Introducing STEM to 7th Grade Girls using SeaPerch and Scratch

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***Abstract*— This Innovative Practice Full Paper discusses a STEM academy that used SeaPerch and Scratch as engaging hands-on approaches to teach seventh grade middle school girls engineering skills, scientific principles, and programming concepts to increase their knowledge and interest in science, technology, engineering, and mathematics (STEM). Adding diversity to the STEM workforce and increasing enrollment in STEM degrees is critical for fulfilling the needs of our modern economy. Today, many organizations/institutions are preparing future workers for the modern workforce by implementing summer camps/academies to engage students in STEM disciplines at a young age. Exposing young students to the critical thinking and reasoning skills that are intrinsic to STEM disciplines can help to alleviate or even combat the decline of students in STEM careers. We have developed an academy to demonstrate STEM concepts to 7th grade girls. Our STEM academy differs from others in several ways: First, it was for 7th grade girls only, creating a non-competitive social learning opportunity, to improve female participation. Second, we hired female instructors and invited female professionals from local industries to assist the academy by serving as mentors and role models for the participants. Third, it introduced STEM concepts and principles to the girls. Fourth, it adopted social learning, e.g., buddy system, to help the girls to learn better. A formal assessment of the 2018 academy found that the academy's participants experienced a significant increase in knowledge and interest in STEM. This paper describes the organization, coordination, content, and assessment of the STEM academy. It describes how the academy was organized and taught, which includes a brief description of the instructional materials, the concepts taught in each hands-on session, how the academy was assessed, the assessment results, the first-year experience of conducting the STEM academy, and lessons learned. This paper provides all the information needed for others to host similar academies and motivate the effort to increase female participation in STEM careers.**

Keywords- STEM academy, increasing female participation in STEM, SeaPerch, Scratch

I. INTRODUCTION

Science, technology, engineering, and mathematics (STEM) have been the foundation for discovery and technological innovation throughout American history [1]. The United States is eager to put more STEM-trained students into their workforce. However, women remain underrepresented in STEM fields. The gender gap in STEM is not supervised and begins with the education [2]. According to the National Girls Collaborative Project Statistics [3], women's participation in STEM at the undergraduate level significantly differs by the specific field of study. In 2015, women received over half of bachelor's degrees awarded in the biological sciences, they received far fewer in the computer sciences (18%), engineering (20%), physical sciences (39%) and mathematics (43%) [3]. In 2016, 12.6% of bachelor's degrees in science and engineering, 7.8% of master's degrees in science and engineering, and 5.0% of doctorate degrees in science and engineering were awarded to minority women [3]. Therefore, increasing diversity, equity, and inclusion in STEM and providing all Americans with lifelong access to high-quality STEM education, especially those historically underserved and underrepresented in STEM, is critical for fulfilling the needs of our modern economy. Introducing STEM concepts to students, particularly women and minorities, at an early age can help encourage them to study STEM and to participate in the STEM workforce in the future.

Summer camps and academies for young students have become very popular to introduce STEM principles, such as engineering skills, scientific principles, and programming concepts, in an engaging and positive manner to increase the students' knowledge and interest in STEM [4]. In the Summer of 2018, several faculty members from our institution organized and taught a one-week STEM academy to introduce STEM concepts to middle school students. In particular, the academy was designed for incoming 7th grade girls with a grant awarded by the Texas Workforce Commission (TWC). The goal of the academy was to increase young female students' interest and knowledge of STEM disciplines. We used SeaPerch and Scratch for fun hands-on activities to demonstrate engineering, science, and programming concepts to 7th grade girls. SeaPerch is an underwater Remotely Operated Vehicle (ROV) developed by the Office of Naval Research and managed by the Association of Unmanned Vehicle Systems International Foundation (AUVSIF). SeaPerch equips students with the resources they need to build an underwater Remotely

Operated Vehicle in an in-school or out-of-school setting. Students build the ROV from a kit comprised of low-cost, easily accessible parts, following a curriculum that teaches basic engineering and science concepts. The SeaPerch program provides students with the opportunity to learn about robotics, science, technology, engineering, and mathematics while building an underwater ROV as part of a STEM curriculum. Throughout the project, students learn engineering concepts, such as buoyancy and circuits as they assembled the frame, mounted the motors, and assembled the control box of SeaPerch, problem solving, teamwork, and technical applications [5].

Scratch is a project of MIT Media Lab's Lifelong Kindergarten Group. It is free to the public. Scratch helps young students to acquire and improve skills such as programming, think creatively, act systematically, and work collaboratively. To the best of our knowledge, this was the first STEM academy for young female students in our region. This paper describes the organization, coordination, content, and assessment of the academy. The purpose of this paper is to share experiences and lessons learned from the 2018 academy for the benefit of those who are considering adopting this practice at their institutions.

The remainder of this paper is organized as follows: Section 2 introduces the motivation for the academy, related work, and how the coding/programming academy differs from other academies. Section 3 describes how the academy was organized and taught. It includes a brief description of the instructional materials and the concepts taught in each hands-on session. Section 4 discusses how the academy was assessed and the assessment results. Section 5 discusses the first-year experience of conducting the STEM academy and lessons learned. Conclusions are in Section 6.

II. Motivation, Related Work, Contributions

According to the U.S. Department of Commerce, women hold 47% of all jobs in the United States but hold only 24% of STEM jobs [6]. The gender gap in STEM begins with education. Only a few women in the United States are earning degrees in STEM, except in the life sciences [7]. The gender gap is especially wide in engineering and computer science. Moreover, the share of STEM degrees is even smaller for women of color in the United States. The national benefits of a strong STEM foundation cannot be fully realized until all members of society have equitable access to STEM education and there is a much broader participation by those historically underserved and underrepresented in STEM fields and employment [1]. Therefore, the STEM academy we organized focused on introducing STEM, especially, Engineering and Computing concepts to young female students to increase their knowledge and interest in STEM.

Nevertheless, changing students' minds and increasing future enrollment in STEM will require sustained programs and initiatives. A broad spectrum of strategies has been used to improve female participation in STEM disciplines. Suitable approaches to improve female participation in STEM are academic exposure, role models and mentors, parental preconceptions and influences, and clubs designed for girls [8]. Social learning is also an effective strategy to engage female students in STEM [9, 10, 11]. Studies conducted by the Association for Computing Machinery (ACM), and the Computer Science Teachers Association (CSTA) revealed that STEM disciplines, such as computer science, face problems regarding lack of exposure and motives, which are essential for the students [8]. Learning opportunities are needed to provide kids, especially females, with interesting and challenging activities in fun and positive environments. Many organizations/institutions are hosting summer camps/academies that attempt to engage students in STEM at an early age by exposing them to fun applications.

Educational robotics, such as Lego EV 3, are examples of such applications that have been used extensively to teach young kids programming concepts. Students can learn to program faster through robotic simulations [12]. Games are as attractive as educational robotics to young kids. Educators have developed game programming platforms to teach introductory programming concepts; plus, many game programming platforms are free and easy to install and maintain. Popular game development platforms for education include Alice, Scratch, Greenfoot, and GameBox, and many more. Many institutions and organizations were very successful on using education robotics or game programming for summer camps to introduce programming concepts to young kids [13-21].

SeaPerch is a very good tool to teach young students engineering pedagogy. The American Unmanned Vehicle Systems International Foundation (AUVSIF) has been able to introduce 350,000 students to engineering using SeaPerch since 2007 [5]. Therefore, we used SeaPerch and Scratch for the 2018 STEM academy to introduce STEM concepts to incoming 7th grade girls. Our team worked to close the gender gap in STEM disciplines by conducting a one-week summer academy for middle school female students. The goal of the academy was to offer hands-on experiences that provided challenging and innovative concepts in learning, problem-solving, analytical skills, and fostering interest in STEM, especially engineering and computer science fields, for middle school girls.

Our academy differed from others in several ways. First, we created a 7th-grade female-only learning environment that created a non-competitive social learning opportunity and built their confidence and self-esteem. Second, we hired female instructors and invited female professionals from local industries to assist the academy as role models for our participants. We also hired female undergraduate students majoring in STEM as counselors to assist our academy. Third, we introduced both SeaPerch and Scratch programming to our participants, whereas others only focused on either SeaPerch or Scratch programming. Fourth,

we provided an opportunity for girls to pair in teams to accomplish project-based tasks.

This article provides detailed information regarding how to organize and teach a similar academy. Contributions of this article include:

- Discussion of the literature review indicating that this type of academy can be effective in attracting females to STEM;
- Description of how to organize and conduct the academy;
- Explanation of the SeaPerch instructional materials;
- Description of the Scratch game programming instructional materials;
- Discussion of the program assessment as well as the assessment results for all outcomes.

The organization and implementation of the STEM academy is discussed detailed in Section 3.

III. Organization and Implementation of the Academy

A. Organization

The goal of the academy was to educate and empower young females to discover STEM fields, and to address equity issues, which are pressing needs in the modern workforce. The 2018 STEM academy was supported by the Texas Workforce Commission and organized by a team of faculty members from the Department of Computer Science and Department of Education at our institution. The total amount of this award was $89,753. We ordered 10 Seaperch starter kits and manuals and two tool kits, and paid their lunch tickets, t-shirts, instructors, student counselors, expense of field trip to NASA /Johnson Space Center in Houston, Texas. We reserved one computer lab, one classroom/lab, and the indoor swimming pool for the academy. All team members were involved in preparing for, organizing, teaching, and assessing the academy. The academy represented a collaborative effort between our institution, the Society of Women Engineers, the Golden Triangle – Texas Alliance for Minorities in Engineering (GT-TAME), ExxonMobil, Motiva, and other industry professionals. Moreover, female undergraduate students were hired to serve as counselors. Accomplished female professionals from surrounding industries were invited as guest speakers to share their professional STEM career experiences. A profile booklet about successful women in STEM was provided to the participants for further exploration in pursuing a STEM career.

Our academy also employed the following strategies to enrich our program:

- Social encouragement: Positive reinforcement of STEM pursuits from family and peers;
- Academic exposure: The availability of, and the opportunity to participate in STEM-related activities;
- Career perception: The familiarity with, and perception of, STEM disciplines as a career with diverse applications and broad potential for positive societal impact;
- Buddy system: Participants work in groups on one SeaPerch and one computer, collaborating to enhance learning.

Parents of the girls are often not aware of what the study of STEM entails, and what careers are available for their daughters. A parent/student orientation was conducted prior to the academy to inform parents about a wide variety of STEM careers that are available for females. Other pre-academy preparations included:

- Promotional brochures, application forms, and consent forms were developed for distribution to middle schools in our region.
- Preparation of teaching materials for SeaPerch.
- Preparation of teaching materials for Scratch.
- SeaPerch student competition rubric was designed.
- Institution's website was designed for advertisement;
- Academy T-shirt was designed and ordered.
- SeaPerch and other equipment were purchased.
- Classroom/lab, computer lab, and indoor swimming pool usage were scheduled.
- Software and data files were installed in the computer lab.
- Pre and post assessment were developed.
- NASA/Johnson Space Center Houston field excursion reservations were made.
- Dining Hall reservation were completed.
- Female professionals' invitations were dispersed.
- Female undergraduate students were selected as student counselors.
- Applications were reviewed and notifications were distributed.
- Parent/student orientation was conducted.

We successfully hosted a one-week STEM academy for 7th grade girls in the summer of 2018. Partnerships were developed with several local schools to help us to recruit female students. One of the collaborative partners provided bus transportation for their students and a chaperone for the academy. The academy was held in one computer lab and one classroom/lab at our institution. We also organized a SeaPerch Challenge Competition event in our indoor swimming pool. All girls participated this competition event. The SeaPerch competition typically include two in-pool components: the obstacle course and the mission course. In addition, to expose females to the wonder of STEM, a field trip was scheduled for fifty 7th grade female students to NASA Johnson Space Center in Houston, Texas, which provided them with an unforgettable, once in a lifetime experience, including being introduced to female engineers and astronauts. Any institution that is interested in organizing

similar camps can use virtual testimony, or virtual explanation about NASA. Table I shows the schedule for the 2018 STEM academy.

Table I: The 2018 STEM Academy Schedule

Time	July 16-20, 2018	July 21, 2018
• 9:00-9:30 am • 9:30-12:00 am • 12:00-1:00 pm • 1:00-3:30 pm • 3:30-4:00 pm	• Check-in • Scratch • Lunch • SeaPerch • Check-out	• Check-in • Johnson Space Center Field Trip, Houston, TX • Check-out

Each participant was assigned a buddy at the beginning of the academy and was always expected to remain with their buddies during the duration of the academy. At no time were participants to change buddies unless an assigned change had been made. Participants worked collaboratively in groups with their buddy on one SeaPerch and one computer to enhance learning.

Fifty 7th grade females attended the 2018 STEM academy, which began July 16th and ended July 21st with a field excursion to the NASA/Johnson Space Center in Houston, Texas. The diversity of the participants is shown in Figure 1. 48% of the participants were African American, 30% were Hispanic/Latina, 10% were Asian, and 4% were White (Non-Hispanic).

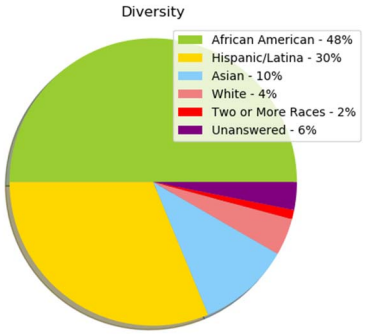

Figure 1. 2018 7th-Grade STEM Academy Participant Diversity

B. Core Curriculum Instruction

The 2018 STEM academy was intended to extend our institution's mission of establishing summer programs that target the national gap between males and females in STEM. The academy was designed to engage students in hands-on activities that were fun and demonstrated beneficial applications of STEM. The hands-on experiences included activities and tutorials that were simple enough that students could complete even with no previous experience. Instructors developed instructional materials oriented to hands-on activities, which included PowerPoint slides to highlight concepts, and hands-on demonstrations. There were video tutorials utilized to assist the girls with beginning levels of application.

The academy provided opportunities for 7th grade girls to use SeaPerch to design and build an underwater Remotely Operated Vehicle in a lab setting. It consisted of designing an ROV to check for buoyancy, displacement, propulsion, tool safety, vector electricity/circuits and switches, ergonomics waterproofing depth measurement, biological sampling, attenuation of light moment arm, and basic physics of motion.

Industry professionals from ExxonMobil and BASF volunteered and worked with the girls throughout the duration of the academy. The participants followed along as the instructor showed them how to cut the frame parts, drill drain holes, assemble the frame, attach a net, seal and waterproof the motors, wire the motors, and mount the propellers. Female student counselors assisted each group of 7th grade girls to provide application guidance. Participants started with assembling the SeaPerch and progressively built up to more complex tasks, such as mounting the thrusters and connecting the control box. Once a task was completed, counselors initialed the log to signify completion of the task. Table II lists the SeaPerch team log that we designed for the academy.

Table II: SeaPerch Team Log for the 2018 STEM Academy

Module 1 Assembling the Frame

- 1.1 – Cut the frame parts
- 1.2 – Drill the drain holes
- 1.3 – Assemble the vehicle frame
- 1.4 – Attach the payload net

Module 2 Mount the Thrusters

- 2.1 – Seal the motors
- 2.2 – Drill holes in the thruster housings
- 2.3 – Connect the tether wires to the motor
- 2.4 – Waterproof the motors with wax
- 2.5 – Mount the propellers onto the shaft
- 2.6 – Mount the thrusters onto the vehicle frame
- 2.7 – Waterproof and mount the tether cable

Module 3 Connect the Control Box

- 3.1 – Gather parts for assembly
- 3.2 – Assemble the power cord
- 3.3 – Install printed circuit board component
- 3.4 – Connect the power cord component
- 3.4 – Conduct tests and finish control box

SeaPerch is a hands-on activity where students build their own vehicles in teams of two to five. Complete kits, containing all components needed to build a vehicle as well as tool bags containing the necessary hand and power tools, were provided to each group. The actual build was facilitated by the illustrated step-by-step build manual and supplemented by PowerPoint presentations and videos of more challenging portions of the construction. The instructor used the enhanced curriculum to emphasize the scientific and engineering principles through classroom lectures.

Once construction was completed, the students verified their vehicle's system functionality by testing switch positions with propeller rotation; balancing their vehicles for transverse and longitudinal stability; and adjusting for near neutral stability by varying the amount of foam flotation to offset the vehicle's weight. Once the 'Try and Fix' sessions were over, the students were ready to compete against their peers.

We also hosted a SeaPerch competition at the indoor pool on campus for the academy. The SeaPerch competition included two components: the obstacle course and the mission course. The obstacle course tested high-speed maneuverability and required the SeaPerch to navigate to the course as quickly as possible. The girls had to develop the skill to turn and adjust the position of the SeaPerch that they built. The mission course incorporated a mission that each team must complete with the SeaPerch related to a particular real-world application. The mission course tested various skills including ability to lift, move, maneuver, and to develop innovative solutions to a technical challenge. Students learned how to work as a team and overcoming obstacles during the construction, such as troubleshooting poorly soldered joints, leaking motors, and non-secure propellers.

We also introduced game programming using Scratch to the girls. The topics covered included an introduction to Scratch, arithmetic and Boolean operations, control structures, basic data structures, and corresponding hands-on projects, for example, the Random Number Guessing Game Project was used to demonstrate how to write a program to generate pseudo random numbers. Students were asked to write a game in Scratch to generate a random integer from 0 to 9, and let the player guess what number was generated. This project demonstrated the students' capability of understanding basic programming concepts such as variables, mathematical operators, logical operators, and control structures.

Our institution's intent, through the implementation of this STEM academy for the girls, was to create a formula for developing a sustainability model that would continue to generate interest in young females to pursue STEM. For follow up and sustainability of the academy, a Saturday session in Fall 2018 and a Saturday session in Spring 2019 were conducted at our institution to provide cohort participants an introduction to coding organization websites that could assist them in forming girl clubs at their school sites. The first follow-up session was held on Saturday, December 8, 2018. The event introduced prior academy participants to animation concepts used by Pixar animators in order to learn the skill of developing their own apps. The second follow-up session was held on Saturday, February 23, 2019, as part of a series of sessions to provide challenging hands-on experiences and innovative concepts that introduced problem-solving and analytical skills. Undergraduate female students from the Department of Computer Science at our institution facilitated the Saturday sessions.

IV. Assessing the Academy

The goal of the STEM academy was to provide hands-on experiences with STEM-related activities to increase the likelihood that female students would possibly pursue STEM careers. The assessment of the 2018 STEM academy was directed by a faculty member with extensive experience in program evaluation. She worked with two computer science faculty members and one education faculty member to develop and fine-tune valid and reliable instruments for assessing the program. An online evaluation instrument was administered to the participants at the end of the academy. The instructors answered the questions with their evaluations of each participant. This indicated whether the perception of the instructor was similar to the perception and response of the students. The instructors noted the students' ability to solve problems daily as they worked with the students, and then adjusted their scaffolding strategies to ensure that each student was successful. The instructors also noted the students' capacity for production, and this could lead to discussions with the students to ascertain their perception of the students' capacity for critical thinking and problem solving.

All objectives were measured with a pre and post evaluation survey. Participants were informed that the pre and post evaluation survey consisted of a five-point scale of knowledge acquired where 1 was the lowest score and 5 was the highest score on their score sheets.

Participants completed pre and post questionnaires that measured students' self-reported knowledge and confidence. The questionnaire also asked participants what was their most and least favorite part of the academy, what can be done to improve the academy, and comments about their experience of learning STEM skills as a female. A sample questionnaire is shown in Table III. A brief summary of answers to the open response questions from the participants are listed as well.

The assessment results of the scaled based questions are shown in Figure 2 (on the last page of our paper). For the fifty 7th grade girls who participated in the 2018 STEM academy, a significant increase of knowledge of all STEM-related topics were noted in the students' assessment report.

Table III: Pre and Post Academy Questionnaire

Please check a box to rate yourself in each of the following areas:	1	2	3	4	5
SeaPerch ROV					
Knowledge of what is ROV					
Knowledge of building a ROV					
Knowledge of operating ROV					
Game Programming					
Knowledge of types of games					
Knowledge of game programming					
Knowledge of game design					
Knowledge of game resources					
Scratch					
Knowledge of Scratch programming					
Knowledge of animating scenes with scratch					
Knowledge of programming concepts with scratch					
Computer Science					
Knowledge of how to use computers					
Knowledge of computer science careers					
Open Response Questions					
Below, please give us your written comments about the academy.					
As a result of attending this academy, will you take STEM-related classes later at your school? ____ Yes ___No					
As a result of attending this academy, would you like to pursue a career in STEM? ____ Yes ___No					
Would you recommend this academy to a friend? ____ Yes ___No					
What suggestions do you have for improving the academy?					
What did you like most about the academy?					
What did you like least about the academy?					
Please comment about your experience of learning new STEM-related skills as a female.					
Please write any other comments you may have.					
Why is NASA important to the United States?					

Question 1: What suggestions do you have for improving the academy?

Here is a partial list of responses for question 1:

- Maybe make the camp last longer
- Everything that I learned was very new for me
- To have this camp all year/in schools
- We should have a robotic building competition.
- Nothing, everything was perfect. The teaching, the learning, and everything the teachers gave me
- The camp is good how it is
- Have more than 2 classes
- I think the camp is amazing already.
- Nothing everything was amazing and a great experience
- Add more classes about computer science

Question 2: What did you like most about the academy?

Here is a partial list of responses for question 2:

- Making blank scratches into a game.
- The thing I liked most about the camp was the coding. Programming.
- Building the underwater robot.
- The most I like about the camp is that I can learn new things and share them with others. Also, I am able meet new friends, learn new things about the camp and knowledge about everything the camp has given me.
- We got to build a robot. Even though our team did not win the competition for the robot, it was fun working together and building it.
- I liked the fact that we get to interact with each other.

Question 3: What did you like least about the academy?

Here is a partial list of responses for question 3:

- Honestly nothing because I loved it all since I like coding and building I found everything interesting.
- Walking in heat

Question 4: Please comment about your experience of learning new STEM-related skills as a female.

Here is a partial list of responses for question 4:

- It was great to know that girls should work on computers too.
- I think coding is pretty fun and cool.
- It definitely opened more knowledge about programming and allowed me to look at it from a different view.
- My experience was amazing and fun.
- I would never try this on my own until my mom started signing me up for this. Now, I would pursue a job in computer science/engineering.
- It is good to know that I can work with computers now, it was a great feeling.
- I have learned many new things, and thought it was awesome that they made a camp just for us girls.
- Learning new things is always fun to me so I am very thankful my teachers picked me to come to this wonderful camp.

- It is easy to learn and it is fun. I don't know why other girls don't enjoy it.
- I think it is cool how females are starting to want to learn more about coding and computer science. It's more of a male dominant field.

Question 5: Please write any other comments you may have.

Here is a partial list of responses for question 5:

- This was one of the greatest experiences of all time.
- I liked this camp because I got to learn new things and do new things like making a video game.
- None, except that I love this camp
- I think they should continue having camps like this. Kids like me are able to learn things that they didn't know before.
- I love this camp and it is fun. I also made lots of friends.
- I would like to come back to the camp.
- Thank you for teaching all this information to us. It has been really fun.

Question 6: Why is NASA important to the United States?

Here is a partial list of responses for question 6:

- It launches rockets and helps people understand space.
- NASA is important because we could learn so much about space.
- It allows us to study more on things we don't fully understand yet it also allows us to improve on science in general.
- It is important to the United States because it helps us see past everything else and makes us see things differently and see the possibility in studying and learning.
- It is important because males and females work together to go to space and make sure the people that are going to space are safe…
- To help people know more about the outside world
- It allows us to be able to study the different planets and moons in our solar system.
- NASA launched the first man onto the moon.
- Without NASA, we wouldn't know what was out there in space.
- To discover new things
- Because it is dealing with space discoveries
- To discover new things
- Because it is dealing with space discoveries

Figure 2 clearly shows that the averages of all post-session assessment questions were increased compared with the averages of all pre-session assessment questions. For example, the average of the knowledge of computer science career increased from 2 (before) to 4.23 (after), the knowledge of animating scenes with Scratch increased from 1.6 to 4.41, and knowledge of building an ROV increased from 1.3 to 4.32. The average of knowledge of how to use computer has the least increase, i.e. from 3.1(before) to 4.77 (after), because our local middle schools offer students computer technology classes to teach them how to use computers. Therefore, the students' pre-session assessment average is relatively higher. The assessment results approved that our participants increased their knowledge in the field of computer science, engineering, and other STEM disciplines and our academy was successful.

Based on the participants' feedback to the open response questions, they liked both the SeaPerch and Scratch programming sessions. They made new friends and learned knowledge in the field of computer science, engineering, and other STEM disciplines. Most importantly, they gained the confidence of learning STEM which impacted their ideas on what they want to be when they grow up. Our academy helped middle school girls build their interests in STEM and gain the confidence of learning STEM-related subjects in the future.

V. First Year Experience and Lessons Learned

Overall, the first year of the STEM academy for incoming 7th grade girls was very successful. The participants benefitted from the experience and gained a better understanding and confidence in STEM. However, our experience did reveal a few areas that need improving. These are described below for the benefit of those who plan to conduct similar STEM academies at their institutions.

Based on participants' feedback, the basic structure will remain the same for future academies with SeaPerch and Scratch game programming as the content. The instructional methods will also be retained. However, the participants commented that the academy was too short. The possibility of extending the academy will be explored.

An independent formal assessment is a very valuable tool for improvement. Most of the questions in the assessment were related to knowledge of STEM. More questions regarding participants' interest in STEM need to be added to the assessment for formal assessment.

VI. Conclusion

A one-week STEM academy with hands-on learning using SeaPerch and Scratch game programming can increase incoming 7th grade girls' interest, confidence and especially their knowledge of STEM. The positive findings of the assessment of the 2018 STEM academy overwhelmingly suggested that all participant cohorts increased their knowledge in the field of STEM. We can conclude that the participants were actively engaged and experienced significant learning during the 2018 STEM academy. We really hope that many of the girls attended the academy will pursue a STEM career.

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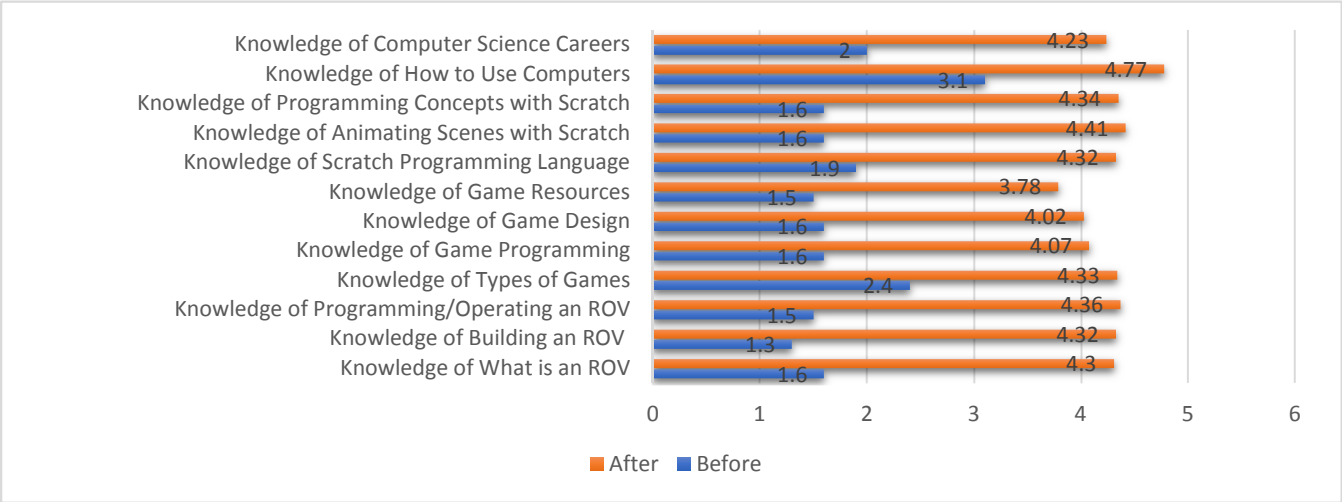

Figure 2. Before and After Average of Assessment Questions

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