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**Stem Summer Youth Workforce Development at CCSU**

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**Abstract**

The Central Connecticut State University (CCSU) Young Engineers Summer (YES) Institute was devised as a public and private sector collaboration that engages middle and high school students in summer learning STEM opportunities that increase the number of students from underserved communities who pursue STEM careers. This program was administered in the Summer of 2019 by faculty of the CCSU School of Engineering, Science, and Technology who can coordinate STEM learning activities using the necessary laboratories and classrooms. The YES Institute has identified key objectives pursued through faculty-led instruction and guidance in STEM subjects and university-level courses; guidance in career and college readiness; and exposure to local companies that utilize STEM activities through tours and paid internships. Leadership and staff members were recruited from the university, local nonprofit organizations, and local businesses. This paper presents the objectives, as well as the operation and results of the most recent on-ground YES Institute program at CCSU. This includes a description of the collaborative coordination of the program, curriculum and activities, and evaluation of the program. The program was found to be successful in engaging middle- and high-school students for college-level STEM activities and curricula, and a number of recommendations were made to ensure that this program is improved and continued in the future.

**Introduction**

The main purpose of the CCSU Young Engineer Summer (YES) Institute was to expose rising middle- and high-school from underserved communities into STEM-related careers. This will allow these youth to be aware of the opportunities, develop the required skill sets in STEM-related field, and prepare them for what it takes to succeed in any academic and professional setting by learning how to work independently and collaboratively. The program aims to strengthen the educational foundations of students from low-income and or first-generation-to-college backgrounds, thereby enhancing their ability to matriculate into competitive college environments. Using the planning proposal from 2018, the program was offered for high school students to gain college academic credit in the STEM-related areas. As a result, in the summer of 2019, rising high school students were given an early-college experience and the ability to earn up to six college credits in Robotics and Manufacturing at CCSU.

While this type program was not necessarily new and many instances can be found in literature and mass media, this report provides perspective and lessons learns with an evolving program. The authors have found this to be a more novel project in that it was done with multiple partnerships with wider-reaching benefits than a typical summer youth program. This includes partnership with CCSU, which was aimed at addressing the university’s strategic plan goal of increased enrollment. This also includes partnerships with local community organizations who both recruited students for our program and were able to use our program to augment and improve their own programs. These partnerships provided for a more established and scalable program just as been found in similar projects that reported successes [1].

The participants were from Boys and Girls Club of New Britain, Boys and Girls Club of Bristol Family Center, and the CCSU TRiO program. This includes a mixture of boys and girls, with a total of 35 middle-school participants and 24 high-school participants, which were divided into separate sections. The middle school included 16 students in first summer session (SS1), and 19 students in the second summer session (SS2). The high school session was conducted over a separate 6-week summer session with formal CCSU courses.

Table 1: Curriculum and Contents for the Two Masters of Engineering Programs

|  |  |  |
| --- | --- | --- |
| Group | Source | Count |
| Middle School, SS1 | B&G Cubs | 16 |
| Middle School, SS1 | TRiO | 19 |
| High School | TriO | 24 |
| 18 |  | 1 |

In the previous years, the CCSU ITBD offered the program to New Britain students only. However, from 2017 the program branched out to non-New Britain students. The program has run with slightly varying content annually for over 6 years. The authors attempted to recruit students from 15 different towns in the greater Hartford area. However, interest was only found in New Britain and Bristol, mainly due to these towns’ close ties to the university.

**Program Objectives**

The YES Institute was created as a public and private sector collaboration that engages middle and high school students in summer learning STEM opportunities that increase the number of students from underserved communities who pursue STEM careers. The YES Institute has identified four main objectives that will be achieved through CCSU faculty-led instruction and guidance in STEM subjects and coursework; guidance in career and college readiness; exposure to local companies that utilize STEM activities through tours and paid internships.

Objective#1: Increase awareness, interest, and motivation to pursue STEM majors and careers among underserved student populations. Students from underserved communities will be recruited from local Boys and Girls Clubs, YMCA, YWCA, TRiO, and New Britain HS to participate in YES—Institute. Students will visit CCSU STEM labs, speak with CCSU STEM college students and faculty, and participate in STEM major and career workshops exposing them to various STEM related fields. Students will visit various businesses, participate in job shadow opportunities, and speak with industry executives about their experiences. Students will engage in interactive student-based learning projects that mirror STEM industry workplace experiences. High school students will enroll in CCSU STEM courses for credit, and seniors enrolled in the program will be provided opportunities to apply to Central with provisional acceptance early in their senior year. Finally, students were asked to journal their experiences, what they have been learning, and share this with faculty.

Objective#2: Provide students with necessary workforce readiness skills (e.g. teamwork and workplace etiquette) needed for successful employment. Students will participate in a special plant tour presentation by a local manufacturing company. Students will engage in team-based projects and assignments in CCSU summer courses and take part in workplace etiquette workshops and seminars.

Objective #3: Increase students’ confidence and perceived ability for success in STEM majors and post-secondary education. Students were to be enrolled in college credit STEM courses and receive tutoring and mentoring and other necessary support by CCSU college students and faculty to ensure adequate progress in summer college courses. This follows the authors’ experiences as well as those of other institutions in providing engagement to students through challenging subjects with provided support and real-world relevance [2].

Objective#4 Increase financial literacy and awareness of the college going process for students and their families. Students and parents will participate in financial literacy and college planning workshops. Students will tour the CCSU as well as a local community college campus.

**Program Support**

This program was administered as a collaboration that was produced through funding, coordination, and operation by people from a variety of organizations and organizational units. The CCSU Community Engagement and CCSU Continuing Education offices provided support in terms of coordinating advertising and recruiting efforts, centralizing planning efforts, and administering funds from private sponsors. The CCSU Admissions Office provided support in setup of special college-level courses for high school attendees, and in enrollment of these attendees. The American Savings Foundation of New Britain, Connecticut provided a scholarship fund to provide the program with a paid administration assistant. The recipient of this scholarship, Ms. Sandy Doan, assisted with program evaluation and documentation procedures. The CCSU School of Engineering, Science and Technology provided access to computer labs, classrooms, and STEM laboratories for program learning activities; as well as funding for two student workers. The CCSU TRiO program recruited middle and high school participants, provided several on-campus activities, and funding for faculty, staff, and meals. The TRiO program has been offered at no cost to eligible students, and the administration of this program utilized the YES Institute to provide summer activities to all of its participants. The New Britain and Bristol Boys and Girls Clubs recruited and transported a group of middles school participants for the program, which they integrated into their own summer activities. The Boys and Girls Clubs administrators offered participation in the YES Institute to all of its members at no cost beyond their existing membership cost.

**Attendance Overview**

Among the middle-school students, most students attended regularly, but there were some instances of tardiness due to family issues, and there were two occurrences of absences. The TRiO and Boys and Girls Club staff assisted with preventing tardiness and absenteeism, as well as managing make-up work when necessary. Instances of tardiness and absenteeism among the high-school students were limited to a single absence at the beginning of the week due to family issues. Otherwise, the TRiO program staff was able to avoid absenteeism for this program, and since students resided on campus, tardiness was not an issue.

**Demographics of Participants**

This demographic information was collected from a voluntary online survey filled out by the students. See Table II for collected demographic information such as age, gender, race, ethnicity, family size, etc. Note this was based on a total of 30 responding participants, and not all participants answered all questions.

Table II: YES Institute Participant Demographics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Age | Count |  | Residency | Count |
| 12-13 | 6 |  | New Britain | 28 |
| 14-15 | 5 |  | Non-NB | 2 |
| 16-17 | 18 |  |  |  |
| 18 | 1 |  |  |  |
|  |  |  |  |  |
| Gender | Count |  | Eligible for | Count |
| Male | 16 |  | free lunch in school | 29 |
| Female | 13 |  | reduced lunch in school | 1 |
|  |  |  |  |  |
| Race | Count |  | Number in household | Count |
| White | 5 |  | 2 | 3 |
| Black | 13 |  | 3 | 2 |
| Asian | 4 |  | 4 | 6 |
| Latino | 12 |  | 5 | 11 |
| Other | 1 |  | 6 | 7 |
|  |  |  |  |  |
| Ethnic Origin | Count |  | Grade level | Count |
| Hispanic | 15 |  | Middle School | 5 |
| Non-Hispanic | 15 |  | High School | 25 |

**Curricula & Activities**

The course curricula were provided by the CCSU faculty using subjects similar to existing university-level courses. Consideration of subjects was based on the established concept that learning modes that include real-world and hands-on activities help provide more conceptual understanding and engagement [3]. Both first and second summer sessions had similar lesson plans. Due to the collaborating organizations’ program schedules, a major difference between the summer program groups was that the length of SS2 was one week longer as compared to SS1, but SS2 only had classes in the morning while SS1 students met all day. Another difference between SS1 and SS2 was that SS2 incorporated marine life into some of its curriculum due to that being the theme of the hosting organization. For example, the SS2 students created CAD and 3D printed models of various plankton species.

In the beginning of the programs, students received a campus tour of the university from CCSU faculty and staff. The students learned CAD-based solid modeling using Solidworks, which they then used to create 3D printed models. Another faculty member provided activities-based applied math instruction. The students also took part in a hands-on course in robotics, mechatronics, and pneumatics.

For the high school portion, the students were able to take CCSU courses ROBO 110 – Introduction to Robotics and ROBO 220 – Parametric Modelling and Simulation. The high school students were separated into two groups (Group A and Group B), which allowed scheduling laboratory sessions for both courses in groups of twelve. This ensured that courses would be similar in structure and student-faculty ratios to what regular CCSU students would experience. At the end of these courses, the students were asked to take a final exam just as regular college students would take.

There was a total of 24 students taking these courses, and among the groups and two courses there were only two failing grades. The students were supplied with books for each class, as well as learning supplies (including book bags, notebooks, pens, flash drives, and water bottles). In addition to academic enhancement activities, the students actively participated in cultural, healthy living, and team building electives that will aid in their transition to the post-secondary environment. Furthermore, the high school program enabled students to live the “college experience” while residing in CCSU dorms throughout the week.

In addition to supplies, all students were given access to CCSU student network drives (cloud storage) and the Blackboard learning management system. All were subject to the same conduct and academic standards as any typical college student. All students were able to print and keep their own 3D model. Breakfast and lunch were served for all students and staff. However, for the high school program, students were given housing as well as dinner to immerse themselves in the college atmosphere. Furthermore, the high school program had extracurricular activities and recreational coaching. Students, in general, were supplied with all the necessary components to excel and enjoy this educational program.

**Instructor and Coordinator Feedback**

Upon completion of the program, the instructors were asked to provide their feedback and recommendations. This includes comments to make note of positive aspects as well as critical feedback that is followed up by suggestions. These comments will be used to improve the program in future years. This feedback can be summarized by the following comments and recommendations.

Positive feedback – middle school activities:

* Participants were generally very enthusiastic and engaged.
* Solid modelling with Solidworks was an excellent way to incorporate all STEM principles at once.
* Community organization staff were helpful in providing transportation for field trips.
* Company that hosted tour provides an excellent variety of technologies as well as a great presentation on career paths.

Critical feedback and recommendations – middle school activities:

* Engagement was lost with more difficult or tedious tasks – break up into groups, try to improve simplicity of instructions and tasks.
* Wide range of ability and interest among students – break up into groups early on so that they can divide tasks.
* Internet access has fairly loose restriction, made it a challenge to avoid temptation – ask network administrator to improve Internet access controls by instructors.
* Having a daily lesson plan is important, but with this group be prepared to be flexible.
* Group projects in a few cases resulted in two or more members not being productive – plan up front that there will be peer evaluations.
* Group projects took a long time if not structured – include a rigid list of tasks to get done, to keep all members working.

Positive feedback – high school activities:

* Students were academically ready for the challenge of the selected courses.
* Keeping the students together throughout the day and night helped avoid absenteeism.
* Some students were able to help each other, and the group was generally supportive of each other.

Critical feedback and recommendations – high school activities:

* It was challenging to maintain the same academic standards as a regular section of the course – need to minimize distractions caused by students and their phones.
* A few students would cause distractions when they lost interest – need to find a way to maintain engagement and require same level of classroom discipline as regular students.
* Students seemed to be under the impression that this was more of a summer camp – need to include more explanation of student responsibilities during recruitment and orientation.
* Program assistants who were sent to assist students were unable to do so in one of the courses and actually caused distractions – make sure that we have assistants who are more familiar with the subject matter.
* Students cannot be trusted with their phones – need to require phones be left in front of room at beginning of class.
* Some students had no previous experience with PC workstation, such as storage, hardware, and Windows applications – need to include a basic tutorial on PC operations prior to any PC-intensive course.

**Post-Assessment Survey of the STEM Career Choice**

At the end of the program, both the middle and high school participants were asked to evaluate their experience through survey instruments created for the two specific groups.

Survey – middle school activities:

A total of thirty-five students completed the survey, which asked questions related to their STEM career interests (Table III). In the numerical data, the students rated the questions on a scale of 1 to 5, with 5 being “strongly agree” and 1 being “strongly disagree”. Part 1: Interest portion has a calculated overall average of 3.41 out of 5 level of interest towards STEM. In the Part II: Intent portion, the students’ level of intent towards the STEM-related field was indicated with average of 3.29 out of 5. As for how the students perceive the STEM-related field in Part III: Perception, an overwhelming number of students (ten) answered “5” on the question “having a career in science would be challenging.” In addition, eight of the fifteen students answered that they strongly agreed that “scientists make a meaningful difference in the world.”

Table III: YES Institute Middle School Participant Survey Questions

|  |
| --- |
| **Part I: Interest** |
| 1. I would like to have a career in science.
 |
| 1. My family is interested in the science courses I take.
 |
| 1. I would enjoy a career in science.
 |
| 1. My family has encouraged me to study science.
 |
| **Part II: Intent** |
| 1. I will make it into a good college and major in an area needed for a career in science.
 |
| 1. I will graduate with a college degree in a major area needed for a career in science.
 |
| 1. I will have a successful professional career and make substantial scientific contributions.
 |
| 1. I will get a job in a science-related area.
 |
| 1. Some day when I tell others about my career, they will respect me for doing scientific work.
 |
| **Part III: Perception** |
| 1. A career in science would enable me to work with others in meaningful ways.
 |
| 1. Scientists make a meaningful difference in the world.
 |
| 1. Having a career in science would be challenging.
 |

Survey – high school activities:

The high school students were asked to complete a course evaluation at the conclusion of their courses, similarly to what is typically asked of college-level students. The topics cover a variety of course aspects which assess the course content, course delivery, learning experience, and overall rating (Table IV). In the numerical data, the students rated the questions on a scale of 1 to 5, with 5 being “strongly agree” and 1 being “strongly disagree”. Some questions were skipped, in which case they were indicated as “n/a”. In course evaluation, the students showed a relatively high rating towards ROBO 220 compared to ROBO 110. The results of these surveys are shown graphically in Figures 1 and 2.

Table IV: YES Institute High School Participant Course Survey Questions

|  |
| --- |
| **Course Content** |
| 1. Assigned reading helped you understand the subject.
 |
| 1. Homework assignments/project helped you understand the subject.
 |
| 1. Tests/quizzes are fair and represent the material covered.
 |
| 1. Course incorporates real-world topics.
 |
| 1. Course objectives (listed in syllabus) were met.
 |
| **Course Delivery** |
| 1. Teaching method helped you understand the subject.
 |
| 1. Class met according to schedule on syllabus.
 |
| 1. Instructor’s attitude towards students.
 |
| 1. Instructor was easy to reach.
 |
| 1. Instructor was helpful.
 |
| **Learning Experience** |
| 1. Value of the classroom experience.
 |
| 1. Value of the online experience.
 |
| 1. Value of the lab experience
 |
| **Overall Ratings** |
| 1. Course
 |
| 1. Instructor
 |



Figure 1: High School Participant Course Survey Responses – ROBO 220



Figure 2: High School Participant Course Survey Responses – ROBO 110

**Findings**

Findings have been determined and presented in terms of how this program met its goals and objectives. The overall goal was to bring this program to children of underserved communities. This was met in that students were recruited through community partners that by their own mission target underserved populations. This includes the Federal TRiO Programs at CCSU: Educational Talent Search (ETS) and Upward Bound Math and Science (UBMS); as well as the Boys and Girls Clubs, YWCA, and YMCA programs of New Britain, Berlin, and Bristol. All high school and over 90% of the middle school participants were from New Britain, which has a poverty rate of 22.0%, compared with 10.4% statewide and 11.8% nationwide averages (U.S. Census Bureau, 2018 American Community Survey).

Objective #1 Increase awareness, interest, & motivation:

This can be seen largely by anecdotal evidence – engaging directly with students, hearing feedback from their counselors and parents, and students' speeches at the closing ceremonies. Additionally, all of our participants were after completion given a survey, focusing on interest, attitude, perception, goals, and motivations regarding STEM career paths. In the Interest portion, there was an overall average of 3.9 out of 5 level of interest towards STEM. Levels of intent towards the STEM-related field was measured with a calculated average of 3.9 out of 5. The Perception portion of the survey found that most of the students agreed with the statements “having a career in science would be challenging,” “scientists make a meaningful difference in the world,” and “a career in science would enable me to work with others in meaningful ways,” for an average of 4.2 out of 5.

Objective #2: Provide workforce readiness skills:

While this year’s cohort of participants have yet to obtain internships, the authors have been working to identify, locate, and track participants from former years to help support this objective. The current COVID-19 pandemic has created a problem for this at the current time, but the group plans to continue gathering tracking data once it can be determined that issues related to the pandemic will not affect the students' ability to pursue STEM-related educational and career opportunities.

Objective #3: Increase confidence & perceived ability for success in STEM majors:

The Intent portion of the survey asked about the students’ intent for pursuing a STEM career and whether they felt that they would be successful in achieving this goal. This area received slightly lower scores than the other areas, but still indicates strong intent and confidence toward pursuing a STEM major and career. Of the two for-credit courses for High School students, one course had a 100% passing rate (C- or better), with an average GPA of 3.47. The second course was completed by 20 of 23 students, with an average GPA of 3.10. Being that these were highly accelerated courses with university-level demands, this indicates a high confidence level among the students that they could complete more rigorous STEM courses.

Objective #4 Increase financial literacy & awareness of the college going process:

This was directed at the High-School students who were believed to be preparing for this part of the process. These students were provided an intensive program that included living in dormitories, career and program selection workshops, and a variety of orientations and workshops on college life. The authors plan to administer follow-up surveys during the Fall 2020 and Spring 2021 semesters to determine the success of this.

**Program Challenges and Benefits**

Two special challenges for this grant program included (1) formalizing and strengthening the relationship with our community partners; and (2) incorporating the middle- and high-school groups into a single program. The authors have definitely strengthened our relationship with the CCSU TRiO program, which has this year provided the bulk of our students. Furthermore, the CCSU TRiO office advertises their programs specifically referring to our programs as subsets of their own. This in the end has created a synergistic relationship, whereas the TRiO programs can be utilized to strengthen our programs, and the TRiO office also benefits from our curricula.

As for the other community partners, this program still relies on these groups only for recruitment. Although they benefit from our programs, the B&G clubs, YMCA, and YWCA do not provide the same secondary programs as TRiO (i.e. college orientation & workshops). It is anticipated that with future years TRiO can include these students in more of its activities.

We have been moderately successful in administering both groups in a single program. The next goal here was to create a curriculum for both levels that has similar courses/activities with learning goals geared toward the two grade levels. The plan is to continue this program in the Summer of 2021, assuming that the COVID-19 pandemic does not affect our activities.

Unanticipated benefits were found in the ability of Boys and Girls Club staff to assist with transportation of students to campus as well as field trips. Originally planning to contract a local bus company, it was found that the B&G Club leaders were able to voluntarily assist the authors with this.

Unanticipated challenges were encountered mainly in the area of preparedness of students for this program. Many students, for example, were unprepared in how to handle basic PC functions, such as file storage and printing. This required the team to utilize our college student workers to assist students with these so as not to take away time from the intended learning activities. The issue of students' mishandling of storage flash drives was remedied by using the university network drive of which space was allotted to these enrolled students.

There was also some unforeseen unpreparedness in terms of student access accounts, for services such as Blackboard and Outlook. Normally, college students are ready to compete their sign-on credentials by the first week of class without an issue. Our group had a number of students who did not have access to their social security numbers or had to deal with other data entry errors that were inevitable when enrolling a large group of students all at once. The authors believe that this all could be resolved in the future with earlier enrollment periods, and an orientation similar to that which regular university students receive.

**Lessons Learned by Program Administrators**

A significant lesson learned from this project was the difficulty in orienting many students to what could be considered "common" technical and procedural tasks. This includes getting enrolled in courses. Some students did not have access to their Social Security numbers, which delayed enrollment in courses and subsequently the learning management systems. It is believed that recruitment should include a clear checklist as to what the students need to have in order to enroll.

Another issue was found that the team needs to better formalize and communicate what is expected and required of the students. Students were accustomed to the idea that not completing homework was "okay" even if it might affect the grade; while in these courses, homework was required in order to keep up with the lab activities. A few students were not accustomed to attention in class being critical (i.e. no phone use, no talking while instructions were given by the instructor). A list of expectations, as well as an orientation session at the beginning, should outline all expectations. The instructors found that for the most part, students adjusted to the expectations when they stopped and explained why it was critical not to miss homework or be distracted in class.

A third issue was the proper use of PC hardware and information technology. Many students had little or no experience in the hardware and/or software found in our computer labs, such as basic desktop computers and peripherals, Windows operating system, Windows-based software applications, and removable storage media. Students caught on to how to use our technology, but the authors feel that an orientation session would be in order before the class began. Loss of data due to losing or damaging flash drives could not be avoided, so the instructors switched to using our regular university network/cloud drives.

**Conclusions and Recommendations**

Among the outcomes, the common theme seemed to be that students can be prepared for STEM higher education and careers if given the confidence provided by exposure to college-level lessons and courses in Middle and High-School. This was accomplished by immersing the participants in the curricula, applying rigorous but realistic learning goals, and guiding them through the course in a way that they achieve these goals themselves. Providing very engaging topics and practices in the classroom and laboratory also helped to show the students how theoretical subjects such as math and physics can be applied to enjoyable and informative activities.

The authors believe that these findings will help improve the program, should key information on the recruitment flyer be implemented, such as requirements for enrollment, expectations, and rules. Additionally, a one-day orientation session, similar to a "First Year Experience" course, will help future students be ready for our courses. In this session, it will not only be ensured that all students will be enrolled and ready physically, but also that they will be provided with learning expectations, how to use the university's information technology, and personal time management skills. This would probably benefit both the Middle and High-School students, and can be combined with any number of orientation sessions on college life. Finally, the authors will make sure that this orientation session ties in with the culminating factory tour activity - how all the basic and technical lessons learned can be applied to various types of higher education programs as well as the job search and workplace environment.

The authors also found that the survey tools were helpful but assessment could be expanded and more inclusive of all aspects of this program. Other programs who published made use of formal evaluation tools that assisted with not only program evaluation, but to link activities more formally to student outcomes within the subjects being taught [4].

Basic classroom procedures will also ensure that students be kept on track. This includes requiring cell phones be placed on a table so that they are not a distraction, using cloud-based file servers rather than physical removable media, and having student monitors check on students' progress during homework sessions.

The main recommendation that can made from this study to others in this field is that youths can take part in college-level activities and courses if given the right preparation and guidance. This does not mean lowering learning expectations or rigor of the assessments; rather, ensure that sufficient support staff is ready to monitor students' progress and provide guidance to get them through the learning process. This also means identifying activities and courses that provide introductory curricula that will be engaging and informative of the topics.

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**Biographies**

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