

JEED-I: INSIGHTS in Ecological Engineering

Evaluating Community-Engaged Capstone Projects for Increasing Coastal Resiliency

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Author Response

We would like to thank the associate editor and the reviewers for the time spent in reading and reviewing our manuscript. We have responded to each of the comments and made the appropriate changes. We have transcribed each of the comments in italics followed by our response in normal text. Line numbers refer to the revised version of the manuscript.

Round 1

Associate Editor

The three reviewers provide detailed feedback on the manuscript describing capstone engineering projects related to coastal engineering in the context of climate change. A summary of the reviews shows disagreement as to the place of this manuscript, but ultimately agreement on an appropriate way forward for editing is apparent.

***Reviewer 1** emphasized the importance of better connecting the manuscript's insights to ecological engineering education. They encourage the authors to discuss how the capstone projects align with ABET outcomes and the proposed ecological engineering ABET criteria. They recommend clarifying terms like "effectiveness" and "benefits" and providing more details about the community engagement process. Additionally, they propose revising headings for better alignment with the manuscript's format and elaborating on the lessons learned for ecological engineering programs.*

***Reviewer 2** commends the manuscript as a valuable contribution to the literature. They appreciate the manuscript's description of virtual community-engaged capstone projects, despite the challenges posed by COVID-19. However, they suggest clarifying the methods to ensure replicability and providing more information on how community engagement was facilitated. They also ask for additional details on how student teams were formed and how well they worked together. They recommend clearer explanations about the community's goals and suggest improving the section on economics by discussing any training the students received. The reviewer concludes by asking for specific recommendations to enhance future engineering programs.*

***Reviewer 3** found the title misleading, as public engagement is addressed in a separate paper. They suggest the manuscript focuses too heavily on conventional engineering solutions like water level management, rather than nature-based solutions (NbS) and future sea level rise scenarios. They believed that the results, centered on channel alterations and flooding duration, align more with traditional engineering, missing opportunities to explore ecological co-benefits. They also express concern that the conclusion about effective community engagement is unsupported by the evidence presented.*

In summary, the manuscript has potential but requires more clarity and depth, especially concerning methodology, community engagement, and the integration of ecological engineering concepts. It is my recommendation that although the reviews are varied, they offer valuable insights, including guidance for recrafting the work in the journal Insights category, and advice on necessary details for validating the topic with the broader context of ecological engineering education.

We agree that the reviews offered valuable insights. Based on the comments, we made major revisions to the manuscript including the addition of a new section – Applications to Ecological Engineering Programs. One of the challenges with addressing the comments from reviewers was the goal of being brief to align with the INSIGHTS article type. We have done our best to address the comments while minimizing the length added to the paper. A discussion of ABET outcomes 1, 2, and 3 was added based upon the request of Reviewer 1. We think this discussion is valuable, but it is what we would recommend removing if the length of the manuscript needs to be reduced.

Reviewer 1

This INSIGHTS paper presents a capstone engineering experience in which engineering education, design, and community engagement are integrated to produce design solutions for a coastal community dealing with sea level rise and associated flooding. The authors identify both benefits and challenges of community engagement in the student capstone experience. While the engineering program engaged in this design process was not a formal ecological engineering degree program, the types of projects highlighted in this paper, which include “nature-based solutions” such as wetlands clearly fall in the realm of ecological engineering. The manuscript would be strengthened, particularly considering the JEED readership, if the authors go further to connect their experience teaching this capstone and insights gained to ecological engineering education and ecological engineering design.

Detailed reviewer notes to be shared with the author and editors:

The following set of comments pertains to this overarching opportunity to improve the current manuscript by providing a stronger link and insights to ecological engineering education:

1. ABET requirements for a “culminating major engineering design experience” are referenced in line 57. This INSIGHTS article would be strengthened if the authors could go further to illustrate how community engaged research also contributes to student’s ability to attain ABET Student Outcomes 2, 3, and 4 (<https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2024-2025/>) and potentially others effectively. The contrast – if there were challenges to attainment or assessment of student outcomes in the context of a community-engaged capstone – would also be insightful.

Thank you for pointing this out. We did not include this in the initial paper because statistical analysis is difficult for such low sample sizes. Outcomes 1, 2, and 3 were assessed for each capstone team completing a project that year based on their final reports and presentations. A summary of the results comparing the community engaged teams and the other teams was added in Table 2. A short discussion of the results is in lines 176-184.

2. Although this is not an ecological engineering program, speak to opportunities to incorporate components of the recently proposed Ecological Engineering ABET curriculum criteria (they have likely changed slightly following the public comment period but the criteria stated here are a useful reference: https://abet.col.qualtrics.com/jfe/form/SV_eh4l5SK8v8az6ce)

We have added section 3.6 to the paper just before the conclusion (lines 372-392) that links our paper to Ecological Engineering programs. We started the section by showing a few links between the capstone projects conducted in this work and the recently approved ecological engineering curriculum criteria. This is a great suggestion to show the relevance to the typical program represented in AEES.

3. Define or otherwise describe what is considered “effectiveness” (e.g., line 92, 122) and “benefits” (e.g., line 123). Did students focus primarily on hydraulic/hydrologic and water quality functionality of the design? Were there other ecosystem services that they considered or that came up in community focus meetings? Even if student consideration of effectiveness and benefits was narrow, discussing opportunities and challenges for students to consider broader ecological and social benefits (a need in ecological engineering education) would provide useful insights.

We have added the following sentence to the Methods (lines 152-154) to better clarify what was meant by effectiveness and benefits: “It is important to note that the effectiveness of designs as evaluated by the student teams focused on flood reduction and water quality improvement.”

We have also briefly addressed challenges and opportunities in the new section 3.6 (lines 372-392).

4. Line 108: Please include a brief description of the composition of the community members with which the project teams were engaged. This information seems relevant as it may tie to outcomes discussed in Section 3.4 (e.g., students would not be likely to have feedback on technical details from some community stakeholder groups but may be more likely to receive feedback from more technical stakeholder groups such as stormwater engineers or managers). In addition, does your team have suggestions or insights to the composition of community engagement groups that would potentially support student attainment of various learning and design outcomes? Particularly to provide broader feedback on project components other than cost (as stated in Line 264).

We have included more details on the members of the core stakeholder group in Section 2.2 (lines 127-130). To the best of our knowledge, none of the members of the core stakeholder group were engineers.

Instead of a change in composition of the group that students engaged with, our team would suggest a change in methods. The students felt they received the most useful feedback during the focus groups that were specific to their project. We would recommend this as a primary method of engagement to facilitate broader feedback. We have added the following sentences (lines 350-353) to provide this recommendation:

“One approach that may be effective for allowing the students to get better feedback is the use of more project specific focus groups. Across all focus groups, students noted the value of learning about local context directly from knowledge holders, and in each case emerged with new considerations to include in the designs.”

5. *Conclusions section – Regardless of the engineering program and associated expectations of the student group in the capstone project, the authors should take the opportunity to highlight challenges and opportunities for ecological engineering programs to incorporate community-engaged student capstone projects. For example, a lack of consideration of future state changes such as SLR could be a major short-coming of an ecological engineering design. In addition to research mentors providing specific guidance during the capstone experience, do the authors have suggestions for concepts such as this that could be incorporated early and/or throughout the educational program to better prepare students for community-engaged capstone design?*

Thank you for this comment. We have added a few sentences (lines 402-406 and 414-418) to the conclusion section that suggest the potential of incorporating community engagement and cost estimates into projects earlier in an ecological engineering curriculum. These experiences would better prepare the students as they enter capstone allowing them to focus more on the engineering analyses during their capstone experience.

The following comments include other suggestions for improving the manuscript:

6. *Consider changing the heading titles, which reflect more of a traditional research paper, to better align with the manuscript content and the INSIGHTS commentary article format. For example, rather than “Study Description” in section 2, the content would be better reflected by a heading such as “Capstone Project Description” or “Capstone project overview and context” or something similar.*

As suggested, Section 2 was changed from “Study Description” to “Capstone Project Overview and Context”. Section 3 was changed from “Results and Discussion” to “Capstone Designs and Education Application”.

7. *The “Results and discussion” section starts abruptly with a description of one of the student projects. It would be useful to first provide an overview of the 3 projects that emerged from the community engagement process (Table 1).*

We agree. The start of section 3 has been changed to a short introduction to the types of projects considered, Table 1, and ABET student outcome results.

Minor comments

- *Consider clearly defining “the research team” at the first mention (e.g., is it the authors? Does it include other graduate students or faculty mentors? And what disciplines are represented by the research team?)*

Thank you for pointing out this was missing. It has been added in the introduction (lines 66-69).

- *In Line 79, give % cover of each land use in the watershed.*

Percentages have been added for agriculture (15%), residences (1%), and wetlands (24%) in line 81.

- *Line 126: It is stated that interactions w/ community members “could have been better.” In what ways specifically, would interactions have been improved toward meeting student educational outcomes?*

We have added the following sentence in lines 156-158: “In person meetings would have allowed more informal and one-on-one interactions with community members before and after the official meeting time.”

We recognize this does not fully address your question, but we have decided to limit our response in an attempt to maintain the brevity of the article and reduce speculation without data to support it.

Reviewer 2

Thanks for allowing me the opportunity to take a glance into your classroom! This manuscript will be a nice contribution to the literature, and I recommend a minor revision. The study describes three capstone engineering teams/projects, which occurred virtually because of COVID, about coastal engineering in the face of climate change. Objectives were to describe designs produced by the capstone teams, examine the proposed designs under future sea level rise, and discussing lessons learned. A unique perspective offered by this paper is the ability to conduct community-engaged capstone projects even though engaging with the community was difficult during the pandemic. Opportunities for improvement include clearer methods and hashing out some of the specific comments addressed below.

We appreciate your review and pointing out ways that we can make our manuscript stronger. We have added more details in section 2.2 to better describe how the capstone teams were formed, who the teams interacted with, and how the teams interacted with different community members.

Specific comments: Abstract – well written. Line 4 recommended to not use the word “significant” unless statistics were conducted to support this. Same for lines 188 and 246.

Thank you for pointing this out. The word “significant” has been replaced or the sentence revised in each of these cases (line 34, 246, and 299).

I would like to see more methodology description in this manuscript. As currently written, I am unsure if someone else could replicate the study methodology.

We have added more details throughout Section 2. Our additions are brief due to our goal of maintaining this as an INSIGHTS article for the journal.

Also, more details about how you facilitated a community-engaged capstone projects during COVID would be beneficial to other educators. Section 2 gives a thorough introduction to the lake, problem, and teams. It also cites a parallel article documenting the community engagement from the students’ perspective. I recommend sharing more about the community’s

characteristics/needs/goals for the project. If their goal is just to address the challenge of flooding broadly, it is clear in line 128.

The goals of the community as expressed in the watershed restoration plan were added in section 2.1 (lines 90-92). The remainder of this section includes information on the project goal. We made a couple of edits to make it clearer that the goal of the project was shared with the community.

The community representatives on the core stakeholder group were added in section 2.2 (lines 127-130).

Lines 98-104: Was there any thought put into the pairing besides their major? I know some instructors use CATME or similar metrics to pair students. Were there any measurements of how the students thought they worked together?

The following sentences were added to section 2.2 (lines 110-112) to clarify how student teams were put together: “The research team was not responsible for assigning students to the capstone teams. Teams are typically put together to provide the knowledge necessary for the project and balance student capability across all capstone teams.”

CATME is a great tool, but was not used in this case. Measurements of how the students thought they worked together are made through an anonymous survey administered to everyone in the capstone class. We were not able to separate the students from this project with those from the rest of the course.

Lines 155-157 state the perspective of the landowner team. I assume this means that some sort of interviewing/human subjects research occurred. Please note whether institutional approval was needed or acquired.

Thank you for pointing out this omission. We have added a note about approval in section 2.2 (lines 161-163).

In line 220, you describe some economics estimations, and one of the key takeaways is that economic analysis emerged as a significant hurdle for students. What type of economics training, if any, did the students receive?

We made quite a few revisions to the Lessons Learned section about the economic analysis. This section now includes the following sentences describing their economics training: “All ECU engineering students take a 2 credit hour engineering economics course typically in their third year. This course covers topics such as cash flows, equivalent worth, benefit-cost, and rate of return, which should have made possible a standard economic analysis for all three projects to compare the project more easily”.

Section 4: Looking for some recommendations here... improve economics classes, etc

Thank you for pointing out this need here. In this section, we have added the suggestion that cost estimates on these types of projects and community engagement could be incorporated into projects earlier in the curriculum (lines 402-406 and 414-418). Learning these skills earlier would allow the students to focus more on the engineering analyses and design once they reach capstone and are trying to deliver a product to a community.

Reviewer 3

The manuscript bridges important issues central to public engagement and solving real world issues. Unfortunately, the title is misleading and engagement was addressed in a separate paper. Improvements include revamping and rewriting to be more clear about the engineering exercise, which appeared to focus on model runs to reduce flooding impacts by creating channels with "shallower depth." NbS and other techniques were not addressed and water level management by itself falls short of NbS, particularly when future SLR was not addressed.

We appreciate you taking the time to read and provide comments on our paper. We agree the students not taking into account sea level rise was a major shortfall and is one of the reasons we included the additional analyses in the paper. We also agree that dredging in this case should not be considered a nature-based solution. We have added some details to the description on the canal dredging project that show they considered a nature-based solution (lines 221-223). The other two projects do incorporate aspects of nature-based solutions. We have not included more details about the engineering exercise as that was outside the scope of this manuscript. We have added more details about the community engagement to make that portion of the manuscript clearer.

The premise of the paper sets up well, particularly in L27-29, but that was not adequately addressed in the manuscript, particularly given that no future SLR levels were modeled for the alternative (L173) nor were resiliency methods/techniques introduced. I see that the results indicated a shorter duration of flooding due to channel alterations and level control structures, but that leans more to conventional engineering (pumping, etc) and is less about ecological engineering and its co-benefits.

We understand this perspective, especially the lack of co-benefits and the lack of future conditions being evaluated by each team. One of our goals for the paper was to show the challenges involved with this type of project and how they could be addressed. We made multiple edits in sections 3 and 4 to provide recommendations on how to get students to the point of being able to better evaluate co-benefits and future conditions.

An overview (L131) of the various projects would strengthen the manuscript (move Table 1 closer to beginning of section).

The beginning of section 3 has been rearranged, which includes moving Table 1 to the beginning of the section.

Graphics (Fig 1) should differentiate projects with labels and be enumerated to match narrative.

Thank you for pointing out this error. Figure 1 has been updated so that the labels in the figure match the project names used throughout the narrative.

Not sure that the manuscript supports the conclusion (L297 "show effective engagement with the community") unless additional evidence for this claim is shown.

We have changed the word “show” to “suggests” (line 408).

Reviewer 4

Editor’s Note: One additional reviewer provided review comments that were completed under the assumption that this was an original research paper. The authors were instructed to use these comments to improve the paper as they saw fit and to respond accordingly.

Round 2

The associate editor provided this summary:

The authors responded comprehensively and adequately to feedback from the associate editor and the three reviewers regarding their manuscript on community-engaged capstone engineering projects. Key revisions and clarifications include the following:

Integration with Ecological Engineering Education: The authors added a new section linking the capstone experience to ecological engineering programs and key ABET outcomes, acknowledging the manuscript’s relevance to the field.

· *Clarification of Terms and Methods:* Definitions for terms like “effectiveness” and “benefits” were added, and more detail was provided on community engagement methods, team formation, and project evaluation.

· *Community Engagement Enhancements:* The authors elaborated on the composition of community stakeholders and recommended project-specific focus groups to improve feedback quality.

· Addressing Reviewer Concerns:

- Reviewer 1’s suggestions led to stronger connections to ecological engineering education and a clear articulation of student learning outcomes.

- Reviewer 2's comments prompted more detailed methodology and discussion of economic training and community goals.
- Reviewer 3's critique about the manuscript's focus and title led to clarifications about the nature-based solutions and the limitations of the student projects, especially regarding sea level rise (SLR) modeling.

· *Structural and Stylistic Revisions:* Section headings were revised for better alignment with the INSIGHTS article format, and figures and tables were adjusted for clarity and relevance.

Overall, upon review by this editor, the manuscript is much improved. It well presents its focus, a case study of three engineering capstone teams collaborating with a rural coastal community in North Carolina to design flood mitigation solutions. It is important that it was conducted during the COVID-19 pandemic, as the projects emphasized community engagement and addressed challenges related to sea level rise, water quality, and economic feasibility, involving community engagement. The manuscript covers interesting approaches for design, as pursued by students; community engagement to communicate priorities; educational insights and lessons learned for implementing such educational project-based curricula; and demonstrated relevance to ecological engineering education and relationship to upcoming ABET criteria. It adequately meets the criteria for an Insights article of this journal, with minor typographical and grammatical corrections upon editorial review.