Development of Effective Distance Learning in Response to Covid-19 Pandemic

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Abstract

As the COVID-19 Pandemic ravages the world, it is essential to examine the effectiveness of instructional and technological tools for distance education that were developed during the pandemic crisis. This paper provides techniques for effective remote instruction and examples of educational tools used during the pandemic at the United States Coast Guard Academy. The authors posit that distance education should be designed to promote study and investigation within authentic, realistic, relevant, and information-rich contexts; with a focus on instruments that consider students' individual needs and learning styles. Remote learning should encourage student responsibility, initiative, decision making, and intentional learning and cultivate an atmosphere of cooperative learning among students and teachers. This is best accomplished by utilizing dynamic, generative learning activities that promote analysis, experimentation, synthesis, problem solving, and assesses student progress in learning through realistic tasks and performances. The paper presents how effective distance education can be delivered by focusing on learning resources, pedagogy, learner support and management.

1. Introduction

Over more than thirty years, distance education has become a mainstream instructional delivery option for college instruction as a majority of universities have been under increasing pressure to cut costs, develop partnerships with industry, and advance innovative teaching methods [1]. For many economically disadvantaged students, members of the military, or individuals balancing the demands of family and a career, distance education has become an essential component to their professional development. As distance education has expanded to meet the growing demand, new teaching methods and innovative instructional technologies offer exciting ways to educate students in a virtual environment [2]. This medium made distance education an extremely attractive tool for reaching new customers worldwide at allow cost to the academic institutions. As the COVID-19 begin to surge across the United States, educators in colleges and universities in the United States have been challenged to drastically increase the use of virtual or distance delivery of courses, tutoring advising and other student support services. To protect health and community resilience, distance learning has become the only safe and practical choice for many students and institutions during the pandemic.

Distance education is a process that provides access to learning when time and distance separate the source of information and the learners. Commonly used Internet and computer technologies have been measured as sufficient for delivering distance learning. Technology-assisted distance education has become increasingly widespread in recent years, owing to the extremely rapid expansion of distance-education technologies. These technologies have evolved from traditional technologies such as mail, telephone, and fax, to instructional television, satellite-based technology, and computer systems such as the Internet [3]. With the increasing availability of the Internet to most potential distance students, internet-based distance courses have been thriving over the years. Although there are many suggestions for how to use the Internet to deliver distance courses, few studies report the actual uses of Internet technologies alone or in combination with other technologies and pedagogical techniques in effective distance learning [4].

The effectiveness of distance learning continues to be discussed, especially in terms of which technologies and pedagogical methods can be implemented to improve student learning [5]. Virtual learning, which attempts to replicate classroom teaching in online mode and is an increasingly prominent form of distance education. As the number of distance-learning programs has increased and the range of delivery techniques have grown, especially during COVID-19 pandemic, it is imperative to examine the use and the effectiveness of distance education methodologies and technologies in order to select and deploy the best alternatives. In this article, we report examples of effective technologies and pedagogical strategies for distance education that was developed especially for distance education during COVID-19 pandemic at the United States Coast Guard Academy (USCGA), a small STEM focused undergraduate military academy. Our intention is to present specific pedagogical methods and strategies that were used in achieving learning goals in a

predominantly teaching-focused undergraduate institution during COVID-19 pandemic.

2. Literature review

Over the years, advances in technology have also altered the way we teach and learn [6]. The use of technology in college classrooms allows us to reach more students and to provide online or remote (virtual) education where students apply the material on their own [7]. Numerous studies have been conducted on effectiveness of distance education increases when instruction is continuously assessed and revised so that teaching methods change and improve over time [8]. The Internet or computer-based instruction enhances quality of learning by enabling students to take new and more active roles in the learning process both inside and outside the classroom where students become active participants who are responsible for their own learning while solving problems which lead to the advancement of critical thinking skills [9].

Many Internet-based technologies such as e-mail, the World Wide Web, conferencing on the Web by using remote team-based platforms for video conferencing and file sharing (such as Microsoft Teams) can be used to assist with teaching. All modern computer-based technologies provide a user-friendly and easy access to text, graphics, audio, and video materials that may be applied in a common and consistent format. Most distance education uses Internet computer platforms to deliver basic course information, such as: course syllabus, schedule, announcements, reading lists, synchronous or asynchronous communication, online testing, discussion groups, conferences, whiteboards, streaming audio, and video [10].

Webpage interactivity or other forms delivered via educational platforms such as WEBCT or Desire To Learn (D2L) help engage students in active application of knowledge, concepts and principles and provide them with feedback and interaction that allow their understanding to grow and evolve [7]. The interaction among students and the instructor with course content is based on participation in discussion groups, quiz questions, conferencing, or live chat. Internet-based environment can use one or more of interactive components at any time. In designing learning environments in nontraditional modes, researchers have recommended using an approach that provides appreciation for multiple perspectives, embedding learning in relevant contexts, and encouraging use of multiple modes of learning and course information representation, and encouraging self-awareness of the knowledge construction process. Computer- and technology-based instruction creates experiences that promote the development of higher-order cognitive skills rather than the transfer of content [11]. Materials can be designed to address the various students' learning styles by incorporating a variety of multimedia elements. While traditional instruction tends to focus on social interaction as students are present in the classroom, computer-based instruction can be designed for collaboration and interaction to deliver an effective learning environment [12].

Research on distance-education theories indicates that distance learning is efficient when students experience situated learning and problem-based learning. Situated learning is present when students' work relies on authentic tasks that take place in real-world settings and knowledge is developed by doing specific tasks in specially designed framework and embedded in social, cultural, and physical contexts [13]. Distance education students are motivated and prefer to actively construct their own internal representations of knowledge rather than just accepting what the instructor provides. Therefore, distance learning students learn the best when they are allowed to experience situated and problem-based learning. The challenge for distance educators is to set up a cognitively rich learning environment which facilitates distance learning that promotes development and assessment of critical thinking [14].

This paper complements educational literature on distance learning by arguing whether distance education that utilizes a mix of computer-based instruction together with other pedagogical techniques provides unlimited opportunities for addressing the development of different skills and to what degree it stimulates students' intellectual efforts and competencies beyond that required in courses delivered in a traditional classroom within division, college, or university level. According to *Guidelines on Distance Education During COVID-19*, developed by the Commonwealth of Learning, Burnaby, British Columbia, there are four key elements to be considered for effective distance education. They are summarized in Table 1. Based on these guidelines, the paper presents that effective distance education can be delivered while focusing on *learning resources*, *pedagogy*, *learner support*, and *management.* The next paragraphs represent examples of effective practices for distance education within each category.

Table 1. 2020 Guidelines on Distance Education During COVID-19

Key Elements	**Characteristics and description**
Learning resources	Content is designed to support self-learning and made accessible to students using a variety of media and technology, including print, radio, television, computers, mobiles, and the Internet. When there are clear objectives and support to achieve specific learning outcomes, effective teaching and learning can happen without students

Key Elements	Characteristics and description
	and teachers being in the same place at the same time.
Pedagogy	Teaching and learning are based on sound pedagogical principles of guided-didactic conversation, and appropriate use of two-way communication tools and technologies that help support dialogue and communication. Interaction between students and other students, students and teachers and students and content results in deeper understanding and is an integral part of distance education. In order to benefit maximally from distance education opportunities, students need to be guided to develop self-directed learning skills.
Learner support	Providing psychological and emotional support to learners at a distance alongside continuous academic interaction are keys to student success. Caring human support at a distance facilitates self-directed learning, reduces student isolation, and creates an environment for student engagements in learning. In order to implement effective teaching and learning at a distance, planning and organization of the teaching and learning process from curriculum development to assessment of student learning needs to be managed by an efficient and accountable administrative staff and faculty.
Management	In order to implement effective teaching and learning at a distance, planning and organization of the teaching and learning process from curriculum development to assessment of student learning needs to be managed by an efficient and accountable administrative staff and faculty.

Source: Adopted from 2020 Guidelines on Distance Education during COVID-19 [15]

The authors argue that the rich environment of distance education should be based on providing four key elements: *learning resources, pedagogy, learner support*, and *management*. This design and delivery will ensure that distance education will (1) promote study and investigation within authentic, realistic, meaningful, relevant, complex, and information-rich contexts while focusing on students' individual learning styles and needs; (2) encourage the growth of student responsibility, initiative, decision making, and intentional learning; (3) cultivate an atmosphere of cooperative learning among students and teachers; (4) utilize dynamic, generative learning activities that promote critical thinking process (i.e. analysis, synthesis, problem solving, experimentation, and creativity among many others); and (5) assess student progress in learning through realistic tasks and performances. All those elements are critical to successfully deliver the distance education of the 21st century.

3. Examples: guidelines on distance education during Covid-19

The rest of the paper provides a response to the *Guidelines on Distance Education During Covid-19* that were developed by the Commonwealth of Learning, Burnaby, British Columbia [15]. Academic departments at the USCGA by coincidence met all 4 guidelines while delivering their distance education response to COVID-19. Several examples are provided in this paper to illustrate how our examples conformed to all four key guidelines on distance education delivery: *learning resources, pedagogy, learner support,* and *management* are discussed below.

3.1. Examples of learning resources

3.1.1. Transportation Engineering Design course. Transportation Engineering is a required course that is offered to juniors in the Civil Engineering Program at USCGA. Because of COVID-19, a second portion of the Transportation course had to be redesigned for remote delivery. A significant portion of the course included the completion of a term project that was part of the national Airport Cooperative Research Program (ACRP). The ACRP guidelines required students to focus on developing design solutions addressing airport needs in certain specified areas. As the course transitioned to remote learning, students had the option to meet with instructors remotely once a week to discuss the project details and their progress. The final deliverable of the project was broken down into smaller tasks so students could better manage their time and effectively complete their projects. In addition, one of the course modules was modified to include the use of several online software packages for completion of several design assignments. The tasks were organized into weekly assignments with descriptions of the online resources that were required for gradual progression, and hence successful completion of the project and other course requirements. *Paveexpress* was one of the online resources used to facility one of the design requirements of the course [16].

Pavexpress is an online pavement analysis and design software that includes web-based educational modules with video instruction by leading industry experts. Most of the students were motivated to use the online resources and were savvy in figuring out the details on their own. A few students struggled and required additional assistance from the instructors. Collaboration between students was highly

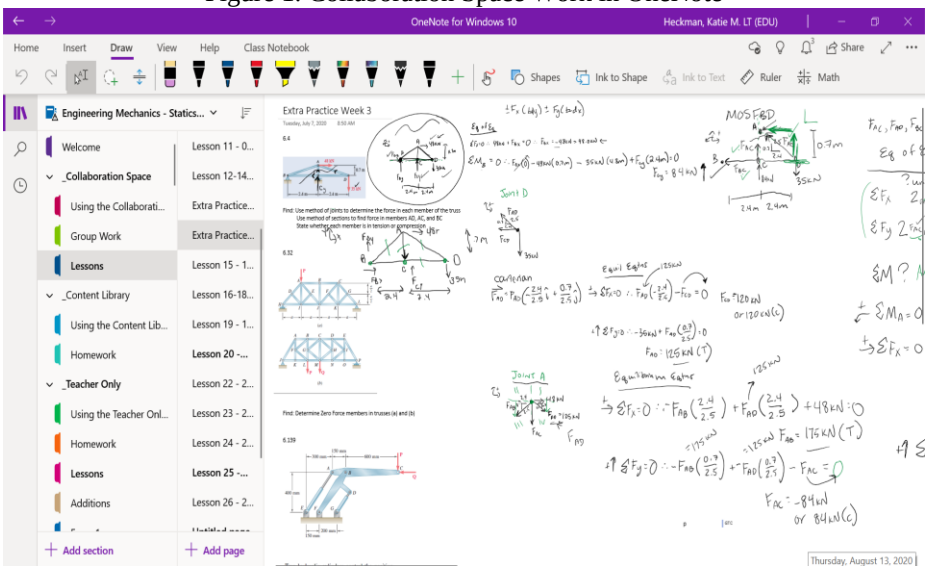
encouraged and the use of instructional video was widely promoted.

3.1.2. Use of technology in Engineering Mechanics course. Engineering Mechanics – Statics, is a basic common course to all engineering majors at the U.S. Coast Guard Academy. One of the important learning tools is the daily homework, completed in the required problem-solving format of DRIDS-V (Define, Research, Identify, Decide, Solve, and Verify), with detailed step-by-step solution. In the Spring semester of 2020, there were eighty-five students divided into four sections and taught by four instructors. The class met three times weekly with an average homework of two problems per class. When shifting to remote teaching due to the COVID-19 pandemic, the instructors decided to keep the required homework, quizzes, and exams as determined by the pre-Covid class syllabus.

Prior to COVID-19 pandemic, the course had been using Desire2Learn (D2L) software primarily for recording and sharing grades, posting homework solutions, posting old exams, and uploading files via a drop box. When remote learning began, required homework shifted to once per week, with answers submitted through D2L and an optional posting of students' detailed engineering work in OneNote. In order to introduce students to OneNote, a bonus assignment was created in OneNote to ensure students could insert their documents using OneNote, prior to requiring it for exam and homework submission.

OneNote was selected because it can be used with Microsoft Teams in order to create a digital notebook space for students and teachers for a class. It is also available as an app. The collaboration tab in OneNote can be used for in class instruction, as it is a space where both teacher and student can write and upload documents. An example of the collaboration tab is provided in Figure 1. The teacher tab can be used for the instructor to set up the course content for distribution into students' individual folders. In statics, the students' notebooks were set up to include handouts, class notes, homework, and exams.

Figure 1. Collaboration Space Work in OneNote



Source: U.S. Coast Guard Academy

OneNote can be accessed through the OneNote app, Teams app, or online through Office 365. It is important to remember that OneNote technology was new to both students and teachers, and it is crucial to teach the technology to ensure it is utilized effectively. The submission of homework assignments or exams using OneNote worked well after initial setup and explanation, with minor issues resolved over time. Homework was submitted directly to OneNote. Students used OneNote to either write their solutions electronically using their tablet and stylus, or workout the homework on paper and upload to OneNote. Instructors could see students' work in real time in OneNote. This capability in OneNote allowed all instructors to grade exams instantaneously.

The primary drawback of using OneNote technology was that there was no mechanism to check the status of completion of assignments. If students did not turn in an assignment, there was no way to know if they chose not to post anything to their notebook, or if there had been technology issue. Based on this experience, a recommendation was made to create assignments in MS-Teams and link the assignment to OneNote for future remote summer school and fall classes. Using MS-Teams to create assignments confirms submission of assignments and

allows for better tracking of completed and graded assignments.

3.1.3. Use of technology in Coastal Resiliency course. *Coastal Resiliency* is an interdisciplinary elective course in the Civil Engineering curricula, but it is open to students from other majors and has included students majoring in Electrical Engineering, Marine and Environmental sciences, Naval Architecture and Marine Engineering, and Government. This course addresses ways of incorporating climate science into engineering and provides exposure to best practices used in the civil engineering community to promote infrastructure resiliency in a changing climate. During the COVID-19 pandemic, the course was revised to provide an effective mechanism for delivering the material and ensuring student engagement in the course. Microsoft Team and D2L were the two platforms used to provide remote delivery of the course.

To keep the course engaging and to facilitate student learning at higher levels during the COVID pandemic, computer simulations and software packages were used. Two examples of these pedagogical tools and how they were implemented in the course include:

- *NOAA's Sea Level Rise Map Viewer* – This is an open source web mapping tool that was adopted to assist students visualize community-level impacts from coastal flooding or sea level rise. Students implemented this tool to generate simulations of how future flooding might impact local landmarks especially within their project areas. Addition information was also generated on water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss and migration, and mapping confidence [17].
- *U.S. Army Corps of Engineers (USACE) North Atlantic Coast Comprehensive Study (NACCS)* – Students used this tool to understand the lessons learned from Hurricane Sandy and used the techniques and resources to recommend resilient options to mitigate the impact of floods [18].

3.1.4. Online instrument for determining students' learning styles. One of the important aspects of effective learning in distance education is to know how the students learn and what learning styles they have. Understanding how students learn is an important part of selecting appropriate teaching strategies especially in distance learning and making students feel safe and comfortable. Knowledge of students' learning styles can assist college professors in adjusting their teaching styles to the students' learning styles. Distance education should be structured so that all learning styles are addressed, enabling every student to become actively engaged in the lessons. When the curriculum is integrated around a theme with proper attention given to brain compatibility, teaching strategies, and curriculum development, learning is enhanced.

There are numerous instruments that can be used to assess the different dimensions of learning style. The instruments vary in length, format, and complexity. Some require special training to administer and interpret, whereas others can be given by following a few simple directions. Though the different instruments have many similarities and attempt to measure learning style preferences, the terminology used to label the learning styles varies widely [19]. We adopted and used the VARK questionnaire that has been developed and used by Neil Fleming at Lincoln University, Canterbury, New Zealand, in 1995. The VARK instrument provides four styles of learning, called: V, A, R, K**.** A simple version of the VARK questionnaire focuses on the modal preferences for learners and teachers [20].

The VARK instrument is a self-reported questionnaire of 13 questions that allows students to describe the features of their educational experience that they most prefer. Each multiple-choice question has four choices that the student has to select. No student or teacher is restricted to only one of the four modes: V, A, R, or K, (V - visual; A – aural; R – read/write; K – kinesthetic). The VARK questionnaire, completed at the beginning of the semester, allows the instructor to select the best mix of learning techniques that are effective and operative for each learning style in an online or virtual environment. When students are provided with instructional methods that meet their learning styles, students are motivated to work hard and hence learn more as the learning process used in a course support student's learning skill and make learning easier and efficient.

3.2. Examples of pedagogy

3.2.1. Active learning: case studies and discussions in Essentials of Economics for Engineers course. Case studies bring "Real-Life" scenarios into the economics classroom to provide an opportunity for students to apply what they learn in the classroom to real-life experiences has proven to be an effective way of both disseminating and integrating knowledge. Our students became engaged in discussions about issues and problems related to the COVID-19 pandemic and its impact on the US and global economy. We also placed students into maximum four-member groups to work virtually on case studies in cooperative and role-playing environments to stimulate critical thinking and awareness of multiple perspectives. This learning environment working well in virtual classrooms. However, a successful class discussion involved planning on the part of the instructor and preparation on the part of the students. Instructors clearly articulated the course expectations because as the instructor carefully plans the learning experience, the

students must comprehend the assigned reading and show up for remote class on time and be ready to learn.

3.2.2. Role-playing and student-led discussions in Coastal Resiliency course. In *Coastal Resiliency*, a *Role-Playing* exercise was developed where students worked in groups of three or four students representing different world regions (Southern Asia, Central Asia, Australia, South America, Western Europe, and Russia). The goal of this active exercise was to seek international aid from the United Nations (UN) for use to mitigate short-term resiliency issues related to climate change. Students were expected to research their selected region for pressing climate-related issues and come up with a proposal to improve resiliency to a selected region's hazards. Students played the roles of regional representatives to the UN to present their proposal as they compete for the aid. Only one region can be awarded the financial aid, so the arguments have to be convincing to a panel of faculty who served as UN officials.

The course also utilized student-led discussions. There were multiple opportunities embedded in the course for students to research a topic and lead class discussions after group presentations to the class. Some examples included researching and making presentations on climate proxies, leading weekly discussions on contemporary issues, risk and vulnerability assessments of several civil engineering sectors and role-playing exercises as previously described. One observation was that students became less engaged in this activity as the semester wrapped up due to the stress of coping with the uncertainties of COVID-19 that resulted in lack of motivation. Students expressed their frustrations about the situation during some of these discussions.

3.2.3. Mixing lectures with the short videos. When teaching Statics at the Coast Guard Academy in person, instructors usually use a 15-25-minute lecture on new material for the day, followed by one or two complete example problems. When transitioning to remote teaching, the instructors decided to change and expand the methods of communicating daily lecture material to students. The students were for the most part at home and across different time zones, so the instructors decided to make lectures optional and recorded the lecture for those who could not attend due to the time zone difference or had challenges with reliable internet. In addition to holding and recording optional live lectures, instructors recorded some additional videos using Teams and OneNote to walk students through additional sample problems based on the topic of the lecture. Both the example videos and live lectures benefited students as they could re-watch the videos if needed while working on homework or reviewing the concept that was not grasped the first time through the material. However, the quality of the live lectures was lacking due to currently available technology. These lectures were done without microphones, lighting, and with tablets that had touch screen issues with detracted from having good quality writing completed on the screen. It was also very hard to teach visual concepts via live lecture on Teams. Statics involves learning new concepts and utilizing knowledge the students already have from previously taken math and science courses. The inability to illustrate a concept in a classroom detracted from students' ability to learn some of the content as well as they could have.

At the end of the semester, a student survey was used to understand what tools worked well for the students to learn the material prior to and during the pandemic. The survey results indicated that the best tools for in-person classroom learning were the classroom lectures, working with other students, and homework. In contrast, while in the remote learning environment, the survey results showed the instructor example videos, homework, and live lecture videos were the top tools for learning. Following this survey, the instructors decided to record more short video examples for the students. The recommendation for future remote classes is to create higher quality pre-recorded content videos that will help the students better visualize the statics concepts. The students would then watch the content prior to class and come to class already understanding the basic knowledge. Remote lectures could then focus on example problems, which can more easily be taught live using the OneNote collaboration tool than visual content.

3. 3. Examples of learners' support

3.3.1. Coastal Resiliency course. A major requirement of the Coastal Resiliency course was the completion of a semester project with an emphasis on practical application and relevance to the local community. Before the spring 2020 offering of the course, instructors established partnerships with local and state officials to develop a list of local community projects. Project stakeholders were invited to present their projects to the students. Students were required to work in groups of four. Projects were assigned based on interest and with priority given to ensuring teams were interdisciplinary. Students were encouraged to engage in assessing the diverse perspectives such as incorporating science into engineering solutions, policy, and community awareness and engagement. Their proposed solutions had to be relevant and compatible to the local community they were assigned. To increase effectiveness of the course, the project focused on practical applications of sustainability, scientific, and engineering principles and students were expected to address the challenges of infrastructure resiliency within the context of changing climatic conditions. The objectives of completing the project included: (1)

Performing a vulnerability assessment or suitable assessment tailored to meet the communities' stated needs; and (2) Developing and identify potential solutions that support long-term community goals and improve resiliency to hazards caused by changing climatic conditions.

Fortunately, all groups had completed their site visits before the COVID-19 pandemic began. The site visits included a meeting with project sponsor, community representatives, a walk through, and discussion of the sponsors' expectations. We observed that immediately after the start of remote instructions, there was a significant drop in motivation and some students did not want to continue working on the projects. Some of them indicated that the lack of contact and communications with stakeholders hindered progress. The instructors insisted that the project requirements were still the same and were required to be done for successful completion of the course. Several mechanisms were put in place to appropriately support students work.

First, we developed and used several milestone project-related assignments to ensure that students were making appropriate progress. All students' responses were reviewed, and feedback was provided to students before the next task was due. These efforts took tremendous toll on the instructors because, there were 10 groups of 3 students; and each submission had to be reviewed by at least two instructors. The grading requirements were significantly amplified as instructors believed that this choice helped motivate students to work harder and to deliver a quality product to the stakeholders. Students were very appreciative of the feedback as it fostered an atmosphere of collaboration and intellectual growth. Initially, the final project deliverables included a project report and a presentation to stakeholders. After the COVID-19 pandemic started, this requirement was revised by replacing the oral presentation with a marketing brochure that stakeholders could use to inform the local community. Instructors felt that this was a good compromise that relieved the stress of coordinating presentations with students at multiple locations and time zones. This aspect was well received by both students and stakeholders. An example of one of the project objective and proposed solution is presented in Figures 2 and 3.

Figure 2. Mystic Seaport Project Scope
(Source: the U.S. Coast Guard Academy)

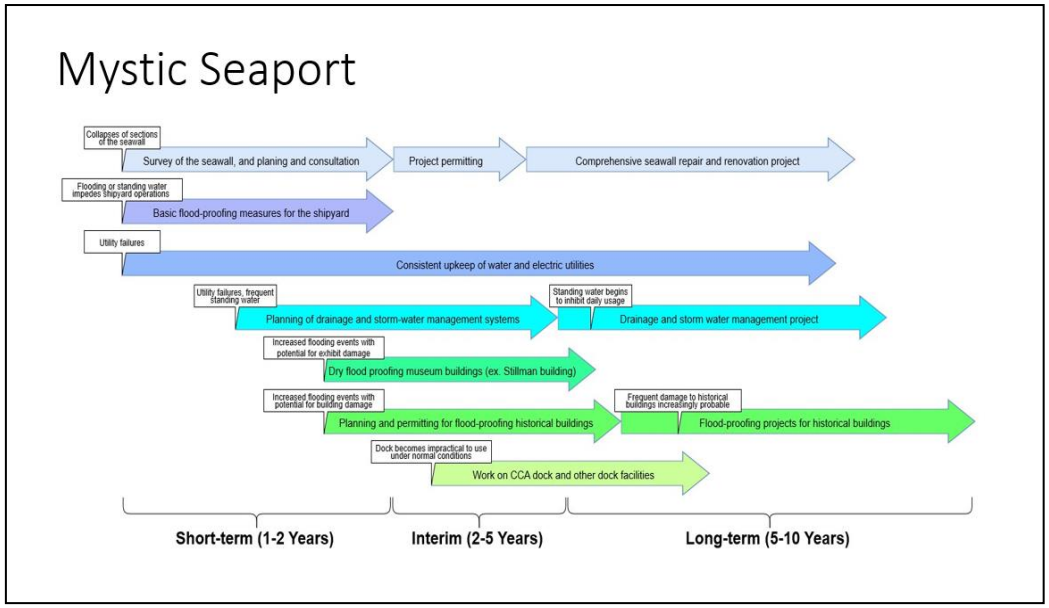


Figure 3. Mystic Seaport Proposed Resiliecy Enhancement Plan
(Source: the U.S. Coast Guard Academy)

3.3.2. Civil Engineering Capstone course. As part of the ABET accreditation requirements, Civil Engineering students were required to complete a final year capstone project that serves as a culminating experience of all the design concepts learned during their undergraduate studies. This capstone course included a major engineering design experience that incorporated several engineering standards and a variety of constraints depending on the project. The projects selected in spring 2020 varied in complexity and provided students with an experience of applying their knowledge through the design, planning, supervision, and managing an actual civil engineering project. The COVID-19 pandemic made it very challenging for students to continue working on their capstone projects because of limited access to the sites and communications with project stakeholders. The capstone course coordinator and faculty advisors had to revise the approach to ensure that students progressed and remained motivated as several students expressed their frustration and lack of motivation in completing the projects once the COVID-19 pandemic began.

Faculty advisors provided emotional support by being sympathetic to the challenges some students faced including difficulty meeting with group members, limited accesses to some resources, etc. Students were also provided with additional guidelines and project management techniques to help them produce the required professional results in a format suitable for engineering practice. All teams were required to complete their projects in smaller manageable tasks with corresponding deliverables for feedback from faculty advisors. Faculty advisors met with their project teams once a week to provide constructive feedback on students' progress and on the quality of student work. The final project report was also divided into 30%, 60%, 90% and 100% submittals that enabled faculty advisors to appropriately critique students' progress. The oral

presentation requirements were also revised to allow students to submit video recordings or animations of their project findings. Most students appreciated the regular feedback and the availability of faculty advisors to address their concerns and answer questions. A significant number of students inferred that this enabled them to stay motivated and focused in completing their senior projects. Due to the increased focus on academics as cadets worked from home during the second half of the Spring 2020 semester and the phased development of final reports, the quality of several capstone final reports exceeded that of reports in previous semesters.

3.3.3. Detailed guidance on projects in Fisheries Management course. One of the successful aspects of remote learning was an introduction of a group projects in the Fisheries Management course after the COVID-19 pandemic began. The purpose of the project was to complement the remote lectures and to provide an active learning facilitated through group projects. To reinforce concepts introduced and learned in the course, each group had to select and analyze a topic on fisheries management using research articles published in scientific journals. Students were required to deliver a five-page analysis of the selected topic followed by a presentation. As the project was introduced quickly after the pandemic

began, students were assisted in completing their projects by receiving detailed guidelines on how to progress with the project. The guidelines were provided to ensure all students understood expectations and objectives of their projects. Students were allowed to select their group members in order to ensure that they were effectively communicating and working remotely with the selected group members.

As the group research project was conducted remotely due to COVID-19 pandemic, the instructor also provided individual group consultations to make sure that the selected articles and issues included in a paper were correctly analyzed in the context of the goals of the course. This ensured that students properly identified and applied the concepts learned in the course. After students received feedback, they shared and discussed the comments received from the instructor with their group members and incorporated their input into their group paper. Students also prepared a presentation on their selected topic in the format of their choice, which ranged from videos of students playing the roles of important stakeholders, panel discussion on Zoom, Power Point presentations with narration and video clips, and storyboard. Group presentations were shared through Discussion Board and each group had to comment and provide feedback for improvement on other presentations.

Based on the students' feedback, the success of the project was attributed to a detailed outline and feedback on every submission provided, which allowed students to progressively correct, improve, and advance the project. Frequent communication among group members and with the instructor in a remote setting was essential to ensure smooth completion of required tasks. The success was also attributed to the fact that the instructor was available for consultations and extra help if it was required. Students appreciated the opportunity of selecting their own articles and topics, which provided a sense of control and ownership. Students also enjoyed communicating via Discussion Board, which was used to replace students' face-to-face interactions that were eliminated due to COVID-19. In the future, the instructor may consider assigning groups for this project, as most students tended to select people they normally work with. Mixing-up groups should allow for increased diversity of perspectives and backgrounds in a more inclusive remote learning environment.

3. 4. Examples of management

3.4.1. Management of education in an age of COVID-19 uncertainty. During the COVID-19 crisis, everyone involved in education – students and their parents, teachers, and administrators – has demonstrated concern, in one way or another, for maintaining some form of educational rigor and academic standards expected for accreditation and educational integrity. While the public's focus is often on the role of the teacher, the fact is that teachers are most often engaged in background dialogue with their immediate school administrators and managers, while trying to determine what can and cannot be done in a remote learning environment. At USCGA, the decision to use specific software, including Microsoft Teams and Desire to Learn (D2L), was made by school administration working closely with our Information Services (IS) department. Some decisions involved dealing with existing contracts as the pandemic set in and resourcing enhanced versions of existing technologies. As elsewhere, all Coast Guard Academy faculty were suddenly faced with the need to teach remotely; flexibility and innovation were encouraged by the Academic Dean and Department Heads. Most faculty, responded very effectively to this new pedagogical reality, despite the fact that most Coast Guard Academy faculty had little to no experience teaching on remote software platforms; certainly it has never been part of the pedagogical tradition of military academies, where the effectiveness of small-sized classrooms is consistently emphasized and maintained. Due to that long-standing tradition of face-to-face pedagogy, Academy's administrators, unfamiliar with those platforms themselves, were suddenly responsible for the management of remotely taught programs.

In the first few months of the COVID-19 crisis it was estimated that over 90% of teachers at all levels of education, from elementary to university, had no experience with remote teaching methods or technologies; for certain, the vast majority readily expressed some concern, to include being uncertain (81%), anxious (75%), and overwhelmed (74%) [21]. While simultaneously stating that they felt "capable" of completing the task, most teachers readily admitted that they felt the need to reduce student expectations in their overall effort to complete their courses and to generally wrap-up the spring semester [22]. But for teachers and students alike, there was really no other option, leaving all involved with rather dramatic adjustments to daily routines. Beyond the steep learning curve for most, many teachers also wondered how to find a proper balance between pressing students to learn more material and paying attention to students' overall well-being; of course, as the COVID crisis continues, this concern remains. Accordingly, for school administrators in charge of managing new remote-based learning environments, gauging faculty comfort and engagement with these sudden changes was part of the challenge.

3.4.2. Diverse needs among academic programs. It was immediately apparent to the Coast Guard Academy's school administrators that remote learning meant different things to different people and that not all faculty were on board with the idea of full

conversion. Initially, there was some resistance to having all courses taught remotely; some seemed amenable, while others believed some form of "hybrid" arrangement would be necessary. Most doubts were raised by senior faculty who had been teaching face-to-face for a number of years. There also were particular challenges in STEM-related courses that required hands-on labs. Without doubt, all concerns were sincerely based on maintaining academic effectiveness and rigor. Ultimately faced with no real option but to somehow complete the spring 2020 semester remotely, there undoubtedly remained misgivings among many faculty members. Many understandably sought guidelines, which management also felt pressure to establish as the semester progressed. Ultimately, anxious for answers as to how best to promote the most effective and safe teaching environment during the pandemic, most continued to rely on dialogues among faculty within individual departments and readily consulted the internet for the latest information.

During Spring 2020 school administrators established a Remote Learning Task Force (RLTF) that included, among others, the Associate Dean for Academic Affairs, faculty from various programs delivering courses for academic credit, and IS staff (the USCGA information technology division). This task force was designed to share best practices in remote learning at USCGA and across higher education and to ensure that faculty and staff were equipped with the necessary tools and training to support their chosen style of remote delivery. RLTF information is posted on Teams, accessible to all faculty, and is regularly updated. Members of the RLTF presented various remote technologies and applications during a faculty in-service day.

The RLTF also gathers concerns and questions from the faculty to resolve any impediments to effective remote delivery. One evident concern was the danger of students copying each other's work, which resulted in this suggestion for a remote class "Honor Statement", by the Academy's math instructors as well as faculty in other disciplines. Another challenge that is ongoing is to maintain sufficient bandwidth and internet support to enable synchronous learning and other virtual activities needed during the pandemic. The information technology leaders have worked to upgrade hardware, software, email and internet capability as the entire 1100-person cadet corps, hundreds of Officer Candidates, faculty, and staff would be relying on virtual options.

As the fall 2020 semester progressed, faculty were also encouraged to use other software packages, such as Camtasia, a tool for recording and sharing videos. Faculty from different departments shared their experiences with Camtasia and other software. In reality, the management model gradually merged into one of "collaborative management," based largely on goodwill of faculty and administration, always maintaining a free flow of dialogue on remote learning and pedagogical methods. Other important RLTF items have included: information on both Microsoft Teams and D2L training, the formulation of new policies regarding the recording of classroom discussions, and the maintenance of existing policies, to include inclusion and diversity. That dialogue continues.

3.4.3. The importance of clear guidance for school administrators. Due to scientific uncertainty and difficulties in adjusting to the COVID-19 outbreak on short notice, school administrators understandably sought out clear guidance from local, state, and federal government authorities, but guidance has been dynamic, often vague, and completely lacking in some aspects. Amidst the growing anxiety of parents, students and faculty, school administrators (at all educational levels) were suddenly faced with the challenge of providing answers, suggesting solutions, and assuring that the infrastructure for remote learning was effective and properly funded. In the Academy's case, as discussed earlier, the required software support was in place. Faculty were usually required to learn Teams on the fly and determine other forms of pedagogical effectiveness as the spring 2020 semester came to an end. Along the way, all school administration meetings and search committees, for both faculty and staff, were suddenly run entirely on Microsoft Teams. Many involved would readily share that, in retrospect, they initially experienced a few hiccups along the way, as faculty and staff adjusted to the new Teams-oriented flows of communication.

Moreover, amidst pedagogical concerns and quick adjustments to Teams and other facilitating remote teaching software, schools around the country were making adjustments to their existing grading schemes. Some adopted Pass/Fail and other alternative grading options, while others maintained what they had used in the past. After much discussion and fervent views expressed on all sides, the Academy's administration made the decision to eliminate H grades (an grade normally awarded to top students in a class that carries a 4.0), minus grades, and D or F grades for the Spring 2020 semester. It was an attempt to mitigate a precipitous drop in GPA because the adjustment to remote learning would be difficult for some. Students who would normally receive a low grade would have a chance to retake the course or make up work and replace a placeholder D or F grade. Indeed, the strong views of individuals can be one of most significant ongoing challenges for school administrators in the post-COVID environments.

Another challenge at the USCGA are decisions on how to balance delivery modes for academic, military, and athletic/health and fitness activities that are all part of developing well rounded officers for the Coast Guard. There have already been two interdivisional

task forces to develop courses of action (COAs) for summer 2020 and the 2020-2021 academic year. At the end of the day, these COAs are suggestions and decisions must be made by Senior Leadership at the Academy and at Coast Guard Headquarters. These factors pose unique challenges to moving forward with decisions on academic delivery policy while also needing to ensure the health and resiliency of the faculty, staff, and cadets

4. Discussions

Many instructional techniques adopted by the USCGA Civil Engineering Program follow Guidelines on Distance Education During Covid-19, developed by the Commonwealth of Learning, Burnaby, British Columbia, which includes learning resources, pedagogy, learner support, and management. Examples of effective practices in the use of technology for distance education within each category are presented for several engineering courses including: A Transportation Engineering Design Course, Engineering Mechanics: Statics, and a Coastal Resiliency Course. Instructors also used an Online Instrument for Determining Students' Learning Styles. Learning resources demonstrate how to support self-learning and illustrate a variety of media and technology that were used to assist students with their learning. The authors believe that with clear objectives and support to achieve specific learning outcomes, effective teaching and learning can happen in remote education. In fact, the rapid shift to remote instruction has sparked innovation and creativity that will have a lasting positive impact on education on the USCGA.

Examples of effective pedagogy include Online Active and Cooperative Learning, Learning with Case Studies and Discussions, and Mixing lectures with the Short Videos. Sound pedagogical tools and technologies must support dialogue and communication, where interaction among students and between students and teachers results in deeper learning in distance education. Examples shows that in order to benefit maximally from distance education opportunities, students need to be guided to develop self-directed learning skills. Learners' Support is documented with Coastal Resiliency Course, Civil Engineering Capstone Course, Detailed Guidance on Projects in Fisheries Management Course, and Personalized System of Instruction. The paper supports the argument that the keys to learners' support, and hence, student success in distance education must be upheld by providing psychological and emotional support to learners together with constant academic interaction from an efficient and accountable administrative staff and faculty. Examples of Management are represented by discussion on Management of Education in an Age of COVID Uncertainty, Diverse Needs Among Academic Programs, and Clear Guidance from School Administrators. The authors provide advice on how to quickly deliver efficient remote education with limited computer and online infrastructure, time, and faculty preparedness.

This paper provides examples of effective technologies and pedagogical strategies for distance education that were developed especially for distance education during the COVID-19 pandemic within the USCGA. The increasing dependency of college education on distance or virtual instruction seems inevitable. We emphasize that remote coursework must be based on an instructor's effectiveness at creating a course design that meets the needs of students for greater engagement in course instruction and greater relevance of the subject matter to an increasingly more global, competitive, and challenging business world. The article explains how effective distance education can be delivered by focusing on learning resources, pedagogy, learner support, and management.

5. Conclusions

Academic institutions across the world have responded to COVID-19 pandemic crisis with a sharp increase in remote learning, in many cases by faculty who are not accustomed to teaching in this modality. The authors have discussed how the faculty at the USCGA has employed effective distance education focused on *learning resources*, *pedagogy*, *learner support*, and *management.* Despite the challenges described with uncertainty and management in a time of crisis and uncertainty, faculty have come together to employ a number of innovative methods that leverage available resources to promote learner-centered instruction while utilizing participation, task performance and collaboration. Much of the success of distance or virtual education rests on encouraging an active role for learners where students must learn to rely on themselves and master the technology necessary to thrive.

An active and cooperative learning can be enhanced in virtual environment. When students become actively involved in the learning process, instructional strategies in virtual environment must allow students to be fully engaged in the learning process to stimulate student learning and advance critical thinking skills and an awareness of many perspectives. Although there are times when lecturing is the most appropriate method for disseminating information, the use of a variety of instructional strategies in college education can positively impact student learning. Teaching strategies should be carefully designed, especially in a virtual education when they are developed and used for the first time. For example, the use of cooperative learning as a pedagogical strategy will encourage small groups of students to work together for the achievement of

educational goal. The authors also stress the importance of faculty and student involvement in the learning process, especially in the remote environment. When integrating cooperative or collaborative learning strategies into an online/remote course, careful planning and preparation are essential. Understanding how to form online groups, ensure positive interdependence, maintain individual accountability, resolve group conflict, develop appropriate assignments and grading criteria, and manage active learning environments are critical to the achievement of a successful cooperative learning experience. Some examples of cooperative and active learning are discussed within the paper.

There have been several lessons learned by the academic faculty and the management at the USCGA regarding instructional delivery in virtual or remote learning environment. Eight Main Lessons Learned at the U.S. Coast Guard Academy include: (1) Remote teaching requires a lot of time to prepare teaching materials and select computer and the Internet technology for course delivery; (2) The combination of synchronous and asynchronous learning can be applied to enhance effectiveness of remote learning. Synchronous activities can improve interaction among students and the instructor, help instructor gage students' emotional well-being, and provide a sense of a learning community; (3) In a remote learning environment, presentation of guidelines and expectations should be spelled out very clearly in the course syllabus and discussed via chatroom early in the course or at least several weeks prior to final submission of a project; (4) Rubrics for projects are helpful tools to ensure students understand expectations and to provide an effective and efficient communication between instructor and students as well as among the group members; (5) For major projects, instructor may consider incremental submissions, with meaningful and timely feedback provided on drafts prior to the next submission; (6) Instructors should regularly meet remotely with the groups or individual students to discuss a particular project's elements. This frequent engagement has been found to be effective in addressing questions and concerns and to maintain a sense of connectedness in a remote learning environment; (7) Teaching effectively involves not only the use of tools, techniques, and strategies to optimize student learning but an understanding of context, in particular how your students learn, how they process information, what motivates them to learn more, and what impedes the learning process; and (8) Each course delivered through virtual learning environment should accommodate all types of learners. Combining a mixture of approaches and teaching methods allows virtual students to choose the instructional instruments that best fits their individual learning styles.

In sum, for those of us who had to adjust our pedagogical approaches in spring 2020, half-way through the traditional spring semester, one thing is clear: remote learning is imperfect. Yet, like it or not, we must also recognize that remote learning methods are likely to become increasingly important and likely will be an integral part of all future education. However, the COVID-19 crisis has unleashed unimaginable levels of creativity and innovation, requiring educators to completely re-imagine instructional methods and challenging students to take ownership of their own learning in ways that will benefit their development as life-long learners in a technological world. The benefits of newfound remote teaching and learning skills will no doubt be invaluable during the COVID-19 crisis and well beyond.

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