Evaluation of Innovative Technology Experiences for Students and Teachers (ITEST) 2013-2014 Grant Activities

For

The Marine Advanced Technology Education (MATE) Center

August 2014

Submitted by:

SESRC

Social & Economic Sciences Research Center (SESRC)

Puget Sound Division
Washington State University

PO Box 43170
Olympia, Washington 98504-3170
Telephone: (360) 586-9292
Fax: (360) 586-2279

Evaluation of Innovative Technology Experiences for Students and Teachers (ITEST) 2013-2014 Grant Activities

For

The Marine Advanced Technology Education (MATE) Center

Candiya Mann

August 2014

Social & Economic Sciences Research Center-Puget Sound Division
203 E. 4th Avenue, Suite 521
P.O. Box 43170
Olympia, WA 98504-3170
(360) 586-9292
Fax: (360) 586-2279

SPONSORSHIP

Support for this project was provided by the Marine Advanced Technology Education (MATE) Center and the National Science Foundation.

ABOUT SESRC

The Social and Economic Sciences Research Center (SESRC) at Washington State University is a recognized leader in the development and conduct of survey research.

SESRC-Puget Sound Division provides technical services and consultation to assist clients in acquiring data, understanding what data means, and applying that information to solving problems. The SESRC Puget Sound Division specializes in research design, data collection and analysis, using both qualitative and quantitative methods. The Division also provides interpretive reports, policy studies, presentations and consulting services directly to individual clients, organizations and consortia.

ACKNOWLEDGEMENTS

The author would like to thank the management at the MATE Center for their leadership, coordination, and helpful suggestions. We are also grateful to the regional coordinators and their support staff, who made themselves available for interviews and provided valuable insights into the project. Finally, this project would not have been possible without the generous and thoughtful input contributed by the student participants, faculty/mentors, parents and judges/volunteers who completed surveys.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Evaluation of Innovative Technology Experiences for Students and Teachers (ITEST) Grant Activities

For the Marine Advanced Technology Education (MATE) Center

BY: CANDIYA MANN & KYRA KESTER

SOCIAL & ECONOMIC SCIENCES RESEARCH CENTER, PUGET SOUND OFFICE

WASHINGTON STATE UNIVERSITY

AUGUST 2014

In September 2013, the National Science Foundation (NSF) funded the Marine Advanced Technology Education (MATE) Center's proposal for an Innovative Technology Experiences for Students and Teachers (ITEST) grant. The MATE Center's ITEST program, titled *Scaling Up Success: Using MATE's ROV Competitions to Build a Collaborative Learning Community that Fuels the Ocean STEM Workforce Pipeline*, leverages their extensive network of remotely operated vehicle (ROV) student competitions. The project's overarching goal is to encourage multi-year student participation in an effort to deepen student interest and learning and reinforce pathways leading to the STEM workforce.

The evaluation is based on multiple data sources, primarily surveys and interviews, and reflects the input of a variety of stakeholders, including students, teachers, parents, judges, volunteers, regional coordinators, and MATE management and staff. This report covers grant activities that took place between July 1st, 2013 and June 30th, 2014.

Findings

Project Goal 1: Increase middle and high school students' interest in STEM and STEM careers, as well as their knowledge of STEM and understanding of how science and engineering work together to solve real-world problems

- **Increased Awareness of STEM Careers:** After building their ROV, 87% of the students surveyed (N=1,429) indicated that they knew more about careers in marine STEM.
- **Increased Interest in STEM Careers:** Almost three-quarters of the students (73%, N=1,426) stated that their ROV project made them more interested in a marine career, and 85% of the teachers (N=290) observed an increase in their students' interest in pursuing a STEM career.

- **Increased Interest in STEM:** Over three-quarters of the students (82%, N=1,420) indicated that their ROV project made them want to learn more about ocean STEM. Ninety-five percent (95%, N=288) of the teachers and 93% of the parents (N=335) observed greater interest among the students in learning STEM.
- **Increased STEM Knowledge & Skills:** The majority of the teachers (97%, N=289) observed improvements in their students' STEM knowledge and skills. Parents (N=337) reported that building an ROV contributed to improving their children's grades in engineering/robotics (66%), science (53%), math (43%) and computers (42%).
- **Increased 21st Century Skills:** Ninety-seven percent (97%, N=288) of the teachers observed increases in their students' skills in team building, problem solving, and/or critical thinking. Seventy-one percent (71%, N=337) of parents reported that their children were better able to work with others; 62% indicated that their child's self-confidence improved; and 39% marked that their child was better organized. 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, and time management.
- **Overall Rating of MATE Center Support:** After the competition season, 60% of the teachers (N=288) rated the support provided by MATE as excellent, and 31% provided a rating of good, for an overall positive rating of 91%.
- **Overall Opinions of ROV Program:** The ROV program was rated positively (excellent or good) by 91% of the students (N=1,435), 99% of the teachers (N=291) and 98% of the parents (N=336).
- **Ability to Apply STEM to Real World Problems:** Over three-quarters (83%) of the students (N=1,420) indicated that participating in the ROV project helped them learn to apply STEM to real world problems, and 96% of the instructors (N=287) observed improvements in their students' abilities in this area.
- **Ability to Communicate Engineering Process and Designs to a Wide Audience:** Eighty percent (80%) of the students (N=1,417) stated that participating in the ROV project helped them learn how to communicate their engineering design to other people. Ninety-three percent (93%) of the instructors (N=289) observed improvements in their students' skills in this area.
- **Influence on Students' Educational and Career Paths:** In 2014, students reported that they were accepted into colleges and universities (Princeton, Cal Poly, and the Robert Gordon University Mechanical Engineering Program), and received apprenticeships (e.g., as a CAD designer), internships (Phoenix Technologies, NASA, Schilling Robotics, FMC Technologies, Hexel Corporation, and SeaTrepid), and job offers (Dominion Diving, "diving with GUE Seattle", and "CAD design for CNC company").
- **Effect of Multi-Year Competition Participation:** Multi-year participants were statistically significantly more likely to state that they learned "a lot more" about STEM careers through the competition, to be interested in pursuing a STEM career, and to have an increased desire to take further coursework in math, science, and/or engineering. Students who participated in the ROV competition for multiple years were significantly

more likely to state that their ROV project helped them apply STEM knowledge and skills to real-world problems and have the ability to communicate their engineering designs to other people.

- **Impacts among Underrepresented Groups:**
    - According to the demographic data in the surveys (N=1,442), the students were over one-quarter female (29%), forty percent (40%) were of minority backgrounds, 29% came from high poverty areas, and 3% reported that they had disabilities requiring accommodations.
    - Overall, there were few statistically significant differences by gender, ethnicity, disability status or socioeconomic status, indicating that the ROV program was effective in producing positive results for under-represented students as well as the students who traditionally participate in STEM learning opportunities. Significant differences include the following:
        - ***Awareness of STEM careers:*** female students and students from high poverty areas made significantly larger gains in their awareness of STEM careers, when compared to male students and students from low poverty areas.
        - ***Interest in STEM careers:*** Minority students were significantly more likely to state that their ROV project made them more interested in a STEM career than white students.
        - ***Interest in STEM topics:*** Students with minority backgrounds and those living in high poverty areas were significantly more likely to state that their ROV project increased their desire to learn more about STEM, when compared to white students and those living in low poverty areas.
        - ***STEM knowledge:*** After the competition, female students and students without disabilities were more likely to indicate that they knew "a lot" about shipwrecks, sinkholes and national maritime heritage sites, compared to male students and students with disabilities.

Project Goal 2: Provide teachers with professional development, instructional resources, and mentors to support and sustain the delivery of STEM career information and learning experiences.

Marine STEM career information was disseminated to students and teachers through workshops, the Summer Institute, presentations to schools, and the competition itself. After the competition, 87% of the students (N=1,429) reported that they knew more about marine STEM careers. After the Summer Institutes, 91% of the teachers (N=11) from the Institute indicated that the Institute helped them better understand the knowledge and skills needed for marine occupations.

- **Increased Confidence Facilitating STEM Learning Experiences:** The percentage of workshop survey respondents (N=17) who rated themselves as "very comfortable" facilitating STEM learning experiences for students rose between the pre and post workshop surveys for science (pre: 59%, post: 63%), technology (pre: 41%, post: 63%), engineering (pre: 24%, post: 44%), and math (pre: 53%, post: 69%).
- **The MATE Community:** Among the post-competition surveys (N=284), 81% of the teachers agreed that they felt they were part of a MATE community that provides support and relevant resources.
- **MATE Robotics Activities/Curriculum Incorporated into Courses and Afterschool Programs:** Sixty percent (60%) of the post-competition survey respondents (N=293) incorporated building ROVs into an after-school club. Twenty-three percent (23%) built ROVs as part of a course; 25% built ROVs as a voluntary activity; and 7% built ROVs in another venue. Close to three-quarters (73%) of the teachers (N=285) stated that they used MATE materials and resources to incorporate ROV building into their course or club, and half (50%) modified their curriculum and teaching based on MATE resources.
- **Classroom Mentors:** In several regions, the regional coordinator matched up college and high school students – in many cases, former ROV competitors themselves – with middle school ROV teams to work with them throughout the competition season. For 27% of the post-competition teacher survey respondents (N=280), a classroom/club mentor came to their site to help their teams. Among these teachers (N=76), over half (54%) indicated that the mentor helped them incorporate robotics into their course or club to "a great extent". The vast majority of respondents (95%) indicated that their mentors were adequately prepared to help them and their students through the ROV design and building process.

Project Goal 3: Increase parental involvement in order to support and encourage students to pursue STEM education and careers.

- **Increased Parental Support of Their Children's Interest in STEM:** Eighty-seven percent (87%, N=330) 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.
- **Enhanced Online Resources:** The MATE Center has focused on developing a variety of resources to help students, teachers, and parents participate in the competition and connect the competition to classroom concepts. Teachers and parents reported that the new resources enabled them to help their students participate in the competition in quotes such as, "I've definitely learned! I'm a social worker - coaching wasn't easy, but the use of MATE website and video instruction allowed for a mother/social worker to coach. Thank you!"
- **Regional Advisory Committees:** Advisory committees included participation from parents as well as industry representatives, professional organizations (e.g., Marine Technology Society), government agencies (e.g., NOAA) 6-12th grade educators,

community college faculty, and university faculty. The regional coordinators were responsive to their committees' recommendations.

Broader Impacts

The MATE Center's ITEST activities have been leveraged in ways that were unanticipated during the writing of the proposal. These "broader impacts" fall into three main categories:

1. Leveraging ITEST activities/funding to raise additional funding by regional coordinators, teachers, schools, and student teams
2. Using ROVs and ROV-based activities outside of the competition by teachers and students
3. Broader impacts on teachers and institutions: new careers, new classes, deeper relationships with students, improved STEM knowledge, increased motivation and engagement with their discipline, and increased professional development opportunities

INTRODUCTION

In September 2013, the National Science Foundation (NSF) funded the Marine Advanced Technology Education (MATE) Center's proposal for an Innovative Technology Experiences for Students and Teachers (ITEST) grant. The MATE Center's ITEST program, titled *Scaling Up Success: Using MATE's ROV Competitions to Build a Collaborative Learning Community that Fuels the Ocean STEM Workforce Pipeline*, leveraged their extensive network of remotely operated vehicle (ROV) student competitions. The project's overarching goal is to encourage multi-year student participation in an effort to deepen student interest and learning and reinforce pathways leading to the STEM workforce.

As stated in the proposal, the goals are fourfold:

1. Increase middle and high school students' interest in STEM and STEM careers as well as their knowledge of STEM and understanding of how science and engineering work together to solve real-world problems.
2. Provide teachers with professional development, instructional resources, and mentors to support and sustain the delivery of STEM learning experiences and career information.
3. Increase parental involvement in order to support and encourage students to pursue STEM education and careers.
4. Track students longitudinally to document how participation impacts their education and career path.

This report covers grant activities that took place between July 1st, 2013 and June 30th, 2014. The MATE Center's ITEST grant evaluation was performed by the Puget Sound Division of the Social and Economic Sciences Research Center at Washington State University.

METHODOLOGY

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

Table 1: Project Strategies and Evaluation Questions

Project Goal	Evaluation Questions
1. Increase middle and high school students' interest in STEM and STEM careers as well as their STEM knowledge and understanding of how science and engineering work together to solve real-world problems. • Add SCOUT+ class • Support for students who want to continue competition at next grade/school • Mentoring from students/industry professionals • Career advice/videos	1.1. To what extent did the MATE robotics activities lead to an increase in the students' interest in and knowledge of STEM content and STEM careers? Did educators and parents observe an increase in the students' interest in STEM content and STEM careers as a result of the robotics activities? An increase in the students' STEM knowledge and skills and 21st Century workplace skills?
	1.2. How did the robotics activities affect students' ability to apply STEM knowledge and skills to finding solutions to real-world problems?
	1.3. How did the robotics activities affect students' ability to communicate their engineering process and designs to a wide audience (from engineers and technicians to the general public)?
	1.4. How did participation in the robotics activities influence students' educational and career paths?
	1.5. What effect did multi-year participation have on the above evaluation questions?
	1.6. Did the robotics activities create the same impacts among underrepresented groups (by gender, ethnicity, socio-economic status, disability) as were found among students who traditionally participate in these types of activities?

2. Provide teachers with professional development, instructional resources, and mentors to support and sustain the delivery of STEM career information and learning experiences. • Curriculum continuum • Progression of ROV kits • Professional development workshops • Regional workshops • Regional teacher-leaders • Increase preparedness of mentors	2.1. Are teachers more confident delivering STEM learning experiences? Delivering career information and outlining career pathways?
	2.2. Do teachers feel they are a part of a larger MATE community that provides support and relevant, necessary resources?
	2.3. Do teachers incorporate MATE robotics activities/curriculum into courses and afterschool programs? Are the courses and/or curriculum adopted by school districts?
	2.4. Are teachers able to access classroom mentors as needed? Do the classroom mentors help them successfully incorporate robotics activities into the course? Are the classroom mentors adequately prepared?
3. Increase parental involvement in order to support and encourage students to pursue STEM education and careers. • Parent online resources/listserv • Regional parent advisory committees	3.1. Did the MATE robotics activities lead to an increase in the parents' support of their children's interest in STEM careers? 3.2. Did the enhanced parent online resources lead to an increase in the parents' ability to provide assistance and support for their children's involvement in the MATE robotics activities? 3.3. Did the regional parent advisory committees provide feedback and advice to help improve the competitions and ensure that the program is inclusive of all participants?

DATA SOURCES

The evaluation relies upon multiple sources of data. The data collection includes input from a variety of stakeholders, including students, teachers, parents, judges/volunteers, regional coordinators, college students helping with grant implementation, and MATE staff. Below are descriptions of each of the data sources. All of the surveys were developed in collaboration with MATE staff and regional coordinators.

ROV Competitions

At the ROV competitions, input was solicited from as many stakeholders as possible, including students, teachers, parents, and judges/volunteers. In the second year of the grant, the competition surveys were primarily administered as paper surveys in a "scannable" format; there was a web option as well. 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). Student and parent surveys were offered in Spanish as well.

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 3,000 students over the past six 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.

As a change from prior evaluation reports, the analysis with this new grant includes all students, covering grades K-16. The prior ITEST grant focused on expanding the entry-level SCOUT class, thus, the evaluation in prior years only included the elementary and middle school students in the SCOUT class in the regions receiving grant funding. The current grant provides resources that benefit all students in the competition so all competition surveys are included in the analysis.

TEACHERS

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 700 respondents over the past six 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.

PARENTS

In contrast to the student and teacher surveys, which have been conducted for years at MATE ROV competitions, 2009-2010 was the first time parent input was solicited. Parents responded enthusiastically and seemed to appreciate the opportunity to provide input. The surveys were implemented again in the second year of the grant. 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.

JUDGES

In 2010-2011, 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.

Regional Workshops

PRE AND POST TEACHER WORKSHOP SURVEYS

Pre and post paper surveys were administered to teacher workshop attendees at the beginning of the workshop day and at the end of the training. The surveys addressed issues of teacher confidence facilitating STEM learning experiences, commitment to bringing a team to competition, concerns about mentoring students in designing and building an ROV, expectations of the workshops, and additional ways that the regional coordinators and the MATE Center could support the participants.

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 Institutes (using the Institute feedback surveys) then again a six to nine months later (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. Because of the timing of the Summer Institute and the evaluation reporting, this evaluation covers the 2013 Institute.

Other Data Sources

Additional data sources informing the evaluation include the annual reports turned in by the regional coordinators to the ITEST grant PI, observations of the Pacific Northwest regional competition, review of participation data, unsolicited letters sent to the regional coordinators and the MATE Center from students, parents and teachers, website review and document review, including supporting technical materials and the MATE Center's annual report.

Evaluation Plans

In the next year, the evaluation will conduct a pilot student follow-up study with the Washington State Education Research Data Center to assess whether students who participate in the ROV competition are more likely to pursue STEM education and careers than a matched group of students.

FINDINGS

Project Goal 1: Increase middle and high school students' interest in STEM and STEM careers, as well as their knowledge of STEM and understanding of how science and engineering work together to solve real-world problems

Evaluation Question(s) 1.1. To what extent did the MATE robotics activities lead to an increase in the students' interest in and knowledge of STEM content and STEM careers? Did educators and parents observe an increase in the students' interest in STEM content and STEM careers as a result of the robotics activities? An increase in the students' STEM knowledge and skills and 21st Century workplace skills?

Increased Awareness of and Interest in STEM Careers: After building their ROV, 87% of the students (N=1,429) indicated that they knew more about careers in marine science, technology, and engineering. Indeed, over one-third (35%) marked that they knew "a lot more". Almost three-quarters (73%) stated that their ROV project made them more interested in a marine career. Overall, 75% of the students were interested in having a career in marine science, technology, or engineering; 20% were not sure, and 5% were not interested in a career in this field. Students mentioned wanting careers such as marine scientist, mechatronics engineer, computer scientist, biomedical engineer, electrical engineer, and mechanical engineer. Students noted that their experience in the ROV program sparked their interest in having a STEM career, with comments such as the following:

> *I found my calling.*
>
> *Before this I wanted to be a doctor, and after competing in my regional competition, I know I want to be an engineer.*
>
> *Through this program I have learned that I wish to pursue a career in engineering and technology; this is truly a great program.*

Among the teachers/mentors who completed post-competition surveys (N=290), 85% indicated that they had observed that their students were more interested in pursuing a STEM career. Ninety-five percent (95%) agreed that the ROV program provided a valuable venue to help prepare their students for a career in marine science and technology.

Parents also noted an increased interest in STEM careers, in comments such as the following:

> *Gives them HOPE that they would enjoy an engineering career - gives them a vision!*
>
> *This program opened his eyes to careers he didn't know existed, thank you.*
>
> *Thank you for this amazing program. It makes my son feel proud, and it makes him reflect on a career choice, which I think is incredible at 11 years old.*

Increased Interest in STEM: Over three-quarters of the students (82%) stated that their ROV project made them want to learn more about ocean science, technology, and engineering. Students indicated that their ROV projects increased their desire to take courses in engineering (65%), science (53%), computer science (44%), math (37%), and other hands-on classes or club activities like robotics, electronics and shop courses (65%). Additionally, 45% of the students wanted to learn more about shipwrecks, sinkholes, and national maritime heritage sites. As one student explained his experience, "Participating in the MATE challenge has given me more experience in engineering, planning, circuits, and more interest in all fields like computer programming, manufacturing, hydraulics, and the science fields." Another stated that the competition affected his interest in robotics as follows:

> *I really enjoyed the program this year, and it really taught me things. I was fascinated - a thing like a frame can be the body of a robot. I really loved it.*

In the post-competition survey, 95% of the teachers/mentors (N=288) indicated that their students were more interested in learning about science, technology, engineering and math. This follows patterns of prior surveys of teachers/mentors. Teachers described experiences such as the following:

ROV Program Testimonials

Students

This club is probably the best thing that has happened to me in my educational career.

Thank you for this opportunity. It has changed my life.

Seeing my team complete our objectives was the coolest thing I've ever seen.

I can't wait to move forward to harder tasks in my next and last year in the ROV competition. The challenge presented before me has motivated me and continues to motivate me towards larger scale projects and ambitions.

Parents

This is a terrific program. An unparalleled opportunity to create, craft and realize.

Great experience. Program incorporates critical thinking, problem solving, team building, and fundamental scientific concepts.

As an all girls team, it's very empowering to be able to problem solve and develop.

ROV has given my son a place at school where he feels he belongs.

Faculty/Mentors

The best STEM program that I have been involved in.

The MATE Center's focus on the complete picture (writing, oral speaking/presentation, poster display/summarizing/marketing, budgeting, technical proficiency, etc.) rather than winning and losing is the main reason the competition is so valuable.

My students were/are very excited. They are already planning for next year's competition. Thirteen kids came into this, not knowing what to expect. Now most of them are talking about becoming involved in some kind of future education in engineering.

Parents concurred with the other sources reporting increased student interest in STEM. Ninety-three percent (93%) of the parents surveyed (N=335) stated that building an ROV has made their child more interested in science, technology, engineering or math. Parents wrote comments such as the following:

Much more interested in future classes, employment in engineering and robotics, etc.

Increased interest in design and fabrication.

Confident and willing to select engineering as college major and rethink career.

Increased STEM Knowledge and Skills: Most students entered with no knowledge about ROV's. Over two-thirds of the students (67%) did not know what an ROV was before entering this program, and for over half of the students (56%), this was their first time building an ROV. One indication of increased STEM knowledge is that before beginning their research for the competition, only 6% of the students indicated that they knew "a lot" about shipwrecks, sinkholes, and national maritime heritage sites. After completing their research, 30% marked that they knew "a lot". One student explained that he "learned a lot more about ROVs, shipwrecks, sinkholes, and preserving our oceans."

Among the teachers/mentors who completed post-competition surveys (N=289), 97% of the respondents reported that they observed improvements in their students' STEM knowledge and skills.

My students gained valuable skills that will be utilized a lifetime. If it wasn't for the program, I feel that our students might have not been exposed to using the tools and tying up the concepts generated by the program.

This is an excellent program. The kids have learned skills like construction, soldering, and electronics. We covered topics like buoyancy, electricity, pressure, prototyping, and troubleshooting. It was a lot of work for my 4-6th graders.

Parents reported that building an ROV contributed to improving their child's grades in engineering/robotics (66%), science (53%), math (43%) and computers (42%).[1]

Increased 21st Century Skills: In the post-competition surveys, 97% of the teachers/mentors (N=288) mentioned that they observed increases in their students' skills in team building, problem solving,

[1] Percentages are calculated among students studying each topic.

and/or critical thinking. Teachers/mentors saw skill development in many areas, as evidenced by their written comments:

> *The experience has been wonderful in building self-confidence.*
>
> *The students had a good experience coming to the competition, and they learned to work well under pressure and to find solutions to unexpected problems.*
>
> *I love how my students willingly engage in problem solving and STEM activities due to their newfound confidence through this program.*
>
> *The students learned to work as a team utilizing each other's strengths. This program was a phenomenal experience for everyone involved.*

When parents were asked what changes they have seen in their child as a result of their involvement in the ROV project, 71% reported that their children were better able to work with others; 62% indicated that their child's self confidence had improved, and 39% marked that their child was better organized. 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, and time management. Comments in this theme include the following:

> *My child has learned how to manage a team and her schedule better after participating in this competition.*
>
> *Learning to be flexible, perseverance when things don't go well, accepting differences as strengths in other individuals.*
>
> *Learned how to work with different people and personalities (some difficult)!*
>
> *Interaction with others has improved a lot.*

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

> *This experience helped me with my skills in teamwork and STEM. It also helped me to be a leader being the project manager of my team.*
>
> *It boosted my communication skills, gave me knowledge in manipulation of tools, and strengthened [the] bonding between me and other engineers.*
>
> *Helped with: teamwork, making decisions, confidence, intelligence.*
>
> *ROV has made me think in ways I have never thought before. Designing was my favorite part.*

This is a great competition; it promotes creative thinking.

Overall Opinions of ROV Program:

Overall, parents rated their children's experience building and competing with an ROV extremely positively. Eighty-three percent (83%) rated it as excellent, 15% gave a rating of good, and 2% marked fair. When asked how valuable the competition has been for the educational development of their child, over three-quarters indicated that it was extremely valuable (76%), 22% stated that it was quite valuable, 2% rated it as somewhat valuable and 0.3% stated that it was slightly valuable. No respondents marked that it was not at all valuable.

I appreciate the judges' interaction with the students; their stories of failure yet persevering to find solutions that work really encouraged my son, who is a perfectionist. My youngest son, since becoming involved on the ROV team, is no longer a lazy student. He has become an enthusiastic learner with direction and purpose. He plans to study engineering in college like his older brothers. We are grateful for the opportunities our children have had through this organization.

My son has had an amazing experience with the ROV. He has truly become a better leader and has developed such a passion for building and creating that he would like to pursue mechanical engineering. Thank you!

An amazing program! This is our first year participating as a school, and the experience has been so positive educationally, socially and developmentally.

Teachers/mentors (N=291) gave uniformly positive ratings of the usefulness of the competition, with 86% stating that it was excellent and 13% indicating that it was good. Teachers/mentors also rated the support provided by the MATE program highly (60% excellent, 31% good, 6% fair, 2% poor, and 0.3% very poor). Teachers/mentors stressed the importance of the program in comments such as the following:

This is the best STEM experience I have been a part of in 21 years of education.

The competition was a critical part of their education. It provided them with motivation and purpose and gave them a venue to share their learning. Students also could specialize on a particular aspect of their ROV, boosting their confidence and technical understanding.

This has been a great program to help develop teambuilding skills around a technical project. The open nature of design options for the ROV allows a creative element to flourish. The competition element helps keep the kids focused and energized to do their best. The marine element offers an additional level of challenge.

Students also rated their experiences building and competing with their ROV very positively, with half (50%) rating their experience as excellent, and 41% providing a rating of good. Eight percent (8%) thought their experience was fair, and less than 2% gave the experience a poor or very poor rating. In the post-competition surveys, students wrote comments such as the following:

> *What the MATE program has established is truly something exceptional. Although Ocean Engineering is at times esoteric and highly technical, this opportunity is truly a rare gem, and for the past two years, I have been privileged to have this opportunity.*

> *This project increased my interest in this field, gave me a lot of experience of team working, hardware and software developing and debugging. I think it's definitely great experience for me.*

> *MATE has been quite helpful to our ROV team over the past few years. It has opened up all sorts of new possibilities for me and has helped me make lifelong friends with people who are interested in what I am.*

Evaluation Question 1.2. How did the robotics activities affect students' ability to apply STEM knowledge and skills to finding solutions to real-world problems?

In the post-competition surveys (N=1,420), 83% of the students indicated that participating in the ROV project helped them learn to apply STEM to real world problems. Ninety-six percent (96%) of the instructors (N=287) observed improvements in their students' ability to apply STEM knowledge and skills to real world problems.

Students recognized the connection between the competition and real-world application of their science and technology skills in the following quotes:

> *I think it was a good learning experience and showed us how to use math and science in real life.*

> *Never stop doing this program! It really helps students learn and explore a lot of different things out in the real world.*

> *This has been a great experience to get hands on training with the science I love.*

> *Building the ROV was fun, and it taught me not only how science can get used in real life, but also that things can be fun, you just have to look.*

Teachers appreciated the opportunities that the ROV projects gave for their students to apply their classroom knowledge to hands-on activities modeled after real-world problems, as evidenced in the following comments:

After 13 years as a FIRST team, our foray into MATE and ROV's has been a great experience. The students have had to make a few adjustments and re-think how to do robotics. As a team, we very much appreciate the real-world application of the task and technology involved, as well as the significantly lower cost of participation compared to our previous robotic competition.

The program shows how all of the disciplines are separate and related to each other. Plus, it is an excellent tool to apply what one learns.

Again, this was a great opportunity for students to apply and develop their skills and knowledge. Thank you!

Parents also appreciated the real-world engineering industry focus of the competition. One parent with experience in the industry explained that the competition provides a valuable vision into engineering careers:

As an engineering major who worked in industry for 16 years, I think MATE involvement is much more like the engineering world - having an engineering job - than "being good at math and science" in the school world. It gives the kids a vision if they are "good at math and science" of what an engineering job could possibly look like. Math and science are way too text bookish where kids typically see little of how they apply to the "real" world. MATE is awesome.

Evaluation Question 1.3. How did the robotics activities affect students' ability to communicate their engineering process and designs to a wide audience (from engineers and technicians to the general public)?

Eighty percent (80%) of the students in the post-competition surveys (N=1,417) stated that participating in the ROV project helped them learn how to communicate their engineering design to other people. Ninety-three percent (93%) of the instructors (N=289) indicated that their students had improved their ability to communicate their engineering process and design to a wide audience.

Many students commented that their communication and presentation skills had increased, in quotations such as the following:

The engineering evaluation was fun! I have better speaking skills now.

Participation in the program has strengthened my communication (with my teammates), presentation skills, and knowledge about wiring and circuits, as well as applying extensive thought to solve problems.

Evaluation Question 1.4. How did participation in the robotics activities influence students' educational and career paths?

Students explained that their ROV projects strengthened their resumes, college applications, scholarship applications, and applications for research fellowships. In 2014, students reported that they were accepted into colleges and universities (Princeton, Cal Poly, and the Robert Gordon University Mechanical Engineering Program), and received apprenticeships (e.g., as a CAD designer), internships (Phoenix Technologies, NASA, Schilling Robotics, FMC Technologies, Hexel Corporation, and Seatrepid), and job offers (Dominion Diving, "diving with GUE Seattle", and "CAD design for CNC company").

The ROV program opened doors to opportunities like STEM camps, the Worldwide Science Fair, the Young Women in Science Program, traveling to the Black Sea ROV competition, the National Student Leadership Conference, working with the R/V Atlantis, attending the Underwater Intervention Conference, and joining "a research cruise".

Students recognized the role of the competition in their education and career paths in quotes such as the following:

> *I used my role as a programming teacher as an essay topic for numerous college applications.*
>
> *Looks pretty fantastic on my resume.*
>
> *I put it on my resume and got invited to STEM.*

Parents also recognized the value of the ROV competition in helping their children determine their educational and career paths:

> *This program has been the making of our son. He already had an internship in the robotics industry this summer before college. It has given him an avenue to excel in the robotics field, and to further work in the world's oceans.*

Evaluation Question 1.5. What effect did multi-year participation have on the above evaluation questions?

While multi-year participation did not affect *whether* students learned more about STEM careers through their ROV projects (87% of both first-year and multi-year participants), it affected the *amount* of learning. Multi-year participants were significantly more likely to state that they learned "a lot more" about STEM careers (first-year participants: 32%, multi-year participants: 40%). Multi-year participants were also more likely to be interested in pursuing a STEM career (first-year: 72%, multi-year: 78%).

Multi-year participation was significantly correlated with an increased desire to take further coursework in the following subjects:

- Math (first-year: 34%, multi-year: 41%)
- Engineering (first-year: 63%, multi-year: 68%)
- Science (first-year: 49%, multi-year: 57%)

Students who participated in the ROV competition for multiple years were more likely to state that their ROV project helped them apply STEM knowledge and skills to real-world problems (first-year: 81%, multi-year: 87%) and communicate their engineering design to other people (first-year: 77%, multi-year 83%).

The multi-year participants were much more likely to state that they learned "a lot" about the competition theme (first-year: 26%, multi-year: 37%). First time participants were more likely to indicate that they wanted to continue to learn more about the competition theme (first-year: 47%, multi-year: 42%).

Demographic Breakdowns

The first-year participants did not differ significantly from the multi-year participants according to gender (72% of both groups were male), disabilities requiring accommodations (first-year: 2.3%, multi-year: 3.5%), or living in a low socioeconomic status neighborhood (29% of both groups).

The multi-year participants were more likely than the first-year participants to be white (first-year: 56%, multi-year: 66%). Compared to the multi-year participants, a greater proportion of the first-year participants were in the SCOUT (first-year: 35%, multi-year: 19%) and EXPLORER (first-year: 14%, multi-year: 11%) classes. The bulk of the multi-year students were in the RANGER class (first-year: 45%, multi-year: 64%). Six percent (6%) of both groups were in the NAVIGATOR class.

Student Testimonials

In the post-competition surveys, many students wrote about the value of participating over multiple years and their plans to continue their involvement in the competition, both as participants and becoming mentors:

> *I have enjoyed my time with the MATE ROV competitions. This is my fourth regional competition: 3 rangers and 1 scout. It was an excellent experience, and it has benefited me in a lot of ways like helping me with problem solving skills.*
>
> *It has been great to be able to complete in three years of these competitions. I may plan to continue this on into high school, as I am currently in middle school.*
>
> *Always an awesome time, I would definitely recommend this competition to everyone. The MATE competition is always very educational and a rewarding experience. This is my third year and I still love it as much as I did in the first!*

I have a great time at this competition every year I go. Besides the point that we get to design and create ROVs and compete them in an incredibly impressive flume tank, but also touring the marine institute is always an eye opener. I had really enjoyed getting to see the bridge simulator this year. [I would rate it] 10/10, would definitely go again.

It was an excellent experience where I learned to how to build an ROV. I look forward to coming back as a mentor in the future.

This competition has been a great experience, and I look forward to coming back as a mentor in the future.

Teachers also saw an increased interest in STEM leading to multi-year participation:

Students are more engaged and more likely to consider a career in STEM than previously. All of my students that participated this year will be back next year and hope to expand their knowledge considerably.

Parents also noted that their children were very devoted to the program and gained skills, knowledge, and STEM career motivation through multi-year participation in the ROV competition:

This is my daughter's second year. Thank to her experience with ROV, she has realized to major in chemical engineering at college next year. Thank you so much. Life changing experience.

The MATE ROV program has been a fantastic experience for my son. This is his fifth year competing, and his engineering design skills are growing exponentially. Thank you!

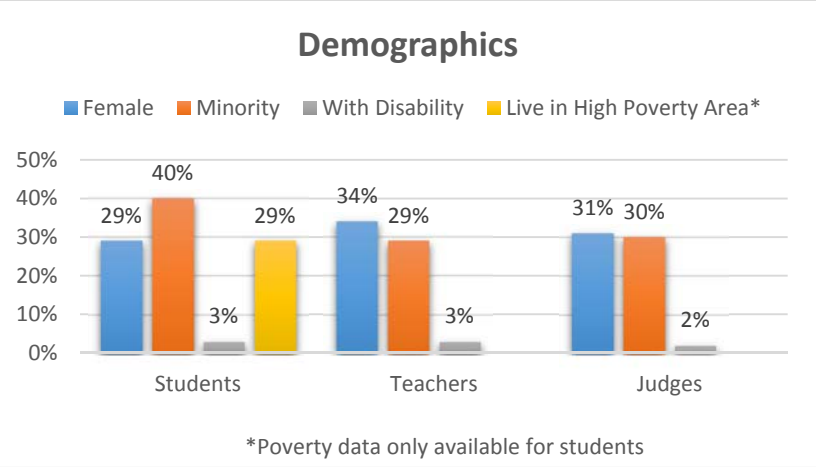
It's been a great experience for my son. He has participated for 3 years so far. He plans to return next year.

Evaluation Question 1.6. Did the robotics activities create the same impacts among underrepresented groups (by gender, ethnicity, socio-economic status, disability) as were found among students who traditionally participate in these types of activities?

Background: Demographics of Students, Teachers and Industry Representatives

According to the demographic data in the surveys (N=1,442), the students were over one-quarter female (29%), forty percent (40%) were of minority backgrounds [2], 29% came from high poverty areas[3], and 3% reported that they had disabilities requiring accommodations.

Figure 1: Student, Teacher, and Judge Demographics



The project has made efforts to include the participation of teachers, college students, staff, and competition judges (industry professionals) of diverse backgrounds who can serve as role models for the middle school students. Over one-third (34%) of the teachers (N=293) were female, 29% were of minority backgrounds, and 3% indicated that they had a disability.

Among the judges completing surveys (N=189), 31% were female, 30% were of minority ethnic backgrounds, and 2% marked that they had a disability.

[2] The sample size of participant surveys from each ethnicity was not large enough to do analysis by individual ethnicity. Instead, all non-white respondents were coded as "minority", and results were analyzed by this "minority status" variable.

[3] High poverty areas were defined as zip codes where the percentage of families with children under age 18 in poverty was higher than the nationwide average of 13.6%. This calculation is based on data from the American Community Survey at the ZTCA level.

Analysis

As the MATE Center is a longstanding center, the evaluation has improved over time. In the 2009-2010 evaluation report, preliminary results presented the trends by gender and ethnicity only. In 2010-2011, the analysis took a different approach. Rather than simply look at trends, the changes in survey administration methods helped us produce a dataset more suitable for more sophisticated analysis. Thus, we looked for statistically significant differences between the under-represented students and the students who more typically participate in these types of STEM events.

This new analysis begged the question: how should success be defined? In consultation with project managers, the evaluators decided that the measure of successfully engaging under-representative students would be that their results were not statistically different from the other students' results. In other words, the under-represented students made the same gains as the other students.

Findings by Student Demographics

Overall, there were few statistically significant differences by gender, ethnicity, disability or socioeconomic status, indicating that the ROV program is effective in producing positive results for underrepresented students as well as the students who traditionally participate in STEM learning opportunities.

The analysis focuses on whether there were statistically significant differences between the groups in the following topics:

- Awareness of STEM careers
- Interest in STEM careers
- Interest in STEM topics
- STEM knowledge

Awareness of STEM Careers

Students were asked to rate their level of awareness of marine science, technology, engineering and math (STEM) careers before building their ROV. They were then asked if they knew more about STEM careers after building their ROV, and if so, how much more. Increased STEM career awareness was reported across the board. There were no statistically significant differences by ethnicity or disability status. There were significant differences by gender and socioeconomic status, as noted below:

- **Gender:** Before the competition, female students were less likely to know "a lot" about STEM careers (male: 29%, female: 20%). After the competition, females were more likely to have increased their awareness of STEM careers (male: 86%, female: 90%), and they were also more likely to rate the amount of new knowledge of STEM careers as "a lot more" (male: 33%, female: 40%).
- **Ethnicity:** There were no significant differences by ethnicity.

- **Socioeconomic status:** Before building their ROVs, students living in high poverty areas were less likely to state that they knew "a lot" about STEM careers (25%) than those in low poverty areas (31%). After the program, the students in high poverty areas were more likely to indicate that they knew more about careers in STEM (90%), compared to those in low poverty areas (85%).
- **Disability status:** There were no significant differences between the responses of the students with and without disabilities.

Interest in STEM Careers

The survey asked students if their ROV project made them more interested in a marine career, less interested, or didn't affect their level of interest. Across the board, students indicated that their ROV project had made them more interested in a marine career.

- **Gender:** There were no significant differences by gender.
- **Ethnicity:** Minority students were significantly more likely to state that their ROV project made them more interested in a STEM career (77%) than white students (71%).
- **Socioeconomic status:** There were no significant differences by socioeconomic status.
- **Disability status:** There were no significant differences between the responses of the students with and without disabilities.

Interest in STEM Topics

The survey explored interest in STEM topics in two different ways. First, the survey asked if the students' ROV project made them want to learn more about marine science, technology and engineering. There were no differences by socioeconomic status or disability. However, students with minority backgrounds (85%) and those living in high poverty areas (84%) were significantly more likely to state that their ROV project increased their desire to learn more about STEM, when compared to white students (79%) and those living in low poverty areas (78%). The high poverty area students were also more likely to want to learn more about shipwrecks, sinkholes, and national maritime heritage sites (low poverty areas: 39%, high poverty areas: 53%).

Next, the students were asked if their ROV project increased their desire to take any of a list of courses. Students could mark as many courses as they wished out of a list including math, computer science, engineering, science, and hands-on classes or club activities. There were statistically significant differences in the courses that the students marked, as follows:

- **Gender:** Female students were more likely than males to state that the project increased their desire to take science (male: 51%, female: 59%) and hands-on courses (male: 63%, female: 71%). Male students were more likely to report increased interest in computer science (male: 49%, female: 36%) and engineering (male: 69%, female: 56%) courses. There were no significant differences between the genders in the increased desire to take math.

- **Ethnicity:** White students were more likely to state that the ROV project increased their desire to be involved with hands-on classes and clubs (white: 67%, minority: 62%). There were no significant differences by ethnicity in the increased desire to take math, science, computer science, engineering or hands-on classes.
- **Socioeconomic status:** There were no significant differences between the responses of the students living in high and low poverty areas.
- **Disability status:** There were no significant differences between the responses of the students with and without disabilities.

STEM Knowledge

There were no statistically significant differences in the gains in knowledge about shipwrecks, sinkholes, and national maritime sites by ethnicity or socioeconomic status. However, there were significant differences by gender and disability status:

- **Gender:** After the competition, female students were more likely than male students to indicate that they knew "a lot" about shipwrecks, sinkholes and national maritime heritage sites (male: 27%, female: 39%).
- **Ethnicity:** There were no significant differences by ethnicity.
- **Socioeconomic status:** There were no significant differences by socioeconomic status.
- **Disability status:** After the competition, students with disabilities were less likely to state that they knew "a lot" about shipwrecks, sinkholes and national maritime heritage sites than students without disabilities (students with disabilities: 25%, students without disabilities: 31%).

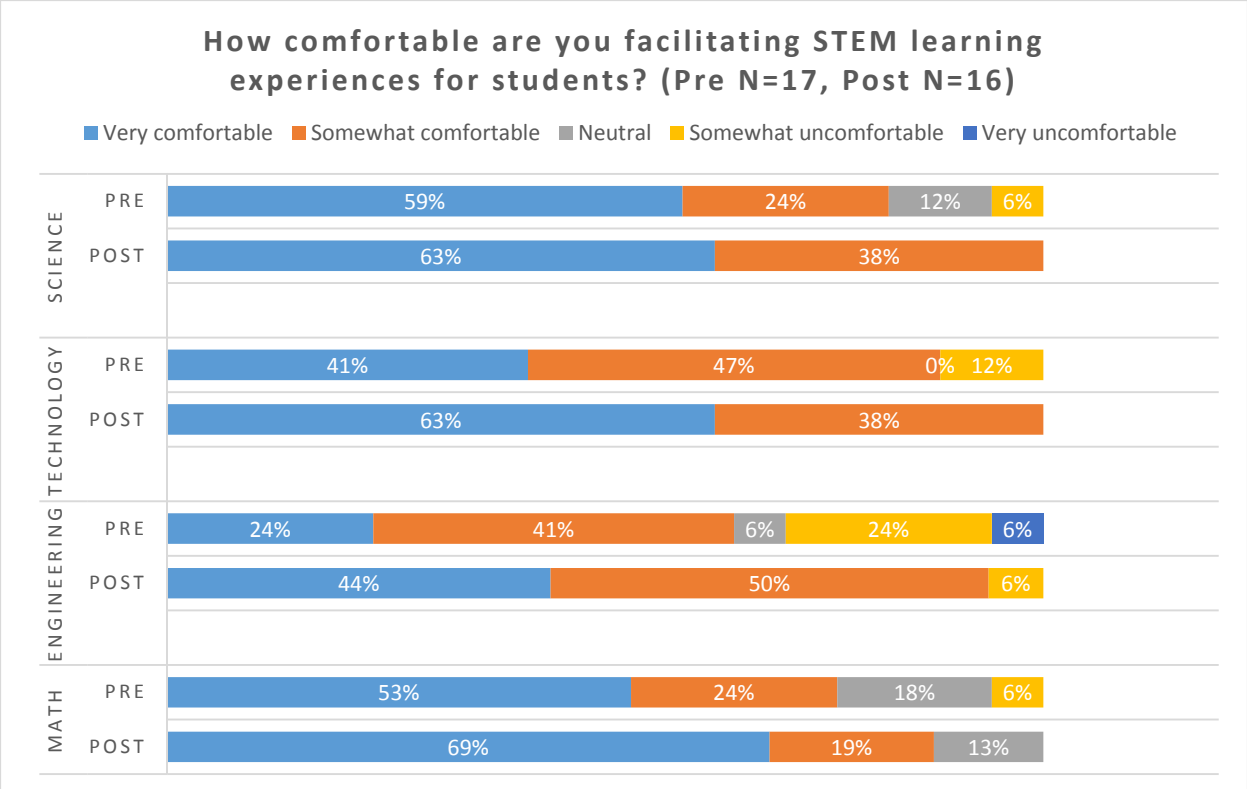
Project Goal 2: Provide teachers with professional development, instructional resources, and mentors to support and sustain the delivery of STEM career information and learning experiences.

Evaluation Question 2.1. Are teachers more confident delivering STEM learning experiences? Delivering career information and outlining career pathways?

Pre and post workshop surveys, post competition surveys, and Summer Institute feedback surveys demonstrate that the participants gained confidence facilitating STEM learning experiences through the training and support provided by MATE.

The percentage of respondents who rated themselves as "very comfortable" facilitating STEM learning experiences for students rose between the pre and post workshop surveys for science (pre: 59%, post: 63%), technology (pre: 41%, post: 63%), engineering (pre: 24%, post: 44%), and math (pre: 53%, post: 69%).

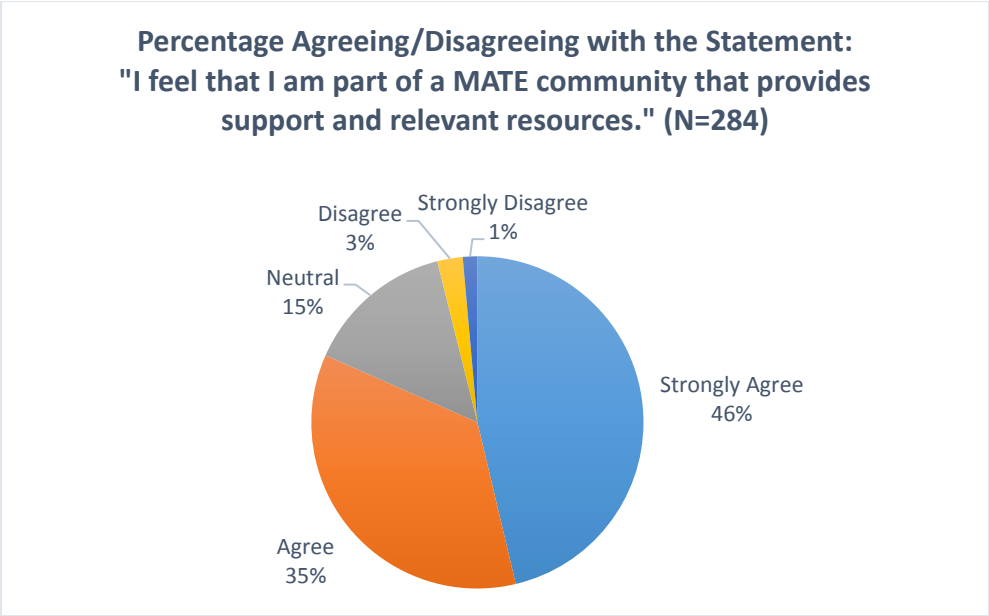
Figure 2: Level of Teacher Confidence Facilitating STEM Learning Experiences: Pre and Post Workshops



Evaluation Question 2.2. Do teachers feel they are a part of a larger MATE community that provides support and relevant, necessary resources?

Among the post-competition surveys (N=284), 81% of the teachers agreed that they felt they were part of a MATE community that provides support and relevant resources.

Figure 3: Percentage Agreeing/Disagreeing that They Feel a Part of a MATE Community

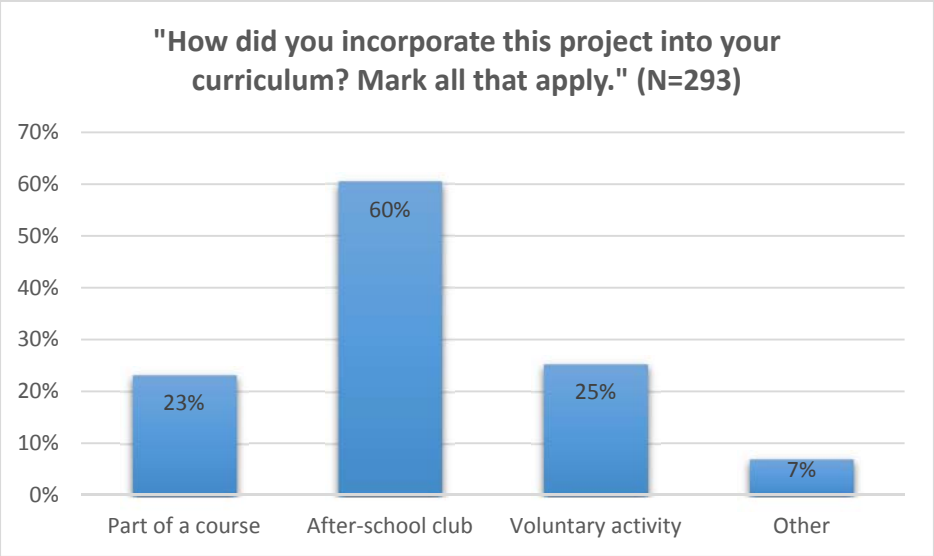


Evaluation Question 2.3. Do teachers incorporate MATE robotics activities/curriculum into courses and afterschool programs? Are the courses and/or curriculum adopted by school districts?

In the post-competition surveys, close to three-quarters (73%) of the teachers (N=287) stated that they used MATE materials and resources to incorporate ROV building into their course or club, and half (50%) modified their curriculum and teaching based on MATE resources.

Sixty percent (60%) of the post-competition survey respondents (N=293) incorporated building ROVs into an after-school club. Twenty-three percent (23%) built ROVs as part of a course; 25% built ROVs as a voluntary activity; and 7% built ROVs in another venue.

Figure 4: ROV Projects in Courses, After-School Clubs, Voluntary Activities, and Other Activities



Teachers using the ROV project as part of a course reported that it worked well for incorporating engineering and science concepts into their curriculum. They also appreciated the real-world focus and hands-on activities.

> *This was an excellent way to incorporate robotics into schools. It links to my focus on oceans and marine ecosystems. Plus, it gives robotics opportunities to my students.*
>
> *MATE is the best program for Engineering we have found.*
>
> *MATE is a nice resource for schools to integrate real world business and engineering concepts for students.*
>
> *My three boys are home schooled. MATE ROV is their winter/spring science curriculum.*

Evaluation Question 2.4. Are teachers able to access classroom mentors as needed? Do the classroom mentors help them successfully incorporate robotics activities into the course? Are the classroom mentors adequately prepared?

In several regions, the regional coordinator matched up college and high school students – in many cases, former ROV competitors themselves – with middle school ROV teams to work with them throughout the competition season. College students also acted as helpers at the workshops. In some cases, the college students received a small stipend (though they stated that they would have done the work without it), and in other cases they received service learning credit, Presidential Volunteer Service Awards, or simply volunteered their time with no recompense. This arrangement worked well for the regional coordinators, college students and middle school students and teachers.

Anecdotal reports suggest that the involvement of college students as mentors can lead to profound experiences for both the college and middle school students. Many sources reported that the middle school students found the college students to be approachable representatives of science. These young adults modeled the paths that the middle school students could take to a STEM career.

For 27% of the post-competition teacher survey respondents (N=280), a classroom/club mentor came to their site to help their teams. Among these teachers (N=76), the mentor helped them incorporate robotics into their course or club to "a great extent" for 54% of the respondents, a "moderate extent" for 30% of the respondents, and a "small extent" for 16% of the respondents. No teachers marked that the mentors were not helpful at all.

The vast majority of respondents (95%) indicated that their mentors were adequately prepared to help them and their students through the ROV design and building process.

Project Goal 3: Increase parental involvement in order to support and encourage students to pursue STEM education and careers.

Evaluation Question(s) 3.1. Did the MATE robotics activities lead to an increase in the parents' support of their children's interest in STEM careers?

Eighty-seven percent (87%) of the parents surveyed (N=330) 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. Five percent (5%) marked that the program participation did not affect how they picture their child's future, and 9% were not sure. Eighty-eight percent (88%) of the parents stated that they feel they have at least some influence on their child's career choice.

Evaluation Question 3.2. Did the enhanced parent online resources lead to an increase in the parents' ability to provide assistance and support for their children's involvement in the MATE robotics activities?

The MATE Center has focused on developing a variety of resources to help students, teachers, and parents participate in the competition and connect the competition to classroom concepts. These resources were not specifically aimed at parents; the enhanced parent resources will be developed in later grant years. Teachers and parents reported that the new resources enabled them to help their students participate in the competition.

> *MATE training materials are very helpful getting kids started. We use the puffer fish training board, the MATE train board, the trigger fish kit, and the puffer fish kits. All are great. Thank you.*
>
> *The MATE book is excellent! I shared a lot of the book with the group.*
>
> *I've definitely learned! I'm a social worker - coaching wasn't easy, but the use of MATE website and video instruction allowed for a mother/social worker to coach. Thank you!*
>
> *Coaching was possible with the help of the tutorials on MATE website but, boy, it wasn't easy! Fun - it was definitely fun!*

Evaluation Question 3.3. Did the regional parent advisory committees provide feedback and advice to help improve the competitions and ensure that the program is inclusive of all participants?

Advisory committees were broadened to invite participation from parents as well as industry representatives, professional organizations (e.g., Marine Technology Society), government agencies (e.g., NOAA) 6-12th grade educators, community college faculty, and university faculty. The committees were implemented at the regional level so the recommendations would be applicable to the local community needs. Advisory committees provided recommendations including:

- Hold workshops
- Provide kits for most needy schools and new teams (funds permitting)
- Schedule online support when requested
- Prioritize recruiting diverse judges
- Reach out to organizations such as the local Boy Scout council to promote the competition
- Create mini-ROVs for the classroom

The regional coordinators were responsive to their committees' recommendations.

Broader Impacts

The MATE Center's ITEST activities have been leveraged by regional coordinators and participants in ways that were unanticipated during the writing of the proposal. Thus, they don't fit under any particular evaluation question. Since the evaluation was not set up to monitor these activities, the findings presented here should be considered preliminary. Next year, the evaluation tools will be modified to capture more of this data.

These "broader impacts" fall into three main categories:

4. Leveraging ITEST activities/funding to raise additional funding by regional coordinators, teachers, schools, and student teams
5. Using ROVs and ROV-based activities outside of the competition by teachers and students
6. Broader impacts on teachers and institutions: new careers, new classes, deeper relationships with students, improved STEM knowledge, increased motivation and engagement with their discipline, and increased professional development opportunities

Leveraging ITEST Activities/Funding

Faculty who led ROV teams and/or attended the Summer Institute reported that they have applied for and won funding from grants and school boards and have received equipment donations from local industry. Examples include the following: "Having an ROV program makes it easier for me to go to local companies and receive equipment for classroom use, e.g. oscilloscopes, multimeters, and computers." Additionally, ROV competition regions outside of the United States have leveraged news of the ITEST grant raise additional funds.

Using ROVs outside the Competition

Many faculty have reported using ROVs or ROV-based activities outside of the competition, incorporating these tools and topics into their classes or clubs in order to bring science to life.

Broader Impacts on Teachers and Institutions

Teachers report a broad variety of positive results from their participation in the ROV competition and professional development, including the following:

- New careers
- New classes
- Deepened relationships with students
- New collaborations with industry, research orgs, and other educational institutions
- Improved STEM knowledge

- Increased motivation and engagement with their discipline
- Increased professional development opportunities (in addition to that offered by MATE)

Quotations from teachers describing these broader impacts include the following:

> *My participation with the MATE ROV club as a parent volunteer led to me switching careers and becoming a chemistry teacher at the High School level.*
>
> *By participating in the MATE ROV competition, I've expanded my own working knowledge of STEM and have been able to better incorporate these streams into the courses that I teach. By participating in the competition, I was able to better network with like-minded teachers and share knowledge essential to doing well in this competition in the future.*
>
> *This program changed my view on science. Loved that it's hands on.*
>
> *Thanks so much for providing this opportunity! My students gained a lot of knowledge and enthusiasm, and I did as well.*
>
> *We now have an all girls' engineering course.*
>
> *We have an Engineering ROV class now. Thanks, ROV.*
>
> *Creating a marine science center (in discussion) and ROV shed in our local community.*
>
> *Relationship with high school and peer schools; more professional development.*
>
> *Partnerships with industry/development opportunity to build relationships with pupils.*
>
> *PD opportunities / presenting at conferences*

CONCLUSIONS

Overall, the MATE Center successfully implemented the first year of ITEST grant activities. 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 students. Involvement in the ROV 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. The evaluation found that the program was effective in producing positive results for under-represented students as well as the students who traditionally participate in STEM learning opportunities.

Parents were passionate supporters of their children's involvement in the program, with comments such as "This program has been the making of our son." Educational research has stressed the importance of family support in a student's 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 professional development activities were effective in increasing teachers' understanding of ocean STEM careers, strengthening their commitment to lead middle school teams in the ROV competition, and improving their confidence in facilitating STEM learning experiences. Teachers incorporated their ROV projects into courses and afterschool programs, incorporating MATE curriculum and resources.