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A multidisciplinary collaboration between graphic design and physics classes responding to COVID-19

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Abstract

Students from graphic design and physics classes at SUNY Cortland collaborated during the spring semester of 2020 on a multidisciplinary project related to the COVID-19 pandemic. In these collaborations, the students' individual contributions were part of a larger project that required a diverse skill set, through which students learned how different skills can complement their own disciplines. The graphic design and physics instructors applied a project-based learning philosophy applying the Common Problem Pedagogy (CPP) framework to construct student-teams composed of both disciplines. This project explored how coordinated social actions can allow the public to exercise control in uncertain times. Students created mathematical models related to the spread of the disease and the economic consequences of quarantine and then communicated the results in scientific reports, which were interpreted and presented as infographics and illustrative visual design posters for public outreach. To share the students' work with the larger community the instructors concluded this project with a virtual public exhibition hosted by the SUNY Cortland Dowd Gallery.

Section 1: Introduction

This paper describes a joint effort of two SUNY Cortland faculty in spring 2020 that was conducted under the Common Problem Pedagogy (CPP) project. The CPP methodology seeks to stimulate creative thinking through ill-defined projects that require multidisciplinary skill sets and collaborative problem-solving, wherein students improve their ability to work as part of a team, develop experience with organizing ideas, develop an appreciation for nuance, see the existence of multiple possible solutions, and increase self-awareness of strengths and weaknesses (Mattingly & Broyles, 2017; Liszka et al., 2022).

An additional goal of such work is to provide opportunities for faculty members to collaborate with colleagues from different disciplines, thereby creating new knowledge and community.

While collaborations between similar disciplines are fairly common, it is much more rare to find connections between STEM fields and the arts. The specific way in which these pedagogical goals were met in the this CPP project fostered conversations across disciplinary boundaries that required students to engage in complex, ill-defined problems like they might encounter in their careers after college. Project-based learning helps students solidify information and deepen their understanding of core content learned in their classes (Fink, 2013, p.7). The central approach to the collaborative endeavor described here was to examine socio-economic issues through the lens of public policy to cultivate an understanding of the extent to which collective action can influence outcomes in times of the pandemic. In this work, the physics students modeled scenarios as a function of various public policies, and the graphic design students translated those models into digital illustrations and infographics intended for public dissemination.

The project described here is the second instance of this kind of work that was conducted by the same instructors (Edlund & Kadas, 2020). The CPP project, is a conceptual pedagogical framework that was funded by the NSF to promote a culture of multidisciplinary thinking at four SUNY campuses. Three common goals of a multidisciplinary pedagogy are to execute projects that require complementary skills, expose students to different schools of thought, and provide opportunities for communication that transcend traditional disciplinary boundaries (Holley, 2009). By bringing together students from detached fields, like physics and the arts, these three goals were put forward as central constructs of the CPP project. For the physics students, the process began with brainstorming sessions to define the very problem and mathematical analysis, followed by group work focusing on interpretation of the results. The graphic design students continued the project with a second interpretative process where they extracted meaning from the technical reports written by physics students. Their work concluded with the production of visual representations to convey a message to the public.

It may be impossible to provide a concise and perfectly encompassing definition of an ill-defined problem (Simon, 1973), though a useful classification is to consider the three aspects of *data*, *method*, and *goal* (Reid & Yang, 2002). This triplet of concepts encompasses the tangibles associated with general questions of *what*, *how*, and *why*? Problems that are ill-defined tend to have limited starting information (data), few rigid guidelines (method), and a sense of broad or general importance (goal). As instructional tools, such problems are meant to mimic many real-world problems that have not been solved. It is often the case that solutions to true ill-defined problems require significant time, effort, and resources, and therefore may not be perfectly amenable to the classroom. One of the primary roles of the instructor in overseeing problem-based learning activities of this sort is to extract a reduced set of core qualities of the ill-defined problem and provide sufficient structure and guidance so that conclusions may be achieved within the constraints of student knowledge, school resources, and time allotted to the course or project.

An ill-defined problem that brings together physics and graphic design students, for example, might not be directly relevant to the future path of all students, but serves their development by providing them with opportunities to engage with collaborators and information that exist outside of the disciplinary boundaries of traditional college curricula. Roth (1995) states that in order for projects to embody attributes of authentic experiences they need to be ill-defined, involve an experience of uncertainty or ambiguity, learning that is driven by current knowledge, students working as part of a community where knowledge and information are shared, and students drawing on diverse experiences and expertise including that of instructors. Describing his studies of inquiry-based lab experiences in physics, Roth (1995) wrote “The curriculum should integrate real-world problems with school subject matter and mandate the use of modern technology to support students’ efforts in constructing patterns and meaningful knowledge.” The emphasis on technology is a critical component of such work because the use of various technologies, including even things like video conferencing, constrains possibilities and shapes communication.

The ill-defined problem shares some elements in common with the concept of “authentic experiences” that are used to expose students to a sense of the real-world work (Reeves et al., 2002). Such work can be especially effective for on-line courses, as was experienced in the spring of 2020, because these kinds of problems highlight the relevance of the discipline and can increase engagement precisely under conditions where engagement tends to flag. Reeves et al. (2002), identify ten criteria that are central to successful implementation of authentic experiences: real-world relevance, ill-defined problems, complex tasks studied over an extended period, incorporation of different perspectives, collaboration, the opportunity for reflection, interdisciplinary application and outcomes, activity that is integrated with assessment, creation of polished products, and space for competing ideas to be explored. The CPP project presented here includes all ten of these elements. While such authentic experiences are often found in discipline-specific environments, like medical school, where the nature of problems is heavily constrained, the underlying idea is to expose students to examples of complex problems encountered in professional work so that they develop a deeper understanding of what is required to be successful and to begin to see themselves as actual practioners of the art (Di Blas, 2022).

The COVID-19 pandemic induced major disruptions in education with challenges at every grade level, and affected people both professionally and personally (Marinoni et al., 2020). One of the many challenges instructors had during the transition was a hurried switch to on-line teaching-learning platforms (St. Amour, 2020). The instructors of this CPP project presented the necessity of virtual communications for this project as an important aspect of professional work interactions. Successful completion of the assignment required students to navigate the challenges of new forms of communication and cross-disciplinary differences in disciplinary vocabulary, understanding, and analysis. Discussions between disciplines as distant as physics and art can create epistemological friction that may cause students to experience discomfort at the beginning stages of the collaborative process. However, by forging interdisciplinary teams, students begin to see their work in connection to the whole and develop newfound appreciation for unfamiliar modalities of communication. According to Holley (2009, p. 18), "Interdisciplinary work integrates knowledge from multiple fields of study to engage in a shared research question or topic. This collaborative exercise requires change in both the cognitive and organizational constructs that shape the traditional disciplines." In this case, students from both graphic design and physics disciplines needed to collaborate together in a way that goes beyond a traditional classroom. Physics students are seldomly tasked in a regular classroom to explain their findings to students from another discipline, and graphic design students rarely work with and interpret scientific data. Adding these collaborative phases into the project allowed students to see how their work meaningfully impacted a new audience as they bridged disciplinary communication barriers. As a model for professional collaborations, this division of labor closely resembles practices that students are likely to encounter in professional work environments.

While pandemics and economies are not typical topics of discussion in physics classes, they have many commonalities with physical systems that makes their study accessible to students with a strong mathematical background. This was a good opportunity for graphic design students to learn about their relationship to technical design projects. While other graphic design projects from this course provide a wide range of topics, mainly dealing with visualizing textual context from the fields of humanities, the CPP project was the only one that required students to confront information in the form of scientific technical reports. This represents an important aspect of their discipline-specific training since graphic design is often considered a service where the graphic designers have little control over the nature of the projects and the information they will work with. In the following we discuss the organization of the project in Section 2, then discuss the students' work and outcomes in Section 3, with concluding thoughts in Section 4.

Section 2: Project Organization

The collaboration described here was the second application of the CPP methodology undertaken by the instructors. In the first instance of this collaboration in 2019 (Edlund & Kadas, 2020), the instructors organized students into teams composed of one physics student and two graphic design students. Under this former collaborative enterprise, each student-group worked on a social or environmental issue of their choice. While this resulted in a large diversity of projects and an interesting set of topics for collective discussion, the instructors realized that the students could have a more effective problem-solving experience by reducing the set of topics to three to allow students to focus and share ideas on developing the numerical models.

Because the two courses did not have the same meeting schedule, this project was set up so that the physics and graphic design students interacted with each other primarily through on-line discussion forums in Blackboard, where they exchanged ideas and documents. A similar structure had been implemented by the instructors in their CPP project from the prior year. This aspect of the interaction was intended to simulate remote collaborations between professional groups that may not ever meet in person.

2.1 Team and Group Composition

In this article, the authors refer to the students working together on a multidisciplinary collaborative effort as a *team*, and refer to the organization of students working together on an intra-disciplinary topical investigation as a *group*. Smaller team sizes have been proven to be more effective at eliciting participation from all members regardless of race, gender, ethnicity, and academic preparedness (Pollock et.al., 2011). Due to the unequal enrollments between the physics and graphic design classes, each team was composed of one physics student and 1-2 graphic design students. The physics class was divided into groups of four students for each of three research questions that broadly focused on issues of quarantine policies, medical preparedness, and the economic impact of pandemic mitigation measures. The topics are described in more detail in the following subsection.

2.2 Project Timeline and Actions

The instructors began planning for a new CPP project approximately two months before the Spring 2020 semester. The outline of the collaboration was introduced to students at the beginning of the term, and one of the first assignments for both classes was to identify important social and environmental issues. The top three concerns that emerged from that exercise were climate change, pollution, and poverty. The novel coronavirus, while present, only made the list at ninth among over twenty topics. In mid-March SUNY Cortland transitioned to remote teaching to comply with new restrictions responding to the rising threat of a COVID-19 pandemic. At this point, the instructors refocused the CPP project to COVID-19 related topics: (a) quarantine and social distancing policies, (b) medical preparedness, and (c) the economic impact of the pandemic. Students welcomed the idea and over their spring break they drafted a new set of research questions for the class to consider. The specific research questions that emerged from that activity were: (a) How will social distancing and quarantine affect the spread of COVID-19? (b) How do the availability of medical resources (staffing, hospital beds, ventilators, masks, gowns, etc.) affect the propagation of COVID-19? (c) How will social distancing and quarantine affect the economy? Importantly, each of these questions is specific and involves an aspect of public policy that can be described quantitatively in a model.

In the first phase of the project the physics students met with the physics instructor in their topical working groups. These meetings took place in three extra sessions outside of regular class hours, over the course of two weeks. Each student shared her ideas with the research group, and notes were recorded in a common file that served as a working document. These discussions were directed by the physics instructor who guided the students toward a numerical model through a series of leading questions, often targeting the idea of how one thing affects another and how that should be translated into a mathematical form. During this phase the graphic design instructor visited the physics class and gave a presentation on the project, to explain to physics students ways that graphic designers transform scientific data into illustrations and information graphics. This phase was important, because the instructors wanted to engage both groups of students to learn about the other discipline's task and role. The graphic design instructor discussed the process by which graphic designers transform data into visual messages, the power of visual communication throughout visual storytelling techniques, and infographics. This part of the project culminated with each physics student writing a technical report on her project and sharing that with her graphic design teammates.

In the second phase of the project the graphic design students started their design of a poster to effectively educate the public about the issue at hand. The first step in this process required the graphic design students to study and analyze the scientific reports where they had to extract the most relevant information for the public audience. To help the students understand the reports, the physics instructor visited the graphic design class on April 20th, and explained the physicist's approach to modeling systems and the meaning of each of the three studies. The goal of this presentation was to provide an introduction to the physicist's view of mathematical modeling and an outline of the projects that the physics students were working on. While this presentation shared a snapshot of mathematical models used in these kinds of problems, the focus was on providing insight into the predictive power of these mathematical models. Therefore, the presentation for the graphic design students provided an example of resource utilization, in this case though the example of fishing. The discussion showed how some levels of fishing are sustainable and concluded by affirming our intuitive sense that over-fishing leads to catastrophic population decline, all of which exists in the mathematical model. The main objective in this presentation was to use a specific example to illustrate how competing "forces" and interests in complex, real-world problems can be modeled in an attempt to avoid catastrophe and find optimal strategies.

The graphic design students were encouraged to discuss the reports with their physics team members on Blackboard. Students begun to reach out to their group members in February, 2020 on-line via Blackboard discussion board. They introduced themselves and discussed their initial research questions just before spring break. As the Pandemic lock-down occurred in March 2020, the instructors realized a potential to reorient students initial questions to new pandemic related questions. Students welcomed the idea, and started sharing news articles on the discussion board. Once the reports were ready, instructors dedicated graphic design class time for students to connect on-line synchronously, via Teams, to discuss the results and ask any questions regarding the report. Due to the fact that the meeting times for the two courses did not overlap, not all students were able to make these sessions. However, because the students were divided into three topical groups, there was at least one representative for each topic. The representatives were able to answer questions, and the instructors were also there to provide context and support for these discussions. Next, graphic design students had several brainstorming sessions where they created a visual story. Through group discussions, the students debated concepts and considered how their audience may receive and make sense of the presented visuals. After these group sessions, graphic design students started working on their digital designs, while getting constant feedback from the graphic design instructor and their peers.

At the end of the semester, students from both classes attended the virtual presentation of their team's project. Graphic design students presented their posters, each of which was followed by a brief discussion with the collaborating physics team member and the instructors. In these discussions the students described their interpretation of the modeling and their goals in the message. Using feedback from these presentations, the graphic design students had the opportunity to submit revised posters. All of the student posters from this collaboration were presented in an on-line exhibition hosted by SUNY Cortland's Dowd Gallery (The Common Problem Pedagogy: COVID-19, 2021).

Table 1

CPP Timeline

Date	Task	Constituent
December 1, 2019	Instructors started planning the project	Faculty
January 28, 2020	Solicit students' top ten main social and environmental concerns	Faculty
February 4, 2020	Setting up Blackboard technology	Faculty
February 26, 2020	Interdisciplinary team members introduced themselves in group discussions on Blackboard (Bb)	Design and Physics Students
March 2, 2020	Graphic design instructor gave a presentation to physics class	Physics students
March 16, 2020	Start of Spring Break (2 weeks)	Design and Physics students
March 20, 2020	Decision to change to COVID-19 relevant topics	Design and Physics students
March 27, 2020	Each student posted on Blackboard an article on her assigned topic and defined a question of public interest	Physics students

March 30, 2020	Interdisciplinary teams discussed their research areas on Blackboard	Physics and Design students
April 1, 2020	Physics students began numerical modeling projects	Physics students
April 17, 2020	Physics students uploaded technical reports to Blackboard	Physics students
April 17, 202	Graphic design students read the uploaded technical reports	Design students
April 20, 2020	Physics instructor gave a presentation to the graphic design class	Design students
April 22, 2020	Graphic design students began the creative process	Design students
May 14, 2020	Graphic design work was due, final project presentations	Design students
May 20- August 30, 2020	On-line exhibition hosted by SUNY Cortland's Dowd Gallery	Physics and Design students

Section 3: Case studies

While the CPP framework aims to establish multidisciplinary collaborations where diverse skill sets are needed, it is also important to recognize the value of discipline-specific work. Discussions of the students' products from the physics and graphic design components are described in greater detail in the following subsections.

3.1 Physics projects

This project was conducted in the third semester of a calculus-based, introductory physics course that covers oscillations, waves, optics, and thermodynamics. The three research areas addressed by the physics students in the CPP project related to the pandemic. The logical connection between the epidemiology of the pandemic and physics occurs because the transfer of disease between people is similar to the transfer of heat energy between systems, for example. Similarly, an economy can exhibit fluctuations as it responds to changes in spending, growth, and government stimulus, much like a mass responding to the sum of various forces imposed on it. The physics assignment for this project was defined by participation in the development of a numerical model and of writing a technical report. Collectively, these activities were weighted at 20% of each student's course grade. On the physics side, this project was an addition to an otherwise full schedule of physics topics that were required by the course description. With that in mind, a 20% weighting of this activity seemed appropriate to encourage strong participation and effort, and yet not dilute the emphasis on the core subjects of this course. This weighting was chosen to be substantial enough that students would consider the CPP project worth a serious investment of effort, yet not so large that it detracted from the official focus of the course.

In the following we will examine some of the work produced in response to research question (a) defined in Section 2, broadly focusing on the spread of the COVID-19 virus, as an example of the work produced for this project. Specifically, the students working on this question examined how different levels of social distancing affect transmission of the disease, and calculated related factors such as total deaths. Social distancing policies were represented in the simulations as different R_0 values, the parameter that describes the total efficacy of transmission and is a function of both inherent qualities of the disease as well as social and environmental factors. Larger R_0 values mean faster and more extensive transmission. Social distancing policies that seek to reduce contact between people can decrease R_0, which results in a slower spread of the disease.

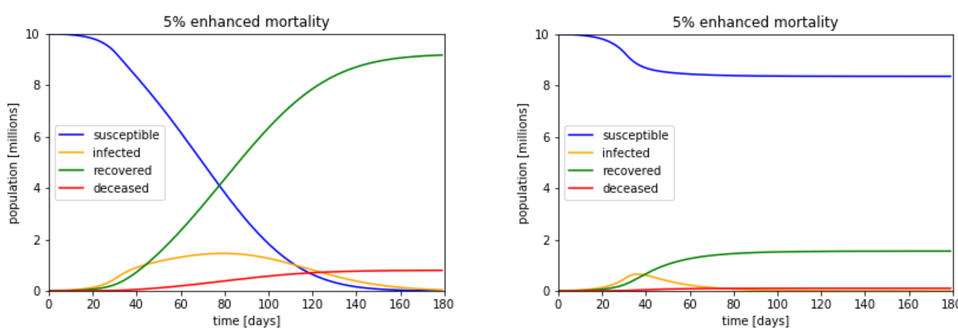

Figure 1. Two examples of graphs produced in response to research question (a) defined previously, how will social distancing and quarantine affect the spread of COVID-19? The scenario depicted in the left graph represents a moderate social-distancing policy, and the graph on the right represents the extreme case of a full shelter-at-home policy that minimizes contact between people. The probability of death for these simulations was significantly enhanced over the actual COVID-19 probabilities for illustrative purposes. A range of other cases were also examined as part of this study.

The work of the physics students culminated in individual technical reports, each approximately 4 pages in length, that were written for an audience of graphic design students. The goal of these reports was to present in layman's terms the guiding question, the mathematical models and, importantly, to communicate the benefits and associated costs of various public policy positions. This last point addresses one of the main pedagogical goals for the physics students, which was to provide context for cost-benefit tradeoffs in decisions of substantial magnitude. A few examples of writing from students' technical reports are presented here. It is important to note that while neither student captured the whole picture, they separately identified aspects of the bigger picture that are necessary for complete understanding of the consequences of our actions.

One student reflected on the importance of slowing the spread of the disease in her conclusion:

> Although hospital carrying capacity and population do play a role on the level of health care available, when social distancing policies are put into place the likely hood of being infected or dying are far lesser than if none are in place. Social distancing gives health care workers a fighting chance of doing their jobs to the best of their ability. By staying inside, we not only helping to slow the spread of the virus, but also helping the health care workers by allowing them ample time to heal those in very bad condition.

In comparison, a second student reached a different conclusion when specifically considering the most severe policies aimed at fighting the spread of the disease:

> It is clear that some sort of policy to slow the spread should be in place. Looking at our model, we can see that by putting in place a shelter at home policy, the spread [is greatly reduced], and the outbreak ends much sooner. But does it really end there? If you look at how many people are left susceptible, 83.5% of the population did not get infected, so as long as COVID-19 acts like other viruses, (once you get it, you can't get it again), 83.5% of the population is still susceptible to getting the virus. I think the shelter at home policy is not the way to go because it is only a matter of time before there is another outbreak. Even though with social distancing, according to our model, the outbreak lasts longer, but over the course of the outbreak, everyone gets infected at some point, leaving no one susceptible to getting the virus.

The previous two passages show the various directions that interpretations of data can follow, highlighting the fact that data itself is often agnostic as to values and higher-level aspects regarding ethics. On one hand, the first student correctly recognizes that the aspect of slowing the spread of the virus is important to give health-care services and research centers time to equip, manage, study, and treat the disease. On the other hand, the approach of "buying time" does not represent a complete solution to our crisis as long as the disease continues to exist somewhere in the world and multiple outbreaks remain possible. The second student's comments get at exactly this aspect and pointedly asks the question of what is achieved by a severe policy that does not achieve to herd immunity?

These perspectives are important because they represent exactly the kinds of discussions about pandemic intervention measures. Both of these analyses identify essential aspects of the problem that together can help create an optimal social policy, and both analyses overlook important aspects of the bigger picture, such as the role of vaccines in achieving herd immunity and the time necessary to develop such responses. The rather different conclusions, along with other diverging perspectives on the research questions studied, were discussed in class with acknowledgement of the places where they succeeded as good interpretations of the models, where they fell short of capturing the whole picture, and where the difficult questions of ethics and social considerations enter that cannot be answered by the data.

3.2 Graphic design projects

Each graphic design student was responsible for reading the technical report produced by her physics partner and transforming this information into a visual language as an infographic or an illustration intended for communication with the general public as 17 by 23-inch poster designs. To help the graphic design students better understand the goals and methodology of the scientific approach to these reports, the physics instructor gave a presentation on numerical modeling. Graphic design students also had the opportunity to ask questions and virtually meet with their physics partners to discuss the technical reports. These collaborative meetings helped physics and graphic design students to bridge disciplinary communication boundaries, which enabled the multidisciplinary teams to bond and engage with the project on a deeper level. In their discussions, students debated different viewpoints and interpretations of the data presented in these reports. Next, the design instructor gave several lectures on visual storytelling and information graphics, which was followed by a series of brainstorming sessions wherein the graphic design students learned how to transform the data into useful information and represent the data as visual stories. The students were guided in this process by explicitly defining the “what, when, and why” of the story, the main characters, the thing that is at risk, and the tension of the situation. Students were encouraged to create a clear articulation of their messages, and why this information might be useful and relevant to the general public. Lupi (2016), explained that it is important “to question the impersonality of a merely technical approach to data, and to begin designing ways to connect numbers to what they really stand for: knowledge, behaviors, people” (77 p.). Therefore, the task was for graphic design students to visually communicate and explain complex scientific ideas and connect with the audience. Students had the option to use illustrative techniques or engage audience with a more complex information graphics. In either avenue they chose, students applied visual forms, typography, illustrations, colors, and composition. This project draws from the CPP philosophy because the instructor provided students with a broad spectrum of options and a general problem-solving tool kit, with which students could find the most appropriate possible solution to the problem at hand, rather than constricting them with a specific vision for the solution.

Students then created their illustrations or infographics using Adobe Illustrator, Photoshop, and InDesign. Students used color coded charts, maps, time-lines, or diagrams to tell the story they found in the data. Where necessary, students created a legend or key that helped their audience interpret the aggregated information. Additionally, students practiced many other graphic design specific skills, particularly the use of graphic design principles, such as hierarchy, color harmony, composition, and layout.

The instructors invited the physics class to participate on the on-line final critique discussion. Final critiques in the art and design discipline are a traditional arena where design students present their work, giving justifications to their design decisions, and instructors ask questions and provide feedback on the final outcome. This was the culminating and final project for the graphic design students; thus, the students could earn a maximum of 100 points, worth 30% of the final course grade. The increased weighting of the graphic design project compared to that of the physics project (30% vs. 20%) was justified because the physics part was outside of the traditional curriculum assignment, while graphic design project was consistent with the theme of the course.

Collaborating with the field of science gave students a unique and additional learning experience, not only to practice interdisciplinary communication skills, but also techniques to transform numerical data into information, and then translate that into visual forms. Students were evaluated based on (a) use of graphic design principles, including use of colors, composition and layout was worth 30 points, (b) effective visual communication of the data at hand, which was worth 10 points, (c) visual narrative and storytelling techniques, which was worth 20 points, (d) craftsmanship/quality of work including social awareness, was worth 20 points, (f) and multidisciplinary communication and project presentation was worth 20 points.

In the following, we will examine three different approaches taken by graphic design students to visualize the scientific reports and compare them with each other. In figure 2 the graphic design student used an illustrative technique, responding to the technical report discussing the impacts of medical preparedness and the importance of social-distancing in reducing the burden on our healthcare system. This illustration conveys a compelling visual story with a diverse representation of our society. It depicts a chaotic and surreal scene of the hospitals and the devastating impact of isolation on mental health.

Figure 2. Student poster design depicting medical preparedness, digital media, 2020.

Figure 3 is an example of a design that examined the economic impact of COVID-19. The student designer depicted a bright and welcoming restaurant that is open for pick-up and delivery. The puddle in front of the door with a upside-down sign provides the public with a concerning tone of an alternate world where businesses are closed. In this representation, the student applied compositional tension between two opposite worlds: a world that could be if we comply with the necessary health restrictions, or on the other hand the world that may be if we fail as a society to respond responsibly to the pandemic. The student designer successfully applied multiple design principles to amplify the tension, including juxtaposed circular and angular forms, contrasting light and dark areas, and off-centering the focal point of the image. To support the importance of this message, the student designer provides the key take-aways related to economic impacts of the shutdown.

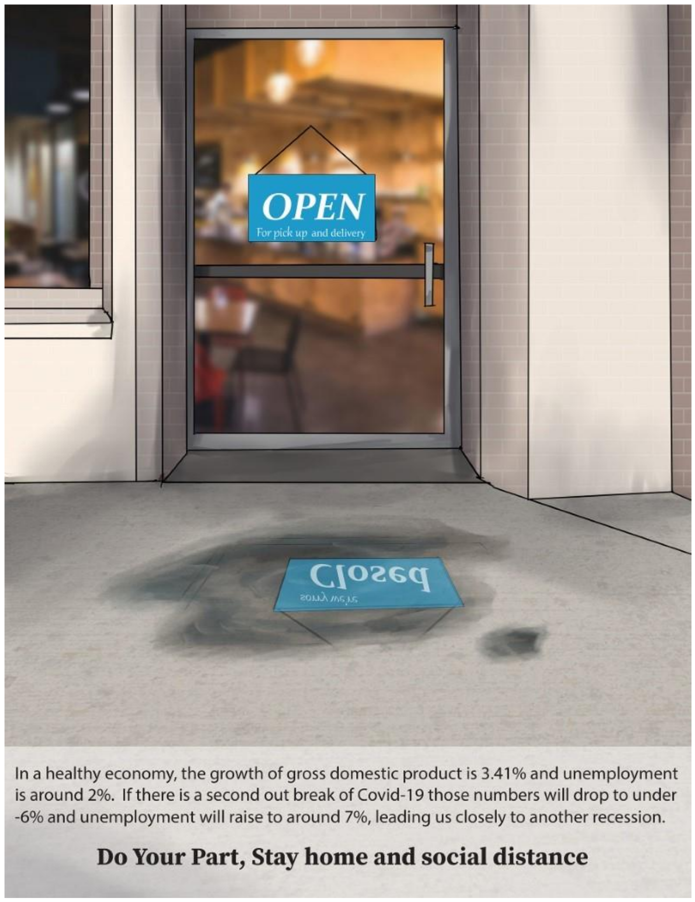

Figure 3. Student poster design depicting the economic impact of the pandemic, digital media, 2020.

The final example, presented in Figure 4, showcases one of the most successful student designs of this project. The student visualized and highlighted some of the key data presented to her in the report on the economic impact of the pandemic. The student took inspiration from American and European soap advertisements from the 40's and 50's. In place of soap bubbles, the student shows large coronaviruses, a stark reminder of an ever-present threat. She applied many design principles, such as contrasting colors of reduced tone, and variation of scale, size and color. The student also applied the Gestalt theory, which enabled her to suggest that the problem is bigger than the artboard can depict, implying the rapid spread of the virus. She used a visual narrative of the data by dividing the composition into three main areas: title, body/main message, and conclusion, which was the underlying takeaway message. This hierarchy leads the viewer efficiently through a condensed economic analysis to the conclusion that protecting public health is similarly important as protecting the economy.

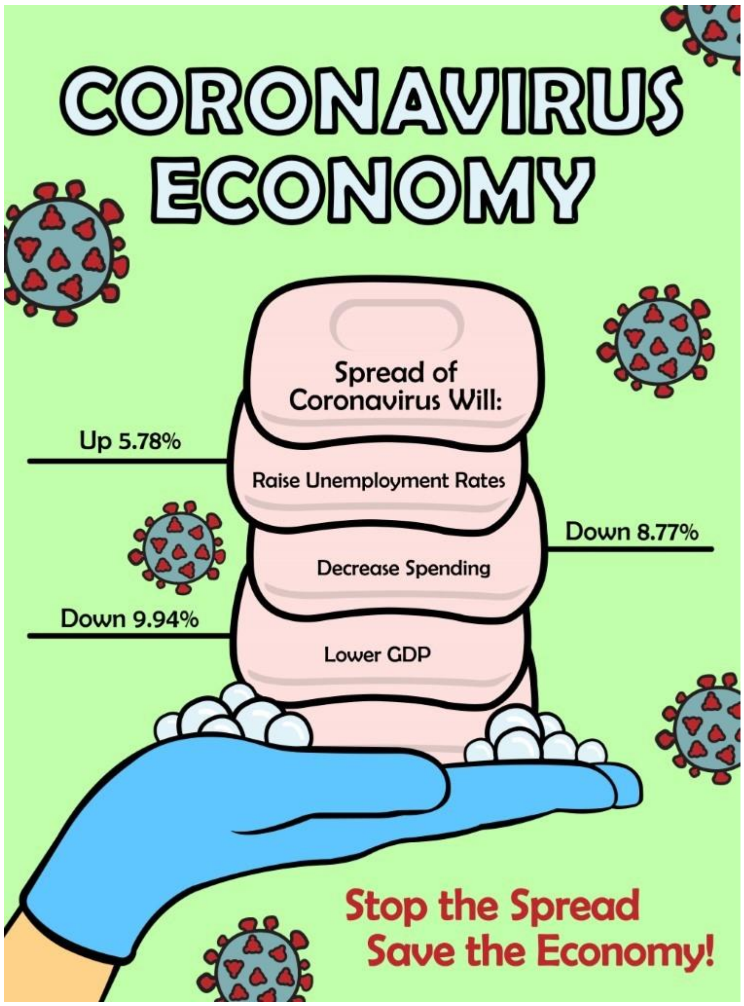

Figure 4. Student poster design depicting the economic impact of the pandemic, digital media, 2020.

Section 4: Conclusions

The pedagogical goals of the CPP framework span a wide range of outcomes. The physics and graphic design collaborative project described here highlighted interdisciplinary communication, ill-defined problems, iterative work, and a wide range of possible solutions. A critical realization for a practitioner of any discipline is that work is an ongoing process that typically requires multiple or possibly many iterations. This idea quickly became apparent to students in this CPP project. During the physics phase, the research questions that structured the work were broad and required that the students grapple with problems like none they had encountered before. Together, and with assistance from the instructor, they developed numerical models of the pandemic response, all of which were ventured as hypotheses. Completion of that work required that they accept a large degree of uncertainty, make assumptions, and offer conditional suggestions for interpretation. The uncertain nature of the work was reflected in the students' technical reports, which contained suggested interpretations of the models, which the graphic design students then had to re-interpret. Continuing in that theme, the graphic design students themselves formed hypotheses for their visual interpretations, and iterated those with feedback from the instructor and peers. Their final design critique was an opportunity for the students to share their thought processes, providing both context for particular design decisions and commenting on alternative concepts or things they might do differently in a subsequent iteration. Throughout this work, the instructors more often participated as expert learners, leading the students through the creative process using guiding questions.

The COVID-19 pandemic has created a situation where faculty and students have had to adapt to new teaching and learning methods and on-line platforms. The instructors in this CPP project found that students were generally committed and deeply invested in their work. For example, one of the physics students went beyond the base requirements for the technical report and delved into the history of prior recessions and the Great Depression. The successful completion of this project led the instructors to conclude that while the unprecedented global health crisis created challenges for teachers and students, it also presented a unique opportunity to demonstrate to students the necessity of virtual communication and the importance of multidisciplinary collaborations. A senior graphic design student commented in an interview for the SUNY Cortland Bulletin, entitled *Physics and graphic design students work together on COVID-19* (2020), that this assignment was the first time that she collaborated with students across disciplines and she felt that it was a meaningful learning experience. These outcomes exemplify some of the core goals of the CPP framework, namely the identification of work that is meaningful to the students, interdisciplinary collaboration, and communication using a variety of media.

This project provided students with an experience of remote collaboration similar to many projects found in contemporary business environments. The process of writing and interpreting technical reports was central to this work, and was implemented as a model of professional interactions between composite teams that may communicate primarily via document exchange. This project required that students, on both sides of the process, put themselves in the shoes of the other to think carefully about how messages will be received and interpreted. By confronting complex issues for which there is no simple answer, the CPP projects discussed here created the opportunity for instructors and students to meaningfully engage with each other in complex discussions where data and values must be synthesized, interpreted, and communicated, thereby illustrating that the answers to these questions requires input from a broad range of perspectives and is inherently a multidisciplinary endeavor.

4.1 Limitations

One of the limitations of this project was that the numerical models developed for these studies were intended to be training exercises and illustrative of broad trends. Accurate models, like those used in emergency response to the pandemic or economic intervention, are far more complex than can be developed and analyzed in a few weeks. Nonetheless, the patterns and relationships that emerged from this study bear some truth to actual events and helped students connect ideas to new techniques. The class discussions of the nuances of the numerical models resembled the complicated discussions surrounding these issues that we continue to debate. These discussions naturally lead us to larger ethical questions that are not answerable with the data alone because central to such decisions are how we define optimal strategies when effects are not equal across subgroups in society. It quickly becomes clear that while numerical modeling is a powerful tool for seeing some of the possible consequences of our decisions, it is an inherently incomplete vision of possible futures. Similarly, the limitations of the graphic design projects were that the students had no previous experience in working with scientific reports, and this was their first encounter of with the topic of information graphics as well. These are relevant engagements in a graphic designer's professional career therefore, it was a significant opportunity to practice science and design collaborations. Under these circumstances, students successfully completed their assignments, and understood the basics of information design and other illustrative visual design techniques, however, this project was only an introductory assignment to the field of information graphics, and additional similar projects are needed to further develop and practice these skills.

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