Cover

Federal Agency and Organization Element to Which Report is Submitted:
4900
Federal Grant or Other Identifying Number Assigned by Agency:
1312333
Project Title:
Scaling Up Success: Using MATE's ROV Competitions to Build a Collaborative Learning Community that Fuels the Ocean STEM Workforce Pipeline
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Recipient Organization:
Monterey Peninsula College
Project/Grant Period:
09/15/2013 - 08/31/2018
Reporting Period:
09/15/2013 - 08/31/2014
Submitting Official (if other than PD\PI):

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- Principal Investigator

Submission Date:
11/04/2014
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)
Jill M Zande

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Accomplishments

* What are the major goals of the project?

Our ITEST Scale-Up project, *Scaling up Success: Using MATE's ROV Competitions to Build a Collaborative Learning Community that Fuels the Ocean STEM Workforce Pipeline*, expands the best practices that we identified, based on evaluation data and regional reporting, as most effective in reaching, engaging, and supporting student and teacher participation in STEM. 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. Our hypothesis is that for each additional year a student participates in engineering design challenges

such as the MATE ROV competition, their likelihood of going to college increases, their likelihood of declaring a STEM major increases, and their likelihood of entering the STEM workforce increases. The following four goals (and the activities described beneath each) provide the foundation for our work:

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.

1a. Add a SCOUT+ competition class so students can gradually step up their knowledge and skills.

1b. Create a support system for students who move on to the next grade and find there are no robotics activities.

1c. Provide opportunities for students to interact with working professionals as well as student mentors to support their learning and provide examples of STEM careers.

1d. Document and share inspirational stories of successful students and working professionals to help students visualize themselves in pathways to STEM careers.

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

2a. Develop a continuum of curriculum that is tied to the Next Generation Science Standards (NGSS) and includes online complementary resources.

2b. Develop a progression of ROV "kits" that complement the curriculum.

2c. Designate regional teacher "leaders."

2d. Offer week-long professional development workshops focused on the curriculum and kits.

2e. Offer regional professional development and student-focused workshops.

2f. Increase preparedness of near-to-peer student and industry mentors.

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

3a. Create an online parents' resource center and listserve.

3b. Form regional parental advisory committees that provide feedback and advice.

4. Track students longitudinally to document how participation impacts their education and career path.

4a. Improve our current student tracking system.

4b. Use the videos described under Goal 1d to document student education and career pathways.

The evaulation report for this grant year is included within the supplemental documents.

* What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

Major Activities:

1a. Add a SCOUT+ competition class. Eleven of the 17 U.S.-based regional competition programs received ITEST funding this year: Florida, the Mid-Atlantic, Monterey, New England, Oregon, Pennsylvania, the Pacific Northwest, Shedd Midwest, Southeast, Texas, and Wisconsin. Three of those regionals added a NAVIGATOR (aka SCOUT+) class. Two more plan to add it in 2015, while two others are considering it depending on the outcomes of their next advisory committee meeting. One regional, Wisconsin, added a SCOUT class; previously it had only offered RANGER. Two of the regionals that added a NAVIGATOR class offered professional development and/or student outreach to support participants.

1b. Create a support system for students. Students and parents looking to start or continue with the ROV competition were connected with the following resources: 1) the regional coordinator nearest them, who in turn facilitated connections with local teams/schools, teacher leaders, parents, and working professionals as well as professional development opportunities and student workshops; 2) MATE's bank of on-line instructional materials, including building instructions, curriculum modules, and how-to videos; 3) the MATE store for access to ROV kits, practice boards, and more; and 4) the link to MATE's forums, which include a technical help and competition FAQs board.

1c. Provide opportunities for students to interact with mentors. Eight of the 11 regionals that participated in ITEST this year connected teams with mentors. The mentors were industry professionals, students, or, in the case of the Oregon regional, teams that mentored other teams. The coordinators of the three regionals that did not explicitly report connecting teams with mentors served as mentors themselves, visiting schools to provide technical assistance and facilitating access to resources (e.g. building materials, pools for testing). All of the regionals utilized industry professionals as judges during the competition events. Engineering evaluations, in particular, provide a terrific opportunity for the students to interact one-on-one with working professionals.

1d. Document and share inspirational stories. The video team covering the 2014 international competition collected more than 18 hours of footage that includes interviews with students, teachers, parents, mentors, working professionals, and regional coordinators. A summary video highlighting the event will be released in late October 2014. From there, videos of students will be put together and shared via the MATE web site.

2a, 2d, and 2e. See **What opportunities for training and professional development has the project provided?**

2b. Develop a progression of ROV kits. Prior to our ITEST Scale-Up award, we had developed two, introductory ROV kits – the Angelfish and the PufferFish. The PufferFish used hobby motors and the Angelfish used bilge pump motors; however the complexity was comparable. Since the award in September 2013, we discontinued the Angelfish kit and completely re-designed the PufferFish kit. We went from simple switches to a printed circuit board with integrated electrical components in an effort to support students to move up to the next level of ROV building. We then developed a new intermediate kit, the TriggerFish, that uses analog motor controllers and joysticks rather than switches – once again in an effort to support students to move up to the next level of ROV building.

The PufferFish kit was further revised in September 2014 with new features that include an amp/volt meter, auxiliary power for additional tools, and a more robust tether management system. The TriggerFish ROV kit was also redesigned with a number of technological improvements, such as a more robust motor controller.

We distributed approximately 300 ROV kits (~$60,000) to the regionals that participated in ITEST activities in Year 1 to support their teacher workshops. In addition, we sold (and continue to) sell these kits through the MATE web site. In addition to the kits provided through ITEST, a number of regionals bought kits (at their expense) to run additional workshops. Schools across the country are also buying kits directly from us; to date in 2014 we have sold more than $110,000 worth of kits.

We believe this speaks well for the long-term sustainability of the program, but also the need to think carefully about the kit designs so that the production process can be properly scaled up. In Year 1 we felt that it was important to focus on fine-tuning the PufferFish and TriggerFish ROV kits in order to maximize the learning potential and minimize production costs and time to"market." In Year 2, we will focus on developing our third ROV kit.

2c. Designate regional teacher "leaders." Seven of the 11 regionals participating in ITEST this year designated at least one local teacher leader to provide support for other area teachers and to assist them with program activities. These teacher leaders led or assisted with professional development workshops and student outreach; mentored other teachers in starting ROV programs at their schools; connected teachers and students with industry and student mentors; helped teams decipher the MATE competition manuals and fielded questions about participating in the event; and presented at conferences and workshops. Those regionals that did not designate a teacher leader plan to in Year 2.

(Continued under Key Outcomes or Other Achievements)

Specific Objectives:

See **What are the major goals of the project?** above.

Significant Results:

Over the course of Grant Year 1, our project:

- Supported 11 regional partners with ITEST funds.
- Added a NAVIGATOR competition class to 3 of those regions; 2 more plan to add it in 2015. One region added a SCOUT competition class.
- Made progress towards creating a multi-year student support system that consists of professional development instructional resources, mentors, parents, and more. The goal is to improve multi-year competition participation by 5% a year over the duration of the grant.
- Provided students with access to student and industry mentors in 8 regions.
- Collected footage at the international competition and are currently working with that footage to produce videos highlighting the event and student successes.
- Made progress towards developing a comprehensive curriculum tied to the Next Generation of Science Standards for middle school that can be adapted to high school.
- Developed 2 ROV kits that complement this curriculum.
- Designated teacher leaders in 7 regions to function as resources for coordinators and other teachers.
- Offered 2 workshops that provided 56 hours of professional development each to 40+ participants, including middle and high school teachers and regional coordinators.
- Offered more than 26 regional professional development workshops that provided an average of 14 hours of instruction more than 480 teachers.
- Offered an additional 260+ regional workshops, such as topic-specific hands-on instruction, information sessions, and pool practice days, that impacted 1,800 students.
- Developed mentor information and training resources to support their role in the classroom and streamline communication.
- Engaged nearly 200 parents in grant activities (e.g. professional development, community outreach events, regional advisory committees, surveys). In addition, directed parents to our online resources and invited them to join our e-mail listserves to support their involvement and improve communication.
- Sixty-five organizations, more than 150 industry professionals, and nearly 125 others (e.g. community members) supported the grant activities. The activities were also supported by 187 high school, 26 community college, 63 university undergraduate, and 29 graduate students as well as 9 community college and 38 university faculty.
- Held 11 regional stakeholders meeting to determine the needs of local audiences.
- Formed 9 regional advisory committees (that include a total of 19 parents) that met at least once to provide guidance and oversight.
- Improved our team and student registration and tracking system using a low-cost, commercial product that will, along with post-competition surveys, help us to

determine 1) how many students are involved for multiple years and 2) how their long-term participation influences their interest in pursuing STEM courses and careers. Based on post-competition surveys (N=1,442), 36% of the students have competed in MATE ROV competitions for multiple years. These students were significantly more likely to indicate that their ROV project helped them apply STEM knowledge and skills to real-world problems and helped them communicate their engineering designs to other people. Multi-year participation was also significantly correlated with an increased desire to take further coursework in math, engineering, and science. Please see evaluation for further details.

- Continued to improve the utility of MATE web resources and use social networking tools strategically to increase communication and collaboration and document successful strategies.
- Used surveys and other instruments to evaluate progress and increase effectiveness and impact.

Key outcomes or Other achievements:

(Continued from Major Activities)

2f. Increase preparedness of student and industry mentors. During Year 1, regional coordinators were encouraged to reach out to and engage new mentors – high school and college students, industry professionals, and community members. We supported their efforts by supplying the following new information and training modules:

- MATE ROV Stakeholders Meeting PPT (stakeholders are or often become mentors, as evidenced by the quote above; see http://www.marinetech.org/files/marine/files/ITEST/MATE%20ROV%20Stakeholders%20Meeting_FINAL_v2.pdf)
- ITEST workshop mentors 2014 PPT (see http://www.marinetech.org/files/marine/files/ITEST/ITEST_workshop_mentors_2014.pdf)
- Using the Monterey Bay Aquarium's "Teen Brain" PPT as a guide, we also discussed the following:
  - Emotions and development
  - Appropriate behaviors (e.g. no physical contact, do not share contact information, etc.)
  - Reporting procedures if there is an incident or issue
- See also 3a below.

It is important to note that regionals can and do modify these materials so that they are better suited for their local mentor audience AND the way in which those mentors will interact with the student teams (e.g. in the classroom, during an afterschool program, in a hosted workshop setting). In addition, training materials and sessions may vary depending on the regional organization and "source" of the mentors. For example, in addition to the orientation (that included the PPT described above) provided by the

MATE Center to student mentors from the California State University Monterey Bay Service Learning Institute, mentors working with schools within Monterey Peninsula Unified School District were required to attend an additional orientation provided by the district.

These efforts have started to have an impact, as evidenced by the following quotes and examples submitted by regional coordinators:

Teachers from school districts were encouraged to mentor each other, and team teaching/vertical alignment was seen in several schools as a result. – Oregon regional coordinator

Keep up with the materials – videos, kits with good documentation, book, etc. These are incredibly valuable for us as instructors and for the new (and old) mentors/coaches as something to focus on for school/parent support. That, and keeping the competition system going with good missions and venues. – Pacific Northwest regional coordinator

What worked particularly well in our region was the establishment of the MATE PA Regional Stakeholders Board. Inviting new members that were capable of investing human capital as well as industry professionals [with] business sense was invaluable. Their involvement along with reaching out the MATE Center enabled us to put forth a truly unforgettable winter workshop and one of our best Regional ROV challenges. – Pennsylvania regional coordinator

3a. Create an online parents' resource center. The new effort to engage parents in Grant Year 1 was through the regional advisory committees. Nine of the 11 regionals that received ITEST funding formed advisory committees. All total, 19 parents served as advisors. All of the regions that formed advisory committees commented on the positive influence that the committees (including the parent members) had on developing their plans and providing advice and feedback. These comments included the following:

What worked particularly well in our region was the establishment of the MATE PA Regional ROV Stakeholders Board. Inviting new members that were capable of investing human capital as well as industry professional business sense was invaluable. Their involvement along with reaching out to the MATE Center enabled us to put forth a truly unforgettable winter workshop and one of our best Regional ROV challenges.

We decided in our stakeholders/advisors meeting that the best way we could help is to improve the competency and confidence of the coaches/teachers/mentors so they could, in turn, help their teams move up the technology scale. We also agreed that immediately providing a new competition class would make it clear to all the students currently participating that we're dedicated to an improved ladder-like approach as supported by this grant.

The new resources that were developed to support parents include the following:

- An overview of the competition (see www.marinetech.org/files/marine/files/ROV%20Competition/2015%20files/MATE%20competition%20info.pdf)
- How to get started (see www.marinetech.org/getting-started/), which includes:
    - Kits and building instructions (see www.marinetech.org/store/)
    - An invitation to join MATE listserves (regional and international)
- FAQs (see www.marinetech.org/faqs/), which includes answers to questions such as "what class do we enter?"

These are resources that support parents as well as others (e.g. students, teachers, industry mentors) seeking information on how to participate. In other words, at this point we did not distinguish between "parent" and resources for other stakeholders. We have discovered that the information that these three audiences are looking for is basically the same.

During Grant Year 2 we will create a specific "Parent Resource Center" page within the competition section of the MATE web site. (We will include links to the Parent Resource Center on our store, curriculum, and other appropriate web site pages.) The resource center will include a "welcome" note targeted to parents as well as links to the information and resources described above. It will also include links to the student success videos that we have planned in Year 2 as well as highlights of evaluation data that demonstrate the positive impact of the program. The idea is that the Parent Resource Center functions as a one-stop shop for parents interested in supporting their children's participation in ROV projects and engineering design competitions.

3b. Form regional parental advisory committees. Nine of the 11 regions participating in Year 1 ITEST activities created advisory committees. Seven of those nine included at least one parent; four of those seven include two or more parents. The majority of the advisory committees grew out of the stakeholders' meetings that each regional was encouraged to hold prior to developing their plan of activities for Year 1. As evidenced by the composition of the regional advisory committees (e.g. parents, industry members, educators), many of the stakeholders became members. In this way, the advisory committees morphed into a body that better represents the local audience. All of the regions that formed advisory committees commented on the positive influence that the committees had on developing Year 1 plans and providing advice and feedback.

4a. Improve our current student tracking system. The 2013-2014 competition season registration system was powered by Active, a company that handles registrations for running and bike races and other sporting events. Active allows the event organizer to customize registration questions and, in addition to the ability to easily download the information into a user-friendly format (e.g. Excel), maintains a long-term database of the information. Students' registration includes middle name/initial field; this information is critical for matching the registration information with the National Student Clearinghouse database. This information, coupled with data gathered from post-competition surveys, will allow us to better track and demonstrate the impact of multi-year competition participation on students' education and career choices. Active continues to add features

that will improve the system – and all at low-cost! The fee is based on the number of "paying" customers and the amount of the transaction; teams (not students) pay a nominal fee to register for the competition.

4b. Use the videos described under 1d. See 1d above.

* What opportunities for training and professional development has the project provided?

2a. Develop a continuum of curriculum. In Year 1, we developed foundational student learning outcomes for the curriculum broken down by competition class (see http://www.marinetech.org/pufferfish-rov-curriculum/). We led two, week-long teacher workshops that were aligned with these learning outcomes; the PufferFish workshop was aligned with the SCOUT class learning outcomes, while the TriggerFish workshop was aligned with the NAVIGATOR class learning outcomes. Presentations, labs, activities, and handouts were developed to support these learning outcomes and can be found here http://www.marinetech.org/pufferfish-rov-curriculum/ and http://www.marinetech.org/triggerfish-rov-curriculum/. (See 2d below for additional information and impact.) We are currently working on packaging the presentations and activities into 50-minute classroom lessons that follow a specified format (see Supplemental Documents).

Our work in Year 1 has lead us to believe that it is not simply a curriculum but rather a comprehensive learning package that includes 1) curriculum (e.g. a lesson and activity book that includes the lessons developed during our summer workshops) aligned with NGSS's Engineering, Technology, and Applications of Science standards; 2) an accompanying ROV kit; and 3) lab packs of resources (e.g. electronic components and other items) focused on the middle school and high school level that will lead to long-term sustainability of the program in schools. We plan to have a draft of our comprehensive learning package in time to be vetted by teachers participating in our 2015 week-long summer workshop. We envision these efforts to result in an ebook(s) that includes how-to videos and demonstrations; however, we believe a hard copy may still be required. We will survey our workshop participants for this type of feedback.

2d. Offer week-long professional development workshops. The fourth annual ITEST Summer Institute, *Intermediate Level ROV Building: The TriggerFish ROV*, took place July 10 – 18, 2013 at Monterey Peninsula College (MPC). This institute targeted coordinators and teacher leaders from the regional competition sites and introduced participants to the TriggerFish ROV kit. Participants also built the MATE Electrical Trainer, a printed circuit board that provides a platform for understanding common electrical components, practicing through-hole soldering, and introducing more advanced electronics. A total of 20 educators attended. Curriculum materials from this institute can be found here www.marinetech.org/triggerfish-rov-curriculum/.

Follow-up surveys show the positive impact that the institute had on the participants. Ninety-eight percent rated the usefulness of the institute as "excellent" or "good." One hundred percent stated that the institute provided valuable ideas that they are using in their courses. All of the

participants (100%) reported that they modified their course content and/or teaching strategies based on their experience. In addition, 98% of the participants reported that they shared the information offered in the MATE institute with other instructors and participated in the MATE ROV competition. Participants also leveraged their experience at the summer institute to bring in grant funding and other resources to support their work with ROVs. Since attending the institute, 80% of the participants have built an ROV with students; as of May 2014, 61 ROVs had been built. In addition to the MATE competition, students used their ROVs to survey invasive species, release salmon, measure water quality, survey shipwrecks, and more.

The fifth annual ITEST Summer Institute, *Introductory Level ROV Building: The PufferFish ROV*, took place July 27- August 3, 2014 at MPC. This institute introduced participants to the PufferFish ROV. Participants learned the fundamentals of ROV building and experienced a variety of hands-on science, technology, and engineering activities that can be integrated into a class or afterschool activity to reinforce foundational knowledge and skills. Curriculum materials from this institute can be found here www.marinetech.org/pufferfish-rov-curriculum/.

All 22 participants (18 teachers and four informal educators) rated the usefulness of the workshop as excellent; all 22 plan to build ROVs with their students. Comments from the surveys included:

The workshop was one of the best I have attended. The lessons and activities were all purposeful and worthwhile. I learned a great deal and am much more confident and comfortable with moving forward in my work with ROVs. I'm very excited to share this with my community!

I can't wait to start my first year of teaching an underwater robotics elective. I feel the institute has helped me clarify a lot of details and has really helped increase my enthusiasm by connecting me with so many other instructors and educators that are working on a similar curriculum.

The full evaluation for the 2014 institute will be included in next year's report. The learning outcomes and curriculum for both workshops can be viewed at www.marinetech.org/files/marine/files/Curriculum/PufferFish/MATE%20Underwater%20Robotics%203%20Classes.pdf

2e. Offer regional workshops. Each of the 11 regions that participated in ITEST this year offered both professional development for teachers and workshops focused on students. All total, 26 professional development workshops were offered to 486 teachers; the following is a breakdown by grade level:

Grade 3-5: 50; Grade 6-8: 208; Grade 9-12: 175; 2-year college: 8; 4-year college: 3; Informal educators: 34; Other (e.g. parents): 8

The workshops ranged from ½-day ROV design and building activities (where the control boxes are pre-built so that the focus is on frame design, motor placement, and buoyancy) to 1-2 day events (that covered simple electronics and building the control box of the PufferFish kit) and week-long workshops (organized similar to MATE's Summer Institutes). The number of hours

of instruction for each teacher ranged from 2 to 42; the average was nearly 14. The workshops were offered after school, on weekends, and/or during the summer.

Each of the 11 regions also offered student-focused workshops. All total, 269 workshops were offered to 1,800 students. Of these students, 1063 were impacted in an after school setting, while 496 and 241 were impacted in school and as part of a community organization event, respectively. The workshops covered topics from basic ROV design and building to simple electronics and PufferFish and TriggerFish ROV kit assembly. Information sessions, pool practice days, and "demo nights," among others, were also offered. The number of individual student contact hours ranged from 2 to 18; the average 8.5.

All of the regions used MATE's ROV kits and/or practice boards in some way; 9 used them as the focus of their workshops. Seven regions reported that the kits were helpful; others offered suggestions for improvement (which are currently being incorporated). Eight regions reported using MATE's on-line curriculum or videos; 7 reported using the instructions for kit assembly.

Comments from regional coordinators about the support they received from MATE included:

Keep up with the materials – videos, kits with good documentation, book, etc. These are incredibly valuable for us as instructors and for the new (and old) mentors/coaches as something to focus on for school/parental support. - Pacific Northwest regional coordinator

Kits were extremely helpful for new teams as the kits gave them a foundation to build upon and made it easier for them to erase the "fear factor" and say yes to the challenge. - Pennsylvania regional coordinator

* How have the results been disseminated to communities of interest?

Between the MATE Center and its regional partners, nearly 50 abstracts, journal papers, newspaper articles, web sites, television news stories, and other publications featured ITEST grant activities. Examples of these are included within the products section of this report.

In addition, between the MATE Center and its regional partners, information about the ITEST project was presented at more than 30 conferences, meetings, community events, workshops, and other events. These included the following:

- The New York City Maker Faire, held September 22, 2013 in New York City, NY.

- Oceans Conference and Exhibition, organized by the Marine Technology Society and the Institute for Electrical and Electronics Engineers Oceanic Engineering Society and held September 23-26, 2013 in San Diego, CA.

- Annual COASTALearning Symposium, held October 10-13, 2013 in Newport, OR.

- Society of Manufacturing Engineers of Philadelphia Annual Banquet, held October 30, 2013 in Philadelphia, PA.

- Washington Association for Career and Technical Education Conference, held October 31, 2013.

- The California STEM Symposium, held November 18-19, 2013 in Sacramento, CA.

- Georgia Assocation of Marine Education Conference, held in November 2013.

- Underwater Intervention Conference and Exhibition, organized by the Marine Technology Society's ROV Committee and the Assocation of Diving Contractors International and held February 11-13, 2014 in New Orleans, LA.

- Southeastern Massachusetts Regional STEM Network Meeting, held March 25, 2014.

- Xperience STEM, held July 29 - August 1, 2014 in Boulder, CO.

* What do you plan to do during the next reporting period to accomplish the goals?

During the next reporting period (Grant Year 2) we will continue to:

- Support regional partners with ITEST funds.
- Add a NAVIGATOR competition class to regionals.
- Compare Year 1 to Year 2 to determine if we have improved multi-year competition participation by 5%.
- Provide students with access to student and industry mentors who are well-prepared to support learning and provide career guidance.
- Document at least 5 student success stories in professionally-formatted videos and create at least 10 more videos of student interviews for evaluation purposes.
- Develop a comprehensive learning package comprehensive learning package that includes curriculum (e.g. a lesson and activity book)aligned with NGSS's Engineering, Technology, and Applications of Science standards; an accompanying ROV kit; and lab packs of resources (e.g. electronic components and other items) focused on the middle school and high school level.
- Improve our PufferFish and TriggerFish ROV kits, create additional sensors and tools that can be added to these kits, and develop a third ROV kit.
- Designate regional teacher leaders to function as resources for coordinators and other teachers.
- Offer 1 workshop that provides 56 hours of professional development to 20 participants, including middle and high school teachers and regional coordinators.
- Offer at least 20 regional professional development workshops that provide 10 or more hours of instruction to 300 teachers.
- Offer an additional 100 regional workshops, such as topic-specific hands-on instruction, information sessions, and pool practice days, to 600+ students, parents, and teachers.

- Add to current mentor information and training to support their role in the classroom and streamline communication.
- Add to the number of parents in grant activities. In addition, direct parents to our online resources and invite them to join our e-mail listserves to support their involvement and improve communication.
- Add to the number of organizations, industry professionals, and others as well as high school, community college, university undergraduate, and graduate students and community college and university faculty supporting the grant activities.
- Form and/or meet with regional advisory committees to provide guidance and oversight.
- Improve our student registration and tracking system and use it in conjunction with post-competition surveys to determine 1) how many students are involved for multiple years and 2) how their long-term participation influences their interest in pursuing STEM courses and careers.
- Improve the utility of MATE web resources and use social networking tools to increase communication and collaboration.
- Use surveys and other instruments to evaluate progress and increase effectiveness and impact.

Please also see the **Major Activities, Key Outcomes or Other achievements,** and the **What opportunities for training and professional development has the project provided?** sections.

Supporting Files

	Filename	Description	Uploaded By	Uploaded On
(Download)	ITEST 2013-2014 Evaluation Report FINAL 9-19-24.pdf	Evaluation of Innovative Technology Experiences for Students and Teachers (ITEST) 2013-2014 Grant Activities For The Marine Advanced Technology Education (MATE) Center report.	Jill Zande	10/01/2014
(Download)	IRB information2.pdf	Response to Action 1.	Jill Zande	11/03/2014
(Download)	NSF Acknowledgement.pdf	Response to Action 4.	Jill Zande	11/03/2014
(Download)	Goal 2a lesson format.pdf	Classroom lesson format.	Jill Zande	11/03/2014

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Products

Books

Book Chapters

Conference Papers and Presentations

- Deidre Sullivan & Jill Zande (2013). *How do we improve the workforce readiness of our students?*. Oceans 2013 MTS/IEEE San Diego. San Diego, California. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Jill Zande and Deidre Sullivan (2014). *MATE ROV competition: Supporting Students Along a Pathway to the Marine Workforce*. Underwater Intervention. New Orleans. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Inventions

Journals

Licenses

Other Products

- *Educational aids or Curricula.*

  Building instructions, instructional resources, and other activities that complement the ROV kits we developed - see http://www.marinetech.org/curriculum/.

- *Educational aids or Curricula.*

  ROV kits and practice boards - see http://www.marinetech.org/store/ for a description of the PufferFish and TriggerFish kits and soldering practice boards.

- *Products of the research (evaluation reports, etc.).*

  NOTE: The Year 1 evaluation report is included within the Supplemental Documents.

  1. During negotiation, additional information was requested regarding the data management plan to ensure how products of the research (reports, instruments, and data) would be made accessible to other researchers.

  Action 2D: Please what was accomplished during Year 1 pertaining to the work you proposed in your responses, including:

  - sharing of evaluation reports, evaluation instruments, de-identified data sets, and website analytics at the project website and ITEST's STEM Learning Resource Center.

  If the goals/objectives were not fully accomplished during Year 1, please include what changes will be made to your plan and timeline to achieve these goals/objectives.

Once our Year 1 annual report is approved, we will share the document with the ITEST STEM Learning Resource Center. At that time, we will also share the evaluation report that accompanied our annual report. We have contacted our ITEST STEM Learning and Research Center liaison to determine what other resources and information they would like to see from us and for instructions on how to submit those materials to Center/STELAR web site.

As stated within the data management plan we submitted during negotiation, http://www.marinetech.org/itest currently contains project and evaluation reports from our ITEST Strategies work. We will add our Year 1 Scale-Up annual and evaluation reports once they are approved. By the end of November 2014, we will also post the survey instruments used, de-identified data sets collected from surveys, and a link to our web site analytics page to this page. At that time, we will 1) add note about and a link to the page on the "about MATE" page of our web site (see http://www.marinetech.org/about/) and 2) as stated within the data management plan, make the page password protected.

- *Video.*

The 2013 competition video summarizes the 2013 interrnational competition event, which took place June 20-22 in Federal Way, WA. The video is housed on both the MATE Center's YouTube and Vimeo accounts and can be accessed here - see http://vimeo.com/73115789

Other Publications

- Pwarren (2014). *CCC ROV Club Qualifies to Compete in MATE International ROV Competition*. Article on ROV regional. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Gray's National Marine Sanctuary (2014). *Carrollton High School Wins GRNMS Southeast Regional ROV Competition*. Article on MATE regional. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Anthony Rimel (2014). *Cheldelin students plunge into underwater robotics*. Article on ROVs in school.. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Anthony Rimel (2014). *Cheldelin students plunge into underwater robotics*. Article on ROV team. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
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- Nancy DuVergne Smith (2014). *Underwater Dreams Features MIT ROV Team*. Article on the ROV documentary Underwater Dreams. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
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- Associated Press (2014). *Winners Named in Global Underwater Robot Event*. Article on the international ROV competition. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Hydro International (2014). *Winners of 2014 International MATE ROV Contest*. Article detailing the winners of the international ROV competition. Status = PUBLISHED; Acknowledgement of Federal Support = Yes
- Bay School blog (2014). *Working Underwater: Bay's ROV Team in Action*. Article on ROVs in school. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Patents

Technologies or Techniques

Thesis/Dissertations

Websites

- *MATE*
  http://www.marinetech.org/

  The MATE web site includes links to the ROV competition, which in turn includes links to each of the MATE regional contest web sites.

- *ROV Underwater Robotics at the Shedd*
  http://sheddrov.wikispaces.com/

  Website for Shedd Aquarium's ROV club.

- *Shedd Aquarium ROV Club Event*
  https://storify.com/Mirandarhk/sheddrov-shedd-aquarium-rov-club-event?utm_content=storify-pingback&utm_medium=sfy.co-twitter&utm_source=direct-sfy.co&utm_campaign=&awesm=sfy.co_tS76

  Website dedicated to ROV club event, including pictures and details on the event.

- *Shedd Aquarium Regional ROV Competition*
  https://storify.com/Mirandarhk/sheddrov-2014-shedd-aquarium-regional-rov-mate-co

  Website devoted to the 2014 Shedd Aquariam Regional ROV Competition

- *Underwater Robotics Program*
  http://www.sheddaquarium.org/Learning-Experiences/Educators--Classrooms/Students-Classrooms/Underwater-Robotics/

  Dive deep into underwater robotics at Shedd Aquarium! A suite of programs introduces teachers and students to science, technology, engineering and math (STEM) principles through the development and application of remotely operated vehicles (ROVs) to investigate aquatic environments

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Impacts

What is the impact on the development of the principal discipline(s) of the project?

A number of prior reports have identified significant problems in educating, recruiting, and retaining U.S. workers for scientific, technological, and operational careers. Such workers are

critical for building and operating much of the nation's infrastructure and for sustaining growth and innovation. The lack of appropriately educated workers is especially pronounced in rapidly evolving ocean fields, such as deep water ocean exploration (especially oil and gas); the engineering of specialized tools and instruments for remote, harsh environments; and the management and use of ocean resources (particularly, renewable resources). The graying trend in the marine workforce adds to the urgency of educating new technical professionals that will adapt and excel in the rapidly advancing ocean workplace.

Workforce studies conducted previously by the MATE Center and funded by the Office of Naval Research identified more than twenty STEM-based ocean occupations that are currently limiting the growth of ocean industries because of the lack of qualified personal. At the top of the list are the following occupations: electronics/marine technicians (including ROV technicians); engineers (electrical, mechanical, civil/structural); and computer scientists (software application developers, computer programmers, hardware developers).

However, these are not 'just' engineers, technicians, and computer scientists; these are professionals that understand ocean applications within their field. For example, ROV technicians in support of ocean operations must have an understanding of ocean science in addition to engineering and computer science since all commercial ROVs possess computer-controlled systems and must be maintained, repaired, and modified in remote locations far from port. These skills sets are transferable to almost every sector of the economy that uses robotics, automation, and computer-controlled systems.

Every year, the ocean attracts thousands of students to pursue degrees in biology because that is a discipline that most students associate with ocean careers. However, the opportunity and compensation in ocean-related engineering, technology, and computer science fields is much greater than the biological sciences. Combining STEM education with ocean applications via the MATE ROV competition network provides students with a pathway to achieve their goals, including the gainful employment that is so critical to engaging students from economically disadvantaged environments. For the ocean occupations in greatest need of qualified individuals, the early education and career preparation is similar. This includes applied math, critical and creative thinking, and design and innovation, which, during the competitions, are presented in an engaging environment that simulates the high-performance workplace.

What is the impact on other disciplines?

Covered above under "What is the impact on the development of the principal discipline(s) of the project?"

What is the impact on the development of human resources?

The work of this project supports the development of a diverse ocean STEM workforce, outlining and allowing students to see a career pathway from upper elementary school to middle and high school to college and into the workplace. Please see the ACCOMPLISHMENTS section for details.

What is the impact on physical resources that form infrastructure?

In order to accommodate development and assembly of ROV kits and other educational aids (e.g., electrical trainers, soldering practice boards, etc.), we modified an office space to house a work area. This is the location of the "MATE store" reference in ACCOMPLISHMENTS.

What is the impact on institutional resources that form infrastructure?

Nothing to report.

What is the impact on information resources that form infrastructure?

Nothing to report.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

Through the impacts described under ACCOMPLISHMENTS, the work of this project is helping to prepare and create a more scientific- and technology-literate society.

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Changes/Problems

Changes in approach and reason for change

NSF's expectation is that the scope of activities will include elaborations and/or revisions that are discussed in pre-award negotiations. The Annual Report and Evaluation Report submitted do not specifically address several NSF questions/ requests and PI elaborations/revisions that were included in the pre-award negotiations.

During negotiation, additional information was requested about the mechanism by which implementation fidelity (or adaptation) of the ROV intervention across regions would be documented.

Action2B1: Please clarify what was accomplished during Year 1 pertaining to the work you proposed in your responses, including:

- conducting face-to-face observations of a subset of the regional efforts.

The PI/Co-PIs conducted face-to-fact observations of three of the 2014 regional contests: the Pacific Northwest, Shedd-Midwest, and Monterey. Prior to the contests, the PI/Co-PIs

developed a list of questions/observations to make during their site visits. They included the following:

- Volunteers/Judges – How many? Training (pre event and day of briefings)? Did they see the judges' forum? Diversity of people – where do they come from?
- Missions/Props – were they built to specs, disputes?
- Safety Inspections – did the safety inspectors attend the webinar?
- Teachers – how much support before the competition, mentors, practice days, workshops?
- Students – how much time did they spend, in class, club, what was the hardest part, favorite part, learned the most, what do they wish was different?
- Parents – Did they get the information they need? What impact did this have on your child?

We felt that all three of the events demonstrated appropriate, if not exemplary, regional fidelity. One area that was identified as needing improvement overall was MATE "branding." At the Shedd-Midwest in particular, the teachers and students knew very little about the MATE Center. We plan to address this in Year 2 by providing each regional with a plethora of MATE brochures and flyers to distribute at their regional workshops and on contest day. We will also send MATE t-shirts to regional coordinators and encourage them to distribute them to key staff and to wear them at events. While we distributed MATE competition banners to regionals several years ago, those that have joined the network since that time do not have them. We will remedy that this year.

Action 2B2: Please clarify whether you have you have considered or established any mechanism for studying the artifacts from the professional development and/or competition experiences for assessing implementation across regions in the event observations were not conducted?

See Action 2B1.

Actual or Anticipated problems or delays and actions or plans to resolve them

NSF's expectation is that the scope of activities will include elaborations and/or revisions that are discussed in pre-award negotiations. The Annual Report and Evaluation Report submitted do not specifically address several NSF questions/ requests and PI elaborations/revisions that were included in the pre-award negotiations.

During negotiation, additional information was requested about the instruments and processes used to collect outcome data and the technical quality of those instruments, with the clear purpose of moving the research/evaluation beyond self-report.

Action 2A: Please clarify what was accomplished during Year 1 pertaining to the work you proposed in your responses that intended to:

- improve the internal consistency of existing surveys by adding questions and standardizing the question constructs;

In Year 1, the post-competition surveys were updated to align with the new ITEST Scale Up goals. In Year 2, we will work with Dr. Min Li to improve the consistency and validity of the surveys. Confirmatory factor analysis will be performed to verify the hypothesized clusters, which provides evidence on the structural validity of the survey questions. Cronbach's alpha coefficient will be produced for the questions within each cluster. Other item analysis will be carried out as well to examine the means, standard deviations as well as item discriminability. This work will be completed by February so the revised surveys can be administered in the spring competitions, which begin in March.

- compare survey data against students' NSC data to provide an additional form of survey validation;

In Year 1, we drafted a survey of competition alumni. In Year 2, we will conduct this survey and provide a dataset of student identifying information to NSC for them to match and return higher education follow-up data. We will then compare the results.

- employ a process for validating competition scoring rubrics and determining and/or establishing methods for ensuring inter-rater reliability of competition scoring such that they may be used as an indicator of student learning; and

In Year 1, we worked with current judges (who include K-12 educators) to transform the poster score sheet into a scoring rubric (see http://www.marinetech.org/files/marine/files/ROV%20Competition/Missions%20and%20Specs/Scoring/2014/2014%20Poster%20Display%20Rubric%20-%20FINAL.pdf for the RANGER and EXPLORER class rubric).

In Year 2, we will revise the rubrics based on feedback that we received from the judges who used them during the 2014 competition season as well as on the results of the alignment study that we will be conducting with Dr. Min Li. The alignment study will focus on how the scoring (i.e. "coding") categories can be mapped back to (1) the competition manual in terms of how the students are mentored or guided and (2) the standards from the engineering proportion of the NGSS, 21st Century Skills, and College Readiness documents.

In parallel, we will be transforming the technical report and engineering evaluation score sheets in scoring rubrics so that they can be piloted during the 2015 competition season. We will work with Dr. Li to conduct a similar alignment study on these rubrics.

In addition, Dr. Li will use the scores that student teams received from judges during the 2014 events to investigate inter-rate reliability. The data file includes the IDs of judges so that a generalizability study can be performed to examine whether judges evaluated the teams consistently or not.

In Year 3, we will conduct a validity study to decide whether scores assigned by judges are comparable to researchers' evaluation. We will select teams by high, middle, and low scores then have the teams' evaluated both by researchers and judges. Findings from both studies will help us determine the judges' guidelines as well as clarify the scoring rubrics.

- design, pilot, and assess psychometric quality for NGSS-aligned pre-post knowledge tests (and for the above competition scoring), with the assistance of Dr. Min Li.

The pre and post knowledge tests are currently being developed and aligned with the instructional materials and the NGSS. Some of the pre-post questions for each module will be the same and some will be different in an effort to determine if a deep conceptual understanding has been achieved and if the participants are able to apply these concepts to new problems. Dr. Min Li will help us determine if the pre and post-test items are comparable in terms of difficulty. We will initially pilot the curriculum modules and the pre and post-tests with ~20 students in January 2015. Dr. Li will analyze the scores to produce item parameters of difficulty index and discrimination index as well as the Cronbach's alpha. In February and March, selected teachers will administer the pre-post tests to at least 150 students.

With this larger sample size, Dr. Li will explore the factor analysis to examine the dimensionality of the measured construct, the differential item functioning analysis to determine whether items may bias against particular sub-groups (e.g., gender, or socio-economic status), and the index of instructional sensitivity to evaluate whether the items reflect the amount of opportunities to learn that students have. After this process, we will modify the tests and/or curriculum and distribute them to all of our partners.

During negotiation, additional information was requested regarding other study designs that might be employed, such as interrupted time series design and/or use of state longitudinal data, to collect more reliable estimates of the average impact of the intervention.

Action 2C: Please clarify what was accomplished during Year 1 pertaining to the work you proposed in your responses, including:

- employing the "modified time series design" that included one pretest of knowledge and attitudes, several interim knowledge tests (quizzes at the end of each module), post- and follow up tests of knowledge and attitudes with possible triangulation with competition scores.

This work will begin in year two, after the development of the curriculum modules and associated pre and post tests.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.

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Special Requirements

Responses to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements.

Nothing to report.

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