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Weaving Social Context Through Foundational Engineering Coursework: Design and Impact of an Integrated Learning Community (NSF-IUSE)

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Introduction

Significant numbers of first-year community college students place below Calculus-level mathematics and face extended prerequisite sequences before engaging with core engineering content [1] [2]. This NSF IUSE: Innovation in Two-Year College STEM Education (ITYC) project addresses this challenge through a two-quarter learning community that integrates engineering, mathematics, history, and English composition. The Engineering in Context (EiC) Learning Community at Whatcom Community College employs place-based learning, community-engaged projects, hands-on mathematics laboratories, and course-based undergraduate research to support precalculus-level students entering the engineering transfer program [3]. A distinguishing feature of this curriculum is its approach to social context: rather than treating social awareness as supplementary content confined to ethics modules or capstone experiences, the learning community positions engineers as inherently working within social, cultural, and political systems throughout the foundational coursework.

This paper reports on findings from the first two cohorts (2023-24 and 2024-25) regarding student development of what we characterize as *ethical awakening*—the emergence of strong moral commitments alongside recognition of tensions between personal values and traditional engineering career pathways. Our companion paper [4] provides detailed analysis of student reflective writing and presents additional evidence supporting these findings.

Curriculum Design for Sociotechnical Integration

Three primary curriculum components work together to foreground the social dimensions of engineering practice throughout the two-quarter experience.

Historical Marker Project (Quarter 1)

This quarter-long interdisciplinary project engages students in original archival research examining 150 years of engineered shoreline development in their region [5]. Students analyze how engineering decisions shaped land use, environmental change, and community well-being while developing historical research skills. Field trips to the local waterfront and regional archives provide direct engagement with place and primary sources. In the engineering portion, students acquire technical skills in Computer Aided Design (CAD), laser cutting, and 3D printing to create physical artifacts. These skills are used to create multimedia presentations that integrating engineering analysis with social impact assessment. The project addresses one of the learning community's essential questions: *"How does the engineered world affect how we live?"* Student feedback indicates the Historical Marker Project provides context for students to engage with the consequences of past decisions, particularly the legacy of environmental contamination,

while also drawing on ways of knowing, including indigenous, STEM, and Humanities, to engage in place-based civic responsibility and stewardship.

Problem Exploration Project (Quarter 2)

For this English composition assignment, students investigate societal problems with plausible engineering dimensions. Students from the first two cohorts explored topics including ocean acidification, housing affordability, public transit access, and declining bee populations. The assignment explicitly instructs students to explore both social and technical aspects of their chosen problem without prioritizing either dimension and without proposing solutions. This constraint encourages students to sit with complexity rather than rushing toward technical fixes.

Sociotechnical Discussion Activities (Quarter 2)

Structured discussions approximately once per week engage students with readings emphasizing the social and political dimensions of engineering work. The timing of these discussions shifts between “engineering time”, “English time”, and “math time” within the weekly class sessions to reinforce the universal relevance of the topics. Students read and discuss articles ranging from an academic paper on the perceived gaps between social and technical aspects of engineering [6], to articles from popular media focused on infrastructure inequality and redlining [7], labor condition implications of industrial automation [8], and an example of more cooperative economic organization of engineering industry [9]. These discussions create opportunities for students to articulate and examine their developing professional values intermixed with their work developing technical skill in math, English composition, computer programming and design.

Evidence of Ethical Awakening

Analysis of culminating reflective writing assignments and alumni interviews from the first two cohorts reveals a consistent pattern we characterize as *ethical awakening*. This phenomenon has two interrelated dimensions: students develop strong moral commitments while simultaneously recognizing barriers to enacting these values within traditional engineering career pathways.

Students from the first two cohorts articulated clear ethical positions in their reflective writing associated with the historical marker project. One student wrote: *"The third and final takeaway is that while creating a solution to a problem you need to look forwards to realize the problems that your original solution may create. What may seem like a permanent solution may end up being a temporary one due to lack of foresight."* Another reflected: *"What I learned about the engineered world is to remember how much an impact you can leave. When these mills were first established there wasn't any thought as to what impact they could leave, and what the future residents of Bellingham could suffer from those consequences."*

Alumni interviews conducted 6-18 months after program completion revealed that this ethical orientation persisted and deepened for at least some students. One alumnus described how the program prompted sustained reflection on career choices: *"As I was looking through colleges and stuff like that and seeing where the colleges send off students to go work and who do they supply with educated adults, I would go down the list and I see, oh, there's a lot of defense agency contractors. And it made me really think about the ethical decisions of what are you willing to do and then where's your ethical code at?"*

Another alumnus connected this ethical development directly to the curriculum's emphasis on societal impact: *"The courses made more of an emphasis on how engineering projects or works overall will impact communities and people, and how we should be more aware about it.... I want to make or work on the stuff that will help the most amount of people."* A third alumnus captured the shift from a purely technical understanding: *"I think it was a decent setting to get me into it, but then realizing it's not always about the money and realizing that there's a lot of good that you could do... the ethical can you sleep at night type of deal. That's what it made me really think about."*

Importantly, faculty observed that this ethical awakening was accompanied by productive tension rather than simple resolution. As one faculty member noted, the goal is supporting students' *"social technical identity awakening"*—encouraging students to view engineering not purely as a technical skill but within a broader context addressing issues like social justice, history, and environmental impacts. The curriculum creates space for students to hold and grapple with the tensions between their developing values and the realities of engineering careers.

Student Appreciation for Interdisciplinary Integration

Student feedback from both cohorts consistently emphasizes appreciation for the interdisciplinary connections the teaching team worked to emphasize. One student from the first cohort reflected: *"Going into the course I had the mindset of these are your humanities courses and these are your science classes and never shall the two meet, but leaving I realize they interact often and need to be aware of each other and pair well."* Another noted: *"This is weird for me to say, but I did actually enjoy the history and the English portions of it quite a bit because we were also able to tie it with the engineering aspects of it. Those are two classes that I hated in high school... But I actually found that I really enjoyed these just because they were able to make it relevant to what I was interested in."*

Alumni interviews reinforced these observations. One described how *"the curriculum was mixed in such a way that it really highlighted the interconnectedness of the skills that you learn... it was interesting to see it in action, how the writing skills that you would learn in a history class help you explain your thinking in a math class."* Another appreciated that *"having [humanities]*

incorporated into engineering felt a lot more fun... I would rather write a paper that was leading me more toward my goals."

Discussion and Implications

The evidence from the first two cohorts suggests that sustained engagement with social context throughout foundational engineering coursework can trigger meaningful ethical development in students. Rather than simply adding ethics content to a technical curriculum, this approach positions social awareness as integral to engineering identity from the beginning of students' academic pathways.

The *ethical awakening* phenomenon raises important questions for engineering education. Students develop strong moral commitments, articulating values like "benefit others" and asking critical questions like "who are you leaving out?" Yet they simultaneously recognize barriers to enacting these values within traditional engineering career pathways. The curriculum does not resolve this tension; rather, it creates space for students to hold and grapple with it. Whether this productive discomfort ultimately supports or hinders long-term retention in engineering remains an open question for future research.

This work demonstrates approaches for integrating social awareness throughout technical foundations rather than relegating it to ethics modules or capstone experiences. The Historical Marker Project, Problem Exploration Project, and structured discussions on sociotechnical dualism represent replicable models that other programs might adapt. The key appears to be the sustained, integrated approach that weaves social context through the entire curriculum rather than just the specific activities themselves. This integrated approach is what one faculty member described as helping students develop a "social technical identity" rather than viewing social and technical dimensions as separate concerns.

Conclusion and Future Work

The Engineering in Context Learning Community's first two cohorts provide evidence that intentional integration of social context throughout foundational engineering coursework can support development of engineering identity that encompasses both technical competence and social responsibility. Student feedback and alumni reflections indicate that this approach helps students see connections between disciplines and develop ethical frameworks that persist beyond the program.

Future work will continue tracking student outcomes as they progress through the engineering transfer curriculum and investigate whether the ethical awakening observed in reflective writing correlates with differences in course-taking patterns, retention, or transfer success compared to students who completed prerequisites through traditional pathways. Additional cohorts will also allow more robust analysis of how this approach affects students from different demographic backgrounds.

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