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NAVAL SURFACE WARFARE CENTER
Dahlgren, Virginia 22448-5100

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NSWCDD ACADEMIC OUTREACH PROGRAM: VIRTUAL STEM OUTREACH

BY MEGAN TROXEL, SARAH FRALICH, AND LUCAS DURHAM

NSWCDD CHIEF TECHNOLOGY OFFICE

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This document describes the Virtual STEM Outreach Program, a new initiative of the Naval Surface Warfare Center Dahlgren Division (NSWCDD) Academic Outreach Program in collaboration with regional partners: Naval Surface Warfare Center Carderock Division (NSWCCD), NSWCDD Dam Neck Activity, and the Surface Combat Systems Center (SCSC) at Wallops Island. The need for a new virtual-based outreach program arose in response to the COVID-19 global pandemic, which triggered a nationwide change in the educational culture to center on social distancing and virtual learning. The Virtual STEM Outreach Program focuses on researching and using various methodologies, practices, and resources that enable virtual learning. This report provides a detailed account of the research conducted, events executed, and data gathered.

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FOREWORD

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JENNIFER CLIFT, Chief Technology Officer
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ILLUSTRATIONS

TABLES

GLOSSARY

ACSE	Advancing Computer Science Education
CONUS	Continental United States
COVID-19	Coronavirus 2019
CS	computer science
DNA	Dam Neck Activity
DoD	Department of Defense
DoDEA	DoD Education Activity
EPA	Educational Partnership Agreement
FY	fiscal year
NAVSEA	Naval Sea Systems Command
NMCI	Navy Marine Corps Intranet
NSWCCD	Naval Surface Warfare Center Carderock Division
NSWCDD	Naval Surface Warfare Center Dahlgren Division
PAO	Public Affairs Office
S&E	scientist and/or engineer
SCSC	Surface Combat Systems Center
STEM	science, technology, engineering, and mathematics
UMW	University of Mary Washington
VRT	Virtual Robotics Toolkit™
VRW	Virtual Robotics Workshop
VSTE	Virginia Society for Technology in Education

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EXECUTIVE SUMMARY

The Coronavirus 2019 (COVID-19) global pandemic triggered a nationwide change to an educational culture centered on social distancing and virtual learning. This educational model prompted the NSWCDD (Naval Surface Warfare Center Dahlgren Division) STEM (science, technology, engineering, and mathematics) Outreach Program to invest resources and time into developing and executing the Virtual STEM Outreach Program. The Virtual STEM Outreach Program is a collaborative effort between Naval Surface Warfare Center Carderock Division (NSWCCD), Naval Surface Warfare Center Dahlgren Division's Dam Neck Activity (NSWCDD DNA), and the Surface Combat Systems Center (SCSC), led by the NSWCDD STEM Outreach Program. The primary objectives of this program were to research and develop new practices, methods, and policies that incorporated online platforms with STEM outreach activities.

The program consisted of specific initiatives that laid the foundation for the virtual Naval STEM Outreach transformation. These initiatives are listed below:

- Virtual Robotics Workshop
- Online Platform Research
- Virtual Meet-an-Engineer Initiative
- STEM-in-a-Box Demonstration Videos Planning
- STEM Career Path Videos
- Online STEM Activity Research
- Ethics Training Updates

Some significant benefits were realized and some challenges were met throughout the Virtual STEM Outreach Program initiatives. Overall, each initiative provided valuable lessons learned that are documented and will be incorporated into all future virtual outreach efforts.

The lessons learned from this program will be used to incorporate virtual outreach methodologies in various other programs such as SeaPerch, SeaGlide, and summer camps. Formal documentation of lessons learned and collaboration with other Naval STEM Outreach partners will enhance the performance of other programs in the Naval STEM Outreach community. The virtual Naval STEM Outreach transformation enables Naval STEM Outreach programs to continue providing local school districts with quality support, resources, and materials in a way that best fits each school's educational model as these models shift to incorporate more virtual and distance learning.

Ultimately, the Virtual STEM Outreach Program furthers three goals of the Naval Sea Systems Command (NAVSEA) STEM Campaign Plan during a time of unprecedented upheaval in education systems [REF 1]:

1) Inspire students in grades K-12 through STEM education and outreach programs that improve student and educator performance (NAVSEA Goal 1).
2) Promote participation in STEM with underserved populations in STEM education (NAVSEA Goal 4).
3) Enhance the effectiveness of NAVSEA STEM initiatives (NAVSEA Goal 5).

1.0 INTRODUCTION

1.1. Purpose

The Virtual STEM (science, technology, engineering, and mathematics) Outreach Program provides teachers and students with resources, training, and educational opportunities through a virtual medium. To adapt to a changing educational culture in response to the COVID-19 global pandemic, virtual outreach is the best choice due to its flexibility, versatility, and ability to reach larger audiences – sharing knowledge on a grand scale. Virtual resources and outreach provide an opportunity to continuously improve and modify the Naval STEM Outreach Program's ability to impact students and educators, including those from socioeconomically disadvantaged areas that have limited access to STEM professionals and resources.

Another aspect of the Virtual STEM Outreach Program is regional collaboration. The NSWCDD STEM Outreach Program is executing its transformation in partnership with the STEM Outreach programs at Naval Surface Warfare Center Carderock Division (NSWCCD), Naval Surface Warfare Center Dahlgren Division's Dam Neck Activity (NSWCDD DNA), and the Surface Combat Systems Center (SCSC). Collaboration greatly increased effectiveness through enhanced access to resources and creative solutions, and it demonstrated that virtual STEM engagement is successful at scale.

1.2. Initiative Overview

The objective of the Virtual STEM Outreach Program is to research virtual methodologies and resources used by partners in the local region and integrate these methodologies into STEM activities such as Teacher Training Workshops and informational talks. The ultimate objective of Virtual STEM Outreach is ensuring NAVSEA STEM continues its mission despite COVID-induced changes in education. This mission is to attract, foster, and cultivate outstanding STEM talent throughout the education continuum to enrich NAVSEA's future workforce, capability, and capacity to meet defense technological challenges [REF 1]. At the K-12 levels, Virtual STEM Outreach supports this mission using the following approaches:

- Engage students through virtual STEM activities, talks, and assistance
- Assist teachers through virtual STEM activities and training workshops
- Create a virtual learning environment that enhances students' retention of STEM material
- Provide students with age-appropriate resources that enable virtual education

In an effort to meet the goals stated above, the Virtual STEM Outreach Program began with a variety of virtual initiatives. Each of the new initiatives served as a test of capabilities and limitations of virtual methodologies and provided valuable lessons learned for planning future events. Some of these events include:

- Virtual Robotics Workshop
- Online Platform Research
- Virtual Meet-an-Engineer Initiative Planning
- STEM-in-a-Box Demonstration Videos Planning
- STEM Career Path Videos
- Online STEM Activity Research
- Ethics Training Updates

2.0 VIRTUAL ROBOTICS WORKSHOP

Robotics workshops empower educators to teach multiple STEM topics (mechanics, basic electronics, algorithmic thinking, coding) to their students by using robotics platforms. Robotics workshops are the first step in a continuum of engagement. When robotics-lessons are established in a classroom, follow-on engagement by Naval STEM Ambassadors is enabled through activities such as SeaPerch, coding clubs, and robotics competitions. As students are mentored in robotics and Naval STEM careers, the future Naval STEM hiring pipeline is enhanced [REF 2].

The first major virtual initiative of the Virtual STEM Outreach Program was the Virtual Robotics Workshop (VRW). The NSWCDD STEM Outreach Program previously offered successful in-person robotics workshops. Another face-to-face robotics workshop was planned for the summer of 2020, but all live-session workshops were canceled beginning in April 2020 due to the COVID-19 global pandemic. Therefore, this workshop was hosted virtually in order to provide the training to the educators because an in-person session was not an option. This virtual workshop was designed to train teachers on the LEGO® EV3 and Ozobot® robots, providing an overview of basic programming and challenges that demonstrate the movement, loops, and logic features of these robots. There were three primary stages of this initiative: planning, execution, and reporting. Each stage consisted of various considerations, discussed in the sections below.

2.1. Planning Stage

The planning stage was the most important of all three stages. It consisted of the following considerations:

- Platform research and selection
- Platform guidance for the educators
- Pre-work for the educators
- Virtual meeting rulesets
- Delivery of equipment

2.1.1. Online Platform Research

Various online platforms were candidates for sustainable, online workshops and trainings. The three main platforms researched, as shown in Table 1, were Zoom™, WebEx® Meeting, and Google Meet™. Specific features necessary for this workshop included: recording capability, unlimited meeting time, Chromebook® compatibility, screen-sharing capability, and breakout room functionality. During the research phase, the different platforms' capabilities and limitations were tested. The table below documents all of the information gathered from this research.

Table 1: Online Platform Comparison

	Zoom™	WebEx® Meeting	Google Meet™
Screen Share Functionality	Yes; host and participants	Yes; host and participants	Yes; host and participants
Device Compatibility	Reliable on multiple devices; including Chromebooks®	Reliable on multiple devices; including Chromebooks®	Reliable on multiple devices; including Chromebooks®
Participant Limit	100	100	100
Chat Functionality	Yes	Yes	Yes
Mute Capability	Yes; host can mute/un-mute everyone	Yes; host can mute/un-mute everyone	Yes; host can mute/un-mute everyone
Recording Ability	Yes	Yes	Yes; only with a G Suite Admin account
Video Sharing	Yes; best approach is online repositories	Yes; videos can be shared from local machines and from online	Yes; best approach is online repositories
Time Constraint	40 minutes; Zoom™ Pro unlimited	50 minutes; WebEx® Meeting license unlimited	60 minutes; G Suite license unlimited
Cost	Free; Zoom Pro™ has license cost	Free; can pay to upgrade	Free; can pay to upgrade
Breakout Room Functionality	Only with Zoom Pro™	Only with WebEx® Training – not compatible with Chromebook®	No
Additional Features	Includes "raise hand" feature	Includes "raise hand" feature, can lock room after start of meeting, whiteboard feature	Well known – user friendly

The final decision for the workshop included two different platforms: WebEx® and Zoom™. This was to allow for breakout sessions throughout the day and partitioned the breakout sessions from the main workshop training session. The decision to use two different platforms was made for two primary reasons: (1) WebEx® Training is not compatible with Chromebooks®; and (2) the workshop trainers had not mastered the breakout feature of Zoom Pro™ because of the short turn-around time to transition to a virtual workshop.

The two different platforms allowed the educators to track both sessions, main and breakout, simultaneously, switching between the two as needed. WebEx® Meeting was used for the main session, and Zoom™ was used to host the breakout sessions. The intuitive interfaces and features, such as hand raising, recording, mute all functionality, and Chromebook® compatibility made WebEx® Meeting and Zoom™ a clear choice for hosting the main session and breakout sessions, respectively. An additional feature for both of these platforms is that an account is not required to join a meeting. This allowed participants to join meetings with just their name and the meeting information. This online platform research was not only crucial for the VRW, but it laid the foundation for all future virtual engagements with students and teachers. This research was also shared with local educators, industry partners, and naval partners.

2.1.2. Workshop Pre-Work and Rulesets

Prior to the event, the educators received a set of pre-work that included resources to help them prepare for the workshop. The pre-work included build instructions for the EV3 robots, preparation steps that needed to be completed for the Ozobot® challenges, VRW rulesets, contact information for the breakout session facilitators, and online platform tutorials for WebEx® Meeting and Zoom™. Through execution of pre-work, the educators knew what to expect from the workshop and were adequately prepared to discuss the topics of the day.

Alongside the pre-work, STEM Ambassadors hosted a "connectivity day" the day before the workshop to enable educators to test their connection to WebEx® and Zoom™. This also allowed the STEM Ambassadors to prepare the educators for the transitioning between the main session and the breakout sessions that they would be involved in during the workshop. A full list of rulesets is available in Appendix A.

2.1.3. Delivery of Equipment

It was important that the teachers had a hands-on experience and could actually use the robots and programs for this workshop, so delivering the equipment was an essential part of the preparation process. Without having the robots, it would have been difficult to train the educators effectively just using the prepared slides. The NSWCDD STEM Outreach Program loaned robots to the teachers to use for the VRW. Leveraging the Educational Partnership Agreement (EPA) vehicle, the robots were loaned to the teachers for use in their classrooms.

2.2. Workshop Execution

The Virtual Robotics Workshop was a full day training event, which alternated practical instruction on coding and algorithms for EV3 and Ozobots® with breakout sessions that allowed the educators an opportunity to practice programming the robots. To prevent technical issues during the virtual training, a thirty-minute connection period was included at the start of the day. After that, the "Welcome and Introductions" followed by "Virtual Workshop Ruleset" sections were twenty minutes and ten minutes respectively. After reviewing the ruleset, the event moved into the beginner EV3 robotics section. The EV3 robotics section was three hours, and the following beginner Ozobots® robotics section was two hours. During the lectures, the presenter was the only person allowed to show their video to the rest of the audience, to minimize any bandwidth issues. The workshop concluded with a thirty-minute wrap-up, conclusion, and survey. In total, the workshop was eight hours, including an hour-long lunch break.

Since there were two main topics covered during the workshop, the educators had the option to register for one or both of the sessions. After the educators registered, they were assigned a breakout session group and received the WebEx® Meeting and Zoom™ links prior to the day of the event. The WebEx® Meeting link was the same for all participants and it was used for the main VRW instructor-led session. There were three Zoom™ links, one for each breakout group. The educators were appropriately divided into these three groups and were provided their specific Zoom™ link. There were three breakout groups that hosted the six breakout sessions during the day – three for EV3 and three for Ozobots®. By breaking the educators into smaller sessions for these interactions, the instructors could focus on individual questions, comments, or concerns the educators had.

To ensure continuity and schedule, facilitators moderated sessions throughout the day. Each breakout session had two STEM Ambassadors, one who was the trainer for that topic and one who was the facilitator. The main session also had a main facilitator; this allowed a dedicated individual to monitor the chat for any questions, admit or remove participants if needed, and mute microphones, if necessary, while the instructor focused on the training session. Overall, meticulous planning and the workshop procedures allowed the VRW to seamlessly transition from face-to-face to completely virtual.

2.3. Virtual Robotics Workshop Report

The NSWCDD STEM Ambassadors and participants in the workshop alike deemed the VRW successful. Twenty-six teachers from eight different local counties attended the workshop (see Figure 1), and the feedback from the participants was overwhelmingly positive. The documented, constructive feedback received from the educators and the lessons learned by the STEM Ambassadors will be used to further improve virtual events.

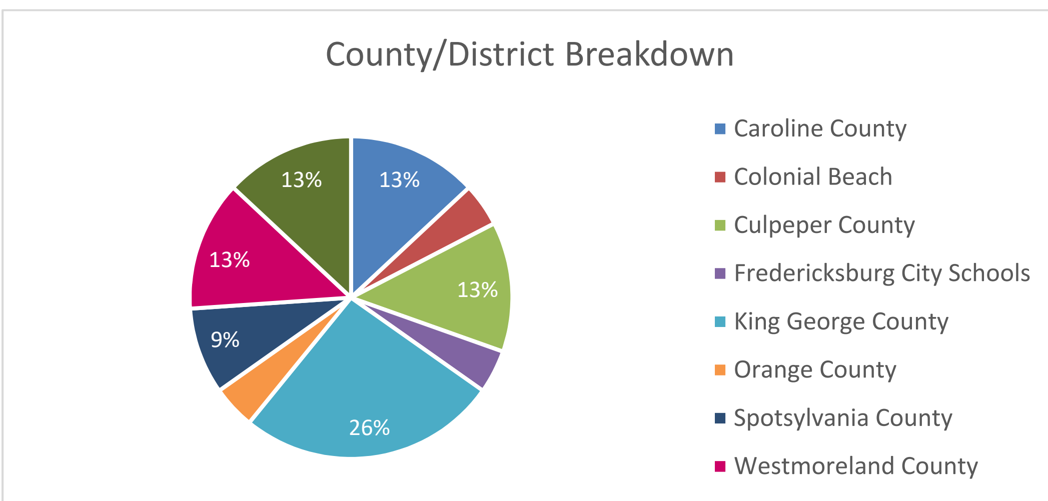

Figure 1: VRW Attendance by Regional District

Based on the data from the workshop, the majority of the attending educators were using these robotics platforms for the first time. Through attending this workshop, the educators were provided resources, materials, and products allowing them to incorporate these robotics platforms into their classroom curriculums. Some of these resources include recordings, informational slides, and sample programming code from the workshop. This workshop provided the resources and tools for educators to better teach robotics in their classrooms.

2.3.1. VRW Challenges

In comparison to in-person events, virtual events have innate drawbacks. Virtual events require significant time for coordination, planning, and communication in order to host the event successfully. Through detailed planning, the VRW Trainer Team was able to overcome this challenge. Due to hosting the VRW on two separate platforms, many of the educators had to use two separate computers in order to participate. In the future, the Zoom Pro™ breakout room functionality will help the STEM Outreach Team to overcome this challenge. Additionally, because not every teacher was using the same operating system for their robotics programming, the STEM Ambassadors faced a challenge when trying to provide general assistance to the educators. In the future, stricter guidance will be provided to educators to ensure that they are using the appropriate operating system for the workshop. Further challenges such as internet connectivity, intermittent lag, and lack of computer processing are difficulties that must be addressed at the personal level, but they do not affect the plausibility of virtual events at large.

2.3.2. Lessons Learned and Next Steps

Figure 2 highlights lessons learned from the Virtual Robotics Workshop, which will help to improve future virtual events. For example, utilizing the breakout session functionality of Zoom Pro™ will allow “group work” or breakout sessions to be more fluid in a virtual setting. Although there is much room for improvement, the VRW was successful in demonstrating that virtual outreach events are viable and can be fruitful for the NSWCDD STEM Outreach Program. The decision to host the workshop virtually coincidentally increased the span of educators who could take part in the workshop.

In order to make virtual events more successful and efficient, hosting more virtual workshops, trainings, and education-based events are the necessary next steps. Therefore, immediately following the success of the VRW, the Virtual STEM Outreach Program team began planning for the Virtual Meet-an-Engineer Initiative, discussed below, and more virtual training workshops.

Technology

- Multiple platforms work, but research should continue into built-in breakout session functionality (i.e., Zoom Pro™).
- Lag involved when trying to show recorded video
- Chromebook limitations with processing power
- When trainers have multiple platforms up, they need to ensure they mute the one not in use.
- Saving a prior recording while running a new Zoom™ session can cause lag.
- All chats are saved with Webex® and Zoom if the session is recorded.

Pre-work

- Need to update the build instructions for EV3 to include better instructions for sensors
- Potentially need a "Best Practices" guide for Ozobots® to assist with troubleshooting (for example: screen settings for syncing)
- Use existing online platform video trainings prior to event.

Planning

- Connectivity period prior to the event was incredibly beneficial.
- Add additional slides into training resources to cover generic topics (renaming program, connection of robot, etc.).
- Add grade-level indication on challenge sheets.
- Need longer lead time for ordering and delivery of equipment to participants
- Longer lead time needed to account for virtual aspects of workshop (breakout group assignments, platform selection, etc.).

Execution

- Additional person in breakout and text group helped with internal communication throughout event.
- Include upfront demos on calibrating/flashing (Ozobots®) and downloading program (EV3).
- Participants should communicate with all participants to minimize confusion rather than sending private messages.

Miscellaneous

- Need to consider option of half day workshops; full day workshops can be draining for trainers and participants.
- Include STEM mailbox on all materials and slides.
- Group picture at end of sessions emulated pictures from in-person events.
- Having one dedicated person to confirm that audio/video is working would minimize extra chat messages and unnecessary conversation.

Figure 2: VRW Lessons Learned

3.0 VIRTUAL MEET-AN-ENGINEER INITIATIVE

The Virtual Meet-an-Engineer initiative attempts to merge in-classroom support with virtual methodologies. Many local schools are hybrid-online or fully online for the fall semester of 2020, so Virtual Meet-an-Engineer activities will consist of scientists and engineers (S&Es) providing an online, interactive, STEM-related presentation on a topic that correlates to the school's STEM schedule. The purpose of the Virtual Meet-an-Engineer activities are to provide students with engaging, real-world applicable lessons, presented by an S&E.

The initiative will be executed in a phased approach:

- The first phase includes working with five schools in four counties to create a foundation for future virtual outreach, generate lessons learned to help improve the initiative, and collect feedback from schools and the STEM Ambassadors. The first phase focuses on specific topics that tie into the school educators' needs. This initial phase will last at least three months to allow the team to collect metrics, which will be evaluated to help plan future events. To ensure consistency, standardized techniques for collecting engagement metrics from educators and STEM Ambassadors have been developed.
- Once the team moves into the second phase, the aperture of the initiative will increase to include more schools and counties; phase two will provide an opportunity for further collaboration with additional external partners to meet the increased demand. Phase two will incorporate all lessons learned from phase one, but it will also allow for more flexibility of topics presented by the S&Es. Figure 3 below, titled "Phase Two Virtual Meet-an-Engineer Topic Submission Process," represents the process flow for this.

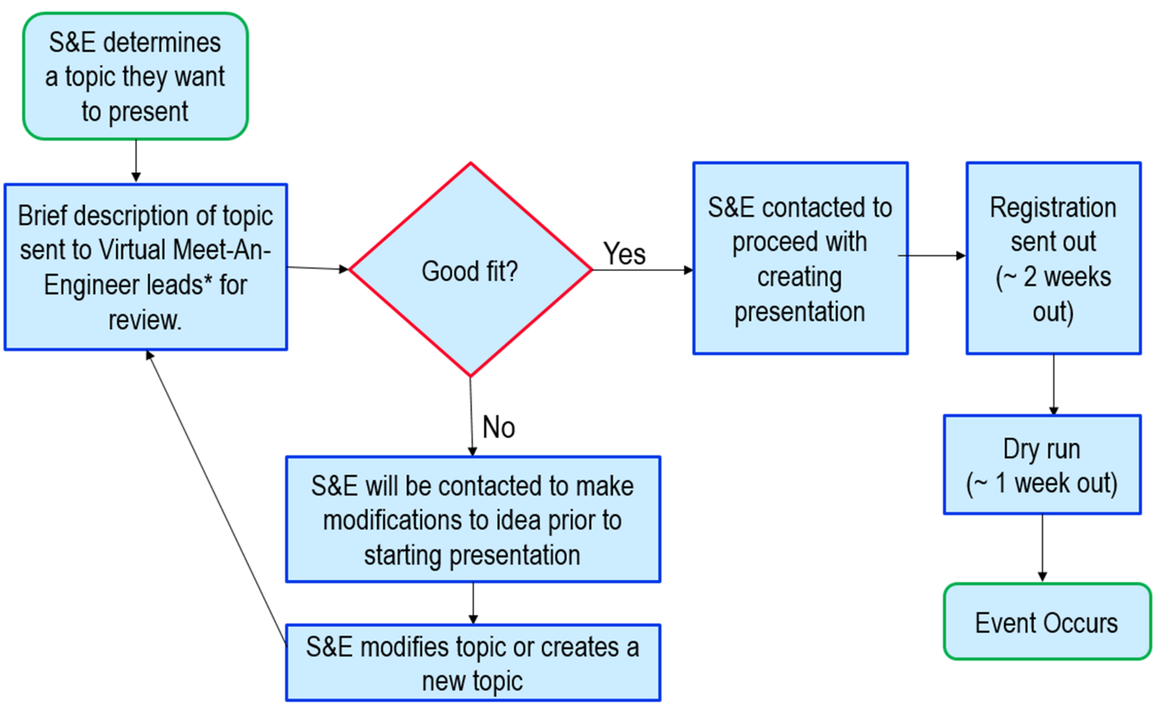

Figure 3: Phase Two Virtual Meet-an-Engineer Topic Submission Process

The VRW demonstrated that it is possible to transfer almost any in-person STEM activity to a virtual platform, given the time and resources to do so. One of the goals of the Virtual Meet-an-Engineer initiative is to demonstrate to the STEM Ambassador community that such engagements are effective and create a variety of virtual activities and presentations that could be demonstrated by any qualified STEM Ambassador. As schools begin to transition to an educational model that relies heavily on distant learning, the virtual STEM Outreach partners will continue to provide Navy STEM-branded resources, materials, and training that are relevant to and consistent with the current and emergent engagement techniques used in the classroom.

4.0 STEM-IN-A-BOX DEMONSTRATION VIDEOS PLANNING

The shift in education to more distant learning and hybrid models, combined with NAVSEA STEM's existing "STEM-in-a-Box" engagement approach, led to the conception of STEM-in-a-Box demonstration videos. The goal is to create and distribute a kit to educators that includes:

1) Handout(s): These explain the high-level scientific phenomena discussed in the video, include step-by-step directions for the activities in the video, and tie the activities to real-world applications.
2) Material(s): These are the necessary materials the educator will need to perform the demonstration in the classroom.
3) Video Recording(s): These are the accompanying video recordings that the educator could incorporate into their lesson to show students Naval S&Es conducting demonstrations that illustrate various scientific principles.

Although these video recordings are a different type of virtual engagement when compared to the live interactions through VRW or Virtual Meet-an-Engineer initiatives, they continue to foster the relationship between the Naval STEM Outreach Program and local schools. Through these videos, the program can encourage students to pursue STEM careers and show them real-world applications of STEM principles, despite the restriction on in-person engagements. Additionally, virtually presented demonstrations can be distributed to other schools in areas beyond the range of in-person programs.

This initiative consisted of the following activities, discussed further in the sections below:

1) Identify an appropriate demonstration as a pilot STEM-in-a-Box Demonstration Video.
2) Create an overall script flow that could be used for all STEM-in-a-Box Demonstration Videos.
3) Create a specific script for the pilot video.
4) Record the video.
5) Distribute the video as part of a NAVSEA STEM-in-a-Box kit.

4.1. Identifying the Pilot Video

When deciding which demonstration would work well for the pilot STEM-in-a-Box Demonstration Video, two concepts were chosen out of the 34 demonstrations and activities in the NSWCDD STEM Outreach Program repertoire. These two concepts were chosen because they show interesting concepts that have direct naval relevance, do not require expensive or complex materials, and involve phenomena readily captured through video techniques. The other activities were not selected for a variety of reasons. For example, the biology activities require days or months of observation and so would not be conducive for a short video, and demonstrations that involve extreme temperatures require safety training that cannot be provided to every recipient of these kits.

4.2. Creating the Script Flow

The presenters will be provided a script with major bullets to outline their publically releasable presentation. They will have the option to integrate additional insight, examples, or appropriate anecdotes into the actual presentation to meet the objectives of these videos better. Because the target audience for these videos is middle school students, presenters will speak and explain the concepts at that level.

The general flow of all videos will be the following:

- Presenter introduction, including name, job title, and short description of job function in terms that engage students and reflect positively on Naval STEM careers
- Brief overview of the scientific principle featured in the video
- Demonstrate the activity/activities, including what materials are required and an explanation of the scientific principle behind the activity so that students understand the "why" of what they just saw.
- Connection to a real-world application and, specifically, to the U.S. Navy
- Conclusion – Thank the viewers for watching, give a quick review of the principle and demonstration(s) seen, share contact information for NSWCDD STEM Outreach, and acknowledge any applicable partner or organization.

4.3. Script for Pilot Video

For the pilot video, Bernoulli's Principle was chosen because of its direct tie to naval engineering. The Bernoulli's Principle demonstrations are highly interactive and do not require any expensive or complex materials. The above flow was followed to create the Bernoulli's Principle script, and four activities were used to demonstrate the concept. Each of these activities is further detailed in the handouts section of Appendix B:

1) Paper trail – Blowing a steady stream of air over a strip of paper creates a difference in pressure that causes the paper to lift.
2) Whirligig – Cutting out a whirligig and adjusting the weight with paper clips or changing the rotor lengths varies the way it falls in counterintuitive ways, explainable only due to the lift created through Bernoulli's Principle.
3) Bernoulli bag – Trying to inflate a bag by breathing into it with no space between one's face and the bag does not work as well as breathing into it from a distance due to the pressure differences.
4) Come-together cans – Placing two empty soda cans on top of a line of straws and blowing through another straw held between the cans causes the cans to move closer to each other.

As the overall script flow indicates, for each activity, an explanation will be provided as to why or how what just happened, happened. For example, the presenter will explain that the paper trail and whirligig activities illustrate lift – a force that opposes gravity – that is created when the air moves faster and creates an area of lower pressure. For the Bernoulli bag, the presenter will show how blowing into the bag creates faster-moving air that is surrounded by lower pressure, and in an attempt to equalize the pressure, higher pressure rushes in to the bag, inflating it.

Similarly, in the case of the come-together cans, the presenter will explain that blowing between the cans creates an area of lower pressure, and the cans move closer to each other as the pressure returns to a more balanced state. Throughout all of these activities, the presenter will explain how Bernoulli's Principle ties these demonstrations and concepts together.

As per the overall script flow, Bernoulli's principle and its naval application will be discussed during the video. For example, the presenter may discuss that, in 2016, the USS *Montgomery* collided with a tugboat because of the creation of a low-pressure area between the vessels due to the fast wind that was moving between the two boats. This application will tie to the come-together cans demonstration. The presenter may also share another real-world example of Bernoulli's principle as seen in the designing of aircraft wings. These wings are made so that the airflow is faster over the top of the wing, so the pressure is lower. This means that the airflow below the wings is slower, causing higher pressure, which causes the lift that allows the aircraft to fly. Finally, as per the overall script flow, the presenter will conclude the video. The entire Bernoulli's Principle script is available in Appendix B.

4.4. Recording the Videos

A partnership with the NSWCDD Public Affairs Office (PAO) is essential in the making of these videos. The plan is to record these videos in early FY21 and use the expertise and resources the PAO offers to develop a quality product to share with the community. As with all STEM engagement products, in accordance with established procedures, the PAO office is responsible for reviewing material for public release. Through discussions with our educational partners, a video duration of 5-10 minutes is appropriate for the age range that will be engaged with this video. Because these videos and kits will be used as supplemental teaching resources – rather than a lesson replacement – this shorter length will allow teachers to seamlessly integrate them into their lessons.

4.5. STEM-in-a-Box Demonstration Video Distribution

Distribution of these videos, and eventual kits, will follow a phased approach. Phase 1 consists of deploying the pilot video as an online resource, using the Regional Educators' Shared Google Drive, to which all local educators have access. During this phase, feedback will be collected from educators to update the pilot video as needed and plan for additional videos.

STEM-in-a-Box kits will be created during Phase 2. This requires identification, purchase, and consolidation of all necessary handouts, materials, and video recordings. Any purchases of STEM materials will occur in accordance with guidance from NAVSEA, as expressed in the Class Determination and Findings memorandum (21,010) from the NAVSEA Chief of Contracts to the NAVSEA Executive Director. [REF 3] Phase 2 will also include the creation of additional videos as well as distribution of kits to middle school teachers that do not have steady access to STEM professionals or support.

Expanded distribution of the existing kits and the creation of additional videos and kits will take place during Phase 3, to further the NSWCDD STEM Outreach Program's impact.

4.6. Lessons Learned and Next Steps

While developing and creating the plans for these videos, several lessons learned were noted. The best demonstrations for these videos are those that require a minimal amount of necessary supplies. More supplies means more space is required for filming, more funds are required for procuring materials, and more supplies need to be sent to educators.

To continue, improve, and expand these STEM-in-a-Box videos, some next steps have already been outlined as part of the planning. Getting students involved in the filming would make the demonstrations more interactive and engaging, and viewers will be able to relate with a live, student audience. Even without students in the videos, introducing the Socratic method will help encourage student viewers to think critically and truly understand what they are witnessing. In this situation, the videos would feature a few prompts to pause so that the viewers would have time to consider and discuss what they are seeing. There are also plans to extend the videos beyond the hands-on scientific or engineering demonstrations to the computer science discipline. The goal is to create videos that feature an S&E giving a quick tutorial of a computer program using a language like Python or C++, expanding the reach to students with different interests and targeting more areas of interest for Naval STEM hiring pipeline development.

5.0 STEM CAREER PATH VIDEOS

Another initiative of the Virtual STEM Outreach Program is a variation of video recordings that primarily focus on a particular S&E's career: the STEM Career Path videos. As mentioned above, the shift in educational culture caused a transition in the approach of STEM outreach. The NSWCDD STEM Outreach team initiated efforts to create videos that continue to engage and inspire students, despite not being able to interact in-person. The desire to showcase some of the different NSWCDD STEM careers sparked the development of these Career Path videos.

This initiative consisted of the following activities, discussed further in the sections below.

1) Collaborating with the Region III Advancing Computer Science Education (ACSE) Consortium to create a list of questions for computer science (CS) professionals to answer about their career paths
2) Identifying appropriate CS professionals for the videos
3) Recording the pilot video
4) Distributing pilot video to ACSE community for feedback

5.1. Collaborating with Region III ACSE Consortium

The Region III ACSE Consortium project is a three-year effort focused on developing, disseminating, and evaluating computer science resources for grades three through eight. This consortium is a partnership between five Region III school divisions, the University of Mary Washington (UMW) School of Education, Code VA, NSWCDD, and the Virginia Society for Technology in Education (VSTE). As a professional learning partner in this collaboration, NSWCDD STEM Ambassadors will discuss their Naval Computer Science careers with students and educators and provide both inspiration and engagement in accordance with NAVSEA STEM program objectives.

The focus of the first year of this project for the NSWCDD STEM Outreach Program was the creation of STEM Career Path videos featuring NSWCDD computer science (CS) professionals. After working with other consortium members and ACSE leaders, a list of questions were created that NSWCDD S&Es answered to discuss their CS profession, necessary CS skills for their profession, and their individual academic and personal journeys in becoming a CS professional.

5.2. Identifying the CS Professionals

NSWCDD has a large population of CS professionals that could have been featured in these videos, but in an attempt to reach a wide variety of students, individuals were chosen carefully. The selected professionals form a diverse group, being of different ages, genders, races, and backgrounds. This was done intentionally in an effort to inspire more students to pursue a career in computer science or STEM and directly supports the fourth goal of the NAVSEA STEM Campaign Plan "promote participation in STEM with underserved populations in STEM education." All the featured STEM Ambassadors are engaging and enthusiastic about their jobs, facilitating a better relationship with the viewers.

5.3. Pilot Video

The first Career Path video features Ms. Molly Thomson, a computer scientist, whose energy and love for her job is contagious, which made her a perfect person for the pilot video. She answered a variety of questions that she received in advance of the recording, giving the viewers a glimpse into the work she does as a computer scientist. For example, after introducing herself, Ms. Thomson talked about how she finds her profession challenging and rewarding, and how she is proud of her contributions to the Navy and national security. Ms. Thomson discusses how she became a computer scientist in an engaging way. To keep the video to a reasonable length, the video was edited down to 2-3 minutes after filming to showcase the most interesting and important aspects of her career. The final video is an interesting vignette suitable for incorporation into course materials educators are preparing through the ACSE Region III grant; this vignette will inspire and engage students at critical ages for successful STEM career development.

A collaboration with the NSWCDD PAO was essential in the development of these videos. NSWCDD PAO has top-of-the-line equipment and expert videographers and editors that ensure video vignettes have professional quality. NSWCDD PAO is also responsible for all aspects of review for public release. One positive outcome of the collaboration between the STEM Outreach Program and PAO in the production of the pilot video is establishment of an effective working relationship between these teams. This partnership also serves as a model that other Naval STEM partners can emulate.

5.3.1 Pilot Video Distribution

The pilot video was released to the ACSE leadership and was received positively. Some comments were received that will be incorporated in future videos featuring additional CS professionals. Currently, Ms. Thomson's pilot video is accessible through the Regional Educators Shared Google Drive, and there are plans in place to publish all of the STEM Career Path videos as part of the #GoOpenVA repository through the Region III ACSE Consortium project. Ultimately, the new Computer Science curriculum the Consortium is developing will become a statewide resource and incorporate the NSWCDD- and Navy-STEM-branded vignettes.

5.4. Lessons Learned and Next Steps

After the first video, some lessons were noted that will be taken into account when developing future videos. Keeping the videos relatively short – no more than five minutes – is best because it would be hard to keep students' interest for much longer, especially since these videos are just one person talking, without much else to watch. This lack of other interactive content sparked another lesson – some footage of the speaker performing elements that show how their career supports the overall Navy mission would enhance these videos, because this additional content would provide a different perspective on the speaker's work.

Moving forward, future videos supporting Naval STEM objectives will feature S&Es of other disciplines. NSWCDD hires a plethora of STEM professionals of differing backgrounds, experiences, and disciplines, so these STEM Career Path videos could display many different fields and career opportunities available at NSWCDD.

6.0 ONLINE STEM ACTIVITY RESEARCH

Along with the creation of videos, successful execution of the VRW, and creation of Meet-an-Engineer, the team has increased their knowledge of online STEM resources. Collaborative research and exploration has been ongoing between the NSWCCD, NSWCDD, NSWCDD DNA, and SCSC STEM Outreach programs to generate a list of available online activities and resources that can be utilized by both educators and STEM Ambassadors for virtual outreach and learning. The Virtual STEM Outreach Program has enabled more than the transformation of current activities; it has also given the team the opportunity to provide online resources and activities to educational partners. The current table of online STEM resources and activities is available in Appendix C. This table is a working document and, therefore, is updated continuously as new research is conducted and documented.

This research has proved fruitful for other STEM Outreach programs. One discovery is a software program called Virtual Robotics Toolkit™ (VRT). This is a virtualized LEGO® EV3 robotics environment, which allows individuals to build and program a LEGO® EV3 as if they had a physical kit in front of them. Multiple STEM Ambassadors were able to download and test this software. Through their testing, they were able to deem it a good capability to host a pilot virtual high school fall camp in an effort to transform the traditionally in-person high school summer camp that occurs annually. Lessons from the fall virtual camp will be documented and incorporated internally for future virtual events.

7.0 ETHICS TRAINING UPDATE

The NSWCDD STEM Outreach Program leads the NAVSEA STEM community in implementation of formal ethics training. Prior to establishment of the Virtual STEM Outreach Program, this training has been implemented at NSWCDD DNA and SCSC. This training has three cornerstones: child protection, resource management, and staying on message. Child protection involves some specific barriers to abuse: two-person adult integrity for all NSWCDD STEM Outreach activities, and a prohibition against one-on-one electronic contact. It is anticipated that the Virtual STEM Outreach Program's ethics training will become a standard and model for other NAVSEA STEM Outreach programs.

Because virtual and hybrid outreaches change how STEM Ambassadors interact with the community, the STEM Outreach Ethics Policy and Best Practices training was updated to include new guidelines to further ensure continuous, strong child-protection features. The NSWCDD Legal Department was consulted, and specific guidance was added to instruct STEM Ambassadors that all virtual sessions need to be recorded and a second adult – be that a teacher or another STEM Outreach Lead – needs to be present and online during all virtual sessions. Since the Ethics Training is in part scenario-based, a new scenario was added to the ethics training as the primary method of conveying the updated guidance. These new guidelines were necessary to keep the ethics training material relevant as the current educational culture shifts. STEM Ambassadors will be expected to complete this training annually.

8.0 VIRTUAL STEM OUTREACH PROGRAM FUTURE

Moving forward, Virtual STEM Outreach will continue to grow even when schools return to a traditional classroom environment; these virtual engagements will still prove to be effective ways of interacting with students and educators. Effective virtual STEM enables the overarching Naval STEM Outreach community to engage communities over greater distance and at scale. Physical engagements are frequently limited by the availability of STEM Ambassadors in communities of interest, travel budgets, and so forth – but virtual engagements can overcome the challenges of geography. This shift towards virtual learning and outreach enables the transformation of existing programs, like SeaPerch, SeaGlide, and STEM summer camps into a new, virtual format. In many ways, the shift to Virtual STEM Outreach has shifted from a reactionary response to a forcing function (COVID-19) into a positive transformation of Naval STEM Outreach.

In the future, Virtual STEM Outreach will guarantee that – regardless of social distancing posture – Naval STEM outreach activities can fulfil the objectives of the Naval STEM strategy. As stated in the strategy, “Through active participation in naval-relevant STEM opportunities, students and professionals learn from each other and increase confidence in themselves and their abilities.” [REF 4]

Virtual Coding Club is one example of an activity that has transitioned from an in-person engagement to one that is virtual, incorporating the lessons learned from this program. This is a biweekly club meeting for about 10 students in grades 4 and 5 at the DoD Education Activity (DoDEA) Dahlgren School. During these meetings, students are taught a brief lesson about coding and then split into breakout groups, where they are given the chance to try out a variety of exercises on their own, with STEM Ambassadors available to help if needed. The club meetings began in September 2020 on a small scale to provide the students, teachers, and STEM Ambassadors involved an opportunity to adapt to this new, virtual approach. The plan is to expand this concept when appropriate and possible, and to use this club as a model for all virtual clubs and recurring engagements.

9.0 SUMMARY AND CONCLUSION

The Virtual STEM Outreach Program is a catalyst for the transformation of the overall NSWCDD STEM Outreach Program and serves as the pilot for a similar transformation for NAVSEA STEM Outreach. There are many benefits of the program that have been realized over the past several months of execution; however, there are some challenges and limitations as well. Overall, the program has taught the STEM Ambassadors and local educator community that virtual and online activities can be a good model for STEM outreach.

9.1. Realized Benefits

The Virtual STEM Outreach Program has enabled new forms of collaboration with educational partners, local naval partners, and more. By incorporating virtual capabilities to existing STEM programs to transform them and creating new activities for the future, a broader range of possibilities is achievable. Virtual activities prevent physical location from limiting attendance and outreach potential. Participation in virtual events provides teachers and students flexibility because attending virtual trainings, workshops, and lectures is possible from any location with an internet connection. Consequently, the reach of the Virtual STEM Outreach Program partners can feasibly extend to the outer bounds of Virginia, Maryland, and other states without the added cost or inconvenience of transportation.

9.2. Challenges and Limitations

Due to the virtual nature of this outreach, many technical difficulties are prevalent. For example, not all areas or schools participating in the virtual events have the same levels of access to stable internet connections. Another limitation is the difference in equipment utilized by school systems. A majority of the surrounding area school systems supply and use Chromebooks® in the classroom, which do not have the same processing power as other machines. The use of Chromebooks® provides the students and teachers with a lightweight, minimalistic computer that may meet many of their school requirements but may limit the functionality of the machine overall. An additional challenge is that the Navy Marine Corps Intranet (NMCI) network does not allow access to most online, public collaboration platforms. Therefore, NSWCDD STEM Ambassadors need to use non-NMCI enabled machines to participate in the virtual initiatives effectively.

9.3. Conclusion

The Virtual STEM Outreach Program was created in response to the COVID-19 global pandemic to continue supporting the community. Its numerous initiatives included:

- Virtual Robotics Workshop
- Online Platform Research
- Virtual Meet-an-Engineer Initiative Planning
- STEM-in-a-Box Demonstration Videos
- STEM Career Path Videos
- Online STEM Activity Research
- Ethics Training Update

All of these initiatives were successfully executed, the lessons learned were documented, and future plans were made to continue the success of the Virtual STEM Outreach Program. More events are being planned and executed; each one building off the successes and failures of the last. As educational models shift to incorporate more virtual and distant learning, the NSWCDD STEM Outreach Program will strive to ensure that the NAVSEA STEM Campaign goals are continuously achieved. Through the self-assessment and formal documentation strategies employed by the virtual STEM collaboration, the campaign goal of continuous improvement is satisfied.

The success of the Virtual STEM Outreach Program shows that, with enough planning, coordination, and communication, virtual events are not only possible, but they are also extremely productive, scalable, and generalizable across communities with historically low representation in STEM fields. The future of the Virtual STEM Outreach Program will include not only the transformation of applicable outreach activities such as summer camps, but also the creation of new initiatives and activities using the research gathered and lessons learned from this program.

10.0 REFERENCES

[1] Smerchanshy, J. H., and McCormack, D. F., *NAVSEA STEM Campaign Plan*, Naval Sea Systems Command, 2019.

[2] Shulenberger, J. D., and Olsonbaker, J., *Solving the Shortage of STEM Personnel in Navy Laboratories: Strategic Plan for Navy Investments in STEM Education Targeted at the "Navy After Next,"* Report APL-UW TR 0901, Johns-Hopkins Applied Physics Laboratory, Laurel, Maryland, 2009.

[3] Lofgren, J. G., "Class Determination and Findings Memorandum 21,010," Naval Sea Systems Command, 2019.

[4] Winter, M. A., *Naval STEM Strategy*, Office of Naval Research, 2016.

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APPENDIX A – VIRTUAL ROBOTICS WORKSHOP RULESETS

A.1. Virtual Robotics Ruleset

1. All sessions are recorded.
    a. Main session through WebEx®
    b. Breakout sessions through Zoom™
2. Only speakers should have their cameras and microphones on. ALL other microphones and cameras should be off.
3. Any questions and comments will be addressed through the chat box or through the "raise hand" feature.
    a. If you have a question to ask or comment to make, please put it in the chat box first or raise your hand.
    b. The facilitator will stop the presenter or look for an opportunity to ask the speaker the question or call on you to ask your own question.
    c. Do NOT turn on your microphone to ask a question while there is an active speaker.
4. Facilitators shall:
    a. Provide their contact information to the educators.
    b. Be able to "mute all" attendees.
    c. Be able to "remove" attendees if necessary.
    d. Keep the workshop flowing smoothly by serving as "gatekeepers" between attendees and speakers.

A.2. Breakout Session Approach

Throughout both beginner trainings, there will be breakout sessions to allow attendees to test what they have learned in the allotted time.

All attendees will be preassigned to a breakout group facilitator prior to the start of the workshop. Attendees will remain with the same breakout group and facilitator for the entire day.

1. The Zoom™ online platform will be used for the breakout sessions.
2. Each attendee should have TWO links:
    a. WebEx® link for main workshop session
    b. Zoom™ link for preassigned breakout group sessions
3. The WebEx® and all Zoom™ sessions will be ongoing the entire day and will have the same meeting information from the start of the day.
4. Attendees must move from WebEx® to Zoom™ to join their breakout groups and then move back to WebEx® to rejoin the main workshop session.
    a. When moving from WebEx® to Zoom™ and back, CLOSE out the window entirely and OPEN a new window. (We have noticed significant lags when two tabs are kept open to run two video streams and screen share on a single Chromebook®. Therefore, we recommend closing the previous window before opening a new window.)

   b. Alternatively, if feasible, use two different machines (laptops, Chromebooks®, or a combination) for the workshop.

A.3. Breakout Session Rulesets

These breakout sessions have similar rulesets to the main WebEx® session. However, with fewer group members, the rules are a bit more relaxed:

1. All sessions are recorded.
2. Ideally, only speakers should have their cameras and microphones on; other microphones and cameras should be off.
3. Any questions and comments will be addressed through the chat box.
   a. If you have a question to ask or comment to make, please put a note in the chat box.
   b. The facilitator will look for an opportunity to ask the speaker the question or call on you to ask your own question.
   c. Do NOT turn on your microphone to ask a question while there is an active speaker.
4. Facilitators shall:
   a. Provide their contact information to the educators.
   b. Keep the breakout time flowing smoothly by serving as “gatekeepers” between attendees and speakers.

APPENDIX B – BERNOULLI'S PRINCIPLE SCRIPT FLOW

1) Introduce yourself
    a. Name
    b. Job title
    c. Short description of job function
2) What scientific principle are you going to be discussing?
    a. Bernoulli's Principle
    b. In the 18th century, a Swiss mathematician named Daniel Bernoulli developed the idea that the faster air flows over the surface of something, the less the air pushes on that surface, and so the lower the air pressure.
3) Activities
    a. "Paper Trail"
        i. Materials needed
            1. Piece of paper that measures roughly 3 in. by 8.5 in.
        ii. Do the activity – explaining what you're doing along the way
            1. Hold the paper under your lips and blow a steady stream of air over the paper. (It should lift up slightly.)
        iii. Explain the scientific principle being demonstrated. Why is the thing happening that is happening?
            1. Consider Bernoulli's Principle: Because blowing air over the paper moves the air faster, the pressure is slightly lower than that below the paper, resulting in a slight lift.
            2. This is why strong windstorms can simply "lift" the roof off of a building.
        iv. Paper Trail Handout

NSWCDD STEM

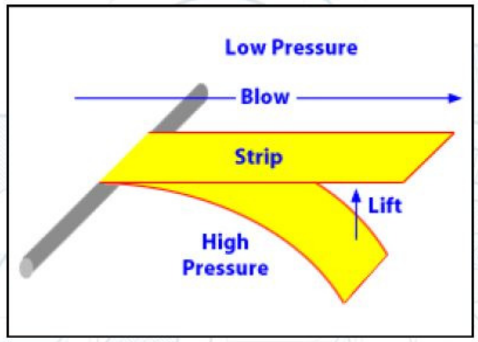
PAPER TRAIL

DIRECTIONS

1. Cut a piece of paper into a strip that is 3 inches wide and 8.5 inches long.
2. Hold an end of the strip just below your lips.
3. Blow a steady stream of air above the paper. What happened?

BERNOULLI PRINCIPLE

Developed by 18th century Swiss mathematician Daniel Bernoulli, the Bernoulli Principle, states that the faster air flows over the surface of something, the less the air pushes on that surface and so, the lower the air pressure. The moving airstream above the paper has slightly lower pressure than the static atmosphere below. The static air below the paper has a higher pressure and tends to move toward the area of low pressure causing the paper to move upward.



NAVY NOTES

Airplane wings are shaped so that airflow is faster over the top of the wing and air pressure is lower. Under the wing, the airflow is slower and the pressure is higher. This causes lift and higher pressure under the wing pushes the wing up. The Navy relies on its planes and jets to deter threats, obtain information, and get supplies .

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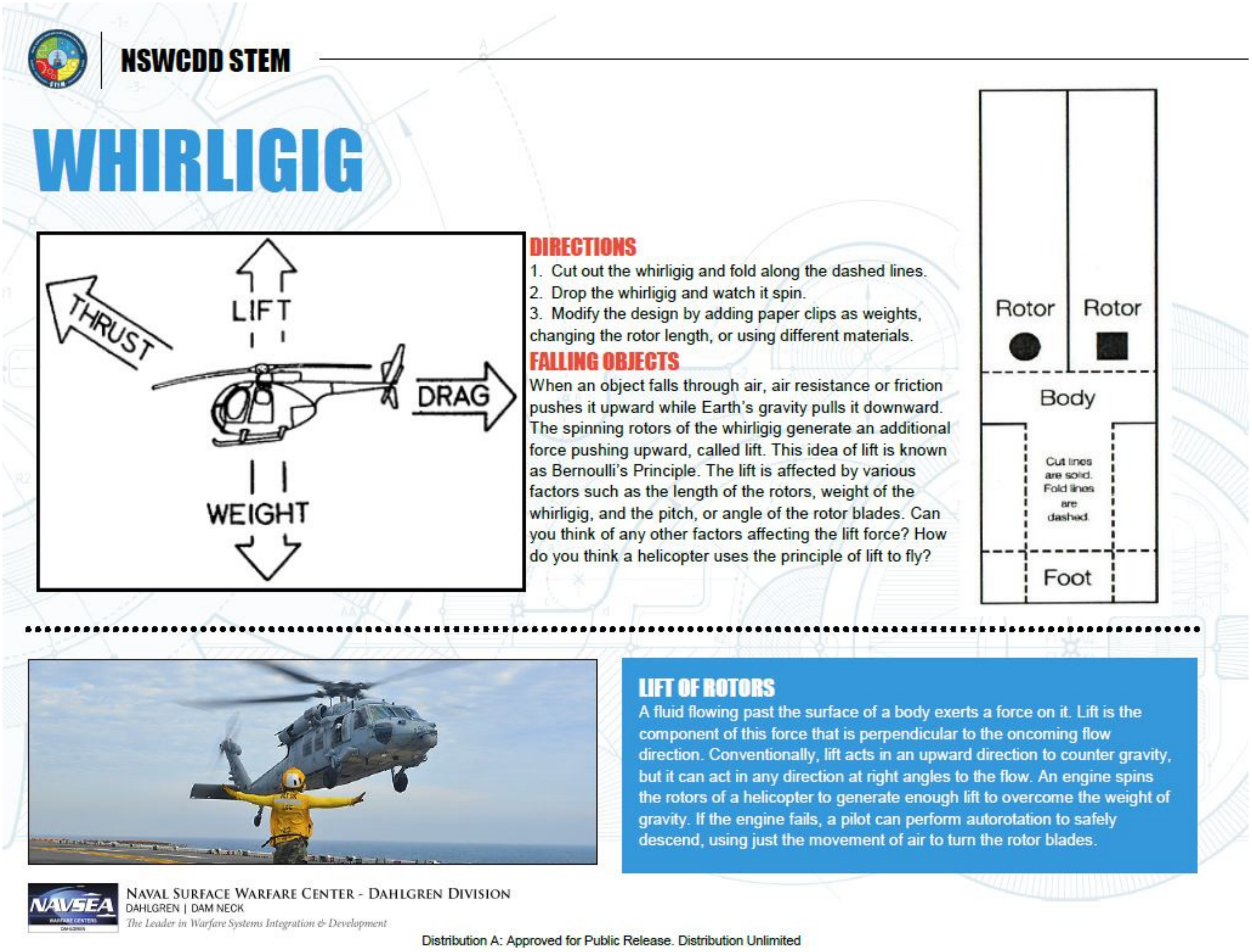
b. "Whirligig"
   i. Materials needed
      1. Paper with outline of whirligig on it – cut along the solid lines and fold along the dashed.
   ii. Do the activity – explaining what you are doing along the way.
      1. After "making" the whirligig, drop it and watch it spin.
      2. Can change it up by adding paper clips for extra weight, adjusting the rotor lengths, or using other materials.
   iii. Explain the scientific principle being demonstrated. Why is the thing happening that is happening?
      1. Bernoulli's Principle causes lift as the spinning whirligig falls through the air. Lift is affected by all kinds of factors, such as rotor length, the weight of the whirligig, and the pitch, which is the angle of the rotor blades.
   iv. Whirligig Handout



c. "Bernoulli Bag"
   i. Materials needed
      1. Bernoulli bag
   ii. Do the activity – explaining what you are doing along the way.
      1. Hold the bag right by your face and blow as much air as possible in three breaths.
      2. Quickly close the bag and push all the air to one side to see how full the bag is.
      3. Let all the air out of the bag.
      4. Have someone hold up the sealed end of the bag.
      5. Hold your side open as wide as possible with your head about a foot from the opening, take a deep breath in, and blow all your air out in one quick stream.
      6. Quickly close the bag and push the air to one side to see how full it is now.
   iii. Explain the scientific principle being demonstrated. Why is the thing happening that is happening?

1. With your face right by the opening, the only air getting into the bag comes from your lungs, which have a fairly low capacity. When you stand back a little and blow quickly, though, that faster-moving air is surrounded by an area of low atmospheric pressure.
2. Bernoulli's Principle explains: the faster the air, the lower the pressure.
3. Blowing into the bag creates that low pressure inside the bag, and higher pressure around you rushes into the bag in an attempt to equalize the pressure. That means that the bag inflates more quickly thanks to the air that is drawn into the bag because of the pressure differences.

iv. Bernoulli Bag Handout

NSWCDD STEM

BERNOULLI BAG

DIRECTIONS

1. Blow as much air as you can into a Bernoulli Bag in only three breaths.
2. Push all the air to the closed side of the bag. How full is it? How many breaths would it take to fill the bag? Are there any other ways we could fill the bag?
3. Remove all air from the bag and have a volunteer hold up the closed side.
4. With your hands, hold the opening of the bag as widely as you can get it.
5. Keeping your head about 1 foot from the opening of the bag, blow one stream of fast moving air into the bag.
6. Immediately close the bag and push all the air to one side. How much air were you able to capture this time? Why?

BERNOULLI PRINCIPLE

If you blow into the bag with your face against the opening, the only air that goes into he bag is the air in your lungs, which have low capacity. Bernoulli's principle helps here! A stream of fast moving air is surrounded by an area of low atmospheric pressure. The faster the air, the lower the air pressure. When you blow into the bag, you create an area of low pressure inside the bag. Higher pressure air around you in the atmosphere rushes into the bag to equalize things. In other words, the bag quickly inflates because air from the atmosphere is drawn into the bag due to the difference in pressure.

NAVY NOTES

Bernoulli's Principle explains how airplanes fly. An airplane wing is shaped and tilted so that air moves faster over the wing than under. That means the air pressure is lower over the wing. The high air pressure under the wing pushes it up. This force is known as lift.

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d. "Come-Together Cans"

i. Materials needed

1. About 20-30 straws, laid out flat to make bed/raft
2. Two empty soda cans, set on top of the straws 5 cm or so apart
3. One other straw, bigger than those laid out

ii. Do the activity – explaining what you are doing along the way.
   1. Hold the bigger straw in between the cans and blow; the cans move towards each other.

iii. Explain the scientific principle being demonstrated. Why is the thing happening that is happening?
   1. Bernoulli's principle explains that faster airflow creates lower pressure, so the air moving between the cans is moving faster than that on the outside, which means the pressure is lower between the cans. This imbalance of pressure causes the cans to move towards the area of lower pressure as the outside pressure forces them together.

iv. Come-Together Cans Handout

NSWCDD STEM

COME TOGETHER CANS

DIRECTIONS

1. Lay down a bed of 20-30 small diameter, round straws.
2. Place two empty soda cans a short distance (5cm) apart on top of the straws.
3. Hold a large straw between the two cans and blow. What happened?

BERNOULLI PRINCIPLE

Developed by 18th century Swiss mathematician Daniel Bernoulli, the Bernoulli Principle, states that the faster air flows over the surface of something, the less the air pushes on that surface and so, the lower the air pressure. The moving air between the cans has a lower pressure than stationary air on the outside of the cans, creating an imbalance of pressure. This causes the cans to move toward the area of lower pressure. The higher pressure air outside of the cans pushes them together.

NAVY NOTES

In October 2016, the USS Montgomery collided with a tugboat that was pushing the ship further from a quay wall, earth retaining structure which is used to dock floating vessels. Winds which were over 30 nautical miles per hour caused the collision. Fast wind moving between the two boats caused low pressure. The two ships moved toward the area of low pressure and collided.

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4) Connect the scientific principle demonstrated to the real world – specifically to U.S. Navy work if possible.
   a. A proper understanding of Bernoulli's Principle is key for the U.S. Navy for refueling ships, designing aircraft, and much more!

   b. For example, in October of 2016, the USS *Montgomery* collided with a tugboat that was pushing the ship because fast wind was moving between the two boats, causing low pressure just as we saw in the “come-together cans” demonstration. As you now know, that draws objects into the area of low pressure, which is exactly what happened, and the boats collided. In fact, the water itself flowing between the boats has the same sort of effect. Because of this phenomenon, sailors and officers have to be extremely careful when operating ships in close proximity to one another – for example, when refueling ships with an oil tanker.
   c. A proper understanding of Bernoulli’s Principle is necessary for designing aircraft wings – the wings must be shaped so that the airflow is faster over the top of the wing, so the pressure is lower. This means that the airflow below the wings is slower, causing higher pressure, which creates the force we call lift. In the Navy, planes and other aircraft are relied on for supplies, information, and to deter threats, so it is extremely important that they fly properly.

5) Wrap up
   a. Thank you for watching this video recorded, produced, and edited by the Naval Surface Warfare Center Dahlgren Division STEM Outreach Program.
   b. Quick summary of principle
      i. Bernoulli’s Principle – faster air flow creates lower pressure
   c. Quick summary of demonstrations seen
      i. Bernoulli’s principle can:
         1. Create lift, as we saw with the strip of paper;
         2. Affect the falling of objects, as we saw with the spinning whirligig;
         3. Cause an area to fill up with more air, as we saw with the bag; and
         4. Cause objects to move towards each other, as we saw with the cans.
   d. Contact information
      i. For more information about these scientific concepts and more about careers, internships, and technical work at NSWC Dahlgren Division, reach out to the STEM Outreach Program through your STEM teacher or librarian.

APPENDIX C – ONLINE STEM RESOURCES AND ACTIVITIES

Name	Description	Age Group or Age Level	Link
Dash	Dash is a free online course that teaches you the basics of web development through projects you can do in your browser. Main languages that the course focuses on are HTML, CSS, and JavaScript.	Not specified, Grades 9-12 based on specific languages taught	https://dash.generalassemb.ly/
Girls Who Code	The Girls Who Code club official website offers many great resources and activities for students. They recently released an article about how they will be posting more activities during these periods where students are doing school online. The activities range in difficulty and age range but the website has many resources. Each activity has a difficulty level with it, which should help students/parents/teachers decide where to start.	All Ages	https://girlswhocode.com/code-at-home/
Microbit	Microbit has developed a synchronous online classroom environment for teaching coding using the Microbit. You can use either MakeCode (a Scratch-like language) or Python. In addition, since the environment includes a virtual simulation of the Microbit, students do not have to have a Microbit to participate. Here is a link to a SparkFun Webinar on the topic. It is a 40-minute session and the instructor is a former Middle School teacher. Discussion of the Microbit and the online environment starts about 15 minutes in, but it is well worth watching the whole clip.	Grades 5-12	https://www.youtube.com/watch?v=7GPkEk-RkWQ https://classroom.microbit.org https://microbit.org/lessons/
Scratch	Scratch is a free programming language and online community where you can create your own interactive stories, games, and animation. This site was designed by MIT and is great for students from 8-16 to learn to code in a fun, easy way.	All Ages	https://scratch.mit.edu/

Scratch Jr.	This site is a spin-off from Scratch and designed for students ages 5-7.	Ages 5-7	https://www.scratchjr.org/
Virtual Robotics Toolkit	Use the official LEGO® MINDSTORMS® EV3 programming environment to write programs to control your virtual robot, just as you would the real thing.	Grades 9-12	https://www.virtualroboticstoolkit.com/
Python for Education Keynote Lecture	With the introduction of a national computing curriculum in the UK, teachers have been searching for a text-based programming language to help teach computational thinking as a follow-on from visual languages like Scratch. The educational community has been served well by Python, benefiting from its straightforward syntax, large selection of libraries, and supportive community. In this keynote, Carrie Anne will discuss existing barriers to Python becoming the premier language of choice for teaching computer science, and how learning Python could be helped immensely through tooling and further support from the Python developer community.	Intermediate Programmers (5th-12th grades?)	https://www.youtube.com/watch?v=gaFk0Sya_HI&index=1&list=PLs4CJRBY5F1LvjmMRjvSUnGJCWGvhRxtI
WeDo 2.0 LEGO® Education	LEGO® Education WeDo 2.0 combines LEGO® elements with intuitive block-based coding and standards-aligned lesson plans that make STEAM learning fun and accessible. LEGO® bricks, sensors and motors help students of all levels develop a concrete and tangible understanding of abstract concepts.	1st-5th Grades	https://education.lego.com/en-us/products/lego-education-wedo-2-0-core-set/45300#confidence
NASA Wallops Flight Facility Visitor Center Virtual Tour	The virtual field trips involve a live presentation and question-and-answer session led by a Visitor Center staff member, and a hands-on activity using items commonly found in the house or classroom. Virtual experiences focus on a variety of STEM topics that relate to Wallops and NASA missions, including; weather, rocketry and exploring the solar system. (minimum 10 participants)	1st-8th Grades	https://www.nasa.gov/wallops/2020/press-release/nasa-wallops-visitor-center-offering-free-virtual-field-trips
Intro to EV3 Programming Curriculum	Introduction to Programming provides a structured sequence of programming activities in real-world, project-based contexts. The projects are designed to get students thinking	Beginner Programmers (4th-8th grades?)	https://www.cs2n.org/curriculum

(Carnegie Mellon)	about the patterns and structures of not just robotics, but also programming and problem solving more generally. This curriculum includes videos, animations, and step-by-step lessons designed to help beginners learn behavior-based programming using the LEGO® MINDSTORMS EV3 hardware and EV3 Classroom scratch-based programming software.		

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