United States Naval Academy

STEM Center for Education and Outreach

Buoying Undergraduate Learning with Informal STEM Outreach

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Abstract

The goal of the United States Naval Academy's STEM Center for Education and Outreach (STEM Center) is to promote hands-on, experienced-based, and project-based learning (PBL) methodology for K-16 STEM educators and students nationwide. The STEM Center conducted pre- and post-event surveys for the undergraduate (midshipmen) facilitators of informal STEM education and outreach events. The survey data reveals midshipmen gains in confidence, communication of STEM concepts, motivation to remain in STEM pipeline, and leadership due to their experiences. Consisting of multiple-choice, Likert-scale, and open-ended questions, survey results are of interest to other organizations providing informal STEM or science outreach and those interested in gauging gains made by activity educators, judges, mentors, or facilitators.

Importance

The United States Navy relies heavily on science, technology, engineering, and math (STEM) talent and is, therefore, interested in boosting STEM literacy among Americans and in cultivating a future STEM workforce. Indeed, the Department of Defense employs more scientists and engineers that any other government agency (Miller, 2011). With this in mind, the United States Naval Academy (USNA) encourages midshipmen to facilitate informal STEM education outreach events for K-16 students and teachers. An informal STEM facilitator organizes resources, creates rich experiences, guides inquiry, and engages participants to promote learning of STEM concepts and methodology. Informal STEM education serves an essential role in society, as the majority of a person's STEM content knowledge is derived from informal sources rather than formal school settings (Falk and Dierking, 2010). Many educational, governmental, private, and commercial organizations offer informal STEM (ISTEM) education opportunities with the primary goal of improving STEM awareness and access. Event participants are often assessed to determine the impact of such events. However, the impact of an ISTEM event on the facilitator, the mentor, the science fair judge, or the educator is often overlooked.

The purpose of this study is to determine if midshipmen facilitators experience measurable gains in abilities and learning motivation as a result of voluntarily facilitating an ISTEM outreach event. Other questions are considered: What effect does this experience have on populations underrepresented in the STEM pipeline? Are facilitator gains significant enough to warrant undergraduate facilitation as a means of STEM pipeline recruitment and retention at the academy?

Methodology

Both quantitative and qualitative methods were employed. Midshipmen facilitators were surveyed using pre- and post-event-specific surveys and two annual, general impact surveys. Pre- and post-event surveys were administered for four STEM events: 1) Girls Day on October 19, 2013, 2) Girls Day on March 1, 2014, 3) MESA Day on November 22, 2013, and 4) MESA Day on November 5, 2014. The number of midshipmen facilitators ranged from 31 to 48 per event. The rate of return for pre- and post-survey responses is displayed in Table 1. Surveys included multiple-choice and Likert-scale questions.

STEM Impact Surveys were administered on December 20, 2013 and December 12, 2014 to 84 and 104 midshipmen, respectively. Only midshipmen with over six hours of informal STEM participation that semester were invited to respond. Questions employed multiple-choice and Likert-scale. The rate of return for each STEM Impact Survey is displayed in Table 2.

A narrative inquiry was employed in order to provide a deeper understanding of one midshipman's facilitation experience and derived meaning. The narrative subject is a female midshipman in her senior year at USNA with over 500 hours of STEM outreach and facilitation experience.

Table 1. Rate of return for event survey responses.

Event	Number of Midshipmen Facilitators	Rate of Return (Pre-Survey)	Rate of Return (Post-Survey)
Girls Day (Oct 19, 2013)	48	50%	35%
Girls Day (Mar 1, 2014)	31	68%	58%
MESA Day (Nov 22, 2013)	33	100%	82%
MESA Day (Nov 5, 2014)	34	100%	100%

Table 2. Rate of return for STEM Impact survey responses.

Survey	Number of Midshipmen Emailed Survey	Rate of Return
STEM Impact Survey 2013	84	50%
STEM Impact Survey 2014	104	63%

Informal STEM Outreach

USNA's STEM Center offers numerous informal STEM outreach events to K-16 teachers and students nationwide, all facilitated by USNA faculty and midshipmen. Events include SeaPerch ROV competitions and builds, Girls Days, MESA Days, Summer STEM Camps, Girls Tech Camps, STEM Educator Training (SET) Sail workshops, and Mini-STEM events. Two event categories were evaluated during this study:

Girls Day is a one-day ISTEM event held at the U.S. Naval Academy for 200 to 250 middle-school girls. Participating girls attend several science and engineering modules focused on physics, bioterrorism, rockets, robotics, weather, bridge building, astronomy, helicopters, engineering design, and others. Each module is led by a USNA faculty member and facilitated by 2 to 4 midshipmen. Participants explore science and engineering concepts and careers using PBL.

MESA Day is a one-day ISTEM event held in partnership with Maryland Mathematics Engineering Science Achievement (MESA). The event is hosted at the Johns Hopkins Applied Physics Laboratory and attended by approximately 250 fifth-grade students from local schools. About 2 to 3 midshipmen facilitate each module on topics such as chemistry of water, materials engineering, robotics, biofuels, underwater gliders, cryptology, engineering design, and others. Midshipmen facilitators are given ownership of each module and have complete control over set-up, structure, and presentation.

Midshipmen Gains due to Facilitation

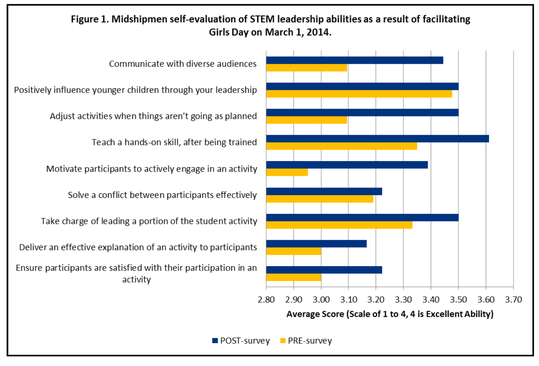

Figure 1. Midshipmen self-evaluation of STEM leadership abilities as a result of facilitating Girls Day on March 1, 2014.

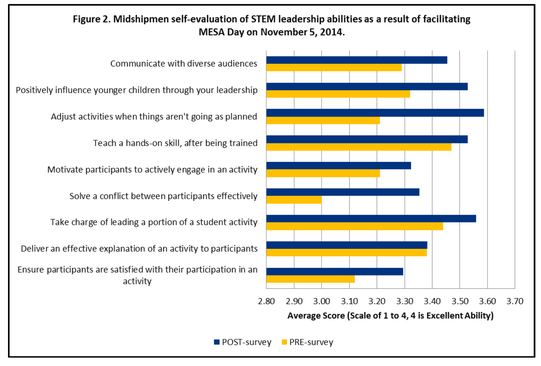

Figure 2. Midshipmen self-evaluation of STEM leadership abilities as a result of facilitating MESA Day on November 5, 2014.

According to pre- and post-survey changes for the March 1, 2014 Girls Day (Figure 1) and the November 5, 2014 MESA Day (Figure 2), midshipmen facilitators indicate improvements in a variety of leadership categories as a result of participation: teaching ability, communication, STEM concept clarification, conflict resolution, improvisation, and module management. Midshipmen facilitators on Girls Day experienced the greatest gains in their ability to motivate event participants, modify activities spontaneously, communicate with diverse audiences, and teach a hands-on activity. On the other hand, midshipmen facilitators for MESA DAY – who had greater control over module organization and presentation – experienced the greatest gains in their ability to modify activities spontaneously, solve conflict between participants, encourage young children, and ensure participant satisfaction (da Rosa et al., 2015).

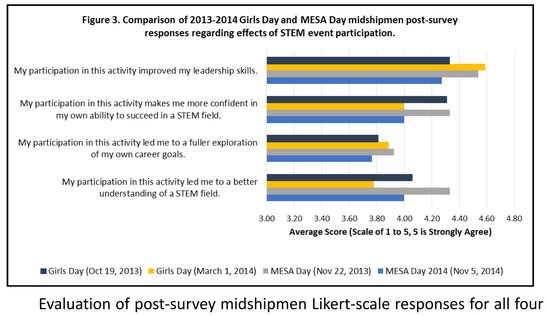

Figure 3. Comparison of 2013-2014 Girls Day and MESA Day midshipmen post-survey responses regarding effects of STEM event participation.

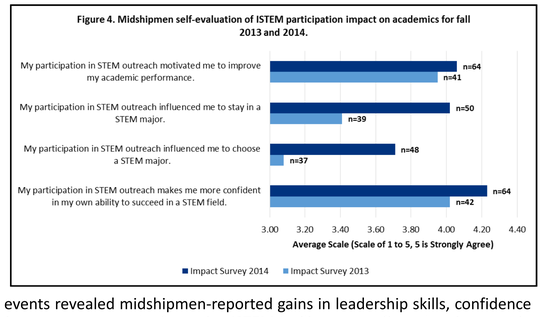

Figure 4. Midshipmen self-evaluation of ISTEM participation impact on academics for fall 2013 and 2014.

Evaluation of post-survey midshipmen Likert-scale responses for all four events revealed midshipmen-reported gains in leadership skills, confidence to succeed in STEM, and understanding of a STEM field (Figure 3). General impact survey results for active ISTEM facilitators confirmed an increase in motivation to improve academic performance and remain in a STEM major and an increase in confidence to succeed in a STEM discipline (Figure 4) (da Rosa et al., 2015).

Midshipmen Narrative

Narrative inquiry exploring a female midshipman's outreach perspective reveals improved interest in STEM subjects via the hands-on, informal teaching employed in STEM outreach. This particular midshipman has over 500 hours of experience in STEM outreach and facilitation accumulated during her time at USNA – significantly greater than the average STEM Center midshipman volunteer. She describes her outreach facilitation experience as rewarding and constructive: "Since I began working with the STEM Center my freshman year, I have improved in areas of public speaking, confidence, and I've learned how to communicate scientific material to non-scientific minded people" (personal communication, Busiek, 2015).

Reflecting on her work as an outreach facilitator with the STEM Center, the midshipman maintains that STEM outreach has the potential to spark and influence kids' interest in STEM fields and careers. She describes the lack of gender diversity in engineering and at service academies, arguing that STEM outreach provides an opportunity to reach students traditionally underrepresented in STEM (female, students of color, students in poverty). Placing undergraduate STEM majors in the role of mentor and facilitator helps to motivate student participants to identify with and work towards STEM as a career choice sooner rather than later. Furthermore, she believes STEM outreach involving hands-on activities and PBL is a useful way to recruit for STEM among the nation's young and to retain for STEM among undergraduates.

Midshipman Busiek facilitating on MESA Day, December 4, 2014

Discussion

According to quantitative and qualitative assessment tools, USNA midshipmen report measureable gains in leadership ability, confidence, communication, and STEM motivation as a result of facilitating ISTEM outreach events. This finding is of interest to other organizations offering informal education to promote STEM access and awareness such as museums, science centers, science fairs, and service learning projects. Indeed, other STEM outreach programs may be interested in assessing gains made by facilitators, mentors, judges, and other informal educators to better determine impact in the community. Moreover, considering the gains made by individual undergraduates as a result of event facilitation, ISTEM facilitation should be considered by other undergraduate institutions as a means of assisting STEM pipeline recruitment and retention.

References

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Acknowledgements

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