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Developing an After-School Program to Increase STEM Interest, Awareness and Knowledge of Minority Females in a Title I Middle School

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Cover Page Footnote
The authors would like to thank the administrators and teachers at Conniston Middle School in West Palm Beach, Florida. The program would not have been possible without the support of the School District of Palm Beach County, The South Florida Science Center and Aquarium and Nova Southeastern University.

Background, Problem and Research Question

Educational leaders in the United States are adamant in stating, "to hold a competitive edge in a rapidly changing global workforce, bolstering the nation's science, technology, engineering and math (STEM) workforce is essential" (National Education Association, 2016). As an example, the United States Department of Commerce (2011) predicted a 10.1% growth of STEM-related jobs between 2015 and 2025, compared to a 6.5% growth rate in other fields. Because of this, supporting K-12 educators as they prepare students for future education and work in these fields is of paramount importance.

Unfortunately, efforts to prepare our students often begin with a tenuous start. Although in their earliest years, children are "natural scientists, engineers and problem-solvers" (Murphy, 2001), by the 8th grade over 50% of students have lost interest in pursuing an education or career in the STEM field. Other researchers, however, argue these students do not lose their interest in STEM, instead an interest was never developed (McCreedy & Kierking, 2013). Regardless of the reason, the fact remains that our STEM pipeline is being drastically reduced by the time students reach middle school; this is especially true for females, students from a lower socio-economic class, and those from racial or ethnic minority groups (Anderhag *et al*, 2016).

Of these, gender disparity is of special concern for educators. Researchers have noted that, while the gender gap is slowly closing, even more can be done to recruit females into STEM related higher education and careers (Hawkins, 2015). In an effort to address this problem, it has been shown that early exposure to informal STEM experiences can positively affect both learning and participation (Langdon et al, 2011). The objective of this project was to develop and evaluate monthly after-school programs and their effect on STEM awareness, interest and knowledge of young middle school females. The study was conducted in an urban, predominantly Hispanic, lower socio-economic Title 1 school in West Palm Beach, Florida and was guided by an over-arching research question asking, "Can participation in bi-monthly after-school STEM workshops increase young females' STEM interest and awareness?"

Participants

Palm Beach County Florida is home to the 11th largest school system in the United States, and is diverse in terms of racial, ethnographic and income characteristics. West Palm Beach, the largest city in the county, has a population of approximately 100,000 residents. This represents a racial breakdown of approximately 42% non-Hispanic white, 33% African-American and 25% Hispanic, earning a median income of approximately $46,000 (United States Census Bureau, 2015).

The School District of Palm Beach County (SDPBC) consists of over 160 K – 12 schools with approximately 183,000 students enrolling each year. Selected schools within the district host over 300 Choice programs; magnet schools offering students the ability to focus on a wide variety of personal interests (e.g., the International Baccalaureate program, programs dedicated to music and the fine arts, information technology and foreign languages). Of the over 160 schools in the system, 16 schools support Choice STEM programs at the elementary and middle school level (Palm Beach County Schools, 2016).

The middle school in which the after-school programs were conducted is a Title 1 institution with a population of approximately 1,000 students. In the most recent school year, the population was 50% Hispanic, 30% non-Hispanic white and 20% African-American, of which over 80% were eligible for free or reduced lunch. The school has two Choice Programs – International Baccalaureate (IB) and Dual-Language Spanish; there is no Choice STEM program (Palm Beach County Schools, 2016).

The purpose of this project is to develop a STEM-focused bi-monthly after-school program at the middle school; due to time and logistic restraints, this study focused specifically on the Science aspect of STEM. The participants included female, predominantly Hispanic 6th grade students. A pre-existing after-school program was in place and administrators agreed to provide teachers, staff and the physical space necessary to support the program. STEM professionals, recruited from the Palm Beach County Science Center and Aquarium and businesses and industry delivered focused presentations at the bi-monthly meetings. These included topics such as robotics, elementary physics, anatomy, geology.

Instrumentation

The *Middle/High School Student Attitudes Toward STEM Survey* (S-STEM) was developed to measure students' STEM interest and awareness (Friday Institute for Educational Innovation, 2012) and has demonstrated reported satisfactory levels of construct validity and reliability (Faber et al, 2013). The S-STEM contains four sections, each designed to measure one construct within STEM (i.e., science, technology, engineering and math). Due to the focus of this study, the researchers used only the science section of the instrument. This section consisted of nine statements with answers ranging from "Strongly Disagree" to Strongly Agree" (Figure 1). The answers corresponded to numeric values ranging from 1 to 5 (e.g., Agree = 3).

Example 1	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	O	O	O	O	O

Figure 1. S-STEM Answer Format

At the end of the school year, 10 students were interviewed by the teachers. These recorded interviews reflected an unstructured approach focused on determining what they liked and didn't like about the program and other presentations they would like to see.

Procedures

The goal of this study was to introduce a variety of science-related topics to young, primarily Hispanic female students in a Title I middle school. This was accomplished through bi-monthly after-school STEM programs, in conjunction with Palm Beach County Schools, the South Florida Science Center and Aquarium and other previously identified schools, businesses and industry.

Specific steps included:

1. Establishing a relationship with the administration and discipline specific teachers within the school.
2. Obtaining university and school district Institutional Review Board approval of the project.
3. Working with school officials to expand the existing after-school program to include bi-monthly STEM meetings.
4. Teachers recruited for the study identified a purposive sample of students meeting the required demographic characteristics. Each student was required to obtain permission from their parent or legal guardian.
5. Speakers from the professional STEM community were identified and asked to participate in a given session; necessary funding for each session was provided from grant funding. These presentations continued bi-monthly throughout the school year.
6. At the first meeting, students completed S-STEM; the survey was subsequently completed following the winter holiday break and at the end of the school year. Also at the end of the school year, interviews with a sample of 10 students were conducted to determine their perceptions of the after school program (e.g., likes and dislikes), suggestions for future work-shops and other insight they might offer.

Data Analysis

A student's average score can range from zero to 5 on the STEM-S; descriptive statistics for the class are shown in Table 1.

Table 1
Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Start of Year	23	.56	3.00	3.56	3.3000	.03707	.17779
Mid-Year	23	1.77	2.67	4.44	3.6726	.09491	.45515
End of Year	23	1.89	2.89	4.78	4.0171	.10016	.48035
Valid N	23						

Using these data, the hypothesis was tested using a repeated-measured analysis of variance (Terrell, 2012):

> *There will be a significance increase in scores on the STEM-S by participants in an after-school STEM awareness program.*

Results (Table 2) from standardized multivariate tests show that all mean differences increased significantly higher (i.e., $p < .05$) over time. This indicates a positive effect of the program on STEM awareness and interest.

Table 2
Multivariate Tests

	Effect	Value	F	df	Error df	Sig.
Time of Year	Pillai's Trace	.670	21.313	2.000	21.000	.000
	Wilks' Lambda	.330	21.313	2.000	21.000	.000
	Hotelling's Trace	2.030	21.313	2.000	21.000	.000
	Roy's Largest Root	2.030	21.313	2.000	21.000	.000

Interviews

In order to better understand the results of the quantitative analysis, 13 of the participants participated in recorded, unstructured interviews and answered the questions (Terrell, 2015):

This is your time to reflect on your time in our Femmes in STEM club. What did you learn? How have you grown as a scientist? How do you see science in your future?

The responses covered the entire range of presentation topics, but the primary focus of student responses was on anatomy and physiology (e.g., *learning about the human body has been a whole new world for me; studying the human body has helped me learn how the whole system of your body works; I learned about bugs, the human body, organs and atoms*). This tied directly to STEM careers many of the students saw themselves pursuing in the future, e.g., marine biology, nursing and veterinary science).

The greatest insight gleaned from the interviews was the importance of the STEM club and its' impact on current coursework in science. Many of the young females felt that participation in the club made them more confident in class, (e.g., *I think I excel in a lot more subjects in science class* and *I'm a lot more confident in my work)* and their overall enthusiasm in science, (e.g., *It's not just boring learning, they made it fun;* y*ou can learn hands-on science and it's really cool*).

Significance

This study demonstrated that minority female students can develop an interest in the sciences at a young age. By participating in the after-school club "Femmes in STEM", students were able to show a significant increase in their interest and awareness of the STEM fields. It further showed that these students developed increased self-esteem and are using this new science knowledge in considering a career pathway in science.

Further research s needed in the application of this knowledge to the career pathway. This study proposes further effort in affording students the opportunity to work with STEM professionals. When the female students are exposed to professionals that are actually practicing in the STEM areas they will be able to better appreciate the possibilities of their own career opportunities. It is anticipated that students' knowledge and appreciation for the sciences will help develop an interest in pursuing a career in science or technology.

Suggestions for Future Research

The focus of this project was 6th grade primarily Hispanic females at a Title 1 middle school in West Palm Beach, Florida. The results will serve to enlighten educators as to the benefit of programs of this type, and allow for the development of similar programs. Students involved in the program not only benefited from the program content, it is possible that this will result in greater representation in their continuing education leading to an increased quality of life.

External Funding & Sustainability of the Project

The United States' Committee on STEM Education (U.S. Department of Education, 2017), is facilitating a comprehensive national strategy for increasing the investment of federal funds in the STEM field. As part of their five-pronged approach, they are focusing on improving opportunities for STEM instruction in K-12 education, and are focusing on better serving historically underrepresented groups in the STEM field. These same concerns and goals are echoed by other national organizations such as the Public Broadcasting Service (2016), the National Education Association (2016), the National Women's Law Center (2016) and The National Action Council for Minorities in Engineering (2016). Opportunities for funding are called for at the national level (e.g., the National Science Foundation, 2016) and the local level (Motorola Corporation, 2016); specific calls for funding are located on these organizations web-sites shown in the reference list. Funding from these sources could ultimately allow for the development of similar after-school programs, the creation of weekend and summer science camps, new or improved in-school science laboratories and STEM focused continuing education for teachers.

Summary

Females, especially those from a minority background, are greatly under-represented in the STEM professions. Many educators, politicians and industry professionals believe this problem begins in the middle school years when many young females become disenfranchised from the STEM field. This study investigated this issue by developing and delivering a series of STEM-focused after-school workshops at a Title 1 middle school in West Palm Beach, Florida. These workshops were presented by STEM professionals from the South Florida Science Center and Aquarium, local schools, industry and businesses. Sixth-grade female students, primarily from an ethnic minority, low socio-economic background, were recruited for these workshops, with their STEM awareness and interest tracked over the entirety of a school year. Results showed a significant increase in the constructs measured. These results can contribute to a

higher quality of life by opening educational and occupational opportunities previously unknown or misunderstood by the participants, their families and communities.

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