A Case Study on Moving the STEM Fence: Exposing STEM to Minority Youth Who are Oftentimes Not Aware of Such Opportunities

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A Case Study on Moving the STEM Fence: Exposing STEM to Minority Youth Who are Oftentimes Not Aware of Such Opportunities

Abstract

Florida Gulf Coast University (FGCU) in partnership with the NAACP of Collier County hosted a two-week, on-campus, STEM camp during summer(s) 2014, 2015, and 2016. The program objectives were to improve students' skills in mathematics; expose students to real-world math and its application in related career fields; increase the students' awareness of STEM fields; expose students to processes that will increase their likelihood of being accepted into post-secondary institutions; expose students to practicing professionals in STEM fields; and create potential internship opportunities for camp participants. A system was designed and implemented that would assist the selection committee in identifying academically talented and motivated students that would be eligible to participate in the camp. The rigorous selection process resulted in the annual selection of forty plus applicants from an annual pool of over one hundred students. The average GPA for the camp participants was 3.8. Eighty percent (80%) of the participants were from underrepresented groups (Black or Hispanic descent) of which forty-one percent (41%) were males and fifty-nine percent (59%) were female. In terms of grade level, twenty-six percent (26%) were 9^{th} graders, thirty-three percent (33%) were 10^{th} graders, and forty-one (41%) were 11^{th} graders. In addition to what we would call the core camp participants who made up the demographics mentioned above, the committee decided to conduct a pilot program and admit students who were not performing as well academically and had been involved in a supplemental educational program; namely, Youth Academy. The average GPA of this sub-group ranged between 1.8 to 2.5. They were selected based on five (5) guiding principles. This paper will describe the overall experiences and results of the broader camp as well as the outcome(s) and manifestations that resulted from the participants attending the camp. This paper places special emphasis on highlighting the improvements gained by the Youth Academy participants in terms of their performances on measured skill sets. In the end, it is hoped that the results from this study, particularly the way it was designed, will be useful in assisting others who might want to move the fence in terms of deciding who gets to be considered in the STEM arena.

Background and Introduction

A study of the science and technology workforce in 100 metro areas across the country ranked the Fort Myers/Cape Coral area seventh-worst[1]. Recognizing that statistic, over the past three years (2014 – 2016), Florida Gulf Coast University in collaboration with the local NAACP successfully completed a two week in-house Residential Pre-Collegiate Summer Camp. The camp's objectives were to increase the students' awareness of STEM fields by exposing them to real-world math and its application in related career fields. In order to meet these goals, a committee consisting of individuals from various backgrounds including; academia, business, and community outreach was formed. In addition, a curriculum that incorporated math, a hands-on projects involving STEM, and an opportunity to develop relationships with STEM professionals was designed.

The summer program was designed as a rigorous problem/project-based educational opportunity geared toward motivated and academically able students who showed interest in a relevant and hands-on education that's heavily focused on STEM. Each year, a pool of over 100 students applied for the program. A selection committee reviewed the application and selected approximately 40 students to participate in the camp. With the luxury of this robust pool of applicants, the committee was able to use selection criteria consisting of a GPA no less than 3.2, listing extra-curricular activities, explaining favorite subjects related to the STEM fields, demonstration of high interest to participate in the program.

The importance of increasing the number of underrepresented minority students in the STEM field has been well documented.[2,3,4.5.] STEM education is finally getting the attention it deserves, as there are many programs, classes, camps, and museum activities that allow for learning STEM subjects. Typically, criteria that requires very high marks is seen in STEM camp programs throughout the nation[6]. Although their high standards are encouraging and according to many, necessary, a large segment of students; especially the ones with GPAs lower than 2.5, are excluded/disqualified[5]. This type of awareness along with the very low representation of ethnic minorities in STEM positions are what prompted the case study/pilot program featured in this article.

The Experiment/Case Study

In 2016, a pilot study was conducted that involved integrating students, who are too often forgotten in the STEM conversation and who have not performed well academically, into the core camp that has proven to be competitive and very rigorous. The STEM summer camp welcomed eight (8) additional, non-conventional STEM qualified students. Throughout the paper, this sub-group will be referred to as the "*Youth Academy*". The average GPA of this sub-group ranged between 1.8 and 2.5 and the students were selected based on the following five (5) guiding principles:

1. Youths should be provided with an environment in which they can learn to express their ideas and feelings.
2. Youths should be provided with opportunities to become self-directed and self-confident.

3. Youths should be provided with appropriate social skills through interactions with peers and adults.
4. Youths should be assisted with developing a love of learning through exploration and discovery.
5. Youths flourish when they develop and demonstrate respect for self and others.

Supplementation Prior to Camp Participation

A supplemental education program was designed and delivered to a select group of students one year prior to the integration of the Youth Academy participants into the STEM summer program. A primarily math and reading based curriculum was designed and executed by qualified personnel. The participants of the Youth Academy met every two weeks at a local high school and engaged in both academic and personal enhancement activities as part of the curriculum. Due to the supplemental instruction received through attending the Academy, it was determined that the Academy participants should get the opportunity to attend the summer camp. During the camp, the Youth Academy participants were blended with the broader group of students for the majority of the activities but were broken out of the larger group for specialized assistance in math at various points during the two weeks. As a way of monitoring progress and the effectiveness of the experience, pre and post-tests as well as participant surveys were administered throughout the camp. This paper highlights the lesson(s) learned from this experience/experiment.

Past Experience of the General STEM Program

The camp organizers successfully completed three summer camps (2014, 2015, and 2016). In order to meet the objectives, a committee of individual from various background including academia, business, and community outreach was established. Additionally, a curriculum that emphasized incorporating math, hands on projects in STEM, and opportunities for building relationships with STEM professionals was designed. The program was delivered in three (3) phases. A certified high school math teacher instructed the morning phase. The second phase, which emphasized the exposure to careers in STEM and hands on projects, was offered by faculty who regularly teach STEM classes at the university level. The third phase was delivered either in panel discussion format with practicing professionals with backgrounds in STEM fields, individuals who currently work in admissions and financial aid offices, and field trips to companies and organizations with major emphasis in STEM fields. Additional information about this summer camp was published by Villiers, et al.[7,8,9].

For the past three years, one hundred twenty seven (127) students from ten (10) different local high schools participated in the summer camp. Eighty percent (80%) of the camp participants are from underrepresented groups (Black or Hispanic descent). Additional information about the students' background and qualifications is summarized below:

- average GPA 3.8;
- forty-one percent (41%) males and fifty-nine percent (59%) females;

- twenty-six percent (26%) of 9th graders, thirty-three percent (33%) of 10th graders, and forty-one (41%) of 11th graders; and
- the students came from ten (10) different high schools in the area.

A combined SAT and ACT pre-test was given to the students on the first day of the camp. In addition, the students took a SAT/ACT post-test toward the end of the camp. Surveys were given throughout the camp in order to obtain the students perspective in STEM fields. These measures were used to evaluate the overall effectiveness of the summer camp.

Pilot Experiment: Capturing the Often Forgotten

Youth Academy Program Initiation

In early fall of 2015, Mr. Pat Cacho, a long time public servant, contacted the University's Foundation office and inquired about developing a program/service that would assist black males in becoming successful, productive citizens – perhaps future leaders. He made a pledge to financially support the program that provided such assistance to that population. The University's Office of Community Outreach and faculty along with community leaders and county school district personnel met on several occasions and collaborated on the initiative. The communication(s) from those meetings garnered a relationship with Golden Gate High School that provided a home base for the Youth Academy that would expose these black male students with a complimentary curriculum. A group of twenty-five (25) underachievers, at risk of dropping out of school due to low academic and/or social performance, was identified. Subsequent meetings were held in order to garner the interest of the students, and then an additional meeting was called in order to get the buy-in of the respective parents and/or guardians. The Academy was finally scheduled to commence in January of 2016.

Youth Academy Program Curriculum

A curriculum was designed and delivered by the program administrators. The curriculum was very intentional and was designed to bridge the gap between academic and social factors that oftentimes lead to a life of juvenile delinquency, if not addressed appropriately. It was purposed to enrich the lives of its participants through a multi-dimensional, educational program that promotes critical thinking, communication, collaboration, creativity, goal setting, positive decision making, career exploration, high school graduation, and post-secondary education. Because meaningful relationships often form between adult professionals and youth in which they interact with, self-esteem and similar rewarding attributes can be enhanced, opening youth to a number of values that can be taught through emulation, such as respect and responsibility. Effective interactions and positive modeling provides opportunities, and from these opportunities leadership, decision-making and goal-setting skills among many others are learned. Youth who attended the academy were given real life opportunities to not only learn and/or fortify these skills, but also to apply them in and among a group of their peers.

The Youth Academy program curriculum contained both an academic component and personal enhancement activities in the curriculum. A copy of the schedule is presented in Appendix 1.

The students met every other Saturday for four hours. The sample breakdown of the program includes the following:

- **Early Morning** (First Two hours) – The early morning sessions were designed with mathematics, reading or language arts. In addition to improving their skills on these subjects, the participants received a block of instruction on ACT/SAT preparation in order to assist the students with the familiarity of the exam(s) as well as to discuss techniques that will enable the students to be well prepared to score high on the exams.
- **Late Morning** (Last Two hours) – The late morning was built on various topics: self-exploration and leadership discussions, goal-setting and time management, employability, personal hygiene/proper attire, public speaking, sex education, effective use of internet, drug awareness, and a communication task verbal and non-verbal). These activities and presentations were strategically selected in order to provide the participants with an in-depth discussion to allow them to understand themselves better as they complete activities that provide an assessment of their likes/dislikes, their learning style(s), their overall level of motivation, career aspirations, self-esteem, etc. During each session, time was allowed to provide the participants the opportunity to engage in meaningful conversations regarding the different styles of leadership and career opportunity, as well as an opportunity to discover which style fits them the best.
- **Tutoring** – The students were required to attend a mandatory tutoring session once a week. The tutoring sessions were conducted by volunteers who had retired from the school system. The students had the opportunities to work on their homework and specific topics that may be causing a challenge. Some students have testified that these tutoring sessions helped them unlock the skills that they have by focusing on their learning styles.
- **Field Trips/None-classroom Activities** – Various field trips along with activities outside the classroom environment were incorporated into the curriculum. A select number of those activities are described below:
    - **Field Experience Obstacle Course/Teambuilding Exercises** – this field experience allowed the participants the opportunity to build and/or enhance their confidence and self-esteem by engaging in the challenge of completing an obstacle course. The participants participated in other team building exercises that emphasized respect for other's opinions, differences, etc. and exposed them to the important principles associated with being a good team player.
    - **Attain to Retain Conference** – this non-classroom activity was designed to assist youth with college preparation as well as to expose students to different topics that will assist with college success. There were a number of break-out sessions with varying topics that support matriculation through the collegiate experience.
    - **Career Conversations** – the participants were taken on a rewarding field experience where they were exposed to successful black individuals who shared how the goal setting process was instrumental in their respective successes. The students were able to have one on one conversations with the many professionals who participated in the annual event.

- **Criminal Justice Agency** – the participants visited a local Sheriff's Office. The purpose of the trip was to recreate a positive interaction(s) with law enforcement personnel and the students.

Program Structure and Results

Youth Academy General Observations

Most of the noticeable changes for the participants of the Youth Academy occurred in three domains; namely affective, social, and academic/cognitive. This part of the article will discuss some selected observations that occurred in each of the before-mentioned domains.

Affective

The affective domain includes feelings, values, appreciation, enthusiasm, motivations, and attitudes. Within the affective domain, the participants demonstrated significant growth. In the beginning of the program, several sessions were planned to identify the Youth Academy participants' perspective on life. During the sessions and one-on-one interviews, the participants progressed from not having the slightest idea of what they wanted out of life to being able to articulate with confidence what they now aspire to do with their respective lives. In addition, the young men showed a tremendous growth in regards to their self-esteem. This transformation was quite obvious as the youth were more confident in their everyday conversations as well as speaking about their future. It was very encouraging to see how the youth started to realize that they had a support network that could allow them to dream and hope for things that were not common to their familial situation(s). The panel presentations that were cited above provided the encouragement that yielded an improved outlook on life as the panelist were all successful black men, with the exception of one black female. By the end of phase I of the Academy, one could clearly see that the young men had a greater appreciation for education and were able to connect the value of education with financial success. In summary, the attitudinal change toward life and what lies ahead was very demonstrative as the youth enthusiastically spoke about their futures.

Social

The learning processes included in the social domain feature performances that directly focus on the development of social skills (i.e., being courteous) as well as the use of social skills to manage situations or problems (i.e., improvising). The five process areas of the social domain include communicating, relating to others, relating culturally, managing, and leading. The youth showed much improvement in this domain. This was evident in the way they conducted themselves in class as well as out on the field experiences. They quickly grasped what it means to speak one at a time as well as to respect others' opinion even if it was in dissention of their own. They were also able to ask insightful and age-appropriate questions at the different outings. One area where the youth blossomed was during meal-time. Initially, the youth would hoard the food with little regard for the rest. After being admonished about that type of behavior, the youth learned to share and actually looked out to make certain that everyone was nourished. Given their circumstances, it was reasonable to expect their initial behavior(s). Some of the youths emerged as leaders while the others acquiesced to being sound supporters. This observation was very noticeable on the obstacle course as well as at the graduation ceremony. In sum, by the end

of phase I, the youth were demonstrating social skills that were age-appropriate regardless of their background.

Youth Academy and STEM Academy

Academic/Cognitive

The academic/cognitive domain includes content knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts and concepts that develop intellectual abilities and skills. The youth were exposed to mathematics as well as reading comprehension. Although anecdotal, the teachers for the reading sessions felt that the students improved drastically after being taught some of the creative techniques for improving reading comprehension. It was very apparent that the youth actually enjoyed and benefitted from the reading sessions. By the end of phase I of the Academy, one could clearly see that the young men were more thoughtful in their responses and they were more analytical in their thinking. They no longer blurted out the first thing that came to mind but took time to think about what they were being asked. This was very noticeable as the youth oftentimes repeated questions in order to make sure that they were hearing the question(s) correctly. This demonstrates cognitive maturity.

In regards to math, the students received instruction that aided them in understanding math and not viewing it in a negative way. The youth were exposed to the level of math that would appear on ACT/SAT exams as they worked through many math problems throughout phase I. It is appropriate to say that the youth embraced math and actually demonstrated a joy for math during the sessions. The math component actually culminated by the youth attending the Summer STEM Camp. The analytics from the camp will speak more to this academic/cognitive domain.

The actual STEM Camp Experience

Mathematics SAT/ACT Prep Summer Program

This year, eight (8) youth from the Youth Academy participated in the STEM Academy. In order to provide a curriculum that would whet the appetite for STEM exploration, a committee of individuals from various background including academia, business, and community outreach designed a curriculum incorporating math and hands-on projects in STEM. The camp was delivered in three (3) phases. The morning phase was math instruction delivered by two certified high school mathematics teacher. The afternoon phase included exposure to careers in STEM fields and hands-on projects offered by regular university STEM faculty. The third phase consisted of panel discussions with local STEM professionals, panel discussions format with university admissions and financial aid officials, and field trips to companies and organizations with major emphasis in STEM fields.

On the first day of the camp, the students were given a Pre SAT and ACT math test. Throughout the duration of the camp, the instructors taught the students algebra, trigonometry, and geometry. The instructors equipped the students with the key components of test taking strategies that can

be used in ACT and SAT testing. Every afternoon, the students were exposed to presentations, projects, and field trips with a focus in various STEM disciplines including:
Marine and Ecological Sciences, Civil Engineering, Bioengineering, Forensic Sciences, Software Engineering, Environmental Engineering, and Chemistry. Each session started with a 20-minute introduction to the particular STEM discipline. The students were divided into groups for hands-on application. Enhancement activities including popsicle stick bridge building, miniature solar go-kart, water treatment, and flight simulation. Efforts were made to expose the students to math concepts in relation to the STEM projects. Descriptions of these projects and activities were presented by Villiers et al.[7].

All the students (regular STEM and Youth Academy students) were given the exact same test regardless of their grade level. The results of the SAT test scores are presented in Figure 1. A similar outcome/result was observed for the ACT test. The Youth Academy students scored lower as compared to the core STEM participants. This was expected since the STEM students had higher qualifying scores in terms of GPAs, etc. Also, the instructor(s) used the results from pre-test as a tool to identify the subjects that needed more emphasis and to develop a strategy that would assist in an effective delivery of the math course. One of the math teachers worked solely with the Youth Academy students along with the three (3) STEM students who scored low on the pre-test. This approach provided the instructor with the ability to work on a "one-to-one" basis with the students, to develop good rapport with them, and to heavily focus on a specific subject that had been most challenging to the students.

The Actual Results:

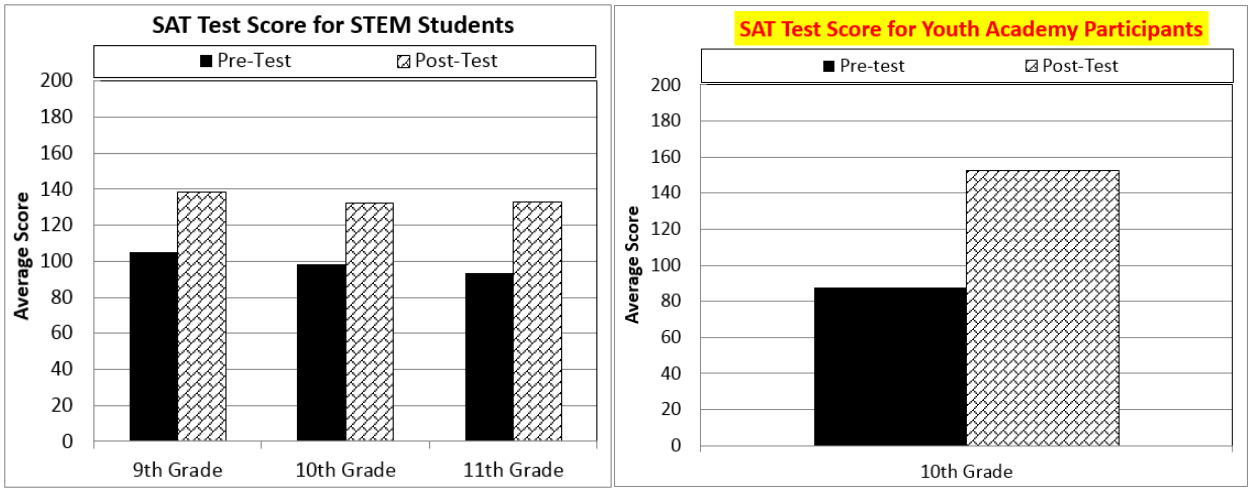

Figure 1: SAT Pre and Post-Test Results (Core STEM scores on the Left and Youth Academy Scores on the Right).

The authors of the paper are aware that a two-week period is not adequate to teach the students all the basics necessary to master high school math. The instructors equipped the students with the key components of test taking strategies that can be used in ACT and SAT testing. Every afternoon, all the students (regular STEM and Youth Academy participants combined) were

exposed to a particular STEM discipline and efforts were made to expose the students to math concepts in relations to the STEM projects. All the students' grades improved on both the ACT and SAT tests (see Table 1 below). The Youth Academy participants' test scores improved the most. On average, the Youth Academy participants' test scores increased by 74% and 94% on the math SAT and ACT practice tests, respectively. In regards to the core participants, the increases were 36% and 21% respectively. This high performance on the Youth Academy participants may be attributed to the special attention provided by their instructor. Although we do not have sufficient data to make such a definitive inference, one may claim that by blending the two groups together during the camp, the Youth Academy participants felt more of a need to rise to the challenge by working a bit harder to keep up with their peers.

Table 1: Effectiveness of the Math Component of the Camp (Core STEM scores on the Left and Youth Academy scores on the Right).

STEM Students		
Gain, %	SAT	ACT
9th Grade	32	24
10th Grade	34	23
11th Grade	42	18

Youth Academy Participants		
Gain, %	SAT	ACT
10th Grade	74	94

Announcing an increased awareness/interest

Surveys were administered throughout the camp in order to assess the students' perceptions of STEM fields to evaluate the effectiveness of the camp. A copy of the survey was presented by Villiers et al.[2]. The survey results related to this module are presented in Figure 2. Every student reported (strongly agree or agree) that the camp increased their awareness in STEM fields. Also, eighty-two percent (82%) strongly agreed or agreed that they will consider STEM fields as a career path as a result of the Camp. However, when they were asked about their level of interest in STEM, the answers were mixed. Seventy-four percent (74%) were interested (extremely interested or very interested) in Science. However only 34% felt the same way about engineering. In addition, sixteen percent (16%) reported that they have no interest in engineering. This was the highest negative response in any of the categories. This number demonstrated that a lot more work is needed in order to attract under-represented students to Engineering. Although the above information refers to the general camp participants, these sentiments were echoed by the Youth Academy group as well.

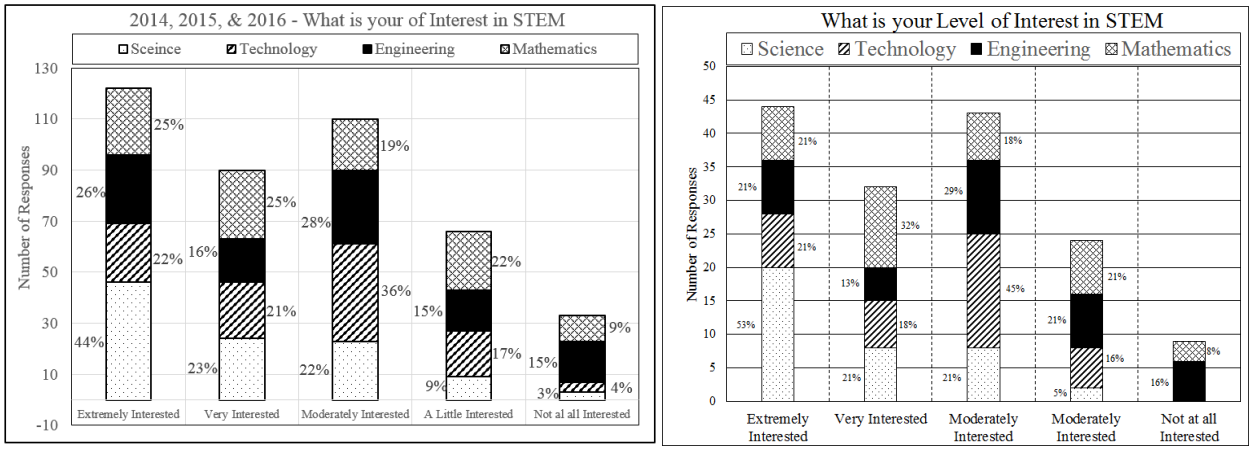

Figure 2: S.T.E.M. Component of the Camp. (Core STEM scores on the Left and Youth Academy Scores on the Right).

Summary and conclusion

The aim(s) of the pilot program was realized in that the Youth Academy students were exposed to a totally new experience – one in which most of the participants gave very little thought toward in terms of STEM as a viable career option. The youth benefitted greatly from the Youth Academy as well as the subsequent attendance at the annual STEM camp. It is important to note that the students showed marked improvement on their test scores after having the general and supplemental instruction at the camp. The information that has been shared in this paper will hopefully cause others who run such camps to be a bit more inclusive by allowing youth who are not presenting high quantitative scores an opportunity to explore STEM opportunities.

Another revelation that resulted from this case study is that early intervention, perhaps in elementary school, can help equal the playing field by giving lower performing youth the needed assistance that will assist them with the tools necessary to have STEM careers. Early identification and on-going nurturing can be very effective in helping move the STEM fence in order to embrace some who might not otherwise have the opportunity. Too often youths are labelled early on in life and the phenomenon of self-fulfilling prophecy either enhances or limits the life course one pursues depending on the label. In terms of this pilot, case study, many if not all of the Youth Academy students had been deemed as those likely to drop out of school. Hopefully, their experience from the camp has assured them that they can learn and do it quite well.

The authors of this paper offer that if youths are given the necessary assistance and tools, they are able to rise to a level that is much higher than what had previously manifested without such interventions. The results of the pilot at least support the notion that sometimes awareness and a

little push can open up a whole new world. This case study provides one example of how creativity has served to move the STEM fence.

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Appendix 1 - Youth Academy Phase II; September 2016 to May 2017

Week	Date	Session I	Session II	Teachers/Speakers	Comments
1	09/10/2016	Intro to Cacho Academy	Experience shared by Phase I participants		Cacho Participants Parents are invited
2	09/24/2016	Math Prep	Self- Exploration	Ms. Hampton/ Dr. Barringer	
3	10/08/2016	Language Arts/Reading Comprehensive	Personal Hygiene/Proper Attire	Ms. Jane Higgins/ Ms. Kim Asher/Dr. Barringer	
4	10/22/2016	Teambuilding - Obstacle Course		Bus	
5	11/05/2016	Math Prep	Public Speaking Part I	Ms. Hampton/ Dr. Villiers	
6	11/19/2016	Language Arts/Reading Comprehensive	Public Speaking Part II	Ms. Jane Higgins/ Ms. Kim Asher/Dr. Villiers/Dr. Barringer	
7	12/03/2016	Language Arts/Reading Comprehensive	Sex Education	Ms. Jane Higgins/ Ms. Kim Asher/TBD	
8	12/17/2016	Math Prep	Holiday Celebration	Ms. Hampton	Cacho Participants Parents are invited

Week	Date	Session I	Session II	Teachers/Speakers	Comments
9	01/07/2017	Language Arts/Reading Comprehensive	Effective Use of Internet Part I	Ms. Jane Higgins/ Ms. Kim Asher/Dr. Villiers	
10	1/21/2017	Math Prep	Effective Use of Internet Part II	Ms. Hampton/ Dr. Villiers	
11	02/04/2017	Attain to Retain		Bus	This activity will occur at Florida Gulf Coast University
12	02/18/2017	Math Prep	Drug Awareness	Ms. Hampton/ Dr. Bruster	
13	03/04/2017	Career Conversation		Bus	This activity will occur at Boys and Girls Club in Naples, Florida
14	03/25/2017	Law Enforcement Day		Bus	
15	04/08/2017	Language Arts/Reading Comprehensive	Verbal Judo	Ms. Jane Higgins/ Ms. Kim Asher/Dr. Barringer	
16	04/22/2017	Language Arts/Reading Comprehensive	Verbal/ Non-Verbal Communication	Ms. Jane Higgins/ Ms. Kim Asher/TBD	
17	05/06/2017	Math Prep	Panel Discussion	Ms. Hampton/ Panel Participations	
18	05/20/2017	Math Prep	Goal Setting-Time Management	Ms. Hampton/ Dr. Villiers	
19	06/03/2017		Graduation		Cacho Participants Parents and Everyone affiliated with Cacho Academy are invited