Environmental Engineering Core Curriculum Transformation: A Skill-Based Approach

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Abstract

The Environmental Engineering (EE) core curriculum at the University of Kansas (KU) is a series of courses taught to upper-level undergraduate students with an EE degree focus in Civil, Environmental, and Architectural Engineering (CEAE) and Chemical and Petroleum Engineering (CPE) and incoming EE graduate students. The EE curriculum focuses on first-principle concepts with correspondingly named courses of Concepts of Environmental Chemistry (CE770), Physical Principles (CE772), and Biological Principles (CE773). At the start of the 2020 academic year, Professors Hutchison and Peltier initiated a course transformation to align course content and increase skill-based curriculum, specifically in writing, modeling, data interpretation, and experimentation (Figure 1). This included a significant expansion of our one-credit Environmental Engineering Laboratory (CE771) into a three-credit course.

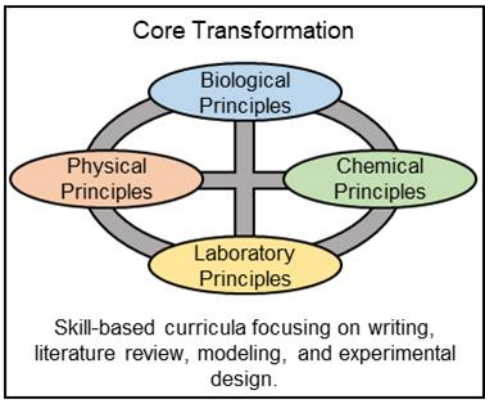

Figure 1: Alignment of the core EE curriculum that incorporated skills.

As these classes represent core courses in the KU EE graduate degrees, writing components were incorporated into each class that mirrored the thesis requirements. These requirements included performing literature searches and properly citing references (CE 770), writing and testing written protocols (CE 771), modeling physical systems (CE 772), and placing relevant data in the context of the current literature (CE 773). Students self-selected topics, and graduate students were encouraged to select topics relevant to their research.

In our key results, we highlight one of the transformed courses and specifically address the implemented writing components. As the course transformations began at the beginning of 2020, the content delivery and standard evaluation procedures were severely disrupted by the COVID-19 pandemic. CE 773 was the first class to implement the updated curriculum, and seven deliverables were designed to help guide students through a properly cited discussion project. The number of primary literature articles required for a comprehensive discussion was varied to account for differences between the graduate and undergraduate sections. Graduate students were required to incorporate ten primary literature articles, whereas undergraduate students were required to incorporate five articles. Student responses were generally positive, and several

students highlighted how the discussion project kept them engaged with the transition to asynchronous content delivery. Select student responses are included below.

"The research papers were interesting to connect the concepts learned in class with higher-level applications."

"The paper assignment was very helpful to me as someone who has not done such an in–depth scientific paper before. It taught me how to read and summarize scientific reports much better, and I learned a lot from it. I also liked the paper discussion assignment because it taught us to read critically and ask questions."

While responses to the discussion project were generally positive, some students offered critical feedback on specific aspects. First, certain students found it challenging to self-select a topic at the beginning of the course and expressed a desire to have spent more time selecting a better topic. Second, blind student peer review was incorporated into the discussion project, and again, select students were averse to this type of feedback.

"Personally, I found the discussion paper to be useful, but I wish I would have picked a better topic/paper to write off of. The topic I used was covered in one of the last weeks of class and after covering that content, what I had been reading and writing about made so much more sense! Maybe a little more discussion about what makes a good paper would be helpful. Even if you decide [on] one topic, picking the actual paper you want to cover is so hard! I think I ended up finding and skimming 20 or 30 papers before finally telling myself I needed to just pick on and move on. I also didn't love the sectioning of the paper. For example, the paper I used had results and discussion in the same sections, so separating those out into two was difficult, and I think made less sense than when they were intermingled. But it was obviously great practice to read the journals, think critically about them, and then write a cohesive paper."

"The assigned research paper should be graded by the teacher only and peer drafts should be eliminated. I found the comments made from my peer draft not very helpful in helping me know what changes needed to be made. Also, our peer's assumed scoring of our draft should not be used to give us an official grade, because there is too much potential for discrepancies upon each student's grading standards."

Figure 2: Word cloud of CE 773 student responses to the question “What aspects of the class were most helpful to your learning?”

Overall, for a first-year implementation, the CE773 discussion project was well received. Students were asked at the end of year course evaluation: "What aspects of the class were most helpful to your learning?" The discussion project was frequently mentioned (Figure 2).

Our preliminary assessment of our course transformation indicates that incorporating skill-based objectives with student-selected content is a success. A complete evaluation of all courses will require additional data collection to facilitate a historical comparison.

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