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STEM OUTREACH THROUGH BALLOONING AND MOBILE DEVICES

Author: Tyler Hughes
University of Alabama in Huntsville, United States of America, tyler.hughes@uah.edu

Presenter: Mark Becnel
University of Alabama in Huntsville, United States of America, mark.becnel@uah.edu

With the increased use of smartphone technology, it is possible to check the status of projects from any location at any time with a cell phone and signal. Development of an android application that will allow users to receive real-time data from the UAHuntsville Space Hardware Club balloon missions is underway. With this ability undergraduate students are able to go to a local school, talk to younger students about science and engineering, all while sharing their experiences they have gained from their chosen career fields. Students who have multiple interests can lead into various STEM related fields. Through the use of this application, students can ask questions of Space Hardware Club members. This creates a relationship and lasting effect between the university and primary/secondary education students in various STEM fields beyond outreach events. Through general observation students have shown a natural interest in projects that produce unpredictable results.

By having other groups and/or teams use a similar method of outreach, the community is benefited because the increased STEM interest at an early age increases the industry workforce over a period of time. Due to the flexibility of the program, teachers are given the resources to continue teaching STEM related projects to future students.

The application that was demonstrated to the student is described within this paper. Below details the results of a student tested scenario with the aforementioned app. The results will attempt to accurately discuss future application, in regards to community outreach, promote STEM education globally, and most importantly, promote it in our own communities.

I. INTRODUCTION

STEM is the acronym for the field of study within the Science, Technology, Engineering, and Mathematics disciplines. One most often refers to STEM when talking about students and their chosen degree paths. The overall goal of STEM education is to teach students the Science, Mathematics, and Engineering concepts using new technologies in order to provide an innovative and interesting course curriculum for students.

STEM is a popular choice among students in areas with a larger population. However, in areas of smaller populations, it is often one of the least chosen fields of study for students. Due to the lack of exciting and interesting ways to introduce the program, students in small urban communities often ignore pursuing STEM careers. One reason for this could be that the students believe it is too hard. They could also have a teacher that they feel doesn't teach the material well. Generally students will only pursue careers that they find interesting and can see themselves happy doing for the rest of their lives. If others have led them to believe that STEM is not interesting, then they are more likely to overlook those career paths. This is the issue that is most commonly observed by people who want to teach the true joys of STEM to today's youth. This issue primarily occurs within the public education system. Private schools generally do well with promoting STEM in a manner that is both fun and entertaining to students. This enables them to have students who are more adept to the concepts that one would learn in STEM education.

As one can expect not all students are immediately drawn to STEM fields. According to The Princeton Review, the top five majors pursued by students in 2012 are business administration, psychology, nursing, biology, and education respectively. Out of these five only two relate directly related to STEM and is related simply by association. The two directly related of course being nursing and biology. Education is related

strictly by association because while its focus is not on STEM, the educators that emerge from these education programs have an influence over today's youth. The public school system has enormous potential to increase student awareness and increase their overall interest in STEM. The key factor to correcting this issue with STEM education is simply to think of new ways for educators to teach students that keeps the subject matter both stimulating and enjoyable. This could be done in a variety of ways with most revolving around the students being able to have more out of class activities. Students fine it rewarding to have been in classes where the teacher has a guest speaker present to the class a STEM topic based upon their past experiences.

II. LENDING A HELPING HAND

A few important to ask regarding expanding STEM education are:

1. Whose job is it to come up with these new ideas?
2. Are educators the only people who can teach students about STEM?
3. What types of outreach have been done previously by other people in our community?

These are simple, but fantastic questions. First, it is the teacher's job to come up with ideas to help educate today's youth about STEM. Generally those who have an interest in seeing more people pursue STEM careers are those that work to come up with new ideas to promote it. Second, anyone with an interest in doing outreach projects are more than welcome to help teach students about STEM. It is in no way limited to educators alone. Finally, community outreach projects will vary from community to community. The best thing to do would be to talk to a mathematics or science teacher at a local public school and ask them what others in the community have done in the past.

III. OUTREACH IN HUNTSVILLE, ALABAMA

At the University of Alabama in Huntsville there is an engineering club called the Space Hardware Club. It is comprised of undergraduate and graduate students who participate in a variety of projects. These projects include CanSat, CubeSat, and BalloonSat. For the purpose of this paper the focus turns to the BalloonSat project.

BalloonSat is a club wide project in which all members participate. In general, this project involves launching payloads on high altitude balloons. The club's first BalloonSat mission occurred on April 2, 2006. As of the writing of this paper, the last BalloonSat mission was BalloonSat 20. Projects range from the testing of new amateur radios to collecting data from a neutron counter. The team generally starts the mission a week prior to the launch by building new payloads and sometimes repairing old ones. The payloads that are worked on during this week do not always end up flying on the mission in which they are created or repaired. Sometimes on launch day a last minute call is made to decide what flies and what does not fly due to the conditions of the launch at that particular moment. Anything can change the launch conditions; generally, it is due to things such as rain, heavy winds, or changes in the amount of helium that was put into the balloon. A general launch day consists of the following:

1. The team meets two hours prior to launch to gather all equipment.
2. One hour prior to launch the equipment is taken to the launch location.
3. About 45 minutes prior to launch, the balloon fill team begins the process of filling the balloon. At this time, other team members begin final check of the payloads to ensure all are operating properly.
4. Half an hour prior to launch, team members begin radio checks and coordinate with the ground station team to ensure that the ground stations is receiving packets of information from the payloads.

5. Ten minutes prior to launch, the balloon fill team takes the balloon over to the payloads. All payloads are tied to the balloon and last minute pictures are taken.
6. Finally, once the balloon is launched the recovery team gets in the campus vehicle(s) and begins their ride to find the balloon.

While the recovery team is out searching for the balloon's landing location the ground station team stays in the communications lab. The ground station team keeps a close watch on the data that the ground station is retrieving from the balloon. Their objective during the course of the recovery is to keep track of the balloon and alert the recovery team if there are any changes in the balloon's expected travel path.

Generally, the club entire launch from preparations to the retrieval of the balloon is approximately seven hours. However, there have been many times when the recovery took significantly longer than expected due to things such as the balloon landing in a tree or landing on top of a mountain.

While this is a project for the entire club, the campus and the faculty as well as local schools are welcome to come watch the event unfold. Occasionally, our club will visit local middle schools to teach students about the BalloonSat project and show them that science can be interesting. On April 13, 2011, the club participated in an outreach project with Liberty Middle School.

In order to teach them about our project and about space, the club gave the students different household materials that they could launch on some balloons. The students would observe the objects before and after the launch. This allowed them to see the effect that the near space environment has on different objects. There was much work that went into showing students how the atmosphere can affect the payloads including a demonstration of how mathematics plays a part within science.

Figure 1: In this picture taken by the Space Hardware Club, Liberty Middle School students wait to launch their payload.

IV. RECEIVING PACKETS FROM YOUR PHONE

Since the Liberty Middle School outreach project, the club has been looking for a different method of outreach that would both benefit the students and the BalloonSat project. Of course when the ground station collects data from the balloon it stores the information in a database. Other than storing the data, the club only had one use for it, which was to use the collected latitude, longitude, and altitude to make a 3-D plot in Google Earth to show our website viewers the path of the balloon as it was traveling during its mission. The first few months of the 2011-2012 school year were spent trying to find a way to find a use for the data that the balloon was collecting. This led to the creation of the SHC BalloonSat application.

Surprisingly, several members in the club requested the ability to view the information on their phones at any given time. Smart phone application development was always a consideration, but a true focal point had not been identified until recently. The downside to this project however was the lack of an obvious starting point except for research on smart phone app development, specifically for Android.

A week and many tutorials later, the project was in full swing. It took roughly five months to get the application complete and released. It wasn't perfect. There were several bugs and some unaccounted features that deviated from the original program design.

The hardest part of the update process is testing. Testing consumes most of the development process, thus the update took three months to complete before it could be released for users to download. Version 1.2 is currently under development which will include functionality to view the data from past missions as well as compare the data, and will include a complete upgrade of the user interface to make it more appealing.

The current features of the application include:

1. The ability to view the last packets received to the database.
2. The ability to choose how many packets appear in the list. Use can choose between five, ten, and twenty packets.
3. The ability to refresh the application and receive the most recent set of data.
4. The ability to change which data appears in the list. The user can choose any combination of the following data: altitude, latitude, longitude, and velocity
5. The user also has the ability to view the last known location of the balloon in Google Maps.

In order to make the application, one simply needs intermediate experience in SQL and Java. Beginner level experience in PHP is also required. Java is the programming language that is used in order to make Android applications, therefore, some knowledge and experience is necessary. Knowledge and experience with SQL would need to include the ability to create a query containing a join. Android applications are not able to connect directly to a database; therefore, you must go through a web service. The web service, or PHP script, queries the database and returns the result to the application.

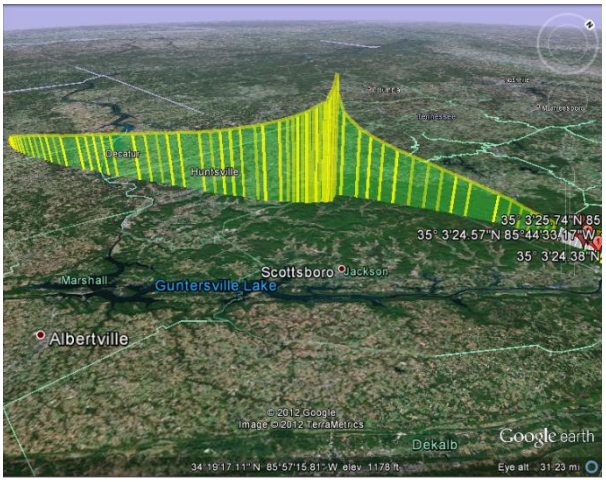

Figure 2: A 3-D view of the balloon's path from BalloonSat 17.

One of the great things about the application is the ability to present the data in real time to students during a balloon launch. This will allow the club to do more outreach projects and show the collected data to the students. Since the application is available in the Android Market students are able to download the application. It is free and available for anyone with an Android smartphone to download.

V. DEMONSTRATING THE APP TO STUDENTS

Over the course of the summer, demonstrations were given to different classes at a local community college. Prior to the presentation was a basic seven question survey. A few of the basic questions included:

1. Age
2. Major in school
3. If they knew about high altitude ballooning.
4. If they own a smartphone, and if they did it asked what kind of smartphone.

The survey results provided the average age of the audience as well as the number of students pursuing STEM based careers. See Figure 4. This information can be very useful for determining how an outreach project can be handled in the future. Using the data collected, one can get a general idea of the student's interest in a given area.

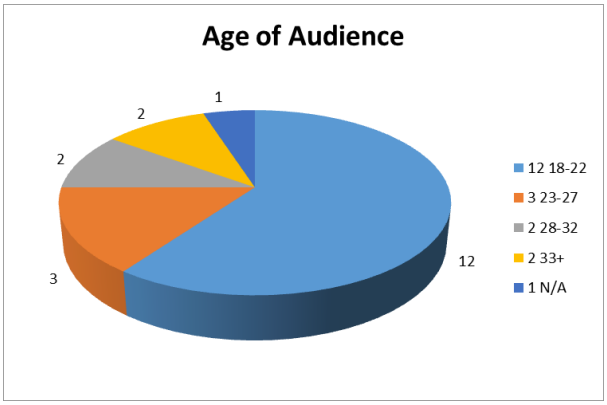

Figure 4: This pie chart shows the ages of the audience and what percent of the audience makes up that age.

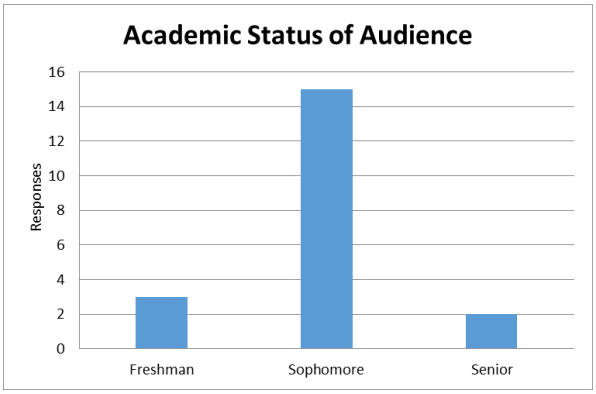

Figure 5: This data, taken from the follow up survey, compares the number of students whose views changed about STEM to those whose views did not change and to those who are unsure about their views regarding STEM.

The presentations primarily focused on STEM and introduced to the students concepts like the BalloonSat project and how it relates to the subject. To further their understanding, each class was shown the application and how it applied to STEM. Those students who had not heard about STEM were interested in finding out if their chosen degree is related to STEM in some degree. A few students were interested in learning how they could contribute to projects like the BalloonSat project. In one of the Java programming classes, a few of the computer science students were interested in finding out how they could create Android applications. They were excited to know that the material that was covered in their course would teach them what they needed to know to begin developing applications.

Following the presentation, the students were asked to complete a seven question follow up survey. See Figure 5. Six of the seven questions contained in the follow up survey were identical to the introduction survey. The last question asked if their views about STEM had changed after hearing the presentation. The data from the last question shows that even if your outreach only affects a small number of students your presentation might be what steers them toward a career in STEM.

VI. LESSONS LEARNED

Based upon the survey results, the community would be better benefited if STEM outreach was focused upon a younger age group. While undergraduate students are able to grasp more of the STEM concepts, their career choice is generally solid. It is hard to get undergraduate students to consider other career fields unless they haven't decided yet on a major. Also younger students are more likely to follow a career path that they believe is interesting.

The Android application appears to get a lot of people's attention, with people asking how to implement it within their own projects. It is an excellent project, because it motivates students to learn more about STEM using familiar technology.

ABOUT THE AUTHOR

Mr. Tyler Hughes is an undergraduate student at the University of Alabama in Huntsville. He is pursuing his bachelor's degree in Computer Information Systems. His primary interest is in database systems and application development.

Mr. Hughes is also a leader of the Space Hardware Club, where his primary focus is in mobile application development for the club's various projects. He also participates as a member of the club's BalloonSat and CubeSat teams.

Mr. Becnel is a graduate student at UAHuntsville. He is also a leader of the Space Hardware Club, and is the 2011-2012 BalloonSat Team Lead.

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