the slow pace of STEM research** | 10.7% | 17.0% | 25.4% | 46.9% | |
| | 57 | 91 | 136 | 251 | **535** |
| **Desire to build relationships with mentors who work in STEM** | 9.2% | 11.2% | 28.0% | 51.6% | |
| | 49 | 60 | 150 | 276 | **535** |
| **Connecting a STEM topic or field to my personal values** | 11.6% | 11.0% | 24.0% | 53.4% | |
| | 62 | 59 | 128 | 285 | **534** |

[12] Chang, M. J., Sharkness, J., Hurtado, S. and Newman, C. B. (2014), What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. J. Res. Sci. Teach., 51: 555–580.

Composite scores were also generated for STEM identity items[13] to assess whether the JSHS program had differential impacts on subgroups of students. Females reported significantly greater impacts on their STEM Identities in comparison to males (small effect size, d = 0.252)[14]. There were no significant differences in STEM Identity by race/ethnicity.

## Interest and Future Engagement in STEM

Since a key goal of the AEOP is to develop a STEM-literate citizenry, students were asked to rate the impact of JSHS on their likelihood to engage in STEM activities outside of required school courses (Table 47). R-JSHS students reported that after participating in JSHS they were more likely to engage in activities such as working on a STEM project or experiment in a university or professional setting (75%), talking about STEM with friends or family (67%), mentoring or teaching other students about STEM (66%), and taking an elective STEM class (64%).

These items were used to create a composite score[15] to test for differences among subgroups of students in the impact of JSHS on students' intent to engage in STEM activities. There were no significant differences by race/ethnicity or gender.

R-JSHS students were also asked to indicate their level of interest in participating in future AEOP programs. Table 48 summarizes student responses. Few students expressed that they were "not at all" interested in future programs (4%-7%), however the majority of students (63%-77%) had not heard of programs other than JSHS. In spite of this limited awareness of other AEOPs, between 20% and 33% of students expressed that they were at least somewhat interested in programs such as SEAP (33%), REAP (31%), and the GEMS Near Peer Mentor Program (21%).

[13] The Cronbach's alpha reliability for these 8 items was 0.950.
[14] Two-tailed independent samples t-test, $t(361) = 2.40$, $p = .017$.
[15] These 10 items had a Cronbach's alpha reliability of 0.930.

**Table 47. R-JSHS Impact on Participants' Intent to Engage in STEM Out of School (n = 541)**

| | Much less likely | Less likely | About the same before and after | More likely | Much more likely | Response Total |
|---|---|---|---|---|---|---|
| **Watch or read non-fiction STEM** | 3.0% | 0.7% | 49.3% | 24.4% | 22.6% | |
| | 16 | 4 | 266 | 132 | 122 | **540** |
| **Tinker (play) with a mechanical or electrical device** | 3.0% | 1.9% | 46.1% | 26.1% | 22.9% | |
| | 16 | 10 | 247 | 140 | 123 | **536** |
| **Work on solving mathematical or scientific puzzles** | 1.5% | 2.6% | 45.0% | 27.7% | 23.2% | |
| | 8 | 14 | 242 | 149 | 125 | **538** |
| **Use a computer to design or program something** | 2.0% | 3.5% | 46.7% | 24.0% | 23.6% | |
| | 11 | 19 | 251 | 129 | 127 | **537** |
| **Talk with friends or family about STEM** | 1.5% | 0.6% | 31.2% | 34.8% | 32.0% | |
| | 8 | 3 | 168 | 187 | 172 | **538** |
| **Mentor or teach other students about STEM** | 1.9% | 1.5% | 30.9% | 32.5% | 33.3% | |
| | 10 | 8 | 166 | 175 | 179 | **538** |
| **Help with a community service project related to STEM** | 1.3% | 1.7% | 33.4% | 33.4% | 30.2% | |
| | 7 | 9 | 179 | 179 | 162 | **536** |
| **Participate in a STEM camp, club, or competition** | 1.7% | 1.3% | 31.0% | 30.8% | 35.3% | |
| | 9 | 7 | 167 | 166 | 190 | **539** |
| **Take an elective (not required) STEM class** | 1.7% | 0.7% | 33.7% | 27.2% | 36.7% | |
| | 9 | 4 | 181 | 146 | 197 | **537** |
| **Work on a STEM project or experiment in a university or professional setting** | 2.2% | 0.6% | 22.4% | 31.8% | 43.0% | |
| | 12 | 3 | 120 | 170 | 230 | **535** |

**Table 48. R-JSHS Participant Interest in Future AEOP Programs (n = 543)**

| | I've never heard of this program | Not at all | Somewhat interested | Very interested | Response Total |
|---|---|---|---|---|---|
| **Unite** | 76.8% | 3.9% | 9.2% | 10.0% | |
| | 391 | 20 | 47 | 51 | **509** |
| **JSHS** | 2.8% | 7.3% | 26.8% | 63.0% | |
| | 15 | 39 | 143 | 336 | **533** |
| **SEAP** | 62.7% | 4.2% | 15.7% | 17.4% | |
| | 328 | 22 | 82 | 91 | **523** |
| **REAP** | 64.6% | 4.6% | 13.8% | 17.0% | |
| | 338 | 24 | 72 | 89 | **523** |
| **HSAP** | 68.3% | 4.5% | 12.2% | 15.0% | |
| | 352 | 23 | 63 | 77 | **515** |
| **CQL** | 74.0% | 4.1% | 10.2% | 11.7% | |
| | 378 | 21 | 52 | 60 | **511** |
| **GEMS Near Peer Mentor Program** | 74.9% | 4.7% | 9.8% | 10.6% | |
| | 382 | 24 | 50 | 54 | **510** |
| **URAP** | 67.8% | 4.3% | 11.7% | 16.2% | |
| | 347 | 22 | 60 | 83 | **512** |
| **SMART College Scholarship** | 63.7% | 4.6% | 12.3% | 19.4% | |
| | 331 | 24 | 64 | 101 | **520** |
| **NDSEG Fellowship** | 70.5% | 5.2% | 11.3% | 13.0% | |
| | 363 | 27 | 58 | 67 | **515** |

N-JSHS students were also asked about their interest in participating in future AEOP programs (Table 49). 98% of respondents indicated that they were at least somewhat interested in participating in JSHS again. Other programs in which N-JSHS were at least somewhat interested included the SMART Scholarship (61%), NSDEG Fellowship (40%), and URAP (39%). Large numbers of respondents indicated that they had never heard of programs other than JSHS, including UNITE (87%), CQL (78%), and the GEMS Near Peer Mentor Program (72%).

**Table 49. N-JSHS Participant Interest in Future AEOP Programs (n = 60-63)**

| | I've never heard of this program | Not at all | Somewhat interested | Very interested | Response Total |
|---|---|---|---|---|---|
| **Unite** | 86.9% | 1.6% | 8.2% | 3.3% | |
| | 53 | 1 | 5 | 2 | **61** |
| **JSHS** | 0.0% | 1.6% | 22.2% | 76.2% | |
| | 0 | 1 | 14 | 48 | **63** |
| **SEAP** | 61.7% | 6.7% | 18.3% | 13.3% | |
| | 37 | 4 | 11 | 8 | **60** |
| **REAP** | 62.9% | 4.8% | 21.0% | 11.3% | |
| | 39 | 3 | 13 | 7 | **62** |
| **HSAP** | 62.9% | 9.7% | 21.0% | 6.5% | |
| | 39 | 6 | 13 | 4 | **62** |
| **CQL** | 78.7% | 6.6% | 9.8% | 4.9% | |
| | 48 | 4 | 6 | 3 | **61** |
| **GEMS Near Peer Mentor Program** | 72.1% | 11.5% | 11.5% | 4.9% | |
| | 44 | 7 | 7 | 3 | **61** |
| **URAP** | 56.5% | 4.8% | 22.6% | 16.1% | |
| | 35 | 3 | 14 | 10 | **62** |
| **SMART College Scholarship** | 32.8% | 6.6% | 34.4% | 26.2% | |
| | 20 | 4 | 21 | 16 | **61** |
| **NDSEG Fellowship** | 51.6% | 8.1% | 24.2% | 16.1% | |
| | 32 | 5 | 15 | 10 | **62** |

Students were also asked which resources impacted their awareness of the various AEOPs (Table 50). Most R-JSHS participants reported that they had not experienced any resources outside of JSHS (66-80%), although the percentage of participants unfamiliar with resources such as the AEOP website, AEOP on social media, and the AEOP brochure are lower than those for FY16 (85-93%). Interestingly, some JSHS participants (16%) indicated they had not participated in JSHS. This suggests that non-presenting students may not perceive themselves as JSHS participants or that it may not be clear to students which program they are participating in.

**Table 50. Impact of Resources on R-JSHS Participant Awareness of AEOPs (n = 548)**

| | Did not experience | Not at all | A little | Somewhat | Very much | Response Total |
|---|---|---|---|---|---|---|
| **Army Educational Outreach Program (AEOP) website** | 69.7% | 4.2% | 9.4% | 5.1% | 11.6% | |
| | 380 | 23 | 51 | 28 | 63 | **545** |
| **AEOP on Facebook, Twitter, Pinterest or other social media** | 79.7% | 7.2% | 3.9% | 2.8% | 6.5% | |
| | 432 | 39 | 21 | 15 | 35 | **542** |
| **AEOP brochure** | 66.5% | 4.6% | 12.2% | 7.2% | 9.6% | |
| | 361 | 25 | 66 | 39 | 52 | **543** |
| **My JSHS mentor(s)** | 40.0% | 12.5% | 16.3% | 9.7% | 21.5% | |
| | 218 | 68 | 89 | 53 | 117 | **545** |
| **Presentations or information shared at the JSHS competition** | 24.5% | 10.3% | 22.5% | 17.3% | 25.3% | |
| | 133 | 56 | 122 | 94 | 137 | **542** |
| **Participation in JSHS** | 16.1% | 9.7% | 24.8% | 17.2% | 32.1% | |
| | 88 | 53 | 135 | 94 | 175 | **545** |
| **Invited speakers at JSHS** | 26.5% | 13.8% | 20.3% | 15.1% | 24.3% | |
| | 144 | 75 | 110 | 82 | 132 | **543** |

## Attitudes toward DoD Research

Since attitudes about the importance of DoD research are an important prerequisite to continued student interest in the field and potential involvement in the future, R-JSHS participants were asked about their opinions of what DoD researchers do and the value of DoD research more broadly (Table 51). Large majorities of students selected "strongly agree" or "agree" for each item, including that DoD researchers solve real-world problems (78%), DoD research is valuable to society (77%); advance science and engineering fields (79%); and develop new technologies (79%). These values are 8-10% higher than those reported in FY16.

**Table 51. R-JSHS Participant Opinions about DoD Researchers and Research (n = 538)**

| | Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree | Response Total |
|---|---|---|---|---|---|---|
| **DoD researchers advance science and engineering fields** | 1.5% | 0.2% | 19.7% | 38.7% | 39.9% | |
| | 8 | 1 | 106 | 208 | 214 | **537** |
| **DoD researchers develop new, cutting edge technologies** | 1.5% | 0.4% | 19.6% | 37.6% | 41.0% | |
| | 8 | 2 | 105 | 202 | 220 | **537** |
| **DoD researchers solve real-world problems** | 1.9% | 1.1% | 19.1% | 34.8% | 43.1% | |
| | 10 | 6 | 103 | 187 | 232 | **538** |
| **DoD research is valuable to society** | 1.7% | 0.9% | 20.3% | 33.8% | 43.3% | |
| | 9 | 5 | 109 | 181 | 232 | **536** |

In the N-JSHS focus groups, participants were asked (n = 22) to describe the Army/DoD careers that they learned about in JSHS in FY17. Participants indicated that they had an increased awareness of STEM research conducted by the Army and DoD after participating in JSHS. For example:

- "I definitely didn't know there were as many lab positions. I knew there were more technical engineering positions in the Army, military and all the branches but definitely not as much of the biological and chemical sciences."
- "I also had no idea about all of these positions for research inside the DoD because when you think of defense you think of active military."
- "We all assume certain things of the Army, Navy, Air Force and forget about the technical, the brain power that has to go into making all that happen. I learned a lot about that from a lot of the keynote speakers."
- "I always had the impression that most of the research was done by contactors rather than actual DOD employees."
- "I'm very interested in machine learning and the Army does seem to have a lot of opportunities for that."
- "I didn't realize there were so many science and STEM opportunities in the Navy or Army or Air Force."

## Education and Career Aspirations

R-JSHS students were asked about their education aspirations both before and after JSHS. As can be seen in Table 52, when asked to think back on how far they wanted to go in school before participating in JSHS,

only .6% of Regional students indicated that they would end their education upon high school graduation. Over half (61%) indicated that before participating in JSHS they aspired to earn a master's degree, Ph.D., or a degree in a medical field. All students responded that after participating in JSHS (Table 53) that they would extend their education beyond high school, and a slightly larger percentage (63%) indicated that they aspired to earn a master's degree, Ph.D., or a degree in a medical field after participating. The percentage of students aspiring to a combined M.D./Ph.D. increased from 11% before JSHS to 15% after participating.

**Table 52. Before R-JSHS – Participant Education Aspirations (n = 345)**

| Before JSHS Aspirations | Response Percent | Response Total |
|---|---|---|
| Graduate from High School | 0.58 % | 2 |
| Go to a trade or vocational school | 0.29 % | 1 |
| Go to college for little while | 0.29 % | 1 |
| Finish college (get a Bachelor's degree) | 9.57 % | 33 |
| Get more education after college | 7.83 % | 27 |
| Get a Master's degree | 21.74 % | 75 |
| Get a Ph.D. | 26.09 % | 90 |
| Get a medical-related degree (M.D), veterinary degree (D.V.M), or dental degree (D.D.S.) | 13.33 % | 46 |
| Get a combined masters/Ph.D. | 11.30 % | 39 |
| Get another professional degree (law, business, etc.) | 5.22 % | 18 |
| Other | 0.29 % | 1 |
| Choose Not to Report | 3.48 % | 12 |

**Table 53. After R-JSHS - Participant Education Aspirations (n = 550)**

| After JSHS Aspirations | Response Percent | Response Total |
|---|---|---|
| Graduate from high school | 0.00 % | 0 |
| Go to a trade or vocational school | 0.00 % | 0 |
| Go to college for a little while | 0.91 % | 5 |
| Finish college (get a Bachelor's degree) | 9.09 % | 50 |
| Get more education after college | 6.73 % | 37 |
| Get a master's degree | 18.00 % | 99 |
| Get a Ph.D. | 32.00 % | 176 |
| Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S) | 13.09 % | 72 |
| Get a combined masters/ Ph.D. | 14.73 % | 81 |
| Get another professional degree (law, business, etc.) | 5.45 % | 30 |

N-JSHS Students were also asked how far they wanted to go in school after participating in JSHS (Table 54). All respondents indicated that they wanted to at least finish college, and 80% indicated wanting to earn a master's degree, Ph.D., or medical degree. N-JSHS students were asked to indicate if they were planning to pursue either a bachelor's degree or an advanced degree in a STEM field (Table 55). An overwhelming percentage of students answered that they intended to pursue a bachelor's degree or advanced degree in a STEM field (94% and 92%, respectively).

**Table 54. After N-JSHS - Participant Education Aspirations (n=68)**

| After Aspirations | Response Percent | Response Total |
|---|---|---|
| Graduate from high school | 0.0% | 0 |
| Go to a trade or vocational school | 0.0% | 0 |
| Go to college for a little while | 0.0% | 0 |
| Finish college (get a Bachelor's degree) | 4.6% | 3 |
| Get more education after college | 9.2% | 6 |
| Get a master's degree | 13.8% | 9 |
| Get a Ph.D. | 40.0% | 26 |
| Get a medical-related degree (M.D.), veterinary degree (D.V.M), or dental degree (D.D.S) | 15.4% | 10 |
| Get a combined masters/Ph.D. | 10.8% | 7 |
| Get another professional degree (law, business, etc.) | 6.2% | 7 |

**Table 55. After N-JSHS - Participant Education Aspirations**

| STEM Degree Type | Yes | No |
|---|---|---|
| Bachelor's degree in a STEM field | 61 (93.8%) | 3 (4.6%) |
| Advanced degree (beyond a bachelor's degree) in a STEM field | 60 (92.3%) | 5 (7.7%) |

## Overall Impact

Students were asked their opinions about the overall impact of participating in JSHS. Responses indicate that R-JSHS students believed that participating in JSHS had substantial impacts on them (Tables 56). For example, over three-quarters (77%) of R-JSHS students reported that JSHS contributed to them being more confident in their STEM knowledge, skills, and abilities, and 69% of students indicated that they are more interested in participating in STEM activities outside of school requirements after participating in JSHS. Impacts on students' awareness of and interest in other AEOPs was more varied, however. While 56% of students indicated that they had more interest in participating on other AEOPs because of their JSHS participation, over a third of students disagreed that they became more aware of other AEOPs (34%) or were more interested in participating in other AEOPs (35%). Fewer students disagreed to these items as compared to FY16, however, when 42% of students disagreed that they became more aware of other AEOPs and 43% of students indicated that JSHS did not increase their interest in participating in other AEOPs. The upward trend in the impact of the program on students' awareness of and interest

in other AEOPs is encouraging and suggests that JSHS should continue to focus effort on promoting and encouraging participation in other AEOPs in order to continue the trend.

The survey items for JSHS Impact on regional students were combined into a composite variable[16] to assess differences between student subgroups. There was a significant gender difference with females reporting higher levels of JSHS overall impact than males (small effect of d = 0.252 standard deviations)[17]. There were no significant group differences based upon race/ethnicity.

In order to further understand the impact of JSHS on students, an open-ended item on the questionnaire asked students at the regional level to list the three most important ways they benefited from JSHS. In the 190 regional student responses sampled (a 33% sample was taken of the 442 responses available), students offered a variety of benefits they received from JSHS participation. Over half of students' responses (52%) indicated that participating in JSHS enhanced their public speaking, presentation, and/or communication skills. Student responses also focused on gaining laboratory and/or research experience (39% of responses), exposure to new concepts and research (36% of responses), the opportunity to interact with like-minded peers (22% of responses), the opportunity to learn about STEM in general (13% of responses), the opportunity to learn about careers (27% of responses), confidence-building (12% of responses), and increased interest in STEM (15% of responses).

N-JSHS students were also asked their opinions about the overall impact of participating in JSHS. Like regional students, students who advanced to the national competition thought the program had substantial impacts on them (see Table 57). For example, a large majority of N-JSHS students (97%) indicated that JSHS contributed to their increased awareness of Army or DoD research and careers, and 87% reported that JSHS contributed to them being more confident in their STEM knowledge, skills, and abilities. Over three-quarters (77%) of respondents were also more interested in participating in STEM activities outside of school requirements, and 88% of participants felt that JSHS contributed to their awareness of other AEOPs after N-JSHS. While over half (54%) of students indicated that JSHS contributed to their interest in participating in other AEOPs, 37% of students indicated that their JSHS participation did not increase their interest in participating in other programs.

[16] The Cronbach's alpha reliability for these 11 items was 0.950.
[17] Two-tailed independent samples t-test, t(361) = 2.40, p = 0.017.

**Table 56. R-JSHS Participant Opinion of JSHS Impacts (n = 539)**

| | 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 | 5.0% | 17.9% | 58.7% | 18.4% | |
| | 27 | 96 | 315 | 99 | **537** |
| I am more interested in participating in STEM activities outside of school requirements | 6.5% | 24.3% | 48.7% | 20.4% | |
| | 35 | 131 | 262 | 110 | **538** |
| I am more aware of other AEOPs | 33.7% | 7.3% | 35.6% | 23.4% | |
| | 180 | 39 | 190 | 125 | **534** |
| I am more interested in participating in other AEOPs | 35.2% | 8.6% | 35.4% | 20.8% | |
| | 188 | 46 | 189 | 111 | **534** |
| I am more interested in taking STEM classes in school | 7.9% | 31.8% | 44.5% | 15.9% | |
| | 42 | 170 | 238 | 85 | **535** |
| I am more interested in earning a STEM degree | 10.3% | 29.3% | 43.1% | 17.4% | |
| | 55 | 157 | 231 | 93 | **536** |
| I am more interested in pursuing a career in STEM | 10.5% | 27.7% | 45.2% | 16.6% | |
| | 56 | 148 | 242 | 89 | **535** |
| I am more aware of Army or DoD STEM research and careers | 27.1% | 7.8% | 38.4% | 26.7% | |
| | 145 | 42 | 206 | 143 | **536** |
| I have a greater appreciation of Army or DoD STEM research | 23.9% | 9.3% | 38.6% | 28.2% | |
| | 128 | 50 | 207 | 151 | **536** |
| I am more interested in pursuing a STEM career with the Army or DoD | 38.6% | 10.8% | 32.5% | 18.1% | |
| | 207 | 58 | 174 | 97 | **536** |

**Table 57. N-JSHS Participant Opinion of JSHS Impacts (n = 62-64)**

| | 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 | 1.6% | 10.9% | 78.1% | 9.4% | |
| | 1 | 7 | 50 | 6 | **64** |
| I am more interested in participating in STEM activities outside of school requirements | 7.9% | 15.9% | 63.5% | 12.7% | |
| | 5 | 10 | 40 | 8 | **63** |
| I am more aware of other AEOPs | 9.4% | 3.1% | 43.8% | 43.8% | |
| | 6 | 2 | 28 | 28 | **64** |
| I am more interested in participating in other AEOPs | 36.9% | 7.9% | 30.2% | 23.8% | |
| | 24 | 5 | 19 | 15 | **63** |
| I am more interested in taking STEM classes in school | 7.9% | 42.9% | 42.9% | 6.3% | |
| | 5 | 27 | 27 | 4 | **63** |
| I am more interested in earning a STEM degree | 9.5% | 30.2% | 52.4% | 7.9% | |
| | 6 | 19 | 33 | 5 | **63** |
| I am more interested in pursuing a career in STEM | 11.3% | 27.4% | 51.6% | 9.7% | |
| | 7 | 17 | 32 | 6 | **62** |
| I am more aware of Army or DoD STEM research and careers | 1.6% | 1.6% | 30.2% | 66.7% | |
| | 1 | 1 | 19 | 42 | **63** |
| I have a greater appreciation of Army or DoD STEM research | 6.3% | 1.6% | 34.9% | 57.1% | |
| | 4 | 1 | 22 | 36 | **63** |
| I am more interested in pursuing a STEM career with the Army or DoD | 38.1% | 7.9% | 30.2% | 23.8% | |
| | 24 | 5 | 19 | 15 | **63** |

Students presenting at the national event were also asked in an open-ended questionnaire item to reflect on the benefits of participating in JSHS. Over half (61%) of the 66 respondents cited the importance of interacting with peers. N-JSHS students (21%) also identified the opportunity to see and learn from others' research as a benefit of JSHS. Another 15% of participants mentioned learning about careers, both in STEM and with the DOD, and 14% cited the presentation experience as a benefit. Other less frequently mentioned benefits included networking with professionals, learning about other AEOPs, tour experiences, and increases in their confidence.

Similar themes emerged from student focus groups. For example:

> "I was able to prepare for the presentations in a more professional way; it helped my public speaking." (R-JSHS Student)
>
> "JSHS has given me more knowledge about possibilities in the future in terms of education and work." (R-JSHS Student)
>
> "The feedback and questions helped me to understand my project and science more realistically." (R-JSHS Student)
>
> "I think the general session talks by researchers, describing what they work on and how they became interested in science, were most beneficial. These really made me excited about science. Also, time spent interacting with other participants I found very beneficial in interesting me in research." (N-JSHS Student)
>
> "I realized how much I love my research project and understanding how the universe, so I've decided to go into theoretical physics instead of computer science. I changed my mind after being inspired by the Nobel Laureate and speaking with JSHS alumni on Saturday morning." (N-JSHS Student)
>
> "I wasn't very aware of the different programs involved with AEOP. JSHS really opened up my eyes to how that would work. Even though I don't see their programs as something I will be doing, it could be a great opportunity for many others, and I will be very likely to recommend to a friend. " (N-JSHS Student)

## Summary of Findings

The FY17 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 58.

| Table 58. 2017 JSHS Evaluation Findings | |
|---|---|
| **Participant Profiles** | |
| **Although application and enrollment rates in JSHS were only slightly lower than in FY16, there is a more substantial downward trend in applications and enrollment when viewed over a two-year period.** | In FY17, JSHS the 47 R-JSHS sites received 8,663 applications (a decrease of 3% from FY16) and were able to accommodate only 64% of applying students (5,577). There has been a 3% decreased since FY16 (5,800) and 8% decrease in the number of applicants since FY15 (9,347). |
| | The majority (64%) of enrolled students in FY17 attended suburban schools. Only 3% of students reported attending urban schools, a sharp decline from the 27% who reported attending urban schools in FY16. About 20% of students reported attending rural schools (an increase from FY16 when 14% attended rural schools, but a decrease from FY15 when 40% reported attending rural schools). |
| | The overall demographics of students responding to the survey were similar to the demographics available for enrolled students, although slightly more White (55%) and more female students (59%) responded to the survey than were in the overall population, and substantially more urban students (33%) responded to the survey than the 3% of enrolled students indicating they attended urban schools. However, the majority of participants were from suburban schools (52%) who completed the survey, reflective of the overall participation being predominantly White. |
| | Half (50%) of the R-JSHS students responding to the questionnaire were oral presenters and 29% were poster presenters at the R-JSHS level while 60% of N-JSHS students responding to the survey were oral presenters and 40% were poster presenters. |
| **Collection of demographic data for JSHS participants improved for FY17, however there remains room for growth in this area.** | Fourteen regions of the 47 regional symposia provided incomplete demographic information about participants, and demographic data was missing for over 3,000 participants - over 50% of enrolled students. In FY16 demographic data was unavailable for 2,065 students (about 37% of enrollees) from 17 regional sites. |

| | |
|---|---|
| **JSHS continued a trend of enrolling a majority of female participants.** | More females than males participated in JSHS in FY17 (58% and 41% respectively), female participants composed a slightly larger percentage of JSHS enrollees in FY17 as compared to FY16 (58% versus 57%). |
| **The ethnic/racial diversity of JSHS remains relatively constant compared to FY16 levels.** | As in FY16, students identifying themselves as White were the largest racial/ethnic group of JSHS participants (53% in FY17 compared to 45% in FY16). Students identifying themselves as Asian were the second largest racial/ethnic group of participants (26% in FY17 as compared to 22% in FY16). Only 6% of students identified themselves as Black or African American in FY17 (compared to 4% in FY16), although the proportion of Hispanic or Latino students increased slightly from 6% in FY16 to 7% in FY17. These findings suggest that JSHS continues to struggle with growing the diversity of participants. |
| **Actionable Program Evaluation** | |
| **Students are motivated to participate in JSHS by various factors.** | Factors motivating student participation in JSHS for FY17 were similar to those cited in FY16 and FY15. As in the past two years, the most often-chosen responses to an item asking students about their motivation for participating were an interest in STEM (78%), followed by a desire to learn something new (69%), and teacher or professor encouragement (61%). |
| **Personal connections continue to be a primary means of information about JSHS, although information disseminated through schools or universities is also an important source of information.** | Students reported learning about JSHS through various means, although the most often chosen response was "someone who works at the school or university I attend" (45%). Another 28% of students reported learning about JSHS via communications through their school ("school or university newsletter, email, or website), while another 19% indicated that a past participant of the program was an important source of JSHS information. Mentors offered similar responses when asked about how they had learned about the program. For mentors, however, the most often cited source of information was a past participant of the program (42%) followed by someone who works at their school or university (22%), and a communication through their school or university (20%). |
| **Students reported being more engaged in STEM practices in JSHS than in their school experiences. However, mentor use of effective strategies and connecting students with other AEOPs is still less than desired.** | Students' responses to questionnaire items asking them about their activities in JSHS and their activities in schools showed that students are significantly more engaged in STEM practices during JSHS than they are in these STEM practices in school. For example, students reported solving real world problems and working with STEM researchers or companies more frequently in JSHS (51%) than in school (49%). Additionally, other areas of difference were: being able to present STEM research to a panel of judges (62% in JSHS compared to 52% in school); interacting with STEM researchers (78% in JSHS compared to 61% in school). |
| | Mentors reported using a variety of strategies to support learners. Mentors increased their use of all strategies in the category focused on establishing the relevance of learning activities for students as compared to FY16. However, |

| | |
|---|---|
| | mentor use of effective strategies in the three other categories decreased slightly from FY16 to FY17. Overall mentor use of strategies to support the needs of diverse learners, strategies to support students' development of collaboration and interpersonal skills, and strategies to support students' engagement in authentic STEM activities were less than in FY16. Further, only about a third (33%) of mentors reported recommending AEOPs that align with students' goals as a strategy to support students' educational and career pathways. |
| **Students are exposed to STEM careers and jobs through JSHS although regional students learned less about STEM careers and jobs in the DoD than about STEM careers more generally.** | A large majority (85%) of R-JSHS students learned about at least one STEM job/career during JSHS. This is an improvement over FY16 when 22% of R-JSHS participants reported that they did not learn about any STEM jobs/careers during the program. Only about half (51%) of R-JSHS students learned about at least one DoD STEM jobs/careers. Again, however, this is an improvement over FY16 when 60% of participants reported that they did not learn about even one DoD STEM job/career. In contrast, all students (100%) attending N-JSHS reported learning about at least one DoD STEM job/career, and 61% of these students learned about five or more of these careers. |
| | A majority of mentors (69%) reported discussing STEM career opportunities in private industry or academia with students, however only 41% reported discussing these career opportunities within the DoD or other government agencies. When asked to rate the usefulness of various resources for exposing students to STEM career opportunities within the DoD, mentors indicated that program administrators or site coordinators are a useful resource and that simply participating in JSHS is very useful in exposing students to DoD STEM careers. |
| **Students and mentors reported high levels of satisfaction with JSHS program components, although judging continues to be an area that students and mentors target for improvement.** | The majority of R-JSHS students were very satisfied with aspects of their JSHS experience including the research experience overall (68%), their working relationship with mentors (67%), and the amount of time they spent doing meaningful research (73%). R-JSHS students expressed concerns about judging in open-ended survey responses and in focus groups, including comments about judges' lack of familiarity with students' areas of research, inconsistent judging, insufficient judge feedback, and negative or insulting judge feedback. These comments are similar to student comments about judging in FY16 |
| | N-JSHS students interviewed in focus groups and open-ended survey responses in FY17 mentioned JSHS improvements in judging and added that they would like to see more focus on poster presentations, would like more time to socialize with other students, and would like more demographic diversity in the event speakers. |
| | Mentors reported being satisfied with various program JSHS program features including communicating with JSHS site organizers (90% were at least somewhat satisfied) and the application or registration process (81% were at least somewhat satisfied). It is noteworthy that 21% of mentors indicated that they did |

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| | not experience support for instruction or mentorship during JSHS activities. When asked to comment on the program in focus groups and open-ended questionnaire items, mentors expressed high levels of satisfaction with the program, but also commented that JSHS could be improved by increasing recruiting for and advertising of the program, increasing the number of judges available, providing students with more judge feedback, and improving the quality or consistency of judging. |
| | When asked to comment on the program in focus groups and open-ended questionnaire items, mentors expressed high levels of satisfaction with the program, but also commented that JSHS could be improved by increasing recruiting for and advertising of the program, increasing the number of judges available, providing students with more judge feedback, and improving the quality or consistency of judging. |
| **Outcomes Evaluation** | |
| | Over 75% of students reported medium or large gains in their STEM knowledge including their in-depth knowledge of a STEM topic (80%) and knowledge of how scientists and engineers work on real problems in STEM (79%). In terms of their STEM competencies, large percentages of students reported medium or large gains in all areas of STEM competencies. Over 50% of students reported some gains in all areas including using knowledge and creativity to suggest a solution to a problem (77%), identifying limitations of methods and tools used for data collection (78%), carrying out procedures for an experiment and recording data accurately (78%), organizing data in charts and/or graphs to find patterns and relationships (74%), and supporting an explanation for an observation with data from experiments (77%). |
| **R-JSHS participants reported gains in their 21st Century Skills as a result of participating in JSHS.** | Large majorities of students reported gains in all areas of 21st Century Skills, including setting goals and reflecting on performance (83%), communicating effectively with others (82%), and viewing failure as an opportunity to learn (81%). |
| **Participants reported gains in areas associated with STEM identity and interest in engaging in STEM in the future as a result of participating in JSHS, indicating that JSHS has a lasting impact on students.** | Students reported gains in items intended to gauge their self-confidence in their abilities to succeed in STEM – their STEM identities – and their interest in STEM. Large majorities of students reported gains in all areas of STEM identity including their sense of accomplishing something in STEM (78%), confidence to try out new ideas or procedures on their own in STEM projects (79%), and interest in new STEM topics (71%). |
| | Likewise, a majority of R-JSHS students reported that after participating in JSHS they were more likely to engage in activities such as working on a STEM project or experiment in a university or professional setting (75%), talking about STEM |

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| | with friends or family (67%), mentoring or teaching other students about STEM (66%), and taking an elective STEM class (64%). These findings suggest that JSHS has a lasting impact on students. |
| **Most JSHS participants had educational aspirations that extended beyond earning an undergraduate degree before they participated in JSHS. Slightly more students aspired to advanced degrees after participating in JSHS.** | Over half of R-JSHS students (61%) indicated that before participating in JSHS they aspired to earn a master's degree, Ph.D., or a degree in a medical field. All students responded that after participating in JSHS that they would extend their education beyond high school, and a slightly larger percentage (63%) indicated that they aspired to earn a master's degree, Ph.D., or a degree in a medical field after participating. The percentage of students aspiring to a combined M.D./Ph.D. increased from 11% before JSHS to 15% after participating. |
| | 100% of N-JSHS students indicated that, after participating in JSHS, they wanted to at least finish college, and 80% indicated wanting to earn a master's degree, Ph.D., or medical degree. 94% of N-JSHS participants planned to pursue a bachelor's degree in a STEM field. |
| **Students and mentors had limited knowledge of AEOPs other than JSHS.** | While over half of R-JSHS students indicated that they were more aware of other AEOPs and more interested in participating in other AEOPs after participating in JSHS, large numbers of respondents (72-87%) indicated that they had never heard of programs other than JSHS, including UNITE, CQL, and the GEMS Near Peer Mentor Program. Nearly all students were at least somewhat interested in participating in JSHS again, and students expressed at least some interest in other programs, including the SMART Scholarship (61% were at least somewhat interested), NSDEG Fellowship (40% were at least somewhat interested), and URAP (39% were at least somewhat interested). |
| | As in previous years, R-JSHS participants reported that participation in JSHS was the most useful resource available to learn about other AEOPs (49% indicated this was at least somewhat useful). Most students had never experienced resources such as the AEOP website or AEOP on social media, although the percentages of students who had not experienced these resources was lower than in FY16. Furthermore, while 87% of students had not experienced the AEOP brochure in FY16, this percentage dropped to 67% for FY17. |
| | Only small percentages of mentors had discussed AEOPs other than JSHS with students, although 21% reported having discussed Unite, and 16% reported discussing AEOP generally without a focus on any particular program. |
| | Mentors' reports of the usefulness of resources for exposing students to other AEOPs were similar to students'. The most useful resources for exposing students to AEOP according to mentors are participation in JSHS (65%) and the JSHS program administrator or site coordinator (51%). |

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| | Like students, many mentors had not experienced several of the AEOP resources, although more mentors experienced these resources than in FY16. For example, while 76% had not experienced the AAS website in FY17, this represents a decline from FY16 when 87% had not experienced this resource. |
| **Most R-JSHS students were more aware of and had positive views of Army/DoD research after participating in JSHS.** | A majority of R-JSHS students indicated that they were more aware of Army or DoD STEM research and careers after participating in JSHS and that they have a greater appreciation for Army or DoD STEM research. About half of R-JSHS students also indicated that they were more interested in pursuing a STEM career with the Army or DoD after participating in JSHS. |
| | The majority of JSHS students strongly agreed or agreed to statements about DoD researchers such as "DoD researchers solve real-world problems" (78%), "DoD research is valuable to society" (67%), and "DoD researchers advance science and engineering fields" (79%). Level of agreement with these statements had increased since FY16 by 8-10%. |

## Responsiveness to FY16 Evaluation Recommendations

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

Evaluation recommendations from FY16 made to programs are highlighted along with a summary of efforts and outcomes reflected in the FY17 APR toward these areas.

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

**FY16 Finding:** In FY17 JSHS continued to experience a decrease in applications and participation in the program overall – which represents a three-year downward trend. For FY17 there were 8,900 applications and 5,300 participants – compared to 9,347 and 5,829 respectively in FY16. In FY17, 34 of the 47 R-JSHS used AEOP's centralized application portal to capture 2,435 of its participants. The rest were self-reported by the remaining regions. This is an area that is in need of focus for FY18. We suggest as an example a couple of 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. For example, most participants at the Kentucky regional site visit were from the greater Louisville region – with very little to no representation from other central and

southeastern parts of the state. We suspect this may be the case for other regional sites. JSHS may also consider utilizing electronic formats to grow participation in JSHS from remote locations – similar to an eCybermission model – for the future. Additionally, it is recommended that JSHS provide the Regional Directors a forum to share best practices in both program administration as well as infusing information about AEOP programs and DoD research and careers into programming.

In addition to increasing participation overall – JSHS should also continue and expand efforts to provide outreach to prospective participants from underserved populations. JSHS participants remained predominantly White or Asian in FY17, as nearly half (45%) of students identified themselves as White with another 22% identifying themselves as Asian. 21% of students chose not to report their race/ethnicity, 4% identified themselves as Black or African American and 6% as Hispanic or Latino. Native American students comprised .3% of the students reporting their race/ethnicity, while .3% identified as Native Hawaiian or Pacific Islander. JSHS should examine housing regional sites within areas that provide great representation of potential diverse JSHS participants and work with regional directors to specifically target schools that have not been well represented in JSHS.

R-JSHS participants reported having experience with STEM activities within JSHS. However, most reported that they were able to use STEM practices more frequently in school than in JSHS. This should be an area of focus for JSHS and AAS should consider providing specific suggestions/guidelines/handbook to regional sites on how to include STEM practices within the programming for R-JSHS. Further, almost half (40%) reported large gains in their STEM knowledge, STEM competencies, and 21st Century Skills after participating in JSHS. In FY17 most participants did not feel that JSHS impacted their abilities to do STEM and associated knowledge. This is another data point that illuminates a need to provide more guidance and structure to the JSHS programming – particularly at the regional level – to ensure that participants are gaining these valuable experiences and abilities during the program.

Program provided/collected demographic data on participants was incomplete, as in FY15 and FY16. It is strongly suggested that JSHS require regional sites to collect full demographic data on all participants – ideally through Cvent in FY18.

**JSHS FY17 Efforts:**

- Continued to grow and expand student participation in JSHS by leveraging the reach of JSHS regional sites to encourage and invite student participation in STEM. R-JSHS used a variety of techniques to reach out to high schools within the geographic area served and invite participation in R-JSHS.
- Targeted outreach and marketing efforts to high schools, statewide teacher associations, regional and state science fairs, STEM affinity groups, internal and external apprenticeship programs, and collaboration with the network of high schools represented in AEOP programs and among the Consortium partners.

- AAS developed messaging, webinars, and Outreach Toolkit for regional symposia to communicate best practices, recruitment strategies and timelines.
- Coordinated with LO to integrate strategic partners from underrepresented groups.
- Shared best practices employed by regions to reach and engage underrepresented students through routine messaging to Regions, conduct of webinars and resource materials on building partnerships.
- Encouraged JSHS Regional Symposia to collaborate with internal and external partners which prepare underrepresented students for success in STEM. Partners included underrepresented school districts, internal and external programs such as Project Trio, Upward Bound, US 2020, Society for Black Engineers, American Chemical Society's Project SEED, other internship programs. See list of additional JSHS partners by R-JSHS at Attachment 2.
- Developed JSHS nominee criteria under the Presidential Scholarship Program to recognize students who achieved high academic success despite challenges or hurdles to success.

**JSHS FY17 Outcomes:**

- JSHS Participation Decline and Recruitment. AAS identified JSHS Regional Symposia with successful recruitment strategies which reach high schools beyond the local area of competition. Additionally, AAS identified JSHS Regional Symposia who had established successful partnerships to identify and expand participation by underrepresented populations.
- In FY 17, AAS developed messaging, webinars, and an Outreach Toolkit to communicate best practices, recruitment strategies and timelines with regional symposia. To connect and develop peer-to-peer networking, the AAS established a ***Best Practices Seminar Series*** to feature presentations by regional symposia directors and strategic outreach partners. Two BPS sessions were hosted by the AAS via web conferencing tools with presentations on "Outreach to Underrepresented Populations," and Judging.
- Purdue's evaluation report singled out the Kentucky JSHS as an example of a regional symposium which served high schools within close proximity of the regional location. Purdue recommended that AAS support expanded outreach efforts; yet, AAS is aware that Kentucky, and some other rural regions such as Kentucky are already engaged in significant outreach efforts. According to reports from the University of Louisville to AAS, Kentucky publicizes JSHS through the Kentucky Science Teachers Association; yet, participation has not grown. "Kentucky states that many rural schools do not have the capacity to engage in competitive STEM projects appropriate for JSHS." West Virginia's outreach efforts in the last two years have been significant with no growth in participation. West Virginia has conducted visits by graduate students to high schools, partnered with two science and engineering fairs (state and Panhandle) and another STEM outreach program (WV SPOT), developed a website, and distributed AEOP and JSHS materials to targeted high schools, including underrepresented high schools. AAS has engaged with both of the above-

mentioned regions to discuss support for increased participation in JSHS. The West Virginia Regional Director commented that they are a small region but deserve the opportunity to be affiliated with the JSHS Program. "The support of JSHS provides access to one of the few available STEM opportunities available for West Virginia students." It is clear in the above two examples, that increased outreach efforts alone will have limited success. The AAS will engage with Kentucky and West Virginia, and other regions with similar challenges, to identify opportunities to provide meaningful programming activities to attract expanded student participation.

- JSHS Participation Data Inconsistencies. Each of the 47 JSHS Regional Symposia manages their registration process and has established administrative procedures which impact data collection. Implementing CVENT in 34 regions has allowed more consistency in data metrics and collection of student applications. Regions which did not use CVENT were requested to include the exact language for the AEOP common questions, demographic questions and their responses as published in CVENT to encourage consistency in data collection across all regions. The independent and unique structure of each regional registration process results in inconsistencies in the data collection, due to the pool of participants included and in the format in which data driven questions are phrased. Another contributing factor to data discrepancy is that all data from participants at the regional and national levels are self-reported. The AAS will work to normalize the participant population required to register and report data by all regions in FY18. While JSHS Regions are collecting data on student applications, the data does not report on the broader impact of JSHS.

- In many states, pre-qualifying events are held that require students to progress in local and school wide competitions to advance to the Regional event. Data is not captured on participation in the pre-qualifying event. Clear-cut examples are seen through JSHS Sub-regions in the States of Alabama, Minnesota, and New York. However, there are many pre-qualifying school events where data is not captured. For example, Virginia states that participating Governors' schools in Virginia have 50 or more students in a classroom doing research projects. In other JSHS regions, the regional director may limit the number of participants who may advance to the regional event. Establishing a quota for the number of student participants by school may be considered due to space limitations or to avoid one school's domination and representation in the event.

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

**FY16 Finding:** In FY16 JSHS participants continued to report dissatisfaction with judging practices and judging feedback at regional competitions – a finding that has been reported in FY14, FY15, and FY16 as well. There were several data points that reinforced this finding, from the R-JSHS survey to N-JSHS focus group sessions and the N-JSHS survey. Participants reported not being satisfied with the quality of and amount of feedback provided from judges – including receiving no written feedback from judges. Further,

participants felt that the judges were not content experts and that they were judged primarily for their presentation skills rather than the actual content and focus of their research project. As has been recommended in previous years, JSHS should develop and implement guidelines for judging that include templates for providing feedback (written and oral) to participants. Further, regional sites should make every effort to have judges that reflect the breadth and depth of STEM content that participants may focus on as much as possible. STEM experts as well as Army/DoD STEM experts should be sought to engage in R-JSHS events. Virtual judging processes that may enable more qualified STEM judges to participate may be a potential strategy – along with virtual competitions for those that are regionally unable to participate.

**JSHS FY17 Efforts and Outcomes:** In FY16, the AAS facilitated an intentional discussion about the topic of judging at the Annual Meeting of Regional Directors and received recommendations to strengthen the judging process. In FY17, the AAS reinstituted the Regional Directors Advisory Council (RDAC) and met to review and revise judging policies and the rules of competition for FY17. The judging revisions have been published in the National guidelines and were distributed to all regional directors through email and website publications. A Best Practice Sharing Seminar (BPSS) on the JSHS Judging Process was also hosted by the AAS in FY17 with presentations on National JSHS rules of competition and judges' recruitment delivered by the Chair of the National JSHS Judging Committee. Regional directors requested that the AAS replicate the PowerPoint files used in the seminar for use by regional symposia in training judges. These were distributed via email and the seminar posted online for reference.

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

**FY16 Finding:** As in FY15 and FY16, less than 50% of JSHS participants agreed that JSHS made them more aware of other AEOPs and only 46% were interested in participating in other AEOPs. Additionally, only 15% of JSHS participants had used the AEOP website and fewer had used social media related to AEOP (9%). Further, only 13% of participants had been provided with the AEOP brochure. Most mentors did not discuss AEOPs with participants – as only 23% discussed Unite, 14% SMART, 12% eCybermission, 11% SEAP, 10% URAP, 10% REAP, 9% HSAP, 5% CQL, and 6% NDSEG Fellowship. These findings are concerning, primarily because these are areas that AAS could address through collective and organized marketing efforts for JSHS. In FY18 AAS should share materials with participants (i.e. brochures, handouts) as well as instructional resources for regional sites (mandatory) to go through with all regional site participants during the overview/orientation session prior to competition or at the conclusion (e.g. slides, speakers). Promotion of the AEOPs should be collective responsibility of each and every program within the consortium.

The majority of participants in R-JSHS (78%) in FY17 reported learning about STEM careers during the program and most (68%) learned about more than one career. However, JSHS did a much less effective job of exposing participants to Army/DoD STEM careers – as only 40% learned about at least one

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

**JSHS FY17 Efforts and Outcomes:**

- The AAS distributes AEOP materials to the JSHS regional symposia for distribution to all JSHS participants, including students, teachers and mentors. The AAS continues to support all AEOP programs through cross-marketing and through social media. In FY17, AAS made pointed efforts to collaborate with the LO and Widmeyer to promote AEOP programs among JSHS participants and alumni. In FY17, targeted communication was sent to alumni to recruit volunteers for eCybermission, for STEM Expo's hosted by both the Army and Navy, and N-JSHS. JSHS participants and alumni were also informed directly by email and social media of the Apprenticeship opportunities available through AEOP. The AAS will continue to distribute branded materials for use by JSHS regional symposia and encourage all regions to include appropriate AEOP language. The AAS has developed a design template for use by R-JSHS in publishing the symposium schedule. The design shows all AEOP/DoD logos properly placed and includes language consistent with JSHS mission and objectives. The design template will be distributed to all R-JSHS for use in FY17.
- Collaborated with the Apprenticeship Program to inform apprentices and invite participation in JSHS.
- Incentivized students through publicizing JSHS scholarship opportunities and other benefits available to participating students.
- Collaborated with Widmeyer, CAM and IPA's to distribute a call to JSHS constituents to apply or volunteer across AEOP programs.
- The AAS continued to collaborate with the Army, Navy and Air Force to identify STEM personnel to participate in regional and national symposia. Travel funds limit participation in regional symposia to those within commuting distance. In FY17, the AAS coordinated a pilot project with RDECOM to showcase Army researchers to student participants. The AAS will continue to explore opportunities to virtually showcase Army/DoD researchers at regional symposia with limited access to resources. With AEOP permission, the AAS will post videos to YouTube and share with JSHS regional sites.
- Recruited and identified a diverse pool of DoD STEM mentors to participate in Regional and National Symposia and showcase experience in pursuit of a DoD STEM career.

- Collaborated with the CAM and tri-service sponsors to develop materials which showcase critical areas of STEM of interest to DoD.
- Collaborated with the AEOP Marketing team to obtain AEOP printed materials and collateral to distribute at regional and national levels.
- Collaborated with the AEOP Alumni team to create profiles on JSHS Alumni and share their experiences with JSHS and DoD STEM careers. Distributed DoD STEM career brochure to R-JSHS.

## Recommendations for FY18 Program Improvement/Growth

Evaluation findings indicate that JSHS experienced success as in previous years. Notable successes for the year include the continued high participation rate for females, growth in percentage of participants that learned about STEM jobs/careers, growth in student reported acquisition of 21st Century Skills and STEM knowledge, and student reported gains in self-confidence and interest in STEM. 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 FY18 and beyond:

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

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

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

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

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

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

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

As in FY17, 59% of R-JSHS participants agreed that JSHS made them more aware of other AEOPs and 55% were interested in participating in other AEOPs. These percentages are slightly improved from FY16 (50% and 46% respectively). However, most mentors did not discuss AEOPs with participants and the percentages decreased in FY17 – as only 21% discussed Unite (compared to 23% in FY16), 14% SMART (compared to 7% in FY16), 12% eCybermission (compared to 8% in FY16), 11% SEAP (compared to 9% in FY16), 10% URAP (compared 4% in FY16), 10% REAP (compared to 8% in FY16), 9% HSAP (compared to 6% in FY16), 5% CQL (compared to 2% in FY16), and 6% NDSEG Fellowship (compared to 3% in FY16). These findings are concerning, primarily because these are areas that AAS could address through collective and organized marketing efforts for JSHS. Widmeyer developed slide decks and other materials should be better utilized by programs to expose participants to other important components of the AEOP pipeline. Promotion of the AEOPs should be collective responsibility of each and every program within the consortium.

The majority of participants in R-JSHS (85%) in FY17 (similar to FY16 78%) reported learning about STEM careers during JSHS. There was also growth in the percentage of participants that learned about at least

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