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IMPROVING STEM RECRUITMENT THROUGH A THEME-BASED SUMMER RESIDENTIAL CAMP FOCUSED ON SEA LEVEL RISE

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Abstract

In this paper, the authors present an enrichment program that focuses on Science, Technology, Engineering, and Math (STEM) concepts. The program is named Building Leaders to Advance Science and Technology (BLAST) and is held each summer at three universities across the Commonwealth of Virginia: Old Dominion University, the University of Virginia, and the Virginia Polytechnic Institute. BLAST is sponsored in partnership among these three universities and the Virginia Space Grant Consortium (VSGC), and is funded by the General Assembly of Commonwealth of Virginia. Its main purpose is to expose high school students to topics related to different STEM fields through engaging hands-on activities so that more high school graduates will choose to pursue STEM careers. The program stems from the first session that was held at Old Dominion University in June of 2016 and was named ODU BLAST 2016. Two additional sessions followed in the summers of 2017 and 2018. Each year, eighty rising ninth- and tenth-grade students from across the state participated in this summer enrichment program. The program is residential and lasts three full days, Sunday to Wednesday, with an overarching theme focused on resilience to climate change and sea level rise. It includes faculty and students from various colleges and STEM fields. The main program has four rotating daily sessions, with additional sessions held on each of the three evenings that students spend on the ODU campus.

Introduction

Sitting between two tidal rivers, the threat of tidal storm flooding is nothing new to Old Dominion University (ODU, 2018). The university frequently has to consider recurring flooding: 1) when deciding whether to cancel classes because of the potential safety threat; 2) when considering where to build new buildings or raze old ones; or, 3) when having to make myriad other daily decisions by an institution that is open 360 days a year. Hampton Roads is located in the southeast region of the U.S., in southeast Virginia, on the cusp of the Chesapeake Bay, an area that represents one of the world's largest metro areas vulnerable to flooding from tidal storms related to climate change. Climate change and resilience has been identified as one of the main research focuses of Old Dominion University, supported by the university's administration and local government. Research efforts focus on various climate-change issues, such as its causes, but also how more resilient communities can be designed and improved to adequately resist future climate changes and sea-level increases (Marfield, 2017).

Due to this initiative, several new programs, centers, and courses have been implemented at the university (Tomovic & Jovanović, 2016). Building Leaders to Advance Science and Technology (BLAST) is an educational program funded by the General Assembly. Its main objective is to increase the number of high school students that will pick STEM as their future career. BLAST programs are administered and funded by the Virginia Space Grant Consortium (VSGC) in the Commonwealth of Virginia (2018). These programs are currently offered at three Virginian universities. The program structure is similar across all locations. VGGC advertises and accepts students based on academic performance, teacher recommendations, and gender; they strive for equal numbers of boys and girls. For this current study, over the course of two days and three nights, eighty students were divided into eight gender-specific groups of ten students that rotated through four, three-hour STEM workshop sessions and three specially designed STEM evening events.

The special events were organized to complement the workshop sessions. In these evening sessions, high school students were introduced to the deans of each participating college, who then introduced their respective colleges and research efforts related to climate change and sea level rise. Program offerings, as well as the individuals involved, are different among the locations. The ODU BLAST 2016 program had four main workshop sessions that were designed and implemented by the faculty from the College of Science and the College of Engineering and Technology. Evening events were designed and implemented by faculty from the College of Sciences, the College of Education, and the College of Arts and Letters.

Opening Night Session: Questioning Climate Change and Sea Level Rise

Faculty: C. Tomovic and V. Jovanović

ODU BLAST 2016 began at the Pretlow Planetarium. In this session, students were introduced to the administration team and participating faculty. Students were asked to reflect on the connections between STEM careers and tackling important challenges that are happening to the communities, due to climate change and sea level rise. High school students then watched a full-dome film, called *Our Living Climate* (2009), which addresses the historical and recent causes for slow, rapid, and sometimes violent changes in earth's climate. The film focuses on how the earth's atmosphere is a dynamic system that has changed many times throughout history. It explains how the atmosphere formed from some of the earliest organisms; how it was altered by super-volcanic eruptions, such as Toba; the methods for directly measuring the past composition of the atmosphere; and, atmospheric changes, due to the extensive use of fossil fuels. While the movie focuses on the history of the earth's atmosphere, and how the atmosphere changes slowly over hundreds of thousands of years or longer, it also discusses the rapid climate changes that are currently being caused by humans. Portions of the film discuss some of the current technology being developed to help fight climate change. After the film, a healthy discussion on whether the causes of climate change were natural or man-made was facilitated by faculty from the College of Science.

Using the planetarium for the ODU BLAST 2016 opening night allowed faculty to start the week's events in a unique, interactive environment. Full-dome planetarium movies are an immersive and inspiring atmosphere, and the goal was to start ODU BLAST with enthusiasm. After the film and the discussion, the director of the planetarium showed some of the current stars and planets visible in the night sky above Norfolk. The evening's events were concluded with everyone having the opportunity to look at Jupiter, Saturn, and Mars through several of ODU's telescopes. Over two days, students attended four hands-on intensive workshop sessions (Tomovic & Jovanović, 2016). These sessions were focused on science and engineering topics regarding solutions to mitigating the effects of climate change and sea level rise. A description of each workshop in greater detail follows.

Session 1: Our Home Planet and Its Place in the Cosmos

Faculty: C. Tomovic, V. Jovanović, B. Terzić, and J. Mason

Faculty, staff, and students from the Department of Physics designed a session with the main goal of showing and teaching the basic physics behind climate change, as well as taking a larger look at why humans should be protecting the planet.

Part 1: The Greenhouse Effect

The activity started by having high school students set up a simple model that demonstrated the greenhouse effect. For each session, the twenty high school students were divided into four groups of five students and given two, 20-oz. bottles filled about a third of the way with water. In one of the bottles, they added two tablets of Alka-Seltzer. When Alka-Seltzer is mixed into the water, it releases carbon dioxide (CO_2). The caps to both bottles had been drilled with holes into which a thermometer was fastened. The caps were then screwed onto the bottles. Both bottles were placed close to a desk lamp with a 75-watt light bulb. During the subsequent 30-40 minutes, in three minute intervals, the students recorded the temperature of the air in both bottles. At the conclusion of the experiment, each group plotted, in different colors, the temperature versus the time for each bottle. Each person was given colored pencils and a pre-made piece of graph paper with "temperature" on the y-axis and "time" on the x-axis. Having the high school students graph their data by hand, rather than using a software program such as Microsoft Excel, reinforced basic math skills that the students already knew. Figure 1 shows a typical graph of temperature versus time.

Once all of the groups had prepared their graphs, one of the graphs was projected onto the wall and a discussion was held on how the presence of CO_2 could be observed in the bottle with the Alka-Seltzer tablets. Typically, the air in the bottle with the extra CO_2 from the Alka-Seltzer tablets becomes several degrees warmer than the bottle without the Alka-Seltzer tablets. The CO_2 inside the bottle with the Alka -Seltzer tablets simulates and acts as a greenhouse gas, meaning that it traps more heat. This demonstration allowed the high school students to create and observe the greenhouse effect in a simple, inexpensive, and effective manner. One important point to note during this experiment, however, is that one group in five typically has difficulties, due to the simplicity of the equipment and issues such as the CO_2 escaping rather than remaining within the bottle. Another issue observed during this study was that the bubbling from the Alka-Seltzer deposited water droplets on the thermometer and cooled it.

Part 2: Waves

Taking temperature data for 40 minutes alone would not be very exciting for the students, so during the same time, the groups performed the greenhouse experiment, an experiment to learn about waves and wave motion. Since photons

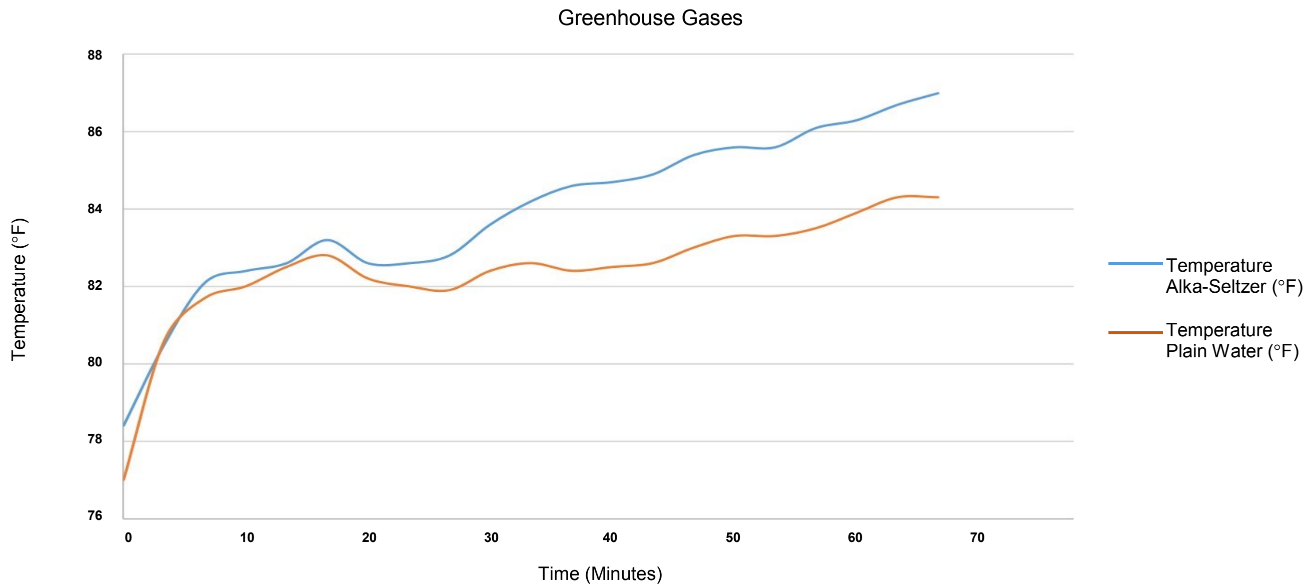

Figure 1. Graph of temperature versus time for greenhouse gases.

interact with our atmosphere and can act as waves, high school students were introduced to the concept of waves, wavelength, wave speed, and frequency. This session needed to be set up in advance so that the timing for the experiment fit into the given workshop time. The main setup had an elastic string stretched across the table and mounted over a pulley. A 400g weight was suspended on the string. A frequency generator was then attached to a speaker and the string was run through the top of the speaker. The speaker then vibrated the string at various frequencies and created standing waves, such as those shown in Figure 2.

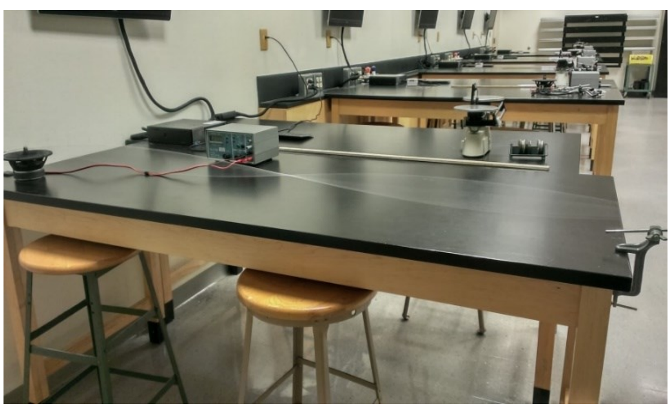

Figure 2. Experimental setup for the waves and wave motion.

The high school students were tasked with finding multiple harmonics of the standing waves, measuring their wavelengths, and calculating the velocity of the waves of the string. After all of the students had time to thoroughly investigate standing waves, they were given a 10-minute challenge to see who could produce the most harmonics on the string. This challenge was well received by all groups, as it was a chance to compete amongst themselves. The record set by one group was 23 full waves over just two meters of string. The only drawback to this challenge was that some of the groups wanted to continue to go back to this part of the workshop rather than move forward to the next experiment. This was typically only a problem with the boys' groups, and not observed with the girls' groups.

Part 3: Infrared Light

The third portion of the workshop allowed the groups to explore different forms of light, and demonstrated that there are forms of light that cannot be perceived by the human eye. By this point, students had been introduced to the nature of waves and light, and how they can interact with the atmosphere. Now, the goal was to show the high school students that light can come in different forms. In order to qualitatively show different forms of light, the high school students were given a solar panel that was connected to an oscilloscope. The students were then given three different kinds of flashlights: 1) a normal, visible-light flashlight; 2) an ultraviolet flashlight (UV); and, 3) an infrared flashlight (IR). The students were given 15-20 minutes to investigate the different types of light and how each influenced the power output of the solar panel. They were encouraged to shine the light on the solar panel repeatedly, flicker the power switch, put pieces of paper between the flashlight and the solar panel, and, given time, investigate the solar panel on their own. The normal flashlight produced expected rises in the solar panel's power output. The UV flashlight also produced rises in the power output of the solar panel. The students were somewhat interested in this flashlight, because it produced the novel "black light" glow. However, many of the students were interested in the IR flashlight, because the infrared light could not be seen, yet it produced the largest power output of the solar panel. The students were particularly interested in this flashlight when they found it had strobe capabilities and could produce both red and blue flashes. They then examined whether the IR and UV lights produced the same effect on the solar panel. The students liked this portion of the workshop, because the directions were less rigid, and they were given the equipment and free reign to explore how all of it interacted.

At the conclusion of this section on infrared light, an IR camera was connected to the projectors in the room so that everyone could see themselves in infrared light. The students enjoyed the activity with the infrared camera, how they measured light emitted by the heat of their bodies, and shared multiple images of it on various social networks. They could see themselves in the dark, as they continued to glow in the infrared, even if they could not easily see each other with their own eyes. The students were shown how their bodies give off infrared light and how that light could, or could not, pass through various everyday objects. For example, the infrared light was blocked by a piece of glass (normally transparent to visible light), but it passed through a trash bag (normally opaque to visible light). The students were then allowed to have fun and encouraged to get in front of the camera to see themselves and their friends in infrared light. Figure 3 shows some of the groups with the infrared camera.

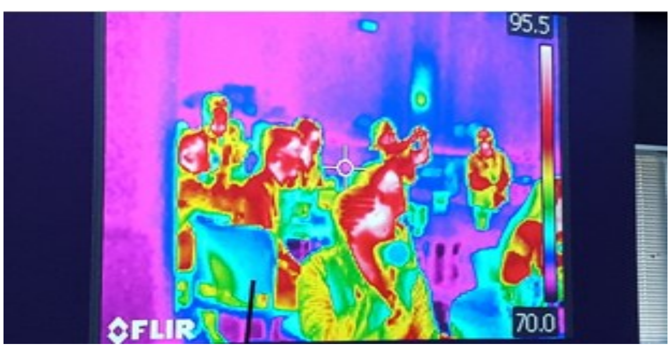

Figure 3. Infrared camera activity during Our Home Planet workshop.

<u>Part 4: Life in the Universe</u>

Finally, after covering topics like the greenhouse effect, waves, and different forms of light, the workshop took a step back to look at the bigger picture of Earth and its climate. Two, 5-minute videos were shown to the students. The first video (Dudnik, 2013) covered the Drake equation (Drake, 2015) and the statistical likelihood of life in the universe. The second video was about the Fermi paradox (2016) and possible reasons why humans have not seen or had contact with alien lifeforms. After the videos, a discussion was conducted with the students, who were asked about their thoughts as to why humans have not found any evidence of aliens or their existence. This discussion allowed the faculty to focus the students' thoughts towards the idea of taking care of, and protecting, the planet. The students arrived at the conclusion that if the only known life form in the universe exists on Earth, then they should be addressing climate change to protect our planet.

Session 2: Water, Water Everywhere and No Place to Go

Faculty: C. Tomovic, V. Jovanović, and M. Erten-Unal

The main objective of this session was to introduce students to civil and environmental engineering. Students learned about the green infrastructure and low-impact development technologies. The main purpose of these activities was to showcase one of the engineering solutions frequently used to alleviate flooding issues that occur as a result of storm waters and the negative effects of sea level rise. After being introduced to these natural and innovative storm-water management strategies, the students built and tested the performance of bioretention cells. Bioretention cells contain different media, including top soil, sand, pea gravel, mulch, and geotextile material to enhance infiltration and improve water quality. They explored how bioretention cells slow and treat storm-water runoff to alleviate flooding and improve water quality. The reactors to simulate and house the media for the bioretention cells were constructed from Plexiglas and had an inlet type of drain and gutters that fed them.

The students were provided the materials and media, including sod, sand, gravel, mulch, and topsoil to build their own bioretention cells. Students then brainstormed, as each group designed their own mix media configuration. They recorded the types of media and the ratios of each material added to the Plexiglas containers. Figure 4 shows the students using two parallel units, one of which they built as a bioretention cell that was designed to reduce flow volume and velocity and pretreat the applied water. The other unit did not have a bioretention cell but did have a Plexiglas surface that simulated an impermeable surface, much like pavement. Figure 4 also shows how the students observed the differences between the two containers when they applied equal flow rates to the two alternatives.

(a) Unit with a mixed-media bio retention system.

(b) Unit without a bio retention system.

Figure 4. Students observing the differences between the two containers when they applied equal flow rates to the two alternatives.

Both systems required a water connection and a water distributor made up of perforated pipes, which simulated a rain event. The students measured and compared the amount of runoff collected from parallel units with and without bioretention cells. Water quality parameters were also introduced, as were the concepts of engineering design through the redesign activity of improved bioretention cells. Their redesign included different configurations, all for the purpose of better design performance. They compared the mixed-media characteristics (the materials and their thickness) of the two bioretention cells and determined the travel time of the water within the media and shared their results between groups. Through this experiment, students developed an understanding of the concepts of infiltration rate, percolation, runoff, and storage capacity. They learned about properties of different media and, additionally, how they affected the movement of water within each media.

Session 3: Changing Oceans and Exploring Acidification and Albedo

Faculty: C. Tomovic, V. Jovanović, and V. Hill

A faculty member from the Department of Earth, Ocean, and Atmospheric Sciences designed this session. Albedo and acidification were chosen as the focus of this session, because these two phenomena produce prominent impacts on climate change in the ocean environment. The aim of this workshop was to introduce students to the principles of climate change in the ocean and to stimulate their interest by providing them with experiences in collecting data and subsequent analysis and synthesis. Both parts of this workshop session were structured to take students from simple to more complex experiments.

Part 1: Albedo

The main part of this ODU BLAST 2016 educational program was to focus on the reflective properties of materials and how these properties play a role in light absorption and heating. The Arctic was used as a case study. The session started with a 10-minute presentation that demonstrated the albedo effect (the fraction of light reflected back from an object), an important concept to convey when discussing the warming of the ocean and why the melting of sea ice and terrestrial snow cover impacts temperature. The students were encouraged to participate by asking them questions about their knowledge of changes in the Arctic and its impact on ecology and local residents. After the presentation, students were presented with two cans filled with water, one black and the other silver. Students used their new knowledge to predict which can would result in greater heating of the water inside. Figure 5 shows the experimental setup in which students observed and recorded the temperatures inside the two cans at an interval of two minutes, once the lamp was switched on.

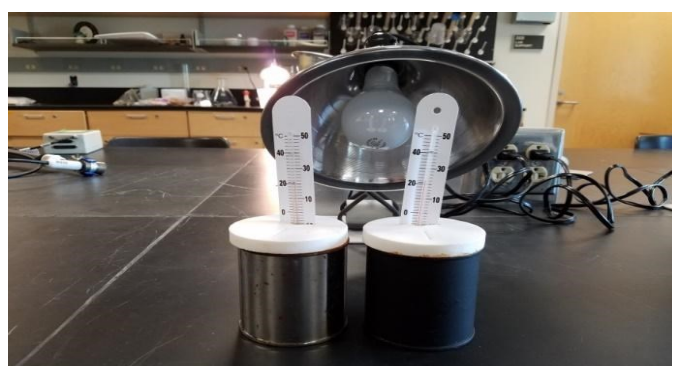

Figure 5. Experimental setup for the albedo session in which each can contained the same volume of water and was capped by a foam disk with a thermometer inserted into the water. The lamp was switched on after the time zero temperature was recorded.

After 20 minutes, the students plotted the temperature data from both cans. They were provided with a graph on which tick marks on the axis were already made. Students had to decide which variables should go on to each axis and then plotted the data. They then drew a best-fit line by eye. The rate of temperature increase for each can was calculated in order to determine in which can water heated more rapidly. The students were introduced to the main concepts of scientific research through hypothesis testing, and by presenting their results. The students then went outside, where they used a light sensor to measure the reflectance of various objects, including a white plaque that was used to stimulate sea ice, a pond surface, soil, grass, and other objects of their choosing. Students calculated the percent of incident light that was reflected and discovered that darker surfaces, such as soil and water, absorb more light than white objects; thus, simulating the high reflectivity of sea ice and snow. In the conclusion of the experiment, the students discussed how to apply this knowledge to the impacts of climate change in the Arctic and more locally.

Part 2: Acidification

In acidification, students learn that burning fossil fuels increases CO_2 in the atmosphere, which is absorbed by the ocean. Increasing CO_2 in the ocean causes the water to become more acidic, thereby impacting coral, bivalves, and certain phytoplankton. This session started with a 10-minute presentation explaining the process of ocean acidification and its impact on organisms. Students were asked to identify which kinds of animals are affected by acidification. The students then moved to testing substances for vulnerability to acidification. They were provided with samples of coral, carbonate sand, silicate sand, oyster shell, and granite. After writing down their predictions, students placed several drops of weak hydrochloric acid on the samples and recorded their observations through the experimental setup (see Figure 6).

The students were then asked if they knew why some substances fizzed under the acid, and then the explanation was shared with them (release of CO_2 gas). Students then used a Bromothymol blue (BTB) solution, a pH indicator, to demonstrate that CO_2 affects the pH of seawater. When blowing into the tubes of the solution, CO_2 in their breath caused a reduction in pH, which was shown by a change in the color of the BTB solution from blue to yellow. This pH indicator has a range of colors from green to yellow, which correspond to the changes. Figure 6 shows how, in the last experiment, students used CO_2 gas bubbled through seawater to observe and record changes in pH as CO_2 concentration increased through the setup. This session used the setup demonstrated by the University of Hawaii C-MORE outreach (2016).

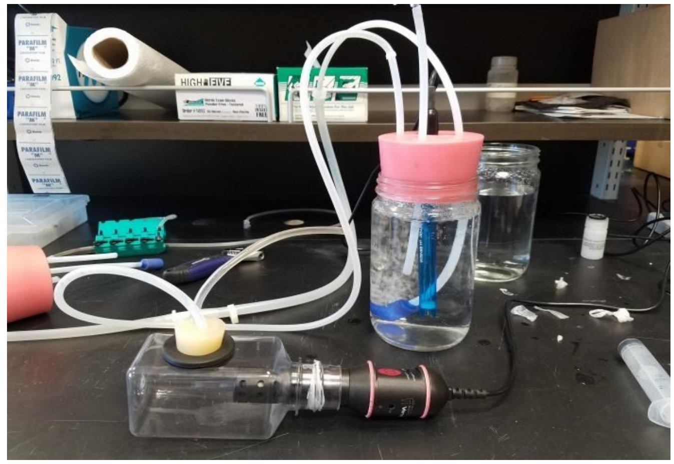

Figure 6. Experimental setup for the acidification session, including a pH probe inserted through a stopper into a glass jar into which CO_2 was allowed to flow, and a CO_2 sensor that measured CO_2 concentration in the air that was displaced from the glass jar.

Students recorded pH and CO_2 using sensors connected to a Vernier Labquest mini; they then plotted the data to look at how pH changes with CO_2 concentrations. They were asked to discuss what they had learned with respect to their understanding of ocean acidification. The aim of both sessions was to expose students to concepts that they may not have been introduced to before, to provide an opportunity for hands-on experimental experience, as well as provide an opportunity to analyze and plot data and calculate rates and percentages. By finishing each session with a discussion and synthesis portion, the aim was to have students solidify their new knowledge and see that even small laboratory experiments could provide them with an understanding of the larger ocean environment. By starting each session with simple demonstrations of concepts and then building on them with more complex experiments, an increasingly challenging environment was provided to the students with a wide range of abilities.

From the albedo part of the session, students learned that as ice and snow melt in the arctic, lower albedo surfaces were exposed, which resulted in more energy absorption and heating. Due to this phenomenon, the loss of snow and ice in the Arctic impacts climate change. In regards to acidification, points for discussion included an explanation of the changes in pH that were used in the experimental setup, and whether it will exceed what is expected in the ocean over the next 100 years. Also, it was used to demonstrate the relationship between CO_2 and pH, and to demonstrate that even small changes can have detrimental impacts on marine organisms; in particular, that even when just one species is affected, it can have cascading impacts on marine ecology, as other organisms rely on them for habitat and food.

Session 4: Satellites, Lasers, and Drones From Sci-Fi to Studying the Impacts of Climate Change and Sea Level Rise

Faculty: C. Tomovic, V. Jovanović, G. McLeod, and D. Smith

The main objective of this workshop was to introduce students to the technologies used for mapping the effects of climate change on sea level rise.

Part 1: Introduction to GIS

This session conveyed the critical importance of geospatial tools and technologies in recording, understanding, and communicating the impacts of sea level rise and storm surge flooding. Figure 7 shows how the high school students were introduced to a 4-step geographic information systems (GIS) problem-solving cycle, as a framework for how geospatial scientists tackle the problem of flooding.

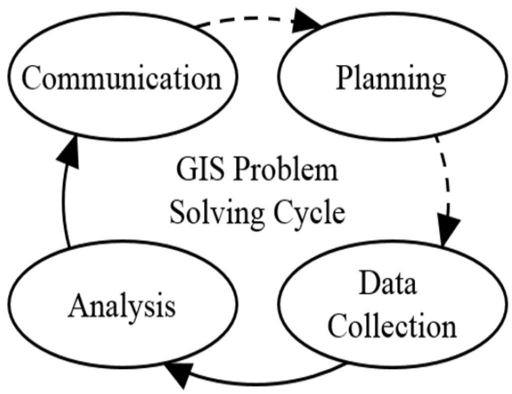

Figure 7. GIS problem-solving cycle.

Using this framework, students were tasked with answering the fundamental question, "How will flooding from sea level rise impact my community?" They conducted the following four primary tasks, as they worked towards developing their answer: Task # 1: Develop a plan fir collecting pictures of locations, buildings, and areas impacted by flooding; Task # 2: Collect simulated flood damage data using GPS, tablets, and digital cameras; Task # 3: Perform visual overlay, analysis, and synthesis of flood hazard data; and, Task # 4: Communicate their findings by creating an interactive "live" Esri Story Map website (2018). At the inception of this session, the students were divided into four, 5-person teams. A graduate student was assigned to guide each team through the process of geospatial discovery and the communication of their results. As the focus of their study, each team was assigned a specific flood-prone neighborhood area within the city of Norfolk (see Figure 8).

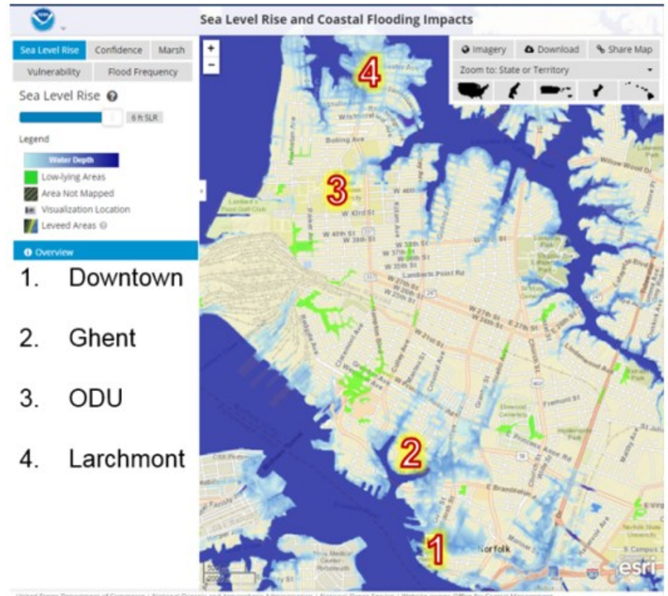

Figure 8. Flood-prone study areas in Norfolk: (1) Downtown, (2) Ghent, (3) ODU, (4) Larchmont.

Part 2: Data Collection

After a brief classroom introduction to the nature of geospatial data and technologies, students were taken outside to a natural area surrounding the ODU science pond. A demonstration was presented on how researchers use small unmanned aerial vehicles (sUAS) to collect data more quickly and efficiently than traditional means. Students were shown how UAS were capable of rapid acquisition of imagery, video, and other data that provide critical information for emergency responders and recovery operations after major storms and flooding events. After the UAS demonstration, the student teams split up to perform a hands-on exercise simulating the collection of flood damage data. Two different collection technologies, stand-alone GPS and web-connected tablets, were presented to the student teams. The main purpose of these activities was to discuss the positive and negative sides of using these different technologies. The other goal was to explain why it is sometimes necessary to have redundant data collected from various sources for scientific research. Students were instructed in the fundamentals of global positioning system (GPS) technology, GPS receiver operations, and conditions of optimal GPS data recording. The differences between capabilities of ruggedized GPS receivers, smartphones, and tablet devices were highlighted and explored. The student teams spent approximately 45 minutes on data collection, learning how to create and generate hazard damage assessment data that were output directly to a "live" website. These simulated data described the condition of a flood-impacted property with an attached photo of the actual damage. Upon completion of their data collection, the teams regrouped in a central location to engage in a 10-minute discussion about their findings and their experiences with using multiple data collection platforms to collect redundant data.

Part 3: Synthesis and Communication

Students returned to the GIS computing laboratory to learn more about sea level rise and begin the data synthesis process. A 15-minute instructor-led presentation was delivered to introduce students to the regional and local-scale impacts of sea level rise in Hampton Roads and Norfolk. Students resumed work in their 5-person teams with two objectives: 1) to learn more about the impacts of flooding in their assigned areas, and 2) to effectively communicate this information to diverse high school students. Towards these goals, the teams engaged in web research and group discussions regarding the history and issues specific to their study areas. They were led in the discovery of a variety of flood mitigation and adaptation strategies, which were available for communities dealing with the challenges of persistent and recurrent flooding. Prior to the development of their communication piece, students were required to engage in organizational planning, and to divide up and execute the tasks necessary to complete their communication piece in a compressed time frame. Student teams worked together to use data collected in the field and information acquired online to build multi-page Story Map websites that explained the flooding conditions and impacts of their study areas. Esri Story Maps are web applications that let authors combine GIS data, maps, narrative text, images, and multimedia. Students were tasked with considering the best format and flow for factual and effective communications of their data synthesis and research. Near the end of the session, the student teams were required to present their Story Map to the entire class. They were asked to discuss the greatest risks posed by sea level rise to the specific group's study area; the most interesting and challenging part related to the creation of a story map and some potential solutions for migration of problems identified in the area of their group. Figure 9 shows the high school students' final Story Maps, which were made public on live web URLs so that the students could share them with their teachers, friends, and family upon completion of the ODU BLAST program.

This special evening event was designed by staff in Student Advising, by faculty in the Department of STEM Education, and faculty in the Department of Theatre and Communications. The purpose of Part 1 - STEM IT! was to provide students a foundation about college life, what it takes to be successful in STEM majors, and opportunities that they should take advantage of during their time in college. The purpose of Part 2 - STEM IT! was to allow students to experience the opportunities and challenges that scientists and engineers experience when working together as a team.

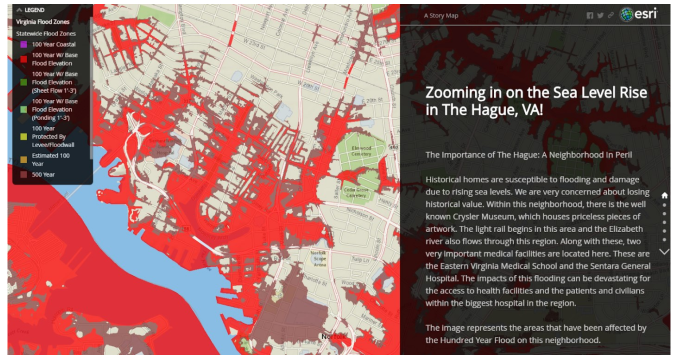

Figure 9. Front page of the Story Map created by BLAST students (Esri, 2018).

Special Evening Event 2: Preparing for College STEM Career—STEM IT!

Faculty: C. Tomovic and V. Jovanović

Part 1: STEM-related Advice and Panel

STEM IT! was introduced by the Dean of the College of Education. The high school students were given a brief presentation about how to be successful in college and in STEM majors, from the perspective of an academic advisor. In the remaining hour, a panel of two female students and two male students, representing biology, modeling and simulation, chemistry, and mathematics, presented their perspectives on what it was like to be a STEM major and afterwards invited high school students' questions. The outcomes the facilitator wanted to accomplish during the workshop included familiarizing the high school students with college life and the differences between high school and college expectations; understanding what it means to pursue a STEM major and how to take advantage of on-campus opportunities to expand their professional growth; seeing and hearing what it is like to major in a STEM field from other students who have been through the college experience; and, finally, introducing students to success strategies specific to STEM majors.

Part 2: Rockets to the Rescue!

Faculty: C. Tomovic and V. Jovanović

This activity led students through a scenario after a disaster. Students discussed issues related to the logistics needed by the emergency responders to the people affected by the flooding. In severe storms, for example, roads, bridges, ports, and runways may not be usable; thus, citizens become isolated. In this interactive session, students built and flew paper rockets, which were used to simulate an alternative means of transportation. Each team of five students was provided plain and colored paper, string, tape, a bottle stopper, and cotton balls (Dunbar, 2016). All teams were assigned the same goals, requirements, and constraints under which to work. In all cases, teams experienced design challenges when building and testing their rockets. After about 1½ hours, teams competed with each other to determine which team had built the rocket that could fly the furthest, and land in designated areas marked by hula-hoops. Propulsion for the rockets was built from tubes and coke bottles in which air was forced from the bottle, through the pipes, and into the rockets for liftoff. During the debriefing sessions, all of the students indicated that they had enjoyed the exercise, but that working together was challenging. Thus, the major purpose of this activity was demonstrated, in particular the challenges associated with team building and resolving conflict in order to achieve a purposeful goal.

Special Evening Event 3: Closing Night Adventures at the North Pole

Faculty: C. Tomovic, V. Jovanović, and V. Hill

This special evening event was conducted by one of ODU BLAST's workshop faculty, who is an Arctic scientist. In this closing event, the high school students were regaled by fun-filled stories about living and working in −40° Arctic conditions. Following a picture-packed PowerPoint presentation, the faculty member entertained a multitude of questions by students who, afterwards, could be heard saying that they wanted to become a science explorer. This special evening was capped off by a challenge between the girls and boys, which was designed to test which one of them could dress the quickest in sub-zero clothing and get into a specially designed sleeping bag before the other. At the end of this special event, each student was called to the front of the room and awarded their personalized ODU BLAST 2016 Certification of Completion. After leaving the auditorium, students were invited to "chill-lax" in the student union, where they played ping-pong, pool, chatted with each other, and topped the night off with some refreshments.

Demographics and Evaluation

Seventy-four students participated in the survey. Eight students were 13 years old, 43 students were 14 years old, and 24 students were 15 years old. Forty students were rising 9th graders, and 35 students were rising 10th graders. When asked about their tentative major in college, the students responded as indicated in Figure 10 (pre-ODU BLAST) and Figure 11 (post-ODU BLAST). While there was likely a selection bias as to who would want to attend a STEM-related event like ODU BLAST, even with this group it was clear, based on the results of the pre/post ODU BLAST 2016 surveys, in the short run, ODU BLAST was effective at changing the attitudes of many of the high school students. A number of students who voiced responses of "don't know" or "definitely not" to their level of interest in majoring in science, technology, engineering, or math increasing moved their responses to "maybe" or "probably" interested in majoring in science, technology, engineering, or math.

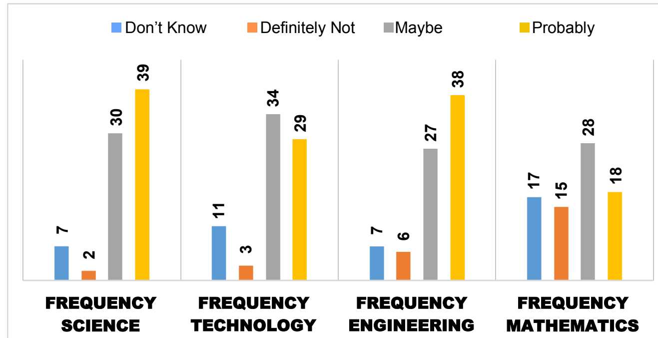

Figure 10. Frequency table for a question related to the students' choice of major (pre-activity).

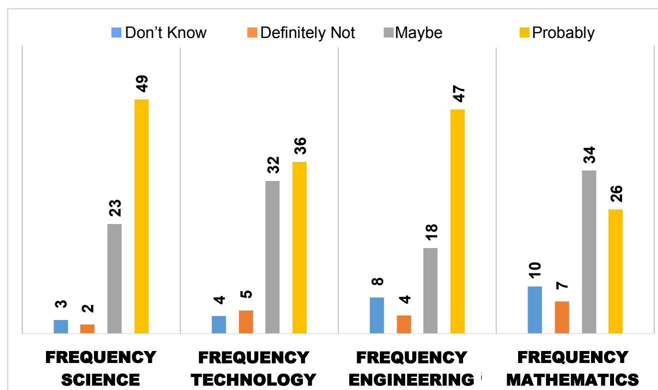

Figure 11. Frequency table for a question related to the students' choice of major (post activity).

The main focus of NASA's Space Grant program through the VSGC is to develop and deliver aerospace-related programs aimed at sparking interest in high-tech professional and educational fields across the Commonwealth of Virginia. The sessions described in this study were related to two of the main NASA missions, sea level change (NASA, 2018a) and Earth (NASA, 2018b). Students in this program were exposed to four different sessions related to STEM areas. The activities focused on interdisciplinary learning and not simply on specific majors offered in each of the colleges. Administration faculty who organized the program were from the Department of STEM Education and Professional Studies, the College of Education, and the Department of Engineering Technology, and the Batten College of

Engineering and Technology. The main workshop sessions in ODU BLAST 2016 were designed and delivered by faculty, staff, graduate, and undergraduate students from the College of Sciences and the Batten College of Engineering and Technology.

Conclusions

ODU BLAST 2016 was the first session that was delivered to high school students on the Old Dominion University campus. Since then, in June of each year, the university has held another session (in 2017 two were held). Various collaborations were formed among the participating faculty. The funding agency supported the overarching theme approach, designed as a residential educational program. Many undergraduate student researchers became graduate students in the following year. Faculty, staff, and students continuously wanted to participate in this community outreach and deliver the program to additional high school students interested in STEM careers. Feedback from students and the funding agency was very constructive, leading to various improvements in subsequent sessions.

Nomenclature

Alka-Seltzer	A pain reliever that contains three active ingredients: aspirin (acetylsalicylic acid) (ASA), sodium bicarbonate, and anhydrous citric acid.
BLAST	Building Leaders to Advance Science and Technology
BTB	Bromothymol blue is a pH indicator
CO_2	Carbon dioxide
Esri	Environmental Systems Research Institute
GIS	Geographic Information System
GPS	Global Positioning System
IR	Infrared
NASA	The National Aeronautics and Space Administration
ODU	Old Dominion University
pH	A logarithmic scale used to specify the acidity or basicity of an aqueous solution
STEM	Science Technology Engineering Mathematics
sUAS	Small Unmanned Aerial Vehicles
URL	Uniform Resource Identifier
UV	Ultraviolet
VSGC	Virginia Space Grant Consortium

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