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Early Engineering Experience (E3) Initiative

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Early Engineering Experience (E3) Initiative

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Abstract

This Work in Progress paper details an initiative designed to broaden exposure and attract increased interest in the study of engineering of a minority-serving institution (MSI) with a plurality of races represented. The University's student population where this initiative is being implemented consists of 26.2% African American and 6% that identify with two or more races. In contrast, the College of Engineering in this University is 20% African American; the freshmen class makes up 6.3% of this figure. By USDOE standards, this characterization is indicative of a predominantly white institution (PWI). According to the Bureau of Labor Statics, underrepresented minorities (URMs) are critical to not only fulfilling the growing need for STEM professionals but also to enhance diversity in the workforce; the National Academy of Science report states similar theories about the need of URMs to increase innovation. This paper focuses on reporting on an initiative seeking to close the gap of African American representation between the College and the University and foster the innovation of URMs in engineering. The initiative Early Engineering Experience targets African American high school juniors and seniors. Designing the program began with the Participatory Action Research Model that ultimately ends with continual program enhancement. The structure of the initiative is not only based on the details of the schedule but also on the feedback of the participants. The lack of URMs in the college provoked an idea from personal experiences at other minority events. With the use of a systematic online document review of current weekend outreach programs, a plan of action was developed, and effective program designs were synthesized.

Based on the systematic review of similar programs, the current plan is to implement a program in February of 2020 that will target about 30 participants. Mentees will be able to connect with multiple organizations such as the VEX robotics club, the National Society of Black Engineers, the Society of Women Engineers, and etc. This weekend initiative is designed to allow participants to gain personal exposure and access to various engineering curriculums, lab collaboration and organizational and club introductions while mirroring the campus activities of four mentors.

“Changing the Conversation: Messages for improving public understanding of Engineering” demonstrates student misconceptions about what the field of engineering entails. Therefore, students are often unaware of the technological contributions that have and can be made through the study of engineering. With the implementation of this program, the initiative will make a lasting impression on the participants. The Early Engineering Experience aims to foster interest in African American youth in a field that is in desperate need of new innovative minds.

Introduction

Most people do not realize the impact of engineering upon their everyday life. Engineers have designed or created so many things around us. Consider the car seatbelt, we buckle up every day and are probably unaware that the original design was neither expandable nor adjustable. A pregnant woman or an above average weight male needed to be accommodated; different personal dimensions resulted in the seatbelt's redesign. This implies that different aspects are instrumental for innovation and expansion. Diverse cultures to include Hispanics and African Americans and individual creativity to include those of women are needful for growing developments in the fields of engineering.

When speaking in general, it's evident that Science, Technology, Engineering and Math (STEM) occupations have a low representation among Underrepresented Minorities (URMs). According to the National Science Foundation, jobs that involve science or engineering show a low percentage of employed African Americans [1]. As of 2015, African Americans that identify with one race are roughly 4 percent engineers and 3 percent physical and related scientists.

These statistics give rise to the question why; why are URMs not pursuing careers in engineering?

Background

Old Dominion University (ODU) is recognized as a minority serving institution with a plurality of races represented. The student population consists of 26.2 percent African American of which 6 percent identify with two or more races. In contrast, ODU's Batten College of Engineering and Technology is 20 percent African American of which 6.3 percent makeup the freshman class. By United States Department of Education (USDOE) standards, such percentage characterizations are indicative of a Predominantly White Institution (PWI) [2].

According to the Bureau of Labor Statistics, URM's are vital to not only fulfilling the growing need for STEM professionals but also critical to heightening diversity in the workforce [3]. A National Academy of Science report states a similar theory that emphasizes the need of URM's to enhance innovation [4]. The low number of URM's in the Batten College of Engineering and Technology provoked the creation of an initiative to attract minority interest to the fields of engineering.

The Program

The Early Engineering Experience (E3) Program was a weekend initiative held February 28, 2020 through March 1, 2020. The program's aim was to expose and enlighten the succeeding generation of African American high school students while attracting their interest to a diverse field of study in Engineering at Old Dominion University. E3 participants mirrored the activities of four campus mentors. They were presented with various engineering curriculums, informed of university clubs and organizations, as well as granted access to lab observations. The weekend program was intended to debunk any myths that dictated or ascribed the study of engineering exclusive to any one race or gender [5]. Appendix A is the program announcement.

The program development mimicked the basic idea of the Participatory Action Research Model (PAR) created by Social Psychologist Kurt Lewin. PAR is a group approach to researching a desire for change. Upon deciding the issue for change, action research was carried out in four stages: planning, acting, observing, and evaluating [6]. The planning stage included the details for how to reach the program's aim; then deciding the first step of action. The decided first step was clarifying the primary focus of the initiative; as previously stated, to attract minority interest to studying engineering at ODU. With the primary aim established, the next endeavor was securing a source for funding. The E3 initiative received

funding from the National Science Foundation (NSF) through the Louis Stokes Alliances for Minority Participation (LSAMP) Grant. A budget proposal (see Appendix B) preceded full allocation of funds.

Step two of the planning stage encompassed the recruitment of program participants. Recruitment was an important aspect; seeking and motivating interest among African American high school students enrolled in schools surrounding the Richmond/Chesterfield and Norfolk/Virginia Beach areas.

Application questions as well as general word usage was selective. As suggested in “Changing the Conversation: Messages for improving public understanding of Engineering”; students’ lack of knowledge and misconceptions of what the field of engineering entails could led to intimidation and lack of motivation in joining the field [7]. The potential mentees were permitted to submit an application of interest on December 19, 2019 through January 20, 2020; on January 6, 2020, an email reminder of the impending deadline was forwarded.

The third step of the planning stage was the establishment of partnerships; teaming up with various campus offices and organizations, in particular the Office of Risk Management. Because the applicants were minors, established guidelines were to be strictly enforced such as adult supervision at all times and parental/guardianship permission to participate in the on-campus program. Four adult leaders, two males and two females were chosen as mentors in compliance with directive that the 10 minors be escorted throughout the weekend. Mentors were subjected to a background check, required to sign a Mentor Agreement and conduct form, complete reimbursement forms and participate in an online training session.

The development of the agenda was step four. A schedule was needed in order to provide the specific details for reserving transportation and lodging as well as meal ordering/catering. Time was of essence

for this 3-day, 2-night initiative. The development of an agenda was critical in maximizing the allotted time. Appendix C is the Program Itinerary.

The highlight from day one was the scheduled tours. The participants were escorted by a senior engineering student. They were presented university facts and took note of various aspects of campus living, signature spots, and familiarizing themselves with the location of multiple resource building such as the Engineering Makerspace & Invention Center (EMIC). The EMIC is a facility created by the college of engineering that provides all students a place to be creative and innovative. Students are provided access to tools, technology and resources from which their ideas can be transformed into a reality. The facility visit was paramount in highlighting the resourcefulness of ODU and reemphasizing the initiative's message that the field of engineering indeed has something to offer. The day's event concluded with a cultural activity along with members of the National Society of Black Engineers (NSBE). The Laser Quest facility presented the STEM Edition; detailing the room design and how it counteracts with lighting and optics. The activity not only introduced participants to the affect of engineering in the recreational industry but also afforded them the opportunity for interaction and dialogue with professional engineers.

Day two highlights were lab activities and a mini organization fair. Students participated in hands on lab experiences where they further explored and gained perspective of the disciplines within engineering. During the Cave Automatic Virtual Environment lab students tested simulated cars equipped with a range of functionality: steering, braking and acceleration. The Virtual Reality lab permitted students to rotation among various stations: one station provided a set of goggles that displayed different settings and visuals, another station provided a stylus to draw or play games. The Motorsports lab was a physical exhibition of what takes place during the production of an automobile.

The organization fair was a small representation of the clubs and organizations available to students who attend the university. Organizations and clubs that were involved emphasized that club participation was not to be considered as just extracurricular activity but an additional learning tool; a provision for the establishment of mentorship. The availability of resources was of importance to these students destined for college.

Per the PAR research model, acting is the second stage. The acting phase was primarily executing the plans of the initiative; each day following through with the schedule created during the planning stage. Because things do not always go exactly as planned, the acting stage required flexibility due to unplanned occurrences and quick responsiveness to unforeseen issues. During the third stage, observation, the detailed written observations and mental reflections of the Program Coordinator in conjunction with those of the mentors was taken into account. The program coordinator noted students' interaction among the mentors and their receptivity to daily scheduled activities. The mentors observed the personal behind the scenes responses of students and their interactions among each other. Assessing the observed actions from the planning stage was useful when attempting to determine the effectiveness of the initiative.

Evaluation is the final stage. This stage is a group collaboration involving critical reflection and analysis of what happened according to all observations and presented data. This data is inclusive of the pre- and post- surveys completed by participants. The students' point of view is of great significance during assessment. Their responses highlight the successfulness and/or ineffectiveness of the initiative from which new ideas may arise or questions that need to be addressed.

Evaluation and Assessment of the Program

A part of the program's goal is continual enhancement. Program enhancement can stem from evaluation; post analysis of observations while the program was occurring as well as post program occurrences at the conclusion of the program. There were pre- and post-surveys by participants. The mentors engaged in group discussions to detail their weekend experience. A key component of action research is evaluation.

The pre- survey was used to assess the students' knowledge prior to program participation. Students were asked four questions; the first question identified that only 30 percent of the students had a clear definition of engineering. The second question showed that 80 percent of the students believed that engineering applied to their everyday lives. Question 3, asked the students if they thought engineering has something to offer them: 50 percent answered definitely while 30 percent answered probably. The remaining 20 percent were indecisive. The final question revealed that 70% of the students had in some way already been exposed to the common disciplines of engineering.

The post- survey consisted of 10 questions. Some were similar questions from the pre- survey; intended to assess if/what information was retained during the weekend initiative. The first question showed that 40 percent had a clear definition of engineering; a small increase while 60 percent still only understood certain aspects of the field. The second and third questions showed that 100 percent of the students declared that not only was engineering applicable to their everyday life but also now believed the field had something to offer them. The fourth question revealed that 80 percent had been exposed to all disciplines during the program initiative. The final questions confirmed that all students connected with something that sparked an interest in at least one of the multiple disciplines and someone from which to build relationship; some peer to peer, other peer to mentor. Each student cited a memorable moment on

the survey. The primary complaint was unfavorable weather. Survey responses agreed that the weekend exposure provided additional knowledge of engineering which led to an increased interest in the study of engineering. A true measure of the program's interest retention was to be determined by forwarding a 60-day post- program survey; COVID-19 circumstances prohibited implementation. The survey could have assessed the level of students' continued interest in pursuing a college curriculum in engineering at ODU. Appendix D is a list of suggested questions.

Encountering Obstacles and Barriers

E3 was not exempt from obstacles and supposed barriers that challenged the fulfillment of the initiative. Many of the program glitches were resultant of communication breakdowns that were traced back to the planning stage and lingered throughout the action stage. During program development, the initiative struggled with obtaining required approval signatures which prohibited consistency. Occurrences that became apparent: a lack of mutual understanding and clear interpretation of directives when communicating with the program mentees, the university offices as well as the parents/guardians of the participants. During the action stage, punctuality inconsistencies affected the flow of the time-sensitive itinerary.

Program Participants, STEM Engagement and Role Models as Key to Career Discovery

The program's functionality rested upon the assistance and commitment of the village: ODU's clubs/ organizations, student leaders, university offices and the diligence of the Batten College of Engineering and Technology Dean's office. Meeting the initiative's objective to expose the fields of engineering while promoting interest in ODU was an accomplishment attributable to the efforts of the mentors and student organizations. The mentors not only provided supervisory oversight but also shared their personal successes as well as failures; both were expressed as instrumental in the journey from freshmen

to upperclassmen. The student organization fair held on day two provided participants the opportunity to mingle among a variety of clubs/organizations and campus resources that would be available to university enrollees. Mentees were not only introduced to and interacted with various features within the college of engineering but also experienced the realities of campus life in general. The organizational fair participants included:

- *Engineers without Borders (EWB)*: EWB-USA supports community-driven development programs worldwide by collaborating with local partners to design and implement sustainable engineering projects, while creating transformative experiences and responsible leaders.
- *National Society of Black Engineers (NSBE)*: The mission of the National Society of Black Engineers is "to increase the number of culturally responsible Black Engineers who excel academically, succeed professionally, and positively impact the community".
- *Society of Hispanic Professional Engineers (SHPE)*: SHPE develop and participate in programs with the industry and the university which benefit Hispanic students seeking technical degrees.
- *The SUMMIT*: Support, advance, and inspire Monarchs of African and minority descent. Through mentoring the organization strive to ignite the student's academic, cultural, and overall development by providing opportunities for growth as role models, leaders, professionals, and scholars.
- *Engineering Ambassadors*: The Dean's Ambassador Program seeks to enhance leadership development and foster a spirit of pride among undergraduate as well as graduate students within the Batten College of Engineering and Technology and the ODU community.
- *Society of Automotive Engineers (SAE)*: SAE provides students a hands-on opportunity to apply classroom knowledge to real-world projects for international competitions.
- *Student Government Association (SGA)*: SGA recommends, promotes and advises the development of relevant programs and services; a medium between student body and university administration.

- *VEX U Robotics Team*: Students from a variety of majors (not only engineering) who design, build and program robots for tournament competitions.
- *Engineering Makerspace and Invention Center (EMIC)*: A state- of- the art resource facility created by the college of engineering that provides students a place to be innovative and creative.
- *Society of Women Engineers (SWE)*: A diverse and dynamic international organization that promotes gender equality in STEM fields; provides a variety of academic, personal and professional resources to support members.
- *Resident Hall Association (RHA)*: RHA serves as an advocate of positive community change. The association is the liaison between the Housing and Residence Life Office and students that reside on campus.
- *Office of Undergraduate Admissions*: This office addresses questions/inquiries that current and/or future applicants have regarding the admissions process.
- *Academic Advisors*: Advisors assist students in navigating through the curriculum requirements of their selected program of study: course selection and scheduling, class withdrawal options and skill assessments.

Conclusion

The absence of knowledge is one factor that can account for the underrepresentation of minorities in the fields of engineering; a lack in understanding what the field entails or what the occupation offers. A review of the pre- and post- survey data gave credibility to “exposure” as a viable route to shedding light on various aspects of engineering among the selected group of mentees. Peer interaction and social fellowship fostered this learning initiative. The program received 55 applications during the open season and continued to receive interest inquiries thereafter. Suggested recommendations included scheduling

the initiative as an annual event, offering multiple sessions, expanding the geographic areas of consideration and increasing the number of student attendees. Another recommendation proposed partnering with local school organizations whose focus is comparable to E3. One such organization is the National Society of Black Engineers (NSBE). NSBE has launched its first pre-collegiate initiative in the Norfolk area. This junior chapter offers membership to students at Norview High School. Partnering with NSBE's junior chapter could prove beneficial in future program recruitments.

Implications for Practice

The end goal of the initiative is to advance the percentage of URMs in the Batten College of Engineering and Technology; however, it's more than likely that the impact of exposing 10 students from a selected geographical area to participate in a real college weekend experience will not be immediately measureable. A more visible impact may require addressing foundational issues that the university perhaps can assist with but would probably require exploration and intervention at the middle school and high school levels. A frequent question that arose among participants regarded what high school classes would prepare them for the college curriculum. An introduction to the core subjects of a STEM curriculum in middle school and high school would not only provide an early introduction to engineering but also provide familiarity with subject matters that could eventually be pre-requisites for college level courses. While it is believed that an increase in the availability of STEM curriculums in minority middle schools and high schools would aid in heightening the percentage of underrepresentation; it is likewise believed that the E3 initiative serves as a practical agent for change.

Implications for Research

A two-fold question yet remains unanswered: how to link students to the professional environment prior to college entrance? The other, can employed engineers contribute in reaching the ultimate goal of

increasing underrepresentation? After investigating efforts to increase the availability of STEM courses, additional exploratory studies and proposed incentives will be needed to develop alternatives that connect students with professionals. One course of action could examine the effects of coupling coursework with apprenticeships or incorporating professional site tours and/or interviews with seasoned professionals. We speculate that implementation of the suggested alternatives will motivate interest and thereby elevate the number of URMs pursuing careers within the fields of engineering.

Acknowledgements

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Appendix A. Early Engineering Experience (E3) Flyer

OLD DOMINION UNIVERSITY
Frank Batten College of Engineering & Technology
I D E A FUSION

NSF

EARLY ENGINEERING EXPERIENCE

2020 Early Engineering Experience e³

FEBRUARY 28 - MARCH 1

For \$25 high school students will be offered a weekend stay with meals included at Old Dominion University with E3. Not only will they be exposed to a diverse field of study in Engineering at Old Dominion University, but they will be able to participate in activities catered to them.

Please Scan to Fill Out Application :

Real College Experience
Exposure to Engineering
Hands on Experience

Appendix B. Budget

Early Engineering Experience(E3) - Proposed Budget				
Expenses				
	Compensation:	4 Mentees(2 females/2 males)	\$350.00	\$1,400.00
	Lodging:	2 nights @Springhill Suites	\$358.00	
		5 rooms x \$358.00(w/ tax estimate)		\$2,000.00
	Food:	4 meal swipes @ dining facility		
		2 x breakfast@ \$7.75	\$15.50	
		2 x dinner @ \$9.75	\$19.50	
		Monarch Plus Card (for incidentals)	\$30.00	
		14 participants@\$65.00		\$910.00
		Catered Meals		
		Friday Brunch 19@\$16.99/meal	\$323.00	
		Saturday Lunch (estimate)	\$400.00	
		Beverages (tea & lemonade)	\$30.00	\$753.00
	Transportation:	Transit bus \$60.00/hour		
		Estimated total travel hours=10		\$600.00
	Miscellaneous	Bottled Water (2 packs)		\$5.00
		Canned Beverages (3 cases)		\$20.00
		Robotic Activity (2 @ \$150.00)		\$300.00
		Entertainment:		
		Roller Skating	15 @ \$11.00	\$165.00
		Cinema tickets	15 @ \$10.00	\$150.00
		Competition Prize (preferably from campus bookstore)		\$250.00
	Total			\$6,553.00

Appendix C. Program Itinerary

Daily Schedule: Spring Semester

Friday, February 28th, 2020

6:00 - 8:00 am Transit bus departed ODU en route to Wal-Mart in Richmond (900 Wal-Mart Way) *Mentors rode bus to supervise and account for students

8:00 - 10:00 am Transit bus departed Wal-Mart in Richmond in route to Wal-Mart in Hampton (1900 Cunningham Drive)

10:15 - 10:30 am Transit bus arrival at Springhill Suites

10:30 - 11:00 am Opportunity to freshen up

11:00 - 12:30 am Students escorted to lunch at Dean's Office Conference Room

12:30 - 1:00 pm Icebreaker followed welcome by Dr. Rafael Landaeta, the Associate Dean of the Batten College of Engineering and Technology

1:00 - 1:40 pm Introduction of mentors, overview of initiative and presentation of program rules

1:40 - 3:00 pm EMIC (Engineering Makerspace and Invention Center) Tour

3:00 - 4:00 pm Free Time

4:00 - 5:30 pm Campus Tour

5:30 - 6:30 pm Dinner and evening activities with mentors

Saturday, February 29th, 2020

9:15 am - 9:45 am Breakfast with mentors

10:00- 12:15 pm Engineering Systems Building (ESB) for Station 1: Lab tours

12:30 - 2:30 pm Station 2: Mini Organization Fair followed by lunch

2:45 pm - 5:00 pm Station 3: Lego Robots

5:30 pm - 6:30 pm Dinner with mentors

6:30 pm - 8:00 pm Free time

8:15 pm -11:00 pm Laser Quest: STEM Edition

Sunday, March 1st, 2020

8:30 am Room checkout process

9:00 - 9:30 am Breakfast with mentors

9:45- 12:00 pm Finish Lego Robots

12:00 - 12:30 pm Robot Race

12:30 - 1:00 pm Reflections & survey

1:00 - 2:30 pm Lunch & free time

2:45 - 3:00 pm Transit bus boarding/departure

Appendix D. 60-Day Post Survey Questions

1. Do you believe engineering has something to offer you?
2. Are you interested in a career in engineering?
3. Is it likely that you will pursue a degree in engineering; if so, what discipline?
4. What colleges or universities are you considering enrolling?
5. List any question(s) that was not addressed during the E3 Initiative.