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Adapting a community engagement project in engineering and education to remote learning in the era of COVID-19

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ABSTRACT

In the spring of 2020, our interdisciplinary community engagement project, bridging courses in engineering and education, was midway through completion when we abruptly transitioned to remote learning due to COVID-19. Remote learning poses unique challenges to community engaged courses that are often inherently interactive and social. We quickly pivoted our project, which originally sent undergraduates into fourth grade classrooms to teach about wind energy and engineering design. Student reflection papers illuminate challenges to skill development and negative socioemotional consequences. Our findings provide insight and suggestions for future implementations of community engagement projects in the era of remote learning.

Key words: interdisciplinary, design process, professional skills

INTRODUCTION

Community engaged learning continues to gain traction as a pedagogical tool due to its well-documented ability to enhance skills and deepen content knowledge (Hatcher and Bringle 2010; Paquin 2006). In the wake of COVID-19, community engagement projects, which are often inherently interactive, face unique challenges in meeting the state's social distancing guidelines (Rhode Island Department of Health [RIDOH] 2020). In mid-March, our interdisciplinary community engagement project was well underway when the university transitioned to remote learning, necessitating immediate modifications. Here, we share our experience in pivoting our project to online learning, reflect on its successes and challenges, and provide recommendations for community engaged learning in the era of COVID-19.

Table 1. KidWind lesson topics and mode of delivery pre- and post-COVID-19.

	Lesson	Topics
Pre-COVID-19: Lessons taught in 4th grade classrooms	1	• Introductions • Energy and Energy Transfers
	2	• What Causes Wind?
Post-COVID-19: Lesson plans emailed to 4th grade teachers	3	• The Engineering Design Process and how it differs from the Scientific Method • Introduction to Wind Turbines and their components • Building and Testing Blades by Measuring Mechanical Energy
	4	• Building and Testing Blades by Measuring Mechanical Energy and Electrical Energy
	5	• Iterating and Finalizing Blade Design

Our project connects courses in engineering and education to support the elementary school teachers in integrating science and engineering instruction reflected in the Next Generation Science Standards (Rhode Island Department of Education 2020). The project consists of three main components. First, university faculty co-facilitate a day-long workshop introducing engineering design and the KidWind model turbine kits (Vernier 2020) to fourth-grade teachers. Next, small interdisciplinary teams of engineering and education students design and deliver five lessons on wind energy and engineering design in the elementary classrooms, outlined in Table 1. The project culminates in a day-long celebration event on our university's campus, facilitated by our undergraduates (Benitz and Yang 2020a, 2020b).

METHODS

Our students planned and taught two of five lessons to the fourth graders prior to remote learning. Training the undergraduates about online teaching tools and pedagogies would be necessary to ensure the same level of effectiveness in their teaching fourth graders remotely. Unfortunately, due to the swiftness of the transition and the existing project timeline, we were unable to implement such instruction. Thus, to deliver on our promise of providing effective engineering lessons for the fourth graders, our students *planned* the remaining three lessons, made revisions with faculty members, and provided finalized lesson plans to their host fourth-grade teachers. Additionally, the celebration event was canceled due to social gathering limitations (RIDOH 2020).

The impacts of these project modifications are assessed through end-of-course survey results and students' project reflections. Here, we focus on the engineering students' learning outcomes. The

Figure 1. Engineering students interact with KidWind equipment (Vernier 2020) in the university classroom (left); engineering and education students teach first lesson in fourth grade classroom (right).

impacts on education majors, fourth grade students and their teachers are of equal importance but are left for another work. This spring, twenty-three junior and senior-level engineering students completed ENGR340: Sustainable Energy Systems. Twenty-one students completed a non-incentivized, online survey at the end of the semester including an identification of enhanced skills. Engineering students wrote reflections before, during, and after the project, providing the necessary opportunity to connect the academic course content to their community engagement experience (Jacoby 1997; Eyler and Giles 1999).

PRELIMINARY RESULTS

Surprisingly, the survey results (in Table 2) show higher response rates to thirteen of sixteen gained or enhanced skills from this year than in the pilot year. We believe the growth in survey responses is likely due to improvements in project documentation, expectations, and organization between the pilot year and this year. For example, instructors explicitly explained how the project deepens students' learning of the course materials and meets the community needs. While results seemingly suggest better outcomes this year, the less

Table 2. I gained or enhanced the following skills from participating in the KidWind Community Engagement Project (select as many as apply).

Skill	Freq. of Response	Percent of Respondents	Delta from Pilot Year
Teamwork	21	100%	+4%
Gain hands-on experience in a community setting	21	100%	+21%
Project planning	21	100%	+17%
Apply what you learned in class in a real-world setting	20	95%	+4%
Communication	20	95%	+8%
Thinking on your feet	20	95%	+12%
Science communication	19	90%	+15%
Flexibility	18	86%	+32%
Problem solving and critical thinking	18	86%	+15%
Deepened understanding of course material	17	81%	+14%
Cross-disciplinary collaboration	16	76%	–11%
Understand both assets and needs in communities	15	71%	+17%
Listening skills	14	67%	–4%
Meet others who enjoy serving the community and build personal networks	14	67%	0%
Build professional connections useful for future internships or jobs	12	57%	+15%
Learning more about cultures/populations different from their own	11	52%	+2%

effective aspects of this year's project are not captured by the survey, necessitating further investigation.

The degree to which skills were gained or enhanced is elucidated through exploring students' project reflections. In the final reflection, students self-evaluated how well they met a personal goal set before the project began. Students' goals fell broadly into six categories, shown in Table 3. Students who focused on deepening content knowledge, enriching interdisciplinary collaboration skills, or improving job prospects, all felt that they achieved their goal in full. However, not all students who aimed to enhance their communication, develop teaching skills, or inspire fourth graders indicated full attainment of their goals. Two students seeking to develop their teaching skills reported failure in meeting their goal. Many students felt that the project modifications impeded their skill development, as shown by some example quotes in Table 3.

Furthermore, student reflections illuminate the socioemotional consequences not captured by survey data. Though not explicitly asked to reflect on the unexpected project modifications due to COVID-19, fifteen of twenty-three students volunteered feelings of sadness, anger, and/or disappointment. Sources

Table 3. Responses to "You had to write a personal goal statement for your "pre-flection". Did you learn everything you expected to learn while working on this project? More? Less? Explain your answer," categorized by goal and counted by student reported level of achievement.

	Did you achieve your goal?		
Goal and Example Student Quotes	**Yes**	**Somewhat**	**No**
Enhance communication skills	11	2	0
I believed delivering these lessons would be good practice in public speaking and a way to communicate engineering ideas to people with little engineering background. […] I believe more practice would have been worthwhile, although I still believe the two lessons completed were a valuable experience.			
I wanted to "extend my communication skills by being able to explain topics to a wide variety of audiences". I was referring to the 4th graders, but with the way the semester sadly went down, I felt my communication skills improved by interacting with the education majors instead.			
Develop teaching skills	3	2	2
I was definitely able to start learning how to teach and I was able to develop some teaching skills more than others. I got a lot of experience with how lesson plans are made and the different aspects that go into a lesson. […] I really wish I could have had done more.			
I only became more excited as the lessons progressed because it certainly became easier to explain things and interact with the kids. Had the other three lessons and RWU visit been able to occur, I'm sure this would only be truer.			
Inspire fourth graders	2	4	0
I think in the short two lessons that we were able to teach, I was able to see the kids get excited for the lessons and activities we brought to the classroom. I think if we were able to complete the project, it would be easier to definitively say that this was accomplished.			
I don't think I connected with [the 4th graders] as much as I wanted to. There were some kids that I felt could trust me, and who warmed up to me, but I didn't have enough time to connect with all of them.			
Deepen content knowledge	3	0	0
I said that I would enhance my understanding of complex theories by being able to explain them at the 4th grade level as well as to the education majors. I feel like that is exactly what happened during the KidWind project, even though we were only able to teach two lessons in the classroom.			
Enrich interdisciplinary collaboration skills	2	0	0
One of the valuable lessons taken away from this whole process was the ability to work with others, more specifically peers outside of our specific majors. It challenged us as engineers to take the material we were learning and verify that we truly understood the material before explaining it to those of another discipline.			
Improve job prospects	1	0	0
Since starting this project I have been to two interviews and mentioned this project to them in depth and the companies were highly impressed.			
Total	23	7	2

of disappointment stemmed from five themes, shown in Table 4, alongside their frequency of occurrence. Of the numerous students who portrayed disappointment, excerpts include,

> I was excited to go and teach the fourth graders every day I went. When I heard that it was not going to happen anymore, I was very sad.

Table 4. Sources of engineering students' disappointment in project modifications and frequency of mentions in reflections, including students who noted multiple reasons for their disappointment. Passages with the word "sad", "mad", "bummed", and "disappointed" were counted.

Sources of Disappointment	Frequency in Reflections
Not teaching full sequence of lessons	11
Less time/interaction with 4th graders	9
Skill development was cut-short	4
Decreased motivation	2
Cancelation of Celebration Event	2

I got to share something that I love to kids to hopefully make them love it too. [...] I was really bummed out that our lessons were cut short and that we can't even have our celebration day.

I was really mad the project had to be cut short, as I was most excited for the on-campus Celebration Event, which of course got cancelled.

NEXT STEPS

End-of-course survey results deceptively point to improved learning outcomes in the second year of our community engagement project. However, closer inspection of students' project reflections uncovers hindered skill development, as well as socioemotional setbacks. These findings inform future implementations of this project, particularly for semesters that continue to be affected by COVID-19.

Students' reflections undeniably advocate for *teaching* all five lessons. Moreover, the reflections reveal that merely *planning* the lessons is not sufficient for deepening skillsets or fulfilling socioemotional factors. To succeed in meeting the learning outcomes of this community engagement project, undergraduates must engage in extensive practice of lesson planning *and* teaching. Should remote learning remain in effect in spring 2021, our students will deliver lessons via video-conferencing, necessitating instruction in those skills and tools. With the foresight to plan for the eventuality of a remote community engagement project, we aim to develop instruction about online teaching tools and pedagogies to go alongside our existing curriculum. Perhaps a strange benefit of the pandemic, this new instruction will provide our students with additional skills to thrive professionally in the 21st century.

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