Evaluation of the Marine Advanced Technology Education (MATE) Center

For the Period of January 1 – December 31, 2016

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Submitted by:

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Evaluation of the MATE Center: 2016
EXECUTIVE SUMMARY


BY: CANDIYA MANN

JULY 2017

The Marine Advanced Technology Education Center (MATE) is one of more than 35 Advanced Technological Education (ATE) Centers supported by the National Science Foundation (NSF). The ATE program promotes the preparation of students for careers in skilled technical occupations. MATE has been funded since September 1997 by NSF to help meet the nation’s growing need for a highly trained technical workforce in ocean-related occupations. The Center’s host institution is Monterey Peninsula College (MPC), in Monterey, California.

Prior MATE Center evaluation reports have concluded that MATE was implementing a program that had gradually grown in strength, refinement and influence to the point where it had a major national impact in its field and that “the cumulative numbers of instructors trained, students deeply involved in exciting learning experiences . . . successful student internships, wide-ranging academic and industry partnerships and related outcomes add up to a convincing picture of MATE’s national prominence.” This evaluation shows evidence that this conclusion continued to hold true, as illustrated by the progress in the MATE Center’s five programmatic goals:

- **Goal 1:** Expand and strengthen academic and industry partnerships and align academic programs with workforce needs.
- **Goal 2:** Research ocean workforce trends, disseminate innovative educational products based on those trends, and encourage the integration of entrepreneurial practices into program activities.
- **Goal 3:** Provide opportunities for students and faculty to collaborate with industry and working professionals.
- **Goal 4:** Provide professional development for college and high school faculty.
- **Goal 5:** Maintain an information clearinghouse.

This final report covers January through December of 2016.
Findings

The evaluation findings indicate that the MATE Center has achieved the expected outcomes.

Goal 1: Partnerships

- **Academic Partnerships:** There are a total of 59 academic partners that have signed an MOU with the MATE Center.
- **Active Academic Relationships:** MATE has over 800 active relationships with academic and information educational organizations.
- **Industry Partnerships:** MATE has nearly 200 active partnerships with industry, including eight new industry partners and one research consortium partner this grant period.
- **MATE Personnel Recruited to Work with National Programs:** MATE works with a variety of governmental agencies and other national programs, including the University National Oceanographic Laboratory System, NOAA, and the Marine Technology Society.
- **General Technology Programs at Partner Colleges Incorporating New Marine Applications into Their Curriculum:** Several of the partners have marine technology programs, including Alpena Community College, Copiah-Lincoln Community College, Northwestern Michigan College, and Cape Fear Community College.
- **International ROV Curriculum Committee:** In February 2016, the third international ROV Competency Project Meeting was held at the Underwater Intervention Conference in New Orleans. Industry and academic partners directed the MATE Center to focus on a strong first year of mechatronics education for students and to research sensor technology in the ocean industry.

Goal 2: Workforce Information and Educational Products

- **Satisfaction with Career and Educational Resources:**
  - Reviews of the MATE textbook have been extremely positive. According to the web survey of textbook users, 66% rated the book as “excellent”; 80% had used the book to educate others (2,048 individuals); and 70% had used the book to build at least one ROV (239 ROVs reported). Respondents provided comments such as, “It is the best reference on the market.”
  - Resources on the MATE website were rated highly (89% “excellent” or “good”, N=90). Materials were used as part of in-school classes (52%), out-of-school clubs (59%, N=76), and to develop new curricula (54%, N=72).
- **Curriculum Development:** Over 100 modules and videos have been developed for a beginning, intermediate, and advanced underwater robotics.
- **SeaMATE:** SeaMATE is a social enterprise, where community college students gain income, work experience, and professional connections as they build ROV kits and other products used in marine technical education. In 2016, the online store brought in
$423,124 in revenue. Since its inception, SeaMATE has involved 41 students, sold over 4,000 kits, and served over 1,500 customers.

**Goal 3: ROV Competition**

- **Background:** The 2016 ROV Competition consisted of 27 regional events and one international competition.

- **Number of Students and Teams:** A total of 637 teams representing 52 elementary schools, 219 middle schools, 253 high schools, 12 community colleges, 82 universities, and 19 “other” organizations (e.g. home schools, 4-H clubs) registered to participate in either the international competition or one of the regional contests that fed into the international event. This included 5,404 students.

- **Increased Awareness of STEM Careers:** After building their ROV, 79% of the students (N=2,148 in 2016) indicated that they knew more about STEM careers.

- **Increased Interest in STEM Careers:** Over three-quarters of the students (77%, N=2,149) stated that their ROV project made them more interested in a STEM career, and 87% of the teachers (N=342 in 2016) observed an increase in their students’ interest in pursuing a STEM career.

- **Increased Interest in STEM:** Over three-quarters of the students (85%, N=2,137) indicated that their ROV project made them want to learn more about STEM. Ninety-six percent (94%, N=343) of the teachers and 96% of the parents (N=431 in 2016) observed greater interest among the students in learning STEM subjects.

- **Increased STEM Knowledge & Skills:** Students reported increased skills and knowledge due to their ROV project in several subjects: engineering (92%, N=2,127), technology (91%, N=2,123), science (81%, N=2,131), the competition theme (73%, N=2,112), and math (63%, N=2,118). The majority of the teachers (99%, N=342) observed improvements in their students’ STEM knowledge and skills. Parents reported that building an ROV contributed to improving their children’s grades in engineering/robotics (73%, N=335), science (57%, N=423), math (45%, N=421) and computers (54%, N=354).

- **Increased 21st Century Skills:** Students reported that participating in the ROV project improved their problem solving (84% agreed or strongly agreed, N=2,124), teamwork (85%, N=2,130), critical thinking (82%, N=2,119), leadership (70%, N=2,118), and organization skills (67%, N=2,113). Ninety-eight percent (98%, N=304) of the teachers observed increases in their students’ skills in team building, problem solving, and/or critical thinking. Parents reported that due to the competition, their children were better problem solvers (95%, N=431), critical thinkers (93%, N=423), team members (96%, N=431), and/or leaders (90%, N=429).

- **Increased Parental Support of Their Children’s Interest in STEM:** Ninety-four percent (94%, N=425) of the parents indicated that participation in the ROV program changed how they envisioned their child’s future, making it easier to picture their child with a STEM career.
• **Overall Opinions of ROV Program:** The ROV program was rated positively (excellent or good) by 89% of the students (N=2,153), 100% of the teachers (N=348) and 99% of the parents (N=430).

• **Repeat Competitors:** Analysis of registration data shows that in 2016, 38% of the students had participated in the competition for more than one year. Compared to one-time competitors, repeat competitors reported that their participation in the ROV program resulted in higher levels of awareness of and interest in STEM careers, gains in interest in taking STEM courses, improvements in STEM knowledge and skills, increased 21st Century skills, and the receipt of awards, honors, and new educational and career opportunities.

• **Influence on Students’ Educational and Career Paths:** Preliminary ROV competition student alumni survey results include the following:
  
  o Among the 220 alumni who earned a college degree, 85% earned a degree in a STEM discipline.
  
  o Among the 236 current college and university students, 85% are studying towards a STEM degree.
  
  o Among the employed alumni (N=320), 73% are currently working a STEM-related job, and 22% currently or previously worked a job related to ROVs or other underwater technologies.
  
  o Two-thirds (67%, N=432) of the alumni credit the ROV competition with influencing their educational or career path “to a great extent” or “somewhat”.
  
  o The ROV competition played a role in alumni attaining employment (37%), admittance into educational programs/college/university (36%), internships (30%), awards (21%), and scholarships (21%).

• **Student Educational Follow-up:** National Student Clearinghouse (NSC) data showed that 66% of the enrolled students (N=1,798) were in a STEM major. The most popular STEM major was engineering (27%). A total of 708 alumni earned 975 degrees, ranging from certificates to doctorates. A total of 76% of the degrees were in STEM disciplines (N=734). Again, the most common STEM category was engineering (33%). By comparison, only 1% of Bachelor’s degrees nationwide were in engineering technologies.

**Goal 3 Continued: Internship Program**

In surveys following the internship, the great majority of students (N=11) said:

• They felt the internship prepared them for future jobs in the field of marine technology (91%);

• The internship increased their confidence working on technical (100%) and scientific (73%) problems;

• They felt the internship was a valuable learning experience (100%);
• They enjoyed working at sea (100%); and
• They would recommend the MATE technical internship program to other students (100%).

The majority of internship mentors (N=10) indicated that:

• Their interns gained skills that increased their employability (100%);
• They would mentor another MATE intern in the future (91%); and
• They were satisfied with the process of hiring an intern (91%).

Also, 91% of the mentors said they would hire their intern as an entry-level employee. Seventy-three percent (73%) of the interns (N=11) stated that job opportunities opened up due to their internship. Four interns accepted employment offers after the internship.

Goal 4: Summer Institutes

The MATE Center held two ROV Summer Institutes in 2016. One introductory Institute, funded by an ITEST grant, and one intermediate Institute, funded by the ATE grant. The intermediate Institute results will be reported here, since this report focuses on the ATE grant. All of the intermediate Institute one-year follow-up survey respondents (100%, N=20) rated the usefulness of the Institute as “excellent” or “good” overall. The majority of the respondents said that based on what they had learned at the Institute, they had:

• Modified the content of their curriculum (90% a great deal or a fair amount),
• Modified their teaching strategies (65%),
• Shared what they had learned with other instructors (74%) and/or students (100%), and
• Used the ROV program to address state-mandated standards (77%).

The participants reported that the Institutes had...

• Helped them better understand the current technologies used in the marine field (95% agree or strongly agree) and
• Provided them with valuable ideas that they are using in their courses and programs (100% agree or strongly agree) and instructional materials that will improve their students’ preparedness for ocean-related occupations (100%).

Since the Institute,

• 90% of the participants have built 158 ROVs with a total of 620 students and
• 84% have developed a new course or improved a course or club, serving 602 students.

Goal 4 Continued: Diving into Sensors Online Course
The Diving into Sensors online course was piloted in 2015 with 63 faculty participants. In 2016, 41 people took the course. The survey data below is from the 2015 course:

- The course was rated positively by the majority of participants: 39% excellent, 46% good, 11% fair, 5% poor, 0% very poor.
- On a scale of zero (no knowledge) to seven (expert), respondents gained an average of more than one category in all topics except for basic electronics. The lower gains in this area could be because students entered with greater knowledge in this area.
- The greatest gains were in Arduino, voltage dividers, sensor technology, and microcontrollers.
- Based on what they learned in the course, 90% of the respondents intend to modify their curriculum, and 86% intend to modify their teaching strategies. Over half the participants (58% yes, 32% maybe, 5% no) plan to use parts of the course with students.

Goal 5: Information Clearinghouse

MATE information and resources have been disseminated widely, for example:

- From January to December 2016 the website, www.marinetech.org, was accessed by 106,899 users (both new and returning), 50% of whom were new visitors.
- The MATE Center, its programs, and/or partners published or were featured in 34 articles published in newspapers, newsletters, and professional journals, such as the MTS Journal.
- MATE Center staff, faculty from MATE partner colleges, summer institute participants, and industry professionals acting on behalf of MATE presented at seven industry and academic conferences. Additional outreach and dissemination was performed at professional meetings, community events, and outreach activities.
- In 2016 the MATE Center supported partners who hosted 22 workshops and events (ranging from a half-day to two days) for approximately 15,000 faculty, students, and community members.
- The winners of the 2015 MATE International ROV Competition – RANGER Class: team Amno and Co, from Seattle – attended the White House Science Fair April 13, 2016, where they met President Obama.
- The MATE Center began writing and distributing an online newsletter in December 2016. The newsletter is currently distributed to 13,345 individuals.
INTRODUCTION

The Marine Advanced Technology Education Center (MATE) began operations on September 15, 1997 as a National Center funded by the National Science Foundation’s Advanced Technological Education (ATE) program. MATE’s mission is to improve marine technical education and thereby to enhance the preparation of technicians who enter America’s marine-related workforce. In the long run, MATE hopes to:

- Meet the needs of the marine industry for appropriately trained and diverse technical professionals in the marine workforce.
- Help community colleges, and, increasingly, high schools and four-year institutions, put into place the curriculum and instruction needed to provide a marine science and technology education aligned with workforce needs for all interested students.

The MATE Center has identified five major goals whose achievement will enable the Center to achieve its mission:

**Goal 1:** Expand and strengthen academic and industry partnerships and align academic programs with workforce needs.

**Goal 2:** Research ocean workforce trends, disseminate innovative educational products based on those trends, and encourage the integration of entrepreneurial practices into program activities.

**Goal 3:** Provide opportunities for students and faculty to collaborate with industry and working professionals.

**Goal 4:** Provide professional development for college and secondary school faculty.

**Goal 5:** Maintain an information clearinghouse.

The evaluation is charged with providing formative feedback to MATE, interim formative reports to MATE, NSF and the MATE National Visiting Committee (a national advisory group), and interim and final summative assessments of MATE’s achievements. This final report covers January through December of 2016.
METHODOLOGY

The evaluation connects each of the Center goals with evaluation questions and expected outcomes of the project. These goals and evaluation questions are presented below.

Table 1: Project Strategies and Research Questions

<table>
<thead>
<tr>
<th>Goal 1: Expand and strengthen academic and industry partnerships and align academic programs with workforce needs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Has MATE collaborated with a broad spectrum of partners to develop competencies for 1) a yearlong foundational curriculum and 2) a year-long ROV certificate/degree? Has the assessment bank been developed? How many community colleges agree to align their existing programs and/or develop new programs aligned with the foundational and ROV competencies and assessments? How many courses, programs, faculty, and students are impacted by these competencies and assessments? How are retention and completion rates affected?</td>
</tr>
<tr>
<td>1.2. Has the ROV competency passport system been endorsed by major ROV industries? How many colleges have been endorsed to validate competencies for the passport? How many students receive passport “stamps” confirming development of how many competencies? Do colleges find that the graduates with passports have higher employment rates than similar students without passports? To what extent do the graduates find that the passports are valuable in documenting their skills and facilitating career progress? Do employers take the passports into consideration when making hiring decisions? To what extent do employers find that the passport holders possess “job ready” skills?</td>
</tr>
<tr>
<td>1.3. Is the number of MATE substantive academic and industry partners increasing?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goal 2: Research ocean workforce trends, disseminate innovative educational products based on those trends, and encourage the integration of entrepreneurial practices into program activities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1. To what extent do the SeaMATE student workers develop improved self-efficacy, leading to high levels of persistence in their pursuit of a STEM career? To what extent do they develop the job readiness skills that employers seek, including 21st Century Life and Career Skills1? How does involvement in SeaMATE impact their performance in their STEM coursework and their educational and career path? How do employers value this experience when making hiring decisions? How do employers rate the student workers’ readiness to be productive employees after they are hired? How many students and colleges participate in the SeaMATE social enterprise? How much revenue does SeaMATE generate to support STEM educational activities?</td>
</tr>
<tr>
<td>2.2. Do educational partners find that the MATE workforce and educational resources meet their needs? Are partners using these materials to modify curriculum?</td>
</tr>
</tbody>
</table>
Goal 3: Provide opportunities for students and faculty to collaborate with industry and working professionals.

3.1. To what extent did participating in the ROV program lead to an increase in the students’ interest in STEM and STEM careers? Did educators and parents observe an increase in the students’ interest in STEM and STEM careers as a result of the program? An increase in the students’ STEM knowledge and skills and 21st Century skills? Did the ROV program lead to an increase in the parents’ support of their children’s interest in STEM careers? How does involvement in the ROV program affect college students and graduates’ employment?

3.2. What are the educational and career trajectories of ROV competition participants and interns? To what extent do they pursue STEM postsecondary studies and employment?

3.3. What are the patterns of student involvement in the competition? Repeat competitors? Students who progress through the pipeline, moving up ROV classes (there are 4 levels), then becoming team mentors, judges, and industry employees?

3.4. Were the interns well-prepared upon entering the internships, and did they have the necessary technical and interpersonal education to successfully complete the internship? Did the students gain the skills and knowledge during the internship that were relevant to their interests and career goals and directly related to industry-driven knowledge and skill guidelines (as developed by the MATE Center and industry professionals)? Did the students who participated in the internship program continue their education at two-year or four-year institutions or enter STEM employment after the internship?

Goal 4: Provide professional development for college and high school faculty.

4.1. Did attendance at the Summer Institutes and online workshops lead to an increase in faculty understanding of the ocean workforce and the knowledge and skills needed to enter the workforce?

4.2. After the Summer Institute and online workshops, did participants share their new knowledge with their students and colleagues? Did they modify their curriculum and/or teaching strategies based on information received during the Institutes? Did they specifically integrate ROV building into their course(s) or club activities?

Goal 5: Maintain an information clearinghouse.

5.1. To what extent is marine technology education and workforce information disseminated through the web site, listserv, Constant Contact, journal articles, conference presentations, and ATE Central? How many resources are shared? How many people are impacted by these resources? How are the resources used? Do they meet the needs of the partners, faculty, students, and other stakeholders?
DATA SOURCES

The evaluation relies upon multiple sources of data. The data collection includes input from a variety of stakeholders, including students, teachers/instructors, parents, judges/volunteers, regional coordinators, student interns, internship mentors (hosts), textbook users, sensor course students, and MATE management. Below are descriptions of each of the data sources. All of the surveys were developed in collaboration with MATE PIs and staff.

ROV Competitions

At the ROV competitions, input was solicited from as many stakeholders as possible, including students, teachers, parents, and judges/volunteers. The competition surveys were primarily paper surveys in a “scannable” format. Online versions of the survey were available for the competition sites that had computer facilities for onsite survey administration. Data entry was completed by scanning the surveys and entering the written comments by hand. Data analysis was performed with the Statistical Package for the Social Sciences (SPSS). The student and parent surveys were available in Spanish.

In 2014-2015, the MATE Center began a valuable collaboration with Dr. Min Li, Associate Professor at the University of Washington’s Department of Education. In 2014-2015, Dr. Li focused on validating the competition scoring rubrics, aligning the student competition manual with scoring rubrics, and improving the internal consistency of the post-competition surveys. In response to Dr. Li’s analysis, the scoring rubrics were updated, as were the student and parent surveys. This work was funded through an NSF ITEST grant. Please see the 2014-2015 MATE Center ITEST Evaluation for Dr. Li’s summary of work conducted in 2014-2015. In 2015-2016, Dr. Li analyzed the data from the revised surveys and confirmed that no further changes were needed.

ROV COMPETITION SURVEY: STUDENTS

At the ROV competitions, students were asked to complete surveys. The survey protocol was a modified version of the student survey that has been administered to more than 6,500 students over the past eight years at regional and international ROV competitions. The survey covered the following topics: awareness and interest in ocean STEM careers, increased desire to take STEM courses due to involvement in the program, awards/honors received as a result of competition experience, and self-assessment of change in STEM knowledge.

ROV COMPETITION SURVEY: TEACHERS/INSTRUCTORS

Teachers also completed surveys at the ROV competitions. The survey protocol was a modified version of the faculty/mentor survey that has been administered to more than 1,350 respondents over the past eight years at ROV competitions. The survey addressed topics such as the value of the competition, incorporation of competition into course curriculum, interest in participating in future competitions,
assessment of change in their students’ STEM knowledge and skills, 21st Century skills, interest in STEM careers, and related topics.

ROV COMPETITION SURVEY: PARENTS

In contrast to the student and teacher surveys, which have been conducted for years at MATE ROV competitions, the 2010 competition season was the first time parent input was solicited. Parents responded enthusiastically and seemed to appreciate the opportunity to provide input. Parent surveys addressed the topics of parental support of their children’s interest in STEM and STEM careers, the value of the competition, and changes they have observed in their children since they became involved in the program. In 2015-2016, 440 parents and other family members (such as grandparents) completed the survey.

ROV COMPETITION SURVEY: JUDGES

In the 2011 competition season, input was solicited for the first time from industry representatives serving as judges at the competitions. This survey collects information on the judges’ experience at the competition, whether they feel it was a worthwhile use of their time, the skills of the students they observed, and their opinions on the usefulness of the competition in preparing future employees. In 2015-2016, 169 judges and 109 volunteers completed the survey.

ROV COMPETITION STUDENT ALUMNI SURVEY

Background: The goal of the alumni survey was to answer the questions: “Where are they now?” and, “To what extent did their involvement with MATE influence their trajectory?” The survey included questions about their higher education, employment, internships, scholarships and other opportunities that opened due to their involvement with the ROV competition.

2014-2015 Progress: The web survey attempted to contact all former competition student participants who were at least 18 years old at the time of the survey. This was complicated by several factors:

- Birthdates entered in multiple formats,
- Unclear identification of student and teacher/mentor status in several competition years, and
- Students often provided parents’ or teachers’ email addresses. Alternately, they provided their school addresses, which were not active after they left that school.

To resolve the uncertainty created by the first two above factors, two screening questions were added to the beginning of the survey.

1. “This survey is designed for people who are at least 18 years of age. Are you at least 18 years old today?” The response options were yes and no. Respondents who marked “no” were filtered out of the survey.
2. “How have you participated in the MATE ROV Competition program? [Mark all that apply.]” The response options were: student on a team, instructor leading a team, judge at a competition, classroom/club mentor assigned to help other teams, and other. Respondents who did not mark “student on a team” were filtered out of the survey.

The survey was programmed into Qualtrics, and quality control was done by the evaluation team, as well as the MATE PIs. The survey was launched on June 16, 2015, with email invitations to 8,544 email addresses. Email reminders were sent to the non-respondents on June 22 and 29, 2015. The survey remains open. The disposition thus far consists of the following:

Of the 8,544 email addresses...

- 1,081 bounced
- 156 possible respondents opted out, including several who contacted the evaluator to explain that they were parents or teachers
- 118 surveys were partially completed
  - 16 were filtered out because they were under age 18
  - 21 were filtered out because they were not a student
  - 79 student alumni over age 18 partially completed the survey
- 626 surveys were completed
  - 109 were filtered out because they were under age 18
  - 85 were filtered out because they were not a student
  - 432 student alumni over age 18 completed the survey

The response rate was calculated using the Response Rate 4 (RR4) calculation from the American Association of Public Opinion Research’s 2011 Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. 7th Edition.

\[
RR4 = \frac{\text{Completed} + \text{Partially Completed}}{\text{Completed} + \text{Partially Completed}} + (\text{Refusals} + \text{Noncontact} + \text{Other}) + e(\text{Unknown})
\]

\[
e = \frac{\text{Known Eligible Sample}}{\text{Known Eligible Sample} + \text{Known Ineligible Sample}}
\]

\[
e = \frac{432 + 79}{432 + 79 + 109 + 85 + 16 + 21} = 0.511 / 0.742 = 0.689
\]

\[
RR4 = \frac{626 + 118}{626 + 118} + (156 + 1,081 + 0) + 0.689 (7,644) = 0.744 / (744 + 1,237 + 5,267) = 744 / 7,248 \approx 0.102 = 10.2%
\]

With this calculation, the preliminary response rate was 10.2%.
To determine whether the respondents were representative of the population, researchers intended to compare respondent demographics with population demographics. Unfortunately, good sources of population demographics are not available for the entire population of the competition (competition years 2006-2014). The demographics of the survey respondents are detailed below, along with the available sources of population demographics.

- The survey respondents were 28% female; 33% were of minority backgrounds; and 3% had a disability. (See Figure 1 below) It appears that the respondents are representative of the population by gender and disability, but the responses of the white students may be over-represented in the survey results.

- The AlumniWeb registration system did not collect student demographics on an individual basis (only a team basis) prior to 2013. This oversight has been rectified, and in 2013 and 2014 (which account for roughly half of the population or 4,054 of 8,544 email addresses), 28% of the students were female, and 46% were minority. Information on student disability was not collected in AlumniWeb.

- The student post-competition surveys are another source of demographic data. Prior to 2011, the post-competition surveys were only administered at the MATE International ROV Competition; beginning in 2011, coverage was broadened, and the post-competition surveys were administered at regional competitions. Between 2011 and 2014, the student demographics on the post-competition surveys (N=6,669) included a total of 28% female students, 40% minority, and 3% with a disability.¹

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¹ Student demographics from 2011-2014 post-competition surveys: 2014 competition: 29% female, 40% minority, N=1,442; 2013 competition: 29% female, 38% minority, N=1,733; 2012 competition: 29% female, 41% minority, N=1,878; 2011 competition: 26% female, 39% minority, N=1,616.
Once the National Student Clearinghouse data match and the Washington State follow-up are completed, the results will be compared with the alumni survey to look for consistencies/inconsistencies in student demographics as well as student follow-up results (e.g., college attendance, completion, and pursuit of STEM degrees).
NATIONAL STUDENT CLEARINGHOUSE DATA MATCH

Background: The National Student Clearinghouse (NSC) is a nationwide source of higher education information. Colleges and universities, numbering over 3,400 institutions enrolling over 96% of college students, share their enrollment data with NSC. The NSC database includes over 130 million students. See http://www.studentclearinghouse.org/ for further information about the NSC.

A total of 3,974 former competition participants (aka “alumni”) were identified for matching with National Student Clearinghouse (NSC) data in the May of 2017. These alumni have birthdates that indicate that they are at least 18 years of age as of May 2017, and their addresses suggest that they live within the United States. Two-thirds of the alumni (66%, or 2,633) were found in the NSC database.

Summer Institute

IMMEDIATE FEEDBACK AND SIX-MONTH FOLLOW-UP SURVEYS

The evaluation of the Summer Institutes is a two-step process, collecting feedback from the participants immediately after the Institute (using the Institute feedback surveys) then again one year later, after the regional ROV competitions (using the Institute follow-up surveys). The follow-up surveys intend to measure the Institutes’ longer-term impact and, in particular, to compare participants’ actions once they returned to their classrooms with the intentions they had expressed at the close of the Institute.

Internship Program

INTERN AND MENTOR SURVEYS

After their internship, the student interns complete surveys covering their acquisition of knowledge and skills, their rating of the support provided by the internship host and the MATE Center, and how their educational and career aspirations have changed due to the internship experience. The intern mentors (hosts) also complete post-internship surveys. They provide feedback on the intern’s preparation, performance, effort level, skill development, whether they would hire the intern, and whether hosting the intern was beneficial to the organization.

Curriculum, Textbook, and Online Resources

TEXTBOOK USER SURVEY

In 2010, the MATE Center released a textbook, Underwater Robotics: Science, Design, and Fabrication. In September of 2014, textbook purchasers were invited to complete a one-time web survey. Of the 386 survey invitations emailed, 6% bounced (23), 1 individual requested to be removed from the survey, and 45 individuals completed the survey, for a response rate of 12%. Respondents provided information on whether and how they had used the book, how many ROVs they had built where the design was
influenced by the book, how many people they had educated with the book, how they would rate the book, and suggestions for other resources they would like the MATE Center to develop.

**ONLINE RESOURCES SURVEY**

With the increased focus on the online resources provided by the MATE Center (instructional videos, PowerPoints, activities, kits, etc.), the evaluation shifted focus to assessing user satisfaction and usage of the online resources. Website users must register to gain access to the online resources. On June 18, 2015, an email invitation was sent to the website registrants who registered or accessed the website between September 2013 and June 2015, a total of 1,995 registrants.

Of the 1,995 emails sent:
- 93 emails bounced
- 19 opted out
- 113 surveys were started
- 106 surveys were completed (5.3%), and 91 respondents had viewed or downloaded resources from the MATE Center website.

The response rate was calculated using the Response Rate 4 (RR4) calculation from the American Association of Public Opinion Research’s 2011 *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. 7th Edition*.

\[
RR4 = \frac{(Completed + Partially Completed)}{(Completed + Partially Completed) + (Refusals + Noncontact + Other) + e(Unknown)}
\]

\[e = \frac{(Known\ Eligible\ Sample)}{(Known\ Eligible\ Sample + Known\ Ineligible\ Sample)}\]

\[e = \frac{91}{91 + 15} = \frac{91}{106} = .858\]

\[RR4 = \frac{(106 + 7)}{(106 + 7) + (19 + 93 + 0) + .858 (1,863) = 113 / (113 + 112 + 1,598) = 113/1,823 = .062 = 6.2\%}\]

With this calculation, the preliminary response rate was 6.2%.

**Other Data Sources**

Additional data sources informing the evaluation include the annual reports turned in by the regional coordinators to the PIs, review of participation data, unsolicited letters sent to the regional coordinators and the MATE Center from students, parents and teachers, website metrics, and document review, including supporting technical materials and the MATE Center’s annual report.
FINDINGS

This chapter reviews the Center goals and associated research questions. Evaluation results from all applicable data sources are summarized under each research question.

Goal 1: Expand and strengthen academic and industry partnerships and align academic programs with workforce needs.

Evaluation Question 1.1. Has MATE collaborated with a broad spectrum of partners to develop competencies for 1) a yearlong foundational curriculum and 2) a year-long ROV certificate/degree? Has the assessment bank been developed? How many community colleges agree to align their existing programs and/or develop new programs aligned with the foundational and ROV competencies and assessments? How many courses, programs, faculty, and students are impacted by these competencies and assessments? How are retention and completion rates affected?

ROV Competency Project Background

In January of 2014 MATE held a partner meeting in conjunction with the ROV committee meeting at the Underwater Intervention conference in New Orleans. Five MATE partner colleges were in attendance in addition to eight industry representatives. Collectively, the group agreed to work on an international ROV curriculum to align educational programs around the world.

In September 2014 the ROV Curriculum Committee convened at Memorial University in Newfoundland, Canada, and outlined in detail an ROV program that would “1) define the competences for a year-long foundational curriculum in electronics, mechanics, hydraulics, robotics, and computer-controlled systems that will prepare students for ROV technology; 2) define the competencies for a year-long ROV technology certificate/degree program that builds upon the foundational curriculum and that is appropriate for either a completer of the year-long foundational curriculum or a technical professional changing careers; and 3) allow for international articulation of 2-year ROV technology degrees with 4-year Bachelor of Technology degree programs that focus on marine technology.”2 More than 20 educators and industry representatives attended.

MATE held the next ROV Competency Project meeting at the February 2015 Underwater Interventions conference. A total of 32 educators and industry representatives took part in the meeting. The meeting covered “recent changes in the offshore industry, safety in the offshore industry, personality test industry uses to hire workers, and how the ROV Competency project could collaborate with the International Marine Contractors Association (IMCA).”

Oil prices fell throughout 2015 and hit a 15-year low as of January 2016. The low oil prices caused a decline in the demand for offshore oil and gas employees.

Developments in the Current Grant Year

The third international ROV Competency Project Meeting was held at the Underwater Intervention Conference in New Orleans on February 25, 2016. Taking into consideration the current economic trends, industry and economic partners in attendance directed MATE to focus on two areas: “first, advocating for a very strong first year in mechatronics that will make students broadly employable in many sectors of the economy and specifically understand the extent to which mechatronics provides a foundation for marine sector occupations and, second, take a more in depth look at sensor technology as it applies to the ocean industry.”

In alignment with these recommendations, MATE has been working with the Center of Excellence in Marine Manufacturing and Technology to define the characteristics and competencies involved in mechatronics occupations and the continuing education available beyond Associate’s degrees to aid in articulation. In addition, MATE will continue its focus on developing curriculum on sensor technology (see professional development section).

3 See 2015 MATE Annual Report.
4 See 2016 MATE Annual Report.
1.2. Has the ROV competency passport system been endorsed by major ROV industries? How many colleges have been endorsed to validate competencies for the passport? How many students receive passport “stamps” confirming development of how many competencies? Do colleges find that the graduates with passports have higher employment rates than similar students without passports? To what extent do the graduates find that the passports are valuable in documenting their skills and facilitating career progress? Do employers take the passports into consideration when making hiring decisions? To what extent do employers find that the passport holders possess “job ready” skills?

The ROV competency passport system has not been developed. See above, Evaluation Question 1.1, for further details.

**Evaluation Question1.3. Is the number of substantive academic and industry partners increasing?**

*Academic partners:* MATE currently has formal partnerships with 59 community colleges and universities. The formal partners must meet certain criteria and sign memoranda of understanding. These partnerships have resulted in the development new marine technical programs and addition of ROV courses to existing programs. Students graduating from these programs have been placed in industry. For example, the partner Alpena Community College developed a new marine technical program in 2011, and all three of their first graduates were hired by Oceaneering International at the 2014 International ROV Competition. MATE has active relationships with over 800 academic and informal educational institutions. An active relationship denotes participation in a MATE activity within the prior three years, including workshops, competitions, and internships.

*Industry partners:* MATE has nearly 200 active partnerships with industry, including eight new industry partners and one research consortium partner brought in during this grant reporting period. MATE’s partnerships resulted in contributions of $82,135 in funds and more than $1.1 million in in-kind contributions.
Goal 2: Research ocean workforce trends, disseminate innovative educational products based on those trends, and encourage the integration of entrepreneurial practices into program activities.

2.1. To what extent do the SeaMATE student workers develop improved self-efficacy, leading to high levels of persistence in their pursuit of a STEM career? To what extent do they develop the job readiness skills that employers seek, including 21st Century Life and Career Skills? How does involvement in SeaMATE impact their performance in their STEM coursework and their educational and career path? How do employers value this experience when making hiring decisions? How do employers rate the student workers’ readiness to be productive employees after they are hired? How many students and colleges participate in the SeaMATE social enterprise? How much revenue does SeaMATE generate to support STEM educational activities?

In 2012, the MATE Center created SeaMATE. SeaMATE is a social enterprise, where community college students gain income and work experience as they build ROV kits and other products used in marine technical education. The college students gain experience in manufacturing, peer-to-peer training, quality control, entrepreneurship, and networking with marine professionals. A total of 41 students have been involved with SeaMATE from its inception through 2016. SeaMATE is based at Monterey Peninsula College, with additional students at Long Beach City College programming and running the SeaMATE CNC machine for customizing the ROV control boxes.

In 2016, the MATE Center added two more ROV kits, and continued to add ROV accessories to the product line sold through the online store. A total of four kits are now available through SeaMATE. In 2016, revenue was $423,124. The kits range in price from $190 to $640. To date, SeaMATE has sold over 4,000 kits and has served over 1,500 customers.

2.2. Do educational partners find that the MATE workforce and educational resources meet their needs? Are partners using these materials to modify curriculum?

The MATE Center has continued to develop resources, building on the success of its 800+ page textbook, Underwater Robotics: Science, Design, and Fabrication, released in 2010. The textbook was the foundation for the development more than 100 modules for a semester long course on beginning, intermediate, and advanced underwater robotics. (See http://www.marinetech.org/curriculum for the
In addition, the MATE Center has filmed over 30 instructional videos on introductory ROV building.

The MATE website requires users to register in order to gain access to the curriculum (system set up in June 2013). In 2015, 29,857 different users logged in to view the curriculum, videos, and other educational resources; 13,526 users downloaded materials.

In 2016, the MATE Center started to transition the educational resources to Google Slides for quick and easy updating and Canvas Learning Management System for course dissemination. Canvas much greater control of who is using the educational products. There are currently five active courses with over 400 participants.

Survey Results

In the post-competition surveys, 81% of the teachers (N=312) stated that they used MATE materials and resources to incorporate ROV building into their course or club, and 63% modified their curriculum and teaching based on MATE resources.

Sixty-three percent (63%) of the post-competition survey respondents (N=350) incorporated building ROVs into an after-school club. Twenty-five percent (25%) built ROVs as part of a course; 22% built ROVs as a voluntary activity; and 7% built ROVs in another venue.

**Figure 2: ROV Projects in Courses, After-School Clubs, Voluntary Activities, and Other Activities**

![Figure 2](image-url)

In the online resources survey conducted in June of 2015, the resources on the MATE website were rated highly, with 89% (N=90) indicating that the resources were excellent or good (40% excellent, 49% good). The majority of respondents indicated that the online resources were accurate (90% excellent or good), effective learning aides (82%), accessible (70%), clear (74%), and complete (73%). (See Figure 3)

Respondents described the materials in the following comments:
The students really learned a lot when using the resources. They looked so happy and proud of themselves. We felt like MacGyver!

They were clear and easy to follow for my students.

I am a big fan of the videos. My students watched several as they were designing their second ROV.

**Figure 3: Ratings of MATE Online Resources**

Survey respondents noted that the online resources could be improved through refining the organization of the resources on the website. The MATE Center is aware of this deficiency and has plans to improve the website structure for instructional resources.

The online resources were used as part of in-school classes (52%, N=73) and out-of-school programs/clubs (59%, N=76). Over half of the respondents (54%, N=68) developed new curricula or activities based on the MATE online resources. Seventy-one percent (71%, N=72) shared the online resources with others (noting that they shared the resources with a total of 666 other people), and 78% (N=74) built an ROV using the online resources as a reference. Respondents indicated that they built a total of 420 ROVs using the online resources as a reference.

In September 2014, a web survey was conducted of the people who purchased the textbook, and 44 individuals responded (response rate: 12%). Feedback was very positive, and it was clear that the book was a valued resource. Seventy percent (70%) of the respondents had used the book to build 239 ROVs.
Well over three-quarters of the respondents (79%) reported that they had used the book to educate 2,048 individuals.

The textbook was rated very positively, with close to two-thirds (64%) indicating that it was excellent, and approaching one-third reporting that it was good. Only 5% (2 respondents) rated the book as fair. Respondents appreciated the fact that the book is “detailed”, “comprehensive”, and “thorough”. The biggest drawback was the size and weight of the book.

Respondent comments stress the value they find in the textbook:

- *It is the best reference on the market. Every classroom that has marine science should have one.*
- *What I like best about this book is the combination of science with practical application. The pictures are great. Students really understand the science when they can see how to use it as demonstrated in the book.*
- *Easy to follow. GREAT book*
- *It is a wonderful reference book when constructing the machine and it gives background when doing workshops.*
- *The history was first rate. All the examples were great too. I really mean it when I say this is a well written book that is very useful for educators that are using ROVs in the classroom.*
- *Logical layout. Well written. As much information as I need almost all topics. It can be picked up and used as a resource quickly if needed. Broad spectrum of subjects. Current material.*
Goal 3: Provide opportunities for students and faculty to collaborate with industry and working professionals.

ROV Competition

Evaluation Question(s) 3.1. To what extent did participating in the ROV program lead to an increase in the students’ interest in STEM and STEM careers? Did educators and parents observe an increase in the students’ interest in STEM and STEM careers as a result of the program? An increase in the students’ STEM knowledge and skills and 21st Century skills? Did the ROV program lead to an increase in the parents’ support of their children’s interest in STEM careers?5

Increased Awareness of and Interest in STEM Careers: In the post-competition surveys, over three-quarters of the students (79%, N=2,148) indicated that due to their ROV project, they knew more about careers in science, technology, engineering, and math (STEM), and over three-quarters (77%, N=2,149) stated that their ROV project made them more interested in pursuing a STEM career.

Figure 4: Effect of ROV Project on Students’ Awareness and Interest in STEM Careers

5 Evaluation question 3.1 also includes the following: “How does involvement in the ROV program affect college students and graduates’ employment?” This information is supplied under evaluation question 3.2.
Overall, 80% of the students (N=2,125) were interested in a STEM career; 16% were not sure, and 4% were not interested in a career in this field. Students mentioned wanting careers such as computer engineer, marine scientist, mechanical engineer, aeronautical science, environmental scientist, and astronaut (of interest since NASA hosted the international competition at the Neutral Buoyancy Lab). Students noted that their experience in the ROV program sparked their interest in STEM careers, with comments such as the following: “Participating in this program has made me interested on working with underwater vehicles as a career.”

Among the teachers/mentors who completed post-competition surveys, 87% (N=342) indicated that they had observed that their students were more interested in pursuing a STEM career since they began designing and building their ROVs. Ninety-seven percent (97%, N=342) agreed that the ROV program provided a valuable venue to help prepare their students for STEM careers.

**Figure 5: Teacher Observations of Student STEM Career Interest**

Parents also noted an increased awareness and interest in STEM careers; 92% (N=424) agreed or strongly agreed that due to the ROV project, their child(ren) know more about STEM careers (61% strongly agreed, 31% agreed, 7% neutral, 0% disagreed, 0% strongly disagreed, 0.9% don’t know). Also,
88% (N=423) agreed that participating in the ROV project has led their children to be more interested in pursuing a STEM career (61% strongly agreed, 28% agreed, 11% neutral, 0% disagreed, 0% strongly disagreed, 0.7% don’t know). Parents described their children’s interest in STEM careers in comments such as the following:

It helped solidify his career choice (mechanical engineering). Excellent program!

He just absolutely loved it and is strongly considering a career in Marine Engineering.

Increased Interest in STEM: Over three-quarters of the students (85%, N=2,137) stated that their ROV project made them want to learn more about science, technology, engineering, and math (50% strongly agreed, 35% agreed, 12% neutral, 2% disagreed, 1% strongly disagreed). As one student explained his experience, “I never enjoyed anything in STEM until I started underwater engineering in high school and went to MATE regionals.”

Students indicated that their ROV projects increased their desire to take courses in engineering (77%, N=2,146), science (74%, N=2,138), computer science (71%, N=2,132), math (61%, N=2,128), and other hands-on classes or club activities like robotics, electronics and shop courses (87%, N=2,35). (See Error! Reference source not found. below.) One student saw the connection between the competition and his or her courses in the following quotes:

The MATE competition was an amazing experience to have. It has helped me in a lot of school subjects and skills.

In the post-competition survey, 94% of the teachers/mentors (N=343) indicated that their students were more interested in learning about science,
technology, engineering and math (54% strongly agreed, 40% agreed, 6% neutral, 0.3% disagreed, 0% strongly disagreed).

**Figure 6: Effect of ROV Project on Students’ Interest in STEM Courses**

Parents concurred with the other sources reporting increased student interest in STEM. Ninety-six percent (96%) of the parents surveyed (N=431) stated that building an ROV has made their child more interested in learning about science, technology, engineering or math (66% strongly agreed, 30% agreed, 4% neutral, 0% disagreed, 0% strongly disagreed, 0.2% don’t know). Parents wrote comments such as the following:

*She is more interested in problem solving and engineering, and what is happening in the science world today.*

*[My child is] excited about studying robotics/mechatronics in college.*

*This is my second child in the ROV program. My first child is currently a junior in college in electrical engineering due to the influence of the ROV program. My second child is also interested and working towards subjects for engineering.*

*He is completely convinced to study mechanical engineering and more...*

**Increased STEM Knowledge and Skills:** In the post-competition surveys, students reported increased skills and knowledge due to their ROV project in several subjects: engineering (92%, N=2,127), technology (91%, N=2,123), science (81%, N=2,131), the competition theme (73%, N=2,112), and math (63%, N=2,118). Students noted their increased STEM skills in comments such as the following:

*This competition made me twice as good as an electrical engineer.*
I’ve learned about camera systems, mechanical frame designs, electrical system designs, and pneumatic system designs, etc.

This program has vastly improved my knowledge of engineering, technology, science, and teamwork skills.

It has strengthened my relationship with my team members and has made me improve my math, science and engineering skills.

Figure 7: Effect of ROV Project on Students’ STEM Skills and Knowledge

Among the teachers/mentors who completed post-competition surveys (N=342), 99% of the respondents reported that they observed improvements in their students’ STEM knowledge and skills (66% strongly agreed, 32% agreed, 1.5% neutral, 0% disagreed or strongly disagreed).

Parents reported that building an ROV contributed to improving their children’s grades in engineering/robotics (73%, N=335), science (57%, N=423), math (45%, N=421) and computers (54%, N=354).6

Increased 21st Century Skills: Students reported that participating in the ROV project improved their problem solving (84% agreed or strongly agreed, N=2,124), teamwork (85%, N=2,130), critical thinking

6 Percentages are calculated among students studying each topic.
(82%, N=2,119), leadership (70%, N=2,118), and organization skills (67%, N=2,113). Students also reported increased self-confidence (75%, N=2,115).

**Figure 8: Effect of ROV Project on Students’ 21st Century Skills**

In responses to open-ended survey questions, students also described gaining 21st Century skills through their experiences building an ROV, such as the following:

*My experience in this program helped me learn about communication and recognizing my skills as a team member. I am proud to represent my school and myself!*

*I've grown as an adult because of this, which I needed, and value it very much.*

*It made me a better leader and a more mature person.*

*Though our robot didn't complete any mission task, I still learned a huge amount about project management, hands-on applications and working as a team.*

In the post-competition surveys, 99% of the teachers/mentors (N=341) mentioned that they observed increases in their students’ skills in team building, problem solving, and/or critical thinking (60% strongly agreed, 38% agreed, 1% neutral, 0.3% disagreed, 0% strongly disagreed). Teachers/mentors saw skill development in many areas, as evidenced by their written comments:

*We are amazed at the growth we have seen in our girls. Their confidence has grown, their knowledge of the engineering process has really grown, and I think [the MATE ROV competition at] Shedd...had a lot to do with that!*
This experience has allowed my students to grow individually and as team leaders. Thank you!

This is about so much more than robots. Students learn the 21st Century skills we always talk about in education but so rarely actually teach. Fantastic stuff.

My students learned to work well as a group and how to implement critical problem solving skills.

Parents were asked about their observations of changes in their children due to the ROV program. The vast majority agreed or strongly agreed that because of the ROV program, their children were better problem solvers (95%, N=431), critical thinkers (93%, N=423), team members (96%, N=431), and/or leaders (90%, N=429). Ninety percent (90%) of the parents (N=425) reported increased self-confidence in their children. In the open-ended comments, parents noted other changes that they observed in their children, including public speaking, leadership, prioritizing, working under pressure, resiliency, focus, time management, and self-confidence. Comments in this theme include the following:

Wonderful to see him become more self-confident, independent and able to adjust to a variety of situations.

I have seen her become very determined and persistent to finish the project / very willing to work even on weekends or after dinner on her own.

He has grown immensely - self-confidence, maturity, even compassion - his team has even reached out to younger elementary students – He now considers himself a leader.

Her self-confidence has gone through the roof.
Overall Opinions of ROV Program: Overall, students (N=2,153) rated their experiences building and competing with their ROV very positively, with over half (52%) rating their experience as excellent, and 37% providing a rating of good. Nine percent (9%) thought their experience was fair. Two percent (2%) gave the experience a poor rating, and 1% rated it as very poor. (See Error! Reference source not found.) In the post-competition surveys, students wrote comments such as the following:

This program opened my eyes to the world of technology and the use of courses such as math and science in the real world, which are not always taught in school. It made me a stronger team member as I needed to work with others to complete the task at hand and also a stronger leader which is useful both inside and outside the classroom. This opportunity has shown me all the possibilities of jobs surrounding technology, math and science out there.

This program was a pleasure to take part in. I increased my overall knowledge in science, math, and engineering and had hands-on experience...that is very rare in other circumstances. I gained a greater knowledge of how to apply my skills to the real world because of this competition. It improved attributes such as teamwork, self-confidence, independence, and decision-making. This program helped me to develop in many ways, and I will be back for it again next year.
Teachers/mentors (N=348) gave nearly uniformly positive ratings of the usefulness of the competition, with 87% stating that it was excellent and 12% indicating that it was good (0.3% rated the competition as fair and 0.3% provided a rating of very poor.) Teachers/mentors also rated the support provided by the MATE program highly (58% excellent, 35% good, 6% fair, 0.3% poor, and 0% very poor). Teachers/mentors stressed the importance of the program in comments such as the following:

"The program gives students opportunities to learn and apply many new skills (design, engineering, operations, project mgr., marketing) and communication / leadership, that they could never get in the classroom. They are better prepared for college and business or any career.

"Provides an excellent opportunity to develop practical skills to supplement conceptual learning. Develops soft skills - communication, team working, time and resource management. For pupils interested in STEM, the competition fired their imagination, and the problem-solving requirements provide superb contextualized problems and stimulate technological thinking."

Overall, parents gave extremely positive ratings to their children’s experience building and competing with an ROV. Eighty-two percent (82%, N=430) rated it as excellent, 17% gave a rating of good, 1% marked fair, and 0.2% were not sure. When asked whether the competition has been valuable for the educational development of their child, 82% strongly agreed that it was (N=430), 18% agreed with the statement, and 0.5% were neutral. No respondents disagreed or strongly disagreed.
Thank you! Involvement in MATE has literally been a life saver for our son. He was struck with a chronic disease 4 years ago. His [ROV] club meetings the past 3 years were, at times, the only activity he could manage to participate in. He would conserve his energy all week to make the meetings.

Evaluation Question 3.2. What are the educational and career trajectories of ROV competition participants and interns? To what extent do they pursue STEM postsecondary studies and employment?

There are two sources of postsecondary data on competition participants: 1) the competition alumni survey and 2) a match with the National Student Clearinghouse data.

ROV COMPETITION ALUMNI SURVEY

Among the 432 student alumni survey respondents over age 18, the preliminary findings included the following:

Background: Alumni Participation in ROV Competition

- Nine percent (9%) of the student competitors later served as a classroom/club mentor assigned to help other teams, 6% served as a judge at a competition, and 4% served as an instructor leading a team.
- Respondents competed as student team members for between one and nine years, with an average of 2.15 years per student.
- Respondents competed as student team members in competition years 2006 through 2015.
- Respondents competed as student team members in all four competition classes: SCOUT (11%), NAVIGATOR (3%), RANGER (36%), and EXPLORER (36%).

Alumni Education and Employment

- The alumni’s highest level of education ranged from high school (no diploma) to doctorate.
- Among the 236 current college and university students, 85% are studying towards a STEM degree.
  - Examples of colleges and universities attended include: Memorial University, Dalhousie, Drexel University, University of California at Santa Cruz, University of North Carolina at Chapel Hill, Naval Postgraduate School, Brown University, Cornell University, Texas A&M
  - Examples of college majors include: Aeronautical engineering, mechanical engineering, computer science, math, electrical engineering, physics, information technology
- Among the 220 alumni who earned a college degree, 85% earned a degree in a STEM discipline.
Examples of degrees include the following: BS and MS in Mechanical Engineering, MS in Electrical Engineering, BS and MS in Biomedical Engineering, BS in Computer Engineering, AS in Applied Marine Biology and Oceanography and BS in Marine Biology

- Almost three-quarters of the alumni are currently employed (74%).
- Among the employed alumni (N=320), 73% are currently working a STEM-related job.
- Among the employed alumni, 14% are currently working a job related to ROVs or other underwater technologies, and an additional 8% have ever worked in a job related to ROVs or other underwater technologies.
- Examples of current jobs include, in the respondents’ own words: Electrical Engineer at General Dynamics Electric Boat designing communication systems for the ships, Motor and Drive Systems Research Engineer, Final Test Technician at Sea-Bird Electronics, I work for Subsea 7 in a department called Intervention and Autonomous Systems as a design engineer. This department designs remote, underwater, technology. Much of our designs are tooling for ROVs or are designed to be functioned and or deployed by ROVs.

ROV Competition’s Influence on Educational and Career Paths

Eighty-eight percent (88%) of the alumni credit the ROV competition with having at least a little influence on their educational or career path. Over one-quarter (29%) indicated that the competition influenced them to a great extent, and 38% marked that the competition influenced them somewhat. Twenty-one percent (21%) noted that the competition influenced them a little; 12% indicated that the competition did not affect them at all, and 1% didn’t know. (See Figure 11)

Figure 11: ROV Competition’s Influence on Education or Career Path

Alumni explained how the ROV competition influenced them in statements such as the following:
The MATE ROV competition gave me my first taste of practical engineering skills and projects. It also was influential in landing my first co-op term with one of our team sponsors.

It showed me another path in life that I wouldn’t have realized. It showed me a deeper love for sciences and has influenced me to become a processing engineer.

The MATE ROV competition really brought the realm of underwater robots into my life. Without it, I would have never worked for a company doing R&D for syntactic foams or R&D for sonar systems or even thought of applying for a job designing submarine systems.

The ROV competition played a role in alumni attaining employment (37%), admittance into educational programs/college/university (36%), internships (30%), awards (21%), and scholarships (21%). (See Figure 12)

**Figure 12: The Role that the ROV Competition Played in Attainment of Employment, Educational Program Admittance, Internships, Awards, and Scholarships**

Examples include the following:

**Employment**

When interviewing for the job, one of the people I talked to asked me about when I first knew I wanted to be an engineer, and we got to talking about my time on the MATE team. He had been on a FIRST team and knew what it takes to be so involved at so young an age, and everything I learned there carried on to my experiences in college.
Documentation on my resume of my roles and responsibilities on my MATE team was noted by many employers as a talking point, not only because it was obviously engineering application focused, but also it was a unique differentiator compared to the other resumes in the pile they have for positions.

I did a ton of electrical design as part of my involvement in the ROV team. It was as a result of that experience that I got hired for my co-op jobs, which led me to being hired full-time.

I am currently an ROV technician and pilot for Oceaneering. The competition gave me exposure to the use of ROVs and allowed me to network with the right people, landing me a job.

Admittance into Educational Programs/College/University

George Fox University was very impressed with my work through MATE. They had never heard of such a program and were very excited about it.

In my acceptance letter into college, they referred to the MATE competition on my resume.

As part of my acceptance to the Faculty of Pharmacy at Memorial University for Fall 2015, I had to complete an interview. This program at MUN is extremely competitive as they will receive over 200 applicants but only accept 40 into the program annually. So during the interview I was asked behavioural questions where I had to reflect on past experiences. For example, “Describe a time when you had to use creative thinking or innovation to solve a problem.” So, of course, I used my experiences in the MATE Competition for a number of different questions as I had gained and learned so much from my time participating. In this way, MATE ROV played a major role in my acceptance into the program.

Internships

NSF REU student researcher (focusing on perovskites solar cells), Hardware engineering intern – electrical at Raytheon SAS (designed circuitry for ATFLIR program)

Pacific Northwest National Laboratory – Battelle Marine Science Lab Summer Intern.
NASA Langley Research Center – Langley Aerospace research Summer Scholars Intern

SpaceX Avionics Internship, designing, building, and testing hardware

Scholarships
I received a number of scholarships – all of which I used my experience in the MATE ROV competition on my resume – and received about $10,000.

I was awarded a local scholarship that was for students aiming to study STEM in college. I used my experiences with the MATE program in several parts of my application. It was ~$5,000. I was also awarded the Vera Joseph scholarship at my college, which is given to five freshman who exhibit great potential in the STEM fields. While I did not apply for this scholarship, I am sure it was based off of my college application, in which I heavily spoke about my experiences with MATE and how they had influenced my studies. I was awarded ~$5,000.

Awards

Mortar Board Leadership Conference Nominee

Best Senior Design Project Student of the Year 2010

Presidents Undergraduate Research Award

Technova Student Achievement Award

Asia Pacific ICT Alliance Award 2011

NATIONAL STUDENT CLEARINGHOUSE DATA

Background

The National Student Clearinghouse (NSC) is a nationwide source of higher education information. Colleges and universities, numbering over 3,400 institutions enrolling over 96% of college students, share their enrollment data with NSC. The NSC database includes over 130 million students. See http://www.studentclearinghouse.org/ for further information about the NSC.

A total of 3,974 former competition participants (aka “alumni”) were identified for matching with National Student Clearinghouse (NSC) data in the May of 2017. These alumni have birthdates that indicate that they are at least 18 years of age as of May 2017, and their addresses suggest that they live within the United States. Two-thirds of the alumni (66%, or 2,633) were found in the NSC database.

Two-Year or Four-Year Colleges/Universities

Among the 2,633 alumni who were found in the NSC database, 49% attended a 2-year college, and 80% attended a 4-year college or university. Note that this is not unduplicated. Some alumni attended both.
Public or Private Colleges/Universities

Among the 2,633 alumni in the NSC database, 84% attended a public college/university, and 28% attended a private college/university. Note that this is not unduplicated, and students may have attended both public and private institutions.

Enrollment Status

Examining the most recent enrollment status reported per alumni (N=2,235), 67% of the alumni were attending college or university full-time. Six percent (6%) were enrolled three-quarter-time. Twelve percent (12%) were attending half-time, and another 10% attended less than half-time.
Majors

A total of 1,779 alumni had a major of study in the database, and 1,668 had a Classification of Instructional Programs (CIP) code. The majors were explored with two methods. First, the CIP codes were matched to a list of NSF-designated STEM CIP codes.\(^7\) With this approach, 901 (51\%) were designated as having a STEM CIP code. The most common NSF STEM Categories were engineering, with 27\% of the alumni, and computer science, with 8\%.

Figure 16: NSC Data: College Majors: NSF STEM Categories

The downside to using the NSF STEM CIP Codes is that certificates and applied associate of science degrees are not included in this list, and these types of completions are common among two-year community and technical colleges, which are a particular area of focus among ATE Centers. Therefore, a second analysis method was employed: the evaluator hand-coded the majors as STEM or non-STEM. With this approach, 66% of the 1,798 competition alumni were enrolled in a STEM major.

Degrees

A total of 708 alumni earned 975 degrees and certificates. Within the degree names, it was possible to determine the type of degree for 890 degrees. The most common type of degree earned by the alumni was Bachelor’s degree (56%), followed by Associate’s degree (23%). Six percent (6%) of the degrees were certificates, and another 5% were Master’s degrees. Two individuals earned doctorates. (See Figure 17)

Figure 17: NSC Data: Type of Degrees Earned

The same two analysis methods were used for the degrees as the majors. First, the CIP codes were matched to a list of NSF-designated STEM CIP codes. There were 734 degrees with CIP codes. With this approach, 416 (57%) were designated as having a STEM CIP code. The most common NSF STEM Categories were engineering, accounting for 33% of the degrees with CIP codes, and computer science, with 6%. In comparison, according to the National Center for Education Statistics, in 2013-2014, only 1% of the Bachelor’s degrees were in engineering technologies.8

8 SOURCE: U.S. Department of Education, National Center for Education Statistics, Higher Education General Information Survey (HEGIS), "Degrees and Other Formal Awards Conferred" surveys, 1970-71 through 1985-86; Integrated Postsecondary Education Data System (IPEDS), "Completions Survey" (IPEDS-C:91-99); and IPEDS Fall
With the hand-coding degrees into STEM and non-STEM, a total of 76% of the degrees (N=828) were in STEM disciplines.

The hand-coded STEM degrees were examined by degree type. (See Figure 19) Compared to other degrees and certificates, it was less common for Associate’s Degrees to be in a STEM discipline (55%). Some of this difference is due to the fact that many Associate’s degrees were given generic names that did not designate a specific discipline, such as General Studies Associate Degree or Oregon Transfer Associate of Arts.

2000 through Fall 2014, Completions component. (This table was prepared September 2015.)
**Evaluation Question 3.3.** What are the patterns of student involvement in the competition? Repeat competitors? Students who progress through the pipeline, moving up ROV classes (there are 4 levels), then becoming team mentors, judges, and ocean industry employees?

According to registration data, as of the 2016 competition season, 38% of the student registrants (N=5,404) had participated in more than one competition. The number of years of participation ranged from one to 15 years. (It is unlikely that any students had participated for 15 years; these surveys may have been completed by teachers instead. The upper end of the range is likely closer to eight years, which 34 students reported.) Sixty-two percent (62%) of the students were participating for the first time. Almost one-quarter (24%) had participated for two years; 6% had participated for three years; 3% had participated for four years; and 5% had participated for five years or more. We have not yet assembled the data to track the students through the pipeline as they move up ROV classes and become team mentors. However, we do have some data supporting the anecdotal reports that students are moving through the pipeline, as 13% of the judges report that they are former student competitors.

Analysis of survey results by multi-year participation yielded some interesting results. There were several statistically significant differences between the first year and multi-year competition participants. Multi-year participants reported that their participation in the ROV program resulted in higher levels of awareness of and interest in STEM careers, gains in interest in taking STEM courses, improvements in STEM knowledge and skills, increased 21st Century skills, and the receipt of awards, honors, and new educational and career opportunities.

Specifically, multi-year participants were significantly more likely to report the following:
**Table 2: Statistically Significant Differences between First-Year and Multi-Year Participants**

<table>
<thead>
<tr>
<th></th>
<th>First-Year Participants: Percentage Strongly Agreeing</th>
<th>Multi-Year Participants: Percentage Strongly Agreeing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased awareness of STEM careers due to ROV program**</td>
<td>30.7%</td>
<td>36.7%</td>
</tr>
<tr>
<td>Increased interest in pursuing a STEM career due to ROV program*</td>
<td>41.2%</td>
<td>46.3%</td>
</tr>
<tr>
<td>Learned how to apply STEM knowledge to solving real world problems due to ROV program**</td>
<td>41.5%</td>
<td>49.3%</td>
</tr>
<tr>
<td>Learned how to communicate their engineering designs due to ROV program**</td>
<td>39.0%</td>
<td>44.5%</td>
</tr>
<tr>
<td>Want to learn more about STEM topics*</td>
<td>48.1%</td>
<td>53.5%</td>
</tr>
<tr>
<td>More interested in taking engineering courses due to ROV program**</td>
<td>39.7%</td>
<td>47.8%</td>
</tr>
<tr>
<td>More interested in taking science courses due to ROV program**</td>
<td>33.1%</td>
<td>41.1%</td>
</tr>
<tr>
<td>More interested in taking math courses due to ROV program*</td>
<td>26.9%</td>
<td>31.3%</td>
</tr>
<tr>
<td>Increased skills and knowledge in engineering due to ROV program*</td>
<td>51.4%</td>
<td>57.2%</td>
</tr>
<tr>
<td>Increased skills and knowledge in science due to ROV program*</td>
<td>36.7%</td>
<td>42.6%</td>
</tr>
<tr>
<td>Increased skills and knowledge in math due to ROV program**</td>
<td>25.7%</td>
<td>32.1%</td>
</tr>
<tr>
<td>Increased leadership skills due to ROV program**</td>
<td>32.3%</td>
<td>43.2%</td>
</tr>
<tr>
<td>Increased problem solving skills due to ROV program*</td>
<td>41.5%</td>
<td>45.8%</td>
</tr>
<tr>
<td>Evaluation of the MATE Center: 2016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

- Increased critical thinking skills due to ROV program*: 40.7% 44.0%
- More interested in a STEM career*: 78.9% 82.6%
- Received an award or honor due to ROV program**: 26.3% 45.4%
- ROV program participation opened educational or career opportunities**: 31.0% 44.9%

* p < 0.05
**p < 0.01
Goal 3 Continued: Internship Program

Evaluation Questions 3.4. Were the interns well-prepared upon entering the internships, and did they have the necessary technical and interpersonal education to successfully complete the internship? Did the students gain the skills and knowledge during the internship that were relevant to their interests and career goals and directly related to industry-driven knowledge and skill guidelines (as developed by the MATE Center and industry professionals)? Did the students who participated in the internship program continue their education at two-year or four-year institutions or enter STEM employment after the internship?

Internship Applications: The 2016 internship program received 56 student applications from 43 colleges and universities. MATE placed 11 students in at-sea internship positions on five different ships, from 11 to 76 days in length. In sum, MATE interns spent a total of 50 weeks at sea in 2016. One additional student was placed in a six-month internship.

Intern Demographics: Of the eleven interns placed, three were women (27%), two were was Hispanic, one was Native American, and six were FAFSA-qualified (50%).

Intern Feedback: In surveys following the internship (N=11), the great majority of interns said:

1) they felt the internship prepared them for future jobs in the field of marine technology (91%);
2) the internship increased their confidence working on technical (100%) and scientific (73%) problems;
3) they felt the internship was a valuable learning experience (100%);
4) they enjoyed working at sea (100%); and
5) they would recommend the MATE technical internship program to other students (100%).

Student comments on the 2016 evaluations include:

- The experience was amazing. After being in the field I can see how important the internship program is for people interested in entering this line of work and I feel very fortunate to have had the opportunity.
- MATE is a very valuable asset to anyone interested in Marine Technology and research.
- Thank you again for this wonderful and eye-opening opportunity. I appreciate the fact that I was chosen to participate in the at-sea internship program and will recommend this program highly to any other student interested in a marine science career.

Internship Mentor (Host) Feedback: Follow-up forms received from internship mentors were also positive. The majority of internship mentors (N=11) indicated that:

1) their interns gained skills that increased their employability (100%);
2) they would mentor another MATE intern in the future (91%); and
3) they were satisfied with the process of hiring an intern (91%).

Also, 91% of mentors said they would hire their intern as an entry-level employee. Three mentors said the following in their evaluations of the program:

- **Well Done - I am consistently impressed with the increasing quality of recruits as it pertains to this specific career.**
- **Excellent program. A great opportunity for a future tech and for the ship who hosts the intern.**
- **Great program exposing students to actual applications of being on a live action research vessel. Keep it up. Great screening of students. I have sailed with MATE students before on the Marcus Langseth. All very intelligent and capable students willing to learn. Great program. Well done.**

**Long-term Internship Results:**

Four of the 11 interns in the 2016 MATE Internship Program accepted employment opportunities in the marine technology industry following their internships.

The survey results showed that among the 2016 MATE student interns (N=11), 73% indicated that job opportunities opened up due to their internship. Interns were offered interviews or accepted positions including the following:

- **I have been hired for a single cruise through Oregon State University with the potential for full time employment between them and Bermuda.**
- **Not directly, but I have been offered a NOAA federal job to become a commissioned officer, and I know that my plan to do the MATE internship was valued by the selection board, based on the sea-going experience, technical training, and the contact I would have with the USCG.**
- **Offered 'working interview' with LUMCON, with chance to be hired**
- **I applied for a Marine Technician position at BIOS and am a strong applicant because of my experiences aboard the R/V Atlantic Explorer. Have already received a skype interview and am currently waiting for an update.**
- **The internship host expressed interest in having me back on an as needed basis or possible employment in future.**
- **I was told to apply for jobs from both Scripps and OSU that had job openings. I also may have opportunities at WHOI.**

As of 2014, the MATE Center has follow-up tracking data on 75% of the 304 interns who had been placed in internships. Of those interns, 57% have gone on to work in a STEM field, 26% are continuing their education in a STEM discipline, and 7% went on to become educators in a STEM subject.
Goal 4: Provide professional development for college and secondary faculty.

Evaluation Questions:

4.1. Did attendance at the Summer Institutes and online workshops lead to an increase in faculty understanding of the ocean workforce and the knowledge and skills needed to enter the workforce?

4.2. After the Summer Institute and online workshops, did participants share their new knowledge with their students and colleagues? Did they modify their curriculum and/or teaching strategies based on information received during the Institutes? Did they specifically integrate ROV building into their course(s) or club activities?

Beginning in the summer of 1999, MATE began to provide week-long summer professional development Institutes for high school and college faculty. The Institutes focused on marine technology, ROV and GIS topics taught by MATE staff and guest instructors. The Institutes provide participants with curriculum materials, lectures, demonstrations, field trips, laboratory work and homework. They concentrate on providing participants with an understanding of how they can teach new courses in these subjects or refine the curriculum in an existing course.

As discussed in previous evaluation reports, the Institutes have been highly successful, with the large majority of participants indicating that they learned a great deal, received useful materials and were using what they learned to modify their curriculum and teaching strategies.

Summer Institutes’ Evaluation

The evaluation of the Summer Institutes is a two-step process, collecting feedback from the participants immediately after the Institute (using the Institute feedback surveys) then again the following spring (using the Institute follow-up surveys).

The feedback survey results have been highly consistent over time, with the great majority of participants saying that the Institutes clearly addressed the topics they had come to learn about and that the Institute workshops were quite useful. Almost all of the respondents also said that they intended to modify their curriculum and/or teaching strategies based on the information they had obtained at the Institutes.

One year after the Institute, all participants receive an invitation to complete the web follow-up survey. This survey attempts to measure the Institutes’ longer-term impact and, in particular, to compare
participants’ actions once they returned to their classrooms with the intentions they had expressed at the close of the Institute.

Summer Institute Participants

In 2016, the MATE Center held two Summer Institutes: one introductory level and one intermediate level workshop. The introductory Summer Institute was funded by an NSF ITEST grant, and the intermediate workshop was funded by the NSF ATE grant. Twenty (20) participants attended the introductory Summer Institute, and 20 attended the intermediate Summer Institute. These faculty participants reach approximately 4,522 students per year, from elementary through university levels.

Table 3: Number of Summer Institute Participants

<table>
<thead>
<tr>
<th>Year</th>
<th>MATE Institute</th>
<th>Faculty Participants</th>
<th>Number of Students Reached by Institute Participants&lt;sup&gt;9&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>Introductory ROV</td>
<td>20</td>
<td>2,133</td>
</tr>
<tr>
<td></td>
<td>Intermediate ROV</td>
<td>20</td>
<td>2,688</td>
</tr>
<tr>
<td>Total</td>
<td>2 workshops</td>
<td>40</td>
<td>4,821</td>
</tr>
</tbody>
</table>

Table 4: Summer Institute Participants’ Home Institution Type (Mark All That Apply)

<table>
<thead>
<tr>
<th>Intermediate ROV Summer Institute (N=19)</th>
<th>Elementary</th>
<th>Middle School/Junior High</th>
<th>High School</th>
<th>2-Year College or Technical Institution</th>
<th>4-Year College or University</th>
<th>Informal Education at a Museum, Aquarium, or Zoo</th>
<th>Other&lt;sup&gt;10&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle School/Junior High</td>
<td></td>
<td>37%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td></td>
<td></td>
<td>63%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-Year College or Technical Institution</td>
<td></td>
<td></td>
<td></td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-Year College or University</td>
<td></td>
<td></td>
<td></td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Informal Education at a Museum, Aquarium, or Zoo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>Other&lt;sup&gt;10&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11%</td>
</tr>
</tbody>
</table>

<sup>9</sup> These numbers are based on the number of students reported by the participants in their follow-up surveys.

<sup>10</sup> Note: “Other” was described by the participants as “Mostly middle, training teachers” and “Informal education at a community non-profit.”
Summer Institute Impact

In the one-year follow-up surveys, the intermediate Summer Institute participants (N=20) rated the usefulness of the Institute very positively (65% excellent, 35% good).

The majority of the respondents said that they had implemented what they learned at the Institute and shared the information with other teachers and with students. (See Figure 20)

- Modified content of course/program (90% a great deal or a fair amount)
- Modified teaching strategies (65%)
- Shared information with other teachers (74%)
- Shared information with students (100%)
- Used ROV program to address state-mandated standards (77%)

Figure 20: Summer Institute: Extent Teachers Modified Curriculum and/or Teaching Strategies, Shared Information with Instructors, and Used the ROV Program to Address State-Mandated Standards

Since the Institute, 90% of the respondents (N=20) have built an ROV with students, and 620 students have participated in an ROV-building experience. A total of 158 ROVs have been built with students.

Since attending the Institute, 85% of the participants have developed a new course or improved a course or club, including the following:
These new courses and clubs served 602 students.

The participants reported that the Institutes had helped them better understand the current technologies used in the marine field (95% agree or strongly agree). They indicated that the Institutes provided them with valuable ideas that they are using in their courses and programs (100%) and instructional materials that will improve their students’ preparedness for ocean-related STEM careers (100%).

Figure 21: Summer Institute: Percentage of Participants Agreeing or Disagreeing with Statements
Respondent comments on the follow-up surveys have consistently indicated that the Summer Institutes have had an impact extending well beyond their participants. Comments from the feedback surveys included the following:

The Summer Institute inspires my teaching and encourages me to elevate the learning expectations for my students. As a result of my participation in the program, I have become more involved in the robotics programs in two different High Schools and strive to learn more about blue technology.

I am extremely grateful for the opportunity I got at MATE. My students are learning a lot about marine sciences, electronics, planning, etc.

Having students assemble the joystick controls for the first time and they are excited to work with the more sophisticated electronics despite being only middle school students.

Yes, the MATE summer institute has allowed me to expand my role as a robotics instructor at my school. The widely recognized MATE summer institute helped my school gain the support of higher level administrators to support the growth of STEM programs in our district.

### DIVING INTO SENSORS ONLINE COURSE

The Diving into Sensors online course was piloted in 2015 with 63 faculty participants and was run for the second time in 2016 with 42 students.

<table>
<thead>
<tr>
<th></th>
<th>2016 Diving into Sensors Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td>0%</td>
</tr>
<tr>
<td>Middle School/Junior High</td>
<td>17%</td>
</tr>
<tr>
<td>High School</td>
<td>46%</td>
</tr>
<tr>
<td>2-Year College or Technical Institution</td>
<td>12%</td>
</tr>
<tr>
<td>4-Year College or University</td>
<td>2%</td>
</tr>
<tr>
<td>Informal Education at a Museum, Aquarium, or Zoo</td>
<td>15%</td>
</tr>
<tr>
<td>Other</td>
<td>7%</td>
</tr>
</tbody>
</table>

The 2015 course evaluation web survey was completed by 58 participants (response rate: 92%). The majority of the 2015 respondents were instructors (93%), from elementary school through four-year college or university – and including informal educators. (See

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11 The follow-up survey was not conducted in 2016 so the 2015 results are presented here.
Table 6) The 55 instructors taught approximately 8,808 students annually.

Table 5: Online Sensor Course Grade Level Taught by Participants (Mark All That Apply)

<table>
<thead>
<tr>
<th>Course</th>
<th>2015 Diving into Sensors Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td>7%</td>
</tr>
<tr>
<td>Middle School/Junior High</td>
<td>35%</td>
</tr>
<tr>
<td>High School</td>
<td>47%</td>
</tr>
<tr>
<td>2-Year College or Technical Institution</td>
<td>9%</td>
</tr>
<tr>
<td>4-Year College or University</td>
<td>10%</td>
</tr>
<tr>
<td>Informal Education at a Museum, Aquarium, or Zoo</td>
<td>7%</td>
</tr>
<tr>
<td>Other(^2)</td>
<td>7%</td>
</tr>
</tbody>
</table>

The course covered the topics of microcontrollers, programming languages, Arduino, potentiometers, joysticks, voltage dividers, sensor technology, motor controllers, basic electronics, breadboards, soldering, and analogue to digital conversion. Respondents rated their knowledge in these topics before and after the course on a scale of zero to seven:

- 0: None
- 1: Minimal
- 2: Low
- 3: Low to moderate
- 4: Moderate
- 5: Moderate to high
- 6: High
- 7: Expert

Before the course, the average knowledge ratings ranged from three (low to moderate) to 4 (moderate) in most topics. After the course, the average knowledge scores increased to roughly five (moderate to high). (See Figure 22)

\(^2\) Note: “Other” included a MATE mentor, college student, 4-H club educator, and a high school TA.
On the scale of zero to seven, respondents gained an average of more than one category in all topics except for basic electronics. (For example, an increase from 1-minimal to 2-low, would be an increase of one category.) The lower gains in basic electronics could be because students entered the course with higher knowledge in this area (mean: 4.6). The greatest gains were in Arduino, voltage dividers, sensor technology, and microcontrollers. (See
Table 6)
Table 6: Diving into Sensors: Mean Number of Categories Gained in Knowledge Scores

<table>
<thead>
<tr>
<th>Course Topic</th>
<th>Mean Number of Categories Gained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arduino</td>
<td>2.05</td>
</tr>
<tr>
<td>Voltage dividers</td>
<td>1.64</td>
</tr>
<tr>
<td>Sensor technology</td>
<td>1.60</td>
</tr>
<tr>
<td>Microcontrollers</td>
<td>1.55</td>
</tr>
<tr>
<td>Analog to digital conversion</td>
<td>1.40</td>
</tr>
<tr>
<td>Joysticks</td>
<td>1.36</td>
</tr>
<tr>
<td>Breadboards</td>
<td>1.29</td>
</tr>
<tr>
<td>Potentiometers</td>
<td>1.26</td>
</tr>
<tr>
<td>Motor controllers</td>
<td>1.21</td>
</tr>
<tr>
<td>Programming languages</td>
<td>1.12</td>
</tr>
<tr>
<td>Basic electronics</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Based on what they learned in the course, 90% of the respondents intended to modify their curriculum, and 86% intended to modify their teaching strategies. Over half of the participants planned to use parts of the course (activities or videos) with students (Yes: 58%, Maybe: 32%, No: 5%, Other: 5%). More than two-thirds planned to use the information from the course to participate in the MATE ROV Competition (Yes: 65%, Maybe: 18%, No: 9%, Don’t know: 9%).

Overall, the course was rated positively by 85% of the participants (excellent 39%, good 46%, fair 11%, poor 5%, very poor 0%).
Goal 5: Maintain an information clearinghouse

Evaluation Questions 5.1. To what extent is marine technology education and workforce information disseminated through the web site, listserv, Constant Contact, journal articles, conference presentations, and ATE Central? How many resources are shared? How many people are impacted by these resources? How are the resources used? Do they meet the needs of the partners, faculty, students, and other stakeholders?

MATE information and resources have been disseminated widely, for example:

- From January to December 2016 the website, www.marinetech.org, was accessed by 106,899 users (both new and returning), 50% of whom were new visitors.

- The MATE Center, its programs, and/or partners published or were featured in 34 articles published in newspapers, newsletters, and professional journals, such as the MTS Journal. In addition, teams participating in the 2016 international ROV competition were asked to produce and circulate a media package. This effort usually results in more than 50 newspaper articles online newsletters, and TV news videos. This brings the total number of articles, online sites, and TV news clips featuring the MATE Center during its tenure as a resource center to more than 800.

- MATE Center staff, faculty from MATE partner colleges, summer institute participants, and industry professionals acting on behalf of MATE presented at seven industry and academic conferences. Additional outreach and dissemination was performed at professional meetings, community events, and outreach activities.

- In 2016 the MATE Center supported partners who hosted 22 workshops and events (ranging from a half-day to two days) for approximately 15,000 faculty, students, and community members.

- Through its social enterprise, SeaMATE, the MATE Center sold $432,124 in products in 2016. SeaMATE is a student-run social enterprise that manufactures and sells underwater robotic kits and accessories.

- As of December 31, 2016, the MATE Center has sold over 2,400 copies of its textbook, Underwater Robotics: Science, Design & Fabrication, at a retail price of $115.00.

- The MATE Center continued to distribute copies of the Catalogue of Marine and Technology Programs in Higher Education, which was produced in partnership with the Marine Technology Society, as well as the Knowledge and Skill Guidelines for Marine Technical Occupations http://www.marinetech.org/workforce/. The integration of these detailed occupational guidelines with more than 50 other marine careers continues to be distributed through www.oceancareers.com, a product which MATE produced with NSF funding from a COSEE grant.

- The winners of the 2015 MATE International ROV Competition – RANGER Class: team Amno and Co, from Seattle – attended the White House Science Fair April 13, 2016, where they met President Obama.
• The MATE Center co-hosted of the 2016 MTS/IEEE Oceans Conference held in Monterey September 19-23, 2016. This high profile role helped to raise awareness on a national level about the role community colleges play in workforce development.

• The MATE Center began writing and distributing an online newsletter in December 2016. The newsletter is currently distributed to 13,345 individuals.

• In 2016, the MATE Center began an effort to increase its social media presence with the help of a media consultant. This effort has increased the number of Facebook posts, Twitter tweets, and photos posted on Flickr. The Center currently has 6,202 “likes” on Facebook, over 1,000 followers on Twitter, and 7,643 photos in Flickr.
CONCLUSIONS

Overall, the MATE Center successfully implemented the ATE grant activities, including expanding and strengthening academic and industry partnerships, updating and disseminating workforce and educational resources, maintaining an information clearinghouse, providing students with opportunities to collaborate with working professionals through the ROV Competition and Internship Program, and providing professional development through the Summer Institutes, Diving into Sensors course, and other workshops. Evaluation results continue to show strong positive outcomes for both teachers and students.

Input from students, teachers and parents all pointed to the strong gains made by the student ROV competition participants. Involvement in the competition generated greater awareness and interest in pursuing STEM careers, increased interest in studying STEM topics, improved STEM knowledge and skills, and increased teamwork, critical thinking and problem solving skills. Follow-up data indicates that the majority of degrees earned by competition alumni were in STEM disciplines – most commonly in engineering – at much higher rates than national averages.

Parents were passionate supporters of their children’s involvement in the ROV Competition, with comments such as, “Our team of no-college-graduate-parents envision themselves as future engineers.” Educational research has stressed the importance of family support in a students’ choice to follow a STEM career path. Evaluation results show that the ROV program impacted the participants’ parents as well, making it easier for them to picture their child in a STEM career.

The MATE Internship Program generated universally positive feedback from both interns and mentors. Interns gained skills that improved their employability in the field, increased their confidence working on scientific and technical problems, and cemented their desire to work in the field. Four of the 2016 interns were hired after completing their internships.

The Summer Institutes were effective in increasing teachers’ understanding of ocean STEM careers and technologies, resulting changes in classroom practices and the development of new courses. Institute participants shared the information they learned with other teachers and implement ROV activities in their courses and programs.

The evaluation results continue to demonstrate the profound impacts produced by the MATE Center in marine technical education across the nation, effectively increasing the STEM workforce, especially related to underwater technologies.