STEMpreneur Pitch: A Hands-on Engineering Entrepreneurship Experience for Middle School Students

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Abstract

Recently, about 100 middle school students were selected from 12 participating Minority Serving Institutions to attend a STEM Youth Summit in San Francisco, CA. Each campus team was asked to apply skills gained over the past year to develop a design/technology solution for solving a United Nations Sustainable Development Goal (UN SDG). Each team created a 2-minute video to pitch their product ideas to an independent judging panel. The top 3 teams were invited to present their pitch before a live judging panel and audience during the Youth Summit. The projects delivered by the top 3 teams are presented in this paper. A discussion on how the teams prepared for the pitch competition is also provided.

Keywords

STEM, Entrepreneurship, STEMpreneur, Youth Summit, UNSDG.

Introduction

The Verizon Innovative Learning (VIL) for Minority Males (MM) program, formerly called the Minority Male Maker (MMM) program was established in 2015 with a cohort of 4 Historically Black Universities and Colleges (HBCUs) through partnership with the Verizon Foundation. In 2016 and 2017, this program expanded to 8 and 4 additional campuses respectively bringing the current total to 16 schools. These 16 campuses are Minority Serving Institutions (MSI). The VIL MM program is an innovative program focused on providing mentoring, entrepreneurial and STEM education to middle school (grades 6 to 8) minority males. This program provides exposure to wide ranging STEM subjects such as 3D design and 3D printing, mobile application development, robotics and entrepreneurship training taught by middle school teachers and college professors at select MSI. A major goal of the VIL MM program is to enhance student engagement and achievement, especially among minority male students.

This program is unique in that participants received intensive hands-on exposure to several engineering principles and technologies during their summer camps and throughout the school year. The program enlightened the participants about the tremendous opportunities and possibilities that STEM disciplines offer for their futures while also encouraging and inspiring them to develop interest in STEM careers. Participating students were also mentored by college students.

While the program goals remain the same among all participating campuses, the implementation differs slightly from campus to campus. For example, at Central State University (CSU), the program consists of two weeks of residential summer camps (2016 and 2017) as well as twice-

monthly follow up activities during the academic year (2016/2017 and 2017/2018). Meeting duration is four hours, two weekends a month. In addition, a robotics club was formed, and team members meets up to three times a month for two to four hours throughout the academic year. The educational course offerings provided includes: robotics, solid modeling and 3D printing, mobile application development, graphic design, drones, mathematics, writing, personal development, and entrepreneurship. 40 students participated during the first year of the program while 60 students participated during the second year.

Hampton University's program consists of two weeks of summer camps (2016 and 2017), three to four full-day (Saturday) meetings per semester, and several after-school activities at select middle schools during the academic year (2016/17 and 2017/18). Each meeting during the weekends lasts for 6 hours. The after-school meetings are 1-2 hours per week. The educational course offerings include coding and mobile application development, 3D modeling, 3D printing, basic circuits, robotics, entrepreneurship, and mentorship. 49 students participated during the first year of the program while 50 students participated during the second year. In addition, students are continually enrolling into the after-school programs.

Delaware State University's program consists of two weeks of summer camp (2016 and 2017), after-school activities once or twice per week as well as once-monthly follow up activities during the academic year (2016/2017 and 2017/2018). Meeting duration on the weekends is four hours, one weekend a month. After school, meetings are 2 hours two times per week. In addition, 4 robotics clubs were formed, and team members meet twice monthly for four hours throughout the academic year. The educational course offerings provided include: robotics, solid modeling and 3D printing, mobile application development, graphic design and entrepreneurship. 40 students participated during the first year of the program while 76 students participated during the second year.

United Nations Sustainable Development Goals

The United Nations Sustainable Development Goals (UNSDGs) are set of goals agreed to by UN members in September 2015 to help frame government policies and agendas over the next 15 years [1]. These SDGs are expansions of the Millennium Development Goals (MDGs). The SDGs represents world leaders' recognition of the universal challenges facing people across the globe regardless of their race, religion or geographical location. These challenges include poverty, hunger, illiteracy, inequalities, climate change, etc. These UNSDGs are illustrated in Figure 1 [1].

Pitch

Recently, about 100 students were selected from 12 participating VIL MM campuses to attend a STEM Youth Summit in San Francisco, CA. Each campus team was asked to apply the skills gained over the past year to develop a design/technology solution for solving a United Nations Sustainable Development Goal (UN SDG).

Each team created a 2-minute video to pitch their product ideas to an independent judging panel. The top 3 teams were invited to present their pitch before a live judging panel and audience during the Youth Summit.

Figure 1: United Nations Sustainable Development Goals [1]

Central State University (CSU) Team

Members of the CSU team were selected based on the recommendation of the VIL MM instructors. During the 2017 summer camp, students were introduced to the 17 United Nations Sustainable Development Goals (UNSDGs) and their project was based on the UN sustainability goal # 6 (clean water and sanitation). Their project was titled "Smart Cup Design Using CAD and 3D Printing". Their goal was to produce a 3D printed cup with a filter for people without access to portable drinking water. This idea came about as a result of watching a YouTube video on people in developing parts of the world drinking from dirty stream water. The team's research indicated that about 10 % of the world's population do not have access to clean water [2-5]. The students made use of the skills gained from their solid modeling and 3D printing classes to produce a prototype model of their cup. The filtering elements were made from readily available materials such as gravel, sand, granular activated carbon, and cotton wool. The gravel traps large debris in the water while the sand traps smaller debris that escaped through the gravel layer. Prototype of their cup, filter and lid as well as the filtering materials are presented in Figure 2.

Figure 2: Prototype of 3d Printed Smart Cup (cup, filtering cartridge, and lid) and filtration materials (gravel, sand, granular activated carbon, and cotton wool).

Hampton University (HU) Team

At Hampton University, eight students were selected amongst 49 participants based on mainly 5 categories on how they demonstrated they: (1) were the most improved, (2) benefited the most from the program, (3) were the most dedicated – attending all activities, (4) were the most active and engaged in assigned activities, and (5) were the most well behaved and cooperative. Six partner middle schools in Hampton and Newport News School districts in Virginia had at least one student on the team. The students met on Saturdays to develop their project ideas on addressing the United Nations Sustainable Development Goals with the mentorship and guidance of engineering and computer science undergraduate students.

The team brainstormed and decided on a concept for the Drone Recyclable Air Water Filter (DRAWF) to serve urban and industrial sites. The focus was on developing solutions for good health and well-being, climate action, and clean water and sanitation UNSGD goals. The benefits of the solution included improving the quality of life of those with respiratory problems by addressing health and well-being. A direct by product of reducing air and water pollution addressed Climate Action. App development and 3D modeling skills were put to practice in developing the app prototype and model design.

Delaware State University (DSU) Team

Members of the DSU team were selected based on the recommendation of the VIL MM instructors. During the 2017 summer camp, students were introduced to the 17 United Nations Sustainable Development Goals (UNSDGs) and their project was based on the UN sustainability goal # 4 (Quality Education). The Delaware State University Minority Male students brainstormed the United Nations Sustainable Development Goals and were divided over the Good Health and Education goals. Although, health and well-being was extremely important they felt that they would be able to reach more people globally if they were able to conceive of something that would impact all or most of the uneducated or undereducated people in the world. The students wanted to ignite minds around the world. This idea grew to become SPARK.

Their product will assist families and children in developing countries by providing access to materials to increase literacy. They researched literacy rates across the world to decide where they would provide this product.

SPARK Education produces a low cost, lightweight, solar-powered tablet that provides educational software for tutorials in core subjects. The software is available in three levels: Novice, Intermediate, and Advanced. This software is available in ten (10) languages (English, Spanish, Russian, Dutch, Portuguese, Swahili, French, Arabic, Punjabi, and Bengali). The students made use of the skills gained from Mobile App Design (MIT App Inventor) to produce a prototype model of their solar-powered tablet.

Judging Criteria

All teams were expected to address the following five criteria in their presentations:

1. Problem Relevance and Community Impact: which issue are you solving for and how does it impact your school or community?

2. Adequacy of solution: how can you address the societal issue with technology? What are the various ways you can tackle this issue?
3. Mobile App/ 3D Design: how did the app concept / 3D design impact the defined problem?
4. Marketability: does the tech solution have the ability to be sold in the marketplace?
5. Solving for a UNSDG: which UN SDG are you solving for and how will the tech solution will make an impact?

To illustrate how the teams addressed the judging criteria, Central State University's team response to the criteria is presented below:

Problem Relevance and Community Impact (which issue are you solving for and how does it impact your school or community?): The impact of safe, clean water cannot be overemphasized. Water is one the key elements required to sustain life. Additionally, water and poverty go hand in hand [5]. Safe water is also tightly linked to human well-being, good health, and quality of life [4-6]. Although about two-third of the earth surface is covered by water, so many people still lack access to safe water. To address one of the 2030 Sustainable Development Goals set by the United Nation for safe drinking water the CSU team decided to design a 3D printed smart cup with a filter and a straw.

Adequacy of solution (how can you address the societal issue with technology? What are the various ways you can tackle this issue?): The team's goal is to help reduce incidence of water borne diseases in developing countries through the use of simple-to-make, cheap, portable, and effective water filtering cups. This cup will be made from materials that are cheap, local and easy to source. The cup itself is durable and not easily breakable. Cup printing and training on the use of the cup will be provided through partnerships with reputable local NGO's. As discussed earlier, the gravel and sand layers remove most of the solid particulates in the water while Granular Activated Carbon (GAC) removes organic chemicals in the water. Activated carbon removes contaminants and impurities through a process known as adsorption [7] by attracting organic chemicals at the molecular level similarly to how a piece of magnet attracts iron filings. Activated carbon removes chlorine, sediment, volatile organic compounds (VOCs), taste and odor from water [7]. Viruses and bacteria in water may be eliminated by the addition of few drops of chlorine to the filtered water or by exposing the filtered water to UV light from the sun.

Mobile App/ 3D Design (how did the app concept / 3D design impact the defined problem?): The students adhered to basic "design thinking" process (i.e. empathize, define, ideate, prototype, test, and implement) while coming up with their solution. The main design and technology tools used to execute the project were Autodesk Fusion 360 Computer Aided Design (CAD) software and 3D printing technology used for rapid prototyping of their design. Rendered image of cup and filter housing design are shown in Figure 3.

Marketability (does the tech solution have the ability to be sold in the marketplace?): The team's marketing approach consists of performing trial runs of the smart cup in order to obtain product reviews that will provide feedback for improving the performance of their cup. The team would like to present their cup to international organizations such as the United Nations to

demonstrate what young minds can do to help attain 2030 SDGs. Ultimately, the team would like to start a small business to help the underprivileged in developing countries.

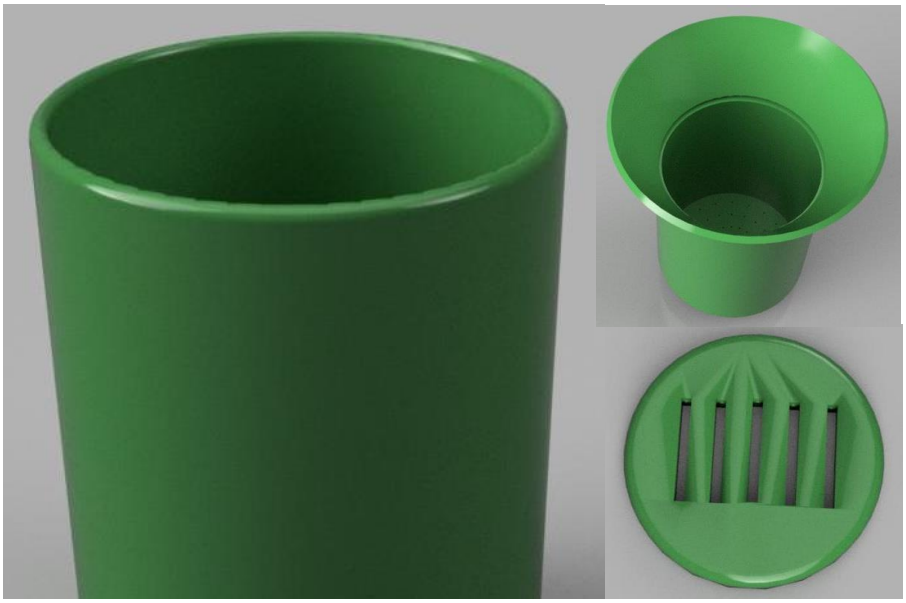

Figure 3: Model of Water Filtration Cup Designed by CSU student participants.

Solving for a UNSDG (which UN SDG are you solving for and how will the tech solution will make an impact?): To address one of the 2030 Sustainable Development Goals set by the United Nation for safe drinking water, the CSU team decided to design a 3D printed smart cup with a filter.

Conclusion

The STEMpreneur pitch afforded participating teams the opportunity to apply technical and entrepreneurial skills to develop innovative solutions to UN SDGs that are of interest to them. The teams presented their solutions to a judging panel consisting of a young entrepreneur and an individual with ties to the venture capital market in addition to the Verizon Foundation judges. The judges provided valuable feedback to the competing teams. The teams that participated in the STEMpreneur pitch were recognized. They were presented with certificates of recognition as well as prize items.

In order to sustain economic growth and hence, national security, the STEM pipeline must be assured. Factors that hinder the engagement and persistence of underrepresented groups in STEM includes educational inequalities (e.g. inadequate school funding/funding formulas that disproportionally affect minority schools), late exposure of kids to STEM/inadequate preparation to STEM, etc. [8]. The program described in this paper addresses few of these factors by providing opportunity and access to mentoring and STEM educational activities to middle school minority students across the country.

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Otsebele Nare joined the Electrical Engineering Faculty at Hampton University (HU) in January 2007. Prior to joining HU, he served as a Research Engineer with the Chesapeake Information Based Aeronautics Consortium (CIBAC) Research Center in Baltimore, MD. He received his doctorate, masters, and bachelors' degrees in Electrical Engineering from Morgan State University, Baltimore, MD. His research interests include Integrative STEM and Electrical Engineering Education; Energy Microgrids; and System Level Synthesis Design Methodologies.

Vaughn Hopkins

Vaughn Hopkins joined the Office of Institutional Research, Planning and Analytics at Delaware State University (DSU) in 2012. In 2016, he joined the Office of Adult & Continuing Education and Summer Programs as Special Projects Director and as Adjunct faculty. Prior to DSU, he spent over twenty years working as an Information Technology Professional with progressive experience with an industry leading global company. He received his BA in Economics with a minor in Management Information Systems from the University of Delaware, Newark, DE and his MBA from DSU, Dover, DE. Mr. Vaughn Hopkins is the Program Co-Director along with Ms. Lillie Crawford for the VIL for MM Directed by DSU.