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ENGAGING DIVERSE YOUTH IN EXPERIENTIAL STEM LEARNING: A UNIVERSITY AND HIGH SCHOOL DISTRICT PARTNERSHIP

Research Article

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Abstract

This paper presents the results of a partnership between a New Jersey school district and four-year university seeking to enhance STEM programming for the district's diverse student population. The project utilized a STEM-focused experiential unit integrated into existing ninth grade school non-science classes (social studies and career readiness courses). A quasi-experimental double pre- and post-test design was used to gauge feeling towards and interest in STEM study among the diverse sample population over a two- year period. Data from Year One was used to refine and adjust the Year Two structure. Results offer credence to the use of focused STEM units with general population students to influence interest in science and STEM-related careers. The experiential component of the unit was most well-received with students supporting its integration into a non-science classroom.

Keywords: STEM, robotics, diverse, experiential learning

1. Introduction

According to a 2015 National Science Board report on the STEM workforce, it is important "that all Americans have access to a high-quality, well-rounded education that includes foundational concepts in STEM". Access, particularly for underserved and underrepresented populations, is a formidable challenge that needs to be addressed in order to increase math and science achievement (National Science Board, 2015). While productive engagement in scientific discourse is challenging for all students, those from disadvantaged backgrounds can have an even more difficult time due to lack of experiences available to students than those from more privileged backgrounds and schools (Holbrook, 2010). Furthermore, students of lower socioeconomic backgrounds may find difficulty with science literacy due to the lack of support at home (Brown, Reveles, & Kelly, 2005). Historically, this group of students is also up against barriers inherent in the school culture (Varelas, Kane, & Wylie, 2011; Barton & Yang, 2000).

Important to STEM exposure is a consideration for the kind of learning that students should experience. The national Next Generation Science Standards (National Research Council, 2013) identifies key classroom practices including the use of experiential learning in science (Kolb, 2015; Witt, 2015). Experiential learning, like a problem-based learning approach, allows students to learn science through authentic, real-life situations. These authentic situations are interdisciplinary in nature offering students a way to see the way scientists utilize knowledge from multiple areas of study in experimentation and study of the phenomenon (Balemen & Keskin, 2018; STEM Taskforce Report, 2014). Benefits of such an approach have been seen in research with learners showing more motivation, interest, and gains in math and/or science achievement (Stinson et al., 2009; Furner & Kumar, 2007). These benefits have gained momentum not only in the United States but across the globe with countries including Turkey aiming to develop STEM education within their educational system through novice teachers (Tekerek & Karakaya, 2018).

Experiential learning and STEM study can take many forms in a classroom setting. A topic of relevance that spans all grade levels and is recognized as an area of importance is that of ocean literacy (NOAA, 2013). The ocean is known to be largely unexplored, yet it also has a direct impact on humans, the Earth's climate and weather. Large organizations such as the National Oceanic and Atmospheric Administration (NOAA, 2013) and The Ocean Project (n.d.) seek to advance ocean literacy in schools with the hope of developing discovery and innovation among future generation explorers and researchers. The study of the ocean is described as interdisciplinary by nature with collaboration among multiple disciplines necessary to bring out and foster new ideas in ocean exploration (NOAA, 2013). With many technical advances over the past decade, new technologies and tools for exploration such as remotely-operated underwater vehicles, ROVs, have quickly become a powerful tool to facilitate this process.

This quasi-experimental study sought to investigate the use of an experiential STEM to build and diversify interest in STEM in the high school setting. Ocean exploration and literacy served as the focus for the project. Of particular importance was targeting a representative sample of the general school population in a non-science setting who might not elect to or have the opportunity to study advanced areas of science or participate in STEM instruction at the high school level.

2. Theoretical framework & empirical support

The theoretical framework of this work stems from the experiential learning model where students use authentic experiences to learn and develop an understanding of concepts. Theory and research have found that learners can build skills and thinking through their own experiences of a presented problem or situation (Kolb, 2015; Hmelo-Silver, 2004). Allowing some independence and exploration as part of the experience allows learners to develop their skills and in turn can lead to increased motivation and retention of content (English & King, 2015; Albanese & Mitchell, 1993; Norman & Schmidt, 1992).

Ocean literacy has become an increasingly important topic for study in K-12 settings (NOAA, 2013; Schoedinger, Cava & Jewel, 2006). Promoted specifically is building learners understanding of the human impact and how exploration can inform future discoveries and innovations that could impact our society and planet. Ocean exploration from both historical and educational contexts is naturally interdisciplinary connecting multiple fields and experts from a variety of STEM areas (NOAA, 2016). This provides a strong platform for experiential STEM learning with real-life application (New Jersey Lead Partner, 2011). Programs implemented in schools focusing on water and ocean literacy have shown promise positively impacting attitudes and interest in STEM-related study (Afterschool Alliance, 2016; Tseng, Chang, Lou & Chen, 2013).

The remotely operated underwater vehicle or ROV is an essential tool for ocean exploration and study (Lewis, 2013). ROVS allow for unmanned underwater exploration made possible through a tether or cable operated remotely by an engineer. With no driver, the ROV is capable of dives at great depths and duration. Models are equipped with photo and video capabilities, providing researchers with footage that can later be used for research and documentation (Regan, 2018). With advances in technology, ROVs have become more common and easily accessible to schools and universities to offer firsthand experiences with underwater exploration (Cook, 2017; Hurd, Hacking, Damarjian, Wright, & Truscott, 2015; Patterson, Elliot & Niebuhr, 2012). A popular example of a program designed to use the ROV as a learning tool is the Seaperch Program. Seaperch uses the hands-on experience of building a replica ROV to motivate and inspire young learners (Giver & Michetti, 2008). These ROVs, made with commonly found materials, allow for the building of a working small-scale replica complete with a propulsion system and hand-held remote to operate it. Another program known for its integration with STEM study in K-12 through university settings is the Marine Advanced Technology Education, MATE, Center's ROV competition. This competition engages learners through an ROV design competition (Moore, Bohm, & Jensen, 2010). Teams ranging from beginner to advanced develop designs from the study of ROV structures, creating their own working replicas that are later tested on their ability to complete tasks like what real ROVs might do from pipe inspection in muddy waters to gathering specimens from simulated underwater habitats. ROV programs and ROV-focused marine science curricula like MATE and Seaperch are common among STEM-based practices providing ways to integrate robotics, engineering and study of underwater environments (Leak, 2017 Hurd, Hacking, Damarjian, Wright, & Truscott, 2015; Green, 2007).

3. Methodology

The project titled *Engaging Diverse Youth in Experiential STEM Learning Opportunities* (EYESTEM) was implemented over a two- year period to investigate potential STEM project structures and formats within the participating school district. The study sought to address the following specific research questions:

1. What is the impact of the EYESTEM unit on students' interest in their opinions and interest in STEM study? Within this question is consideration for the type of instructional approach to the unit that would work for a non-science high school setting.
2. What is the impact on students' attitudes and learning of the EYESTEM unit in a non-science high school class setting?

3.1 Research design

A quasi-experimental double pre-post-test design was used to gauge interest in STEM and impact of the EYESTEM unit. In each of the three schools in the district selected, a sample of classes was selected with a student demographic makeup representative of the school population. Each of these classes was then identified as one of two experimental groups and the control group for Year One. One experimental group participated in an experiential EYESTEM unit that included a webquest exploration (denoted as ExpWQ in Tables 1-5). The other experimental group participated in the unit but had an added experiential element of team building a small-scale ROV (denoted as ExpROV in Tables 1-5). The final group of students served as the control group receiving no change to their normal instruction. In Year Two, based on the success of the experiential element (ExpROV), the experimental group with web exploration was eliminated.

3.2 Participants

The school district, referred to as GEHR, located in southern New Jersey, selected for EYESTEM identified a need to increase STEM pathways among its students, especially its underserved student populations. GEHR, a large district spanning 324 square miles, is divided into three high schools including Absegami, Oakcrest and Cedar Creek serving a diverse group of over 3,000 students (New Jersey Department of Education, 2015). The population is mixed among the high schools with a high rate of economically disadvantaged students (41%, 46% & 57% respectively) and underrepresented ethnicity groups (Asian, Hispanic, & Black populations at 50%, 54%, & 35%). Performance data in biology for 2014-2015 indicates a wide range among performance levels with two of three schools' students performing below 50% proficient or advanced proficient (47%, 23%, & 64%).

Existing STEM study in the participating schools was isolated to magnet programs in the sciences with limited enrollment and within junior/senior college-prep track elective courses.

To capture the general population, the sample student population of this study was drawn from freshmen level courses all students must take. Year One pulled from select freshmen level social studies courses while Year Two pulled from a required career and educational technology (CET) courses offered by the schools. See Table 1 for details on study participants.

3.3 Instrument

A blend of quantitative and qualitative data was used to determine the impact of EYESTEM. Data was collected via a pre-post survey that included demographics and a series of Likert-style questions related to attitude and interest towards STEM drawn from an existing S-STEM survey (Friday Institute for Educational Innovation, 2012). Measures for each of the S-STEM subsections of the survey are determined through a preset 5-point or 4-point Likert scale containing prompts gathering details including: opinions about the study of science, opinions about the study of engineering and technology, and interest in future STEM career areas. Based on a large scale pilot of the instrument, the S-STEM was found to have strong consistency (Cronbach alpha range of .89-.92) particularly for high school level respondents (Wiebe et al, 2013).

All groups completed the survey at the start and end of the project. Additional questions were added to the post-test and completed by those in the experimental groups. These questions blended Likert-style and open-ended prompts asking students to describe their reaction to the experiential project and interest in future STEM initiatives. See Table 5 and Figure 2 for prompts and scales used.

Table 1**.** *Participants by year, group, gender, and ethnicity*

Year 1		Gender		Ethnicity				
		Female	Male	White	Black	Hispanic	Asian	Other
ExpROV	Count	45	42	45	7	13	6	16
	%	51.7%	48.3%	51.7%	8.0%	14.9%	6.9%	18.4%
ExpWQ	Count	51	32	42	15	5	5	16
	%	61.4%	38.6%	50.6%	18.1%	6.0%	6.0%	19.3%
Control	Count	52	41	49	2	12	8	22
	%	55.9%	44.1%	52.7%	2.2%	12.9%	8.6%	23.7%
Total	Count	148	115	136	24	30	19	54
	%	56.3%	43.7%	51.7%	9.1%	11.4%	7.2%	20.6%
Year 2		Gender		Ethnicity				
		Female	Male	White	Black	Hispanic	Asian	Other
ExpROV	Count	16	40	24	7	8	5	12
	%	28.6%	71.4%	42.9%	12.5%	14.3%	8.9%	21.4%
Control	Count	172	198	177	56	44	31	62
	%	46.5%	53.5%	47.8%	15.1%	11.9%	8.4%	16.7%
Total	Count	188	238	201	63	52	36	72
	%	44.1%	55.9%	47.2%	14.8%	12.2%	8.5%	17.3%

3.4 Treatment

Two faculty from a nearby university with expertise in STEM worked collaboratively with GEHR teachers and administration to develop and implement the EYESTEM experiential units for Year One and Year Two. With the Atlantic Ocean in proximity to all schools and a strong marine science center at the university, underwater exploration and technology were selected as the focus STEM topic.

The EYESTEM goal was to provide students with an opportunity to develop ocean literacy through the topic of underwater exploration, including robotics in the form of remotely operated vehicles, ROV. The unit content built upon existing work by the National Oceanic and Atmospheric Administration, (NOAA), including educational materials and their website (2016). The unit further aligned with Next Generation Science Standards (NGSS) that support the exploration of real-life problems rooted in science (2013). Specifically, the focus question and problem for exploration were how scientists use ROVs to explore the deep ocean. Objectives included being able to describe systems and capabilities of ROVS, make inferences about what can be learned from deep water habitats using ROV technology, and discuss the importance as well as the potential of ocean exploration from both a historic and modern perspective.

Year One and Year Two differed slightly in the treatment approach. In Year One, two experiential methods were used with experimental groups. The first involved a teacher-led discussion on ocean exploration with video highlights followed by a self-guided web quest using NOAA materials (2016). This was concluded with small group sharing of concepts and ideas. For the second method, a teacher-led discussion on ocean exploration took place followed by a hands-on build and testing of a small-scale replica ROV (see Figure 1). The replica, as shown, consisted of common items including: small plastic piping and connectors; film canisters (for buoyancy and ballast), two small rotating motors with propellers, connecting wires, small pre-made plastic mounts, and a basic remote with mounted battery as well as toggles to control direction and power of motors. Kits with all parts were provided to student teams who had to use them to build the ROV body and remote using schematics provided. This included the full construction of the ROV body, soldering of wires, and the building of the remote itself. The work concluded with testing of the ROV and small group collaboration on the uses of ROV technology and its application to ocean exploration. In Year Two, based on Year One results, only the latter method was used with the experimental group.

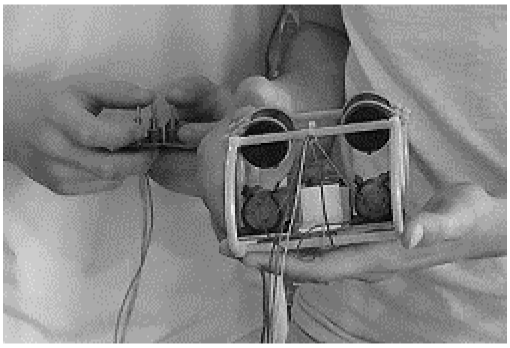

Figure 1. Close-up of small-scale replica ROV completed by experimental group participants

3.5 Procedure

Implementation of the project was done within the schools' existing curriculum and class structures. Duration was set for two-hour sessions for three consecutive days. (This was shortened to two days for Year Two due to scheduling issues.) Teachers asked to implement the EYESTEM unit were pre-trained by University faculty on underwater exploration and robotics. A full day training was conducted including in depth discussion of unit content and instruction on the ROV building kit (School of Engineering, n.d.; Madlab, n.d.). In addition, University faculty and at least one university undergraduate science major volunteer was present to support the teacher's instruction. (This was done purposely since teachers were in non-science classrooms.)

Participants in the project were organized through existing class structures. All classes (Social Studies for Year One and CET for Year Two) were part of the project with a designated number of classes serving as the experimental group(s). All other students were part of the control group. See Table 1 for participant breakdown. During training, teachers collaborated with university faculty to prepare an implementation schedule including designation of classes.

The EYESTEM unit began with the pre-survey taken by all participants prior to instruction. The next day implementation began for all designated experimental groups. (Keep in mind that Year One and Year Two differed slightly in terms of treatment for experimental groups.) At the end of implementation, all participants took the post-survey.

4. Findings and discussion

S-STEM survey data collected were gathered and analyzed in categories based on the organization of the S-STEM survey. The first of these categories represented feelings towards the study of science. Table 2 reports data from this category. Analyses consisted of a one-way between-groups analysis of variance (ANOVA). In cases where the test for homogeneity of variances was violated the non-parametric Kruskal-Wallis Test was utilized. An initial review of mean responses between groups for Year One revealed those experiencing the ROV build more strongly agreeing with all but one statement, “I can handle most subjects well, but I can’t do a good job with science”. Additionally, five statements revealed statistically significant differences between groups at the $p<.05$ level (see Table 2). However, in Year Two the results are reversed with the control group means reflecting stronger agreement for all statements. In two cases for the same year a statistically significant difference was found at the $p<.05$ level between groups including “I know I can do well in science” (Exp: $\mu=3.73$, SD=1.01; Control: $\mu=3.23$, SD=1.17, $p=.05$) and “I am sure I can do advanced work in science” (Exp: $\mu=3.04$, SD=1.17; Control: $\mu=3.29$, SD=1.19, $p=.02$).

Table 2. *Participant responses and statistical analyses on the study of science by year and group*

Year 1							Year 2				
Statement	Group	n	Mean	SD	Mean Rank	Asymp. Sig.	n	Mean	SD	F	Sig.
I am sure of myself when I do science.	ExpRov	87	3.66	.76	146.49	.01*	56	3.48	.97	3.58	.06
	ExpWQ	82	3.18	1.08	113.73						
	Control	91	3.43	.968	130.32		367	3.65	.99		
I would consider a career in science.	ExpRov	87	3.34	1.12	149.90	.02*	56	3.02	1.09	0.01	.91
	ExpWQ	83	2.87	1.25	122.47						
	Control	93	2.86	1.45	123.76		367	3.04	1.26		
I know I can do well in science.	ExpRov	87	3.95	.79	148.49	.02*	55	3.73	1.01	3.76	.05*
	ExpWQ	83	3.46	1.17	119.55						
	Control	93	3.52	1.30	127.69		366	3.88	.93		
I expect to use science when I get out of school.	ExpRov	86	3.51	1.16	3.12	.05*	54	3.19	1.05	0.25	.62
	ExpWQ	80	3.14	1.15							
	Control	90	3.11	1.22			355	3.21	1.22		
Knowing science will help me earn a living.	ExpRov	87	3.46	1.07	1.96	.14	54	3.33	.87	0.32	.57
	ExpWQ	83	3.20	1.18							
	Control	93	3.12	1.32			363	3.41	1.09		
I will need science for my future work	ExpRov	87	3.36	1.14	2.50	.08	55	3.07	1.02	0.20	.66
	ExpWQ	83	3.04	1.26							
	Control	93	2.97	1.29			356	3.23	1.17		
	ExpRov	86	3.30	1.14	1.17	.31	53	2.94	.95	2.03	.16

Science will be important to me in my life's work.	ExpWQ	81	3.17	1.12							
	Control	90	3.03	1.23			356	3.21	1.14		
I can handle most subjects well, but I can't do a good job with science.	ExpRov	87	2.54	1.17	.20	.82	56	2.34	1.01	0.75	.39
	ExpWQ	81	2.65	1.24							
	Control	90	2.57	1.26			370	2.42	1.13		
I am sure I could do advanced work in science.	ExpRov	87	3.47	1.12	3.90	.02*	55	3.04	1.17	5.24	.02*
	ExpWQ	83	2.98	1.31							
	Control	91	3.05	1.32			368	3.29	1.19		
Likert Scale from 1 (Strong Disagree) to 5 (Strongly Agree); * *p*<.05											

The second series of survey statements focused on the study of engineering and technology. Analyses were completed in a similar style to the previous section discussed (see Table 3). An initial review of mean responses reflects those building the ROV in more agreement than other groups for Year One. This pattern continues in Year Two with all statements yielding stronger means for the experimental versus the control group. Though variation is seen within means calculated, the ANOVA completed only revealed statistical significance for the Year One groups for three of the nine statements given and none for Year Two groups.

Table 3. *Participant responses and statistical analyses on the study of engineering and technology by year and group*

		Year 1					Year 2				
Statement		n	Mean	SD	F	Sig.	n	Mean	SD	F	Sig.
I like to imagine creating new products.	ExpRov	87	3.75	.81	4.70	.01*	56	3.52	1.08	0.00	.96
	ExpWQ	82	3.24	1.16							
	Control	93	3.49	1.19			369	3.43	1.07		
If I learn engineering, then I can improve things that people use every day.	ExpRov	87	3.74	.86	4.29	.02*	56	3.64	.98	0.02	.89
	ExpWQ	81	3.35	1.03							
	Control	90	3.69	.93			370	3.58	.98		
I am good at building and fixing things.	ExpRov	86	3.59	.96	3.90	.02*	55	3.64	.97	0.06	.81
	ExpWQ	79	3.14	1.12							
	Control	91	3.44	1.09			367	3.40	1.03		
I am interested in what makes machines work.	ExpRov	87	3.37	1.09	1.73	.18	56	3.36	1.09	0.01	.93
	ExpWQ	80	3.04	1.16							
	Control	91	3.24	1.21			364	3.17	1.20		
Designing products or structures will be important for my future work.	ExpRov	87	3.11	1.10	1.26	.29	56	3.09	.98	0.54	.46
	ExpWQ	82	2.87	1.17							
	Control	90	2.90	1.07			364	2.87	1.09		
I am curious about how electronics work.	ExpRov	86	3.64	.94	1.83	.16	56	3.48	.95	0.24	.63
	ExpWQ	82	3.33	1.13							
	Control	91	3.54	1.12			365	3.35	1.14		
I would like to use creativity and	ExpRov	87	3.67	.96	2.47	.09	55	3.55	1.07	0.20	.66
	ExpWQ	82	3.34	1.15							

innovation in my future work.	Control	90	3.63	1.02			368	3.46	1.12		
Knowing how to use math and science together will allow me to invent useful things.	ExpRov	87	3.66	.99			56	3.57	.93		
	ExpWQ	81	3.36	1.13	1.89	.15				0.07	.79
	Control	91	3.62	1.093			368	3.53	1.08		
I believe I can be successful in a career in engineering.	ExpRov	87	3.66	.986			56	3.25	1.08		
	ExpWQ	81	3.36	1.13	.72	.49				0.22	.64
	Control	91	3.62	1.09			368	3.10	1.17		

Beyond feelings regarding the study of sciences, the survey also included a section for students to identify the level of interest in STEM careers. Descriptions of each career were given with a 1-4 scale Likert style response provided as noted in Table 4. Means and standard deviations by group were compared for post-test responses. Mean responses were stronger for the Year One experimental group with the ROV build for most careers (all but Environmental Work). Year Two results differed with the control group reporting more interest in all careers except engineering and computer science where the experimental mean was slightly higher (ExpRov μ=2.55, SD=1.02, Control μ=2.47, SD=1.09; ExpRov μ=2.35, SD=1.04, Control μ=2.29, SD=1.03).

Table 4. *Participant responses and statistical analyses on career interest in STEM areas by group and year*

Career Type		Year 1			Year 2		
		n	Mean	SD	n	Mean	SD
Physics	ExpRov	87	2.20	.90	56	1.96	.81
	ExpWQ	81	2.20	.84	---	---	---
	Control	91	2.27	.94	370	2.23	.95
Environmental work	ExpRov	87	2.17	.88	56	2.04	.85
	ExpWQ	81	2.23	.87	---	---	---
	Control	90	2.23	.94	369	2.15	.89
Biology & Zoology	ExpRov	87	2.59	.92	56	2.27	.94
	ExpWQ	82	2.44	1.04	---	---	---
	Control	91	2.36	1.07	368	2.35	.98
Veterinary work	ExpRov	86	2.52	.94	55	2.22	.96
	ExpWQ	81	2.43	.94	---	---	---
	Control	91	2.43	1.01	366	2.40	1.00
Mathematics	ExpRov	86	2.38	1.01	56	2.04	.95
	ExpWQ	82	2.04	.87	---	---	---
	Control	91	2.34	1.08	369	2.23	1.00
Medicine	ExpRov	87	2.68	.95	56	2.36	.96
	ExpWQ	81	2.54	.96	---	---	---
	Control	90	2.59	1.00	367	2.67	1.07
Earth Science	ExpRov	85	2.31	.86	56	2.04	.85
	ExpWQ	80	2.21	.82	---	---	---
	Control	88	2.06	.95	364	2.16	.90
Computer Science	ExpRov	86	2.29	.95	55	2.35	1.04
	ExpWQ	82	2.27	1.00	---	---	---

	Control	88	2.17	1.05	368	2.29	1.03
Engineer*	ExpRov	---	---	---	55	2.55	1.02
	ExpWQ	---	---	---	---	---	---
	Control	---	---	---	368	2.47	1.09
4-point scale from 1 (Not at all interested) to 4 (Very interested) *Career added for Year 2 survey							

In addition to the S-STEM sections described above, a series of questions were tailored to capture the impact of the EYESTEM unit. Table 5 provides survey prompts with data and analyses completed. Analyses vary from Year One to Year Two based on the groups utilized. For Year One a paired-sample t-test was used to determine how experimental structures compared. Data from Year One was used to narrow the structure for Year Two to one experimental group. As a result, a one-sample t-test was completed using a test value to measure variation in participant responses. For both years, statistical significance was found in several areas. Year One mean responses illustrate those participants completing an ROV build liking the STEM activity more (ExpROV μ =1.74, SD=.89 vs ExpWQ μ =3.22, SD=.86) but webquest-only participants liking it more in the context of the Social Studies course (ExpWQ μ =2.03, SD=.89 vs ExpROV M=3.68, SD=1.18). All mean responses for Year One indicated interest in the implementation of additional STEM program structures. For Year Two, mean responses indicate students liking the STEM activity (μ =2.15, SD=.97) but not as strongly as in the CET course (μ =2.26, SD=.95). In terms of interest for future STEM projects, Year Two participant mean responses indicated the highest interest for a week-long format (μ =2.49, SD=1.10). Beyond quantitative data, a series of open-ended statements were included in the Year Two survey as shown in Figure 2. Words describing the experience (question 20) were mainly positive (39 out of 55 responses received) including responses such as “fun”, “cool”, and “amazing”. When asked what was liked about the project (question 21), respondents felt strongly regarding the experiential structure and collaborative component of the work. Areas not liked included shortness of the project and inability to choose classmates to work with (question 22).

Table 5. *Participant survey responses and statistical analyses for experimental groups to EYESTEM unit by question and year*

		Shortened Survey Statement	Liked STEM Activity	Liked STEM in SS* class	Interest in other potential STEM program structures			
					Week Long	Full Year	Summer Program	After school
Year 1	ExpRov	Mean	1.74	3.22	3.22	2.64	2.08	2.31
		n	84	87	87	87	86	87
		SD	.89	.86	.86	1.12	1.01	1.14
	ExpWQ	Mean	3.68	2.03	2.05	1.76	1.73	1.71
		n	79	80	80	83	78	83
		SD	1.18	.89	.91	1.03	.92	1.02
	T-test results	*t*	-11.90	8.86	8.54	5.35	2.32	3.60
		df	161	165	165	168	162	168
		Sig.	.00**	.00**	.00**	.00**	.00**	.00**
Year 2			Liked STEM Activity	Liked STEM in CET* class	Week Long	Full Year	Summer Program	After school
	ExpRov	Mean	2.15	2.26	2.49	2.15	1.76	1.85
		n	55	55	55	55	54	54

		SD	.97	.95	1.10	1.11	.97	1.11
	T-test results	*t*	-6.53	-5.84	3.30	.97	-1.82	-.98
		df	54	54	54	54	53	53
		Sig.	.00**	.00**	.00**	.33	.07	.33
			Test value=3		Test value=2			
			Scale- 1 (Loved it) to 5 (Didn't like it at all)		Scale- 1 (Not interested) to 4 (Very interested)			
* SS stands for Social Studies; CET stands for Career and Educational Technology **p<.005								

Topic	***Sample responses***
One word to describe experience (Question 20)	39 positive statements such as • Fun • Amazing • Enjoyable • Outstanding • Inspiring • Great 7 neutral or not applicable statements such as • Alright • Building 9 negative or blank statements such as • Non-existent • Complicated
One thing enjoyed from experience (Question 21)	• Ability to work on own • Using tools • Assembling & testing of ROV • "i liked how we got to build the sub and test it out and find out what was going wrong if there was anything." • "Making the robot was the best part. Testing it and making sure it worked felt like I had accomplished something." • "I enjoyed following the directions to physically put together a product that can be useful for a problem that people are trying to solve."
One thing not enjoyed from experience (Question 22)	• Not able to choose who they worked with on teams • Not being able to keep the ROV • Not always active since it was done in teams • **Over half of the respondents said "nothing" or none*

Figure 2. Sample qualitative participant responses from Year Two of Post-Survey

5. Conclusion

Implementation of the EYESTEM Project over the two-year period provided varied results offering insight into the impact of the project as well as the potential for future study. The first year illustrated that exposure to the STEM unit could positively influence students' thoughts about the study of science especially in engineering and technology that is consistent with research that links self-efficacy in STEM with interest in post-secondary study in STEM fields (Wang, 2013). (This may have been a result of the unit being focused in underwater robotics though it cannot be said for certain.) The format of the STEM unit mattered with responses favoring the ROV build in Year One and guiding the structure for Year Two study. This provides additional support to project-based on experiential learning experiences in STEM (Balemen & Keskin, 2018; Afterschool Alliance, 2016; Hmelo-Silver, 2004; Albanese & Mitchell, 1993) Results differed with the integration of the unit in various settings (SS versus CET courses) so it was not possible to determine where the unit was best integrated. However, there is consistent support for additional STEM programming with the Year Two responses favoring a week-long structure. Qualitative results illustrate a generally positive tone to the experience that further supports additional STEM programming consistent with research by Wang (2013). It is important though to note that Year Two results did not seem to have as significant of an influence on the study of science or careers in STEM areas though influences were still seen in related fields of study to the EYESTEM unit. These findings are in alignment with other studies that increased interest and attitudes regarding STEM study through similar short-term STEM units (English & King, 2015; Nugent et al., 2010).

Lessons learned from this study are valuable in addressing the need for high-quality science education that benefits all students (U.S. Department of Education, 2016; National Science Board, 2015; PCAST, 2010; National Research Council, 2007), not just those students that elect advanced study in science. The initial impact from this short-term study illustrates the positive influence relevant, standards-aligned short-term STEM work can have on student interest, attitudes, and possible career paths. More sustained, long-term study is needed on varied STEM structures use in the high school curriculum and how it can influence various groups of students, particularly underrepresented populations, including their future interest in STEM study and careers.

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