# Linking Technical Efficiency and Social Responsibility: The Role of Reflection in Project-Based Engineering Learning

**Dr. Aparajita Jaiswal, EPICS-College of Engineering, Purdue University**

Dr. Aparajita Jaiswal is a Lecturer in the Engineering Projects in Community Service (EPICS) program at Purdue University. Her teaching and research focus on engineering education, teamwork, and experiential learning. She integrates project-based design, human-centered approaches, and technology-enhanced pedagogy to prepare students as ethical, and world-ready professionals.

**Jorge Martinez, Purdue University – West Lafayette (College of Engineering)**
**Mr. Andrew Pierce, Purdue University – West Lafayette (College of Engineering)**

Andrew Pierce is the Assistant Director for the EPICS program at Purdue University in West Lafayette, Indiana. He received his bachelor's and master of science degrees in biomedical engineering from Purdue University. He spent five years as a development engineer in the medical device industry, designing a number of commercial medical devices and generating ten patents before returning to West Lafayette to help lead the EPICS program. In his ten years with EPICS, he has developed extensive experience in the administration of community-engaged design programs. As part of the leadership team, he has led the EPICS program to be recognized with numerous awards, including the W.K. Kellogg Foundation Community Engagement Scholarship Award and Outstanding Experiential Education Program by the Society of Experiential Education.

**Brandon R Stevens, Purdue University – West Lafayette (College of Engineering)**

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## Background

Engineering education increasingly emphasizes project-based and community-engaged learning as a way to help students apply technical knowledge in authentic settings [1]. In such environments, students are not simply solving bounded technical problems. They must respond to changing constraints, collaborate with teammates, communicate with stakeholders, and consider how design decisions affect real people and communities [2], [3]. These experiences can be powerful, but experience alone does not guarantee learning. Students also need opportunities to interpret what happened, connect it to broader ideas, and consider how it should shape future action [4]. Experiential learning theory positions reflection as the mechanism that links action to understanding [5]. Rather than learning only through lectures or abstract concepts, learners make meaning by engaging in authentic tasks, examining those experiences, and transforming them into broader insights and future practice [5]. In engineering education, reflection has similarly been recognized as important for helping students connect technical work with professional growth, ethical awareness, and contextual understanding [6]. Community-engaged engineering may be especially generative in this regard because it exposes students not only to design challenges, but also to the social, ethical, and interpersonal dimensions of engineering work [7], [8].

Although project-based and community-engaged experiences are increasingly common, less is known about what students' reflections actually reveal about learning in these settings. Existing studies often emphasize project outcomes, skill development, or student attitudes, but they less often examine how students themselves make sense of what they experienced, especially when technical, interpersonal, and social dimensions are tightly intertwined [2], [6]. This leaves an important gap. We know reflection matters, but we know less about what kinds of learning become visible when students are asked to interpret a community-engaged engineering experience in writing. This study addresses that gap by examining structured final reflections written by undergraduate students in an Engineering Projects in Community Service (EPICS) course. Using Kolb's Experiential Learning Cycle as a deductive lens, the study investigates how students represented their learning after participating in a community-engaged engineering project with a nonprofit organization supporting individuals experiencing homelessness.

The research question guiding this study is: **RQ:** What does students' structured final reflection reveal about experiential learning in a community-engaged engineering course?

## Theoretical Framework

This study draws on Kolb's Experiential Learning Cycle [5], which conceptualizes learning as a process through which experience is transformed into understanding and action. The framework identifies four interrelated stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Concrete experience refers to direct involvement in a task or situation. Reflective observation involves looking back on that experience and interpreting what occurred. Through abstract conceptualization, learners connect those reflections to broader ideas, principles, or explanations. Active experimentation involves applying those insights to future situations and practices.

Because Kolb's Experiential Learning Cycle was embedded in the course design, it informed both the pedagogical structure of reflection and the theoretical framing of this study. In the analysis, the framework was not treated as a rigid or strictly linear sequence of learning. Instead, it served as a conceptual lens for examining which dimensions of experiential learning were evident in students' written reflections and how those dimensions were expressed in the sociotechnical context of community-engaged engineering work.

## Methods

### *Context*

The study was conducted in an Engineering Projects in Community Service (EPICS) course at a large Midwestern university. EPICS is a long-standing community-engaged engineering program in which multidisciplinary student teams partner with nonprofit and community organizations to design solutions to locally identified needs [4], [9]. Unlike short-term classroom projects, EPICS emphasizes sustained collaboration, iterative design, and stakeholder engagement. These features make it a useful setting for examining experiential learning because students must navigate technical work, teamwork, and community context simultaneously.

In the course examined here, students partnered with a local nonprofit organization supporting individuals experiencing homelessness. Working in teams, students designed a mobile application intended to help users locate essential resources such as shelters, food pantries, and healthcare services. The project required students to engage in technical design and development while also considering usability, access, stakeholder needs, and the broader social context of homelessness.

### *Integration of Kolb's Learning Cycle into the Course*

Kolb's Experiential Learning Cycle was intentionally embedded throughout the EPICS course to support reflective and adaptive engineering practice [4]. Early in the semester, students were introduced to the four stages of the cycle and to the role of reflection in community-engaged design. Faculty and teaching assistants reinforced the value of structured reflection during design reviews, partner meetings, and team work sessions. Reflective prompts were incorporated throughout the course to encourage students to connect their technical work, teamwork experiences, and community interactions to broader learning. In this way, reflection was positioned not as an add-on, but as part of how students were expected to make sense of project work.

### *Participants and Data Collection*

Participants were 15 undergraduate students enrolled in the EPICS course. As part of course requirements, students completed a structured end-of-semester reflection that served as the primary data source for this study. The reflections were required for course completion but were not graded for content, a choice intended to reduce performance pressure and encourage candid responses.

Students were asked to select two of four thematic areas- personal and professional development, social impact, academic enhancement, or ethics and write approximately 300 words for each. Across these prompts, students were encouraged to reflect on their strengths and growth, teamwork, community needs, assumptions and values, disciplinary learning, and ethical responsibilities. These final reflections were selected because they asked students to synthesize learning across the semester and articulate how they interpreted the project as a whole. The purpose of this study was therefore not to trace developmental change across multiple time points, but to examine the kinds of learning students made visible when asked to look back on a community-engaged engineering experience retrospectively [6].

***Data Analysis***

This study used Kolb's Experiential Learning Cycle [5] as a pre-defined deductive coding framework. The framework and operational definitions used for coding are presented in Table 1.

Table 1. Kolb's Experiential Learning Cycle Operationalized for Deductive Coding

| **Stage** | **Operational Definition** | **Key Verbs / Processes** | **Purpose in the Cycle** |
|---|---|---|---|
| Concrete Experience (CE) | Learning begins when individuals directly encounter a situation, task, or challenge. These tangible experiences provide the basis for later reflection and understanding. | Feeling, experiencing, participating, engaging | Provides a firsthand basis for new learning through direct involvement in an event or task. |
| Reflective Observation (RO) | Learners look back on what occurred, paying attention to details, reactions, and multiple perspectives in order to interpret the experience. | Observing, reflecting, describing, understanding | Encourages learners to examine and interpret experience from multiple viewpoints. |
| Abstract Conceptualization (AC) | Learners develop broader ideas, explanations, or general principles from reflection. | Thinking, conceptualizing, integrating, theorizing | Transforms reflections into abstract models or generalizations that can guide future action. |
| Active Experimentation (AE) | Learners apply newly formed ideas to future situations, practices, or decisions. | Doing, testing, applying, experimenting | Applies newly formed concepts to practical contexts, extending learning through action. |

A deductive thematic analysis was conducted using Braun and Clarke's six-phase process [10]. First, all final reflections were read in full by the research team to develop a holistic understanding of students' experiences and to generate initial analytic memos. Next, using the operational definitions in Table 1, the first author conducted line-by-line coding, assigning excerpts to one or more of Kolb's four stages. Coding focused on semantic content rather than latent meaning in order to remain consistent with the deductive nature of the analysis. After initial coding, excerpts were organized into four stage-specific clusters: concrete experience, reflective observation, abstract conceptualization, and active experimentation. These clusters were then reviewed for cross-case patterns in how students described experience, reflection, broader conceptual meaning-making, and future-oriented application. A second coder independently reviewed a subset of coded reflections to examine consistency in code application. Discrepancies were discussed until consensus was reached, and coding boundaries were refined accordingly. Excerpts that did not align with the operational definitions were not included in the final thematic summaries. Since the dataset consisted of retrospective end-of-semester reflections, the analysis does not claim to document developmental progression across time. Rather, it examines how students represented their learning in ways that aligned with Kolb's four stages when reflecting on the project as a whole.

## Results

Across the final reflections, students' accounts showed evidence of all four stages of Kolb's experiential learning cycle. However, the stages were not represented as isolated or strictly sequential. Instead, students often moved from describing direct engagement, to interpreting what those experiences meant, to articulating broader principles and future intentions within the same reflection. Still, distinct emphases were visible across the data. Concrete Experience was most evident in students' descriptions of direct participation in technical and stakeholder-facing work. Reflective Observation appeared when students looked back on those experiences and interpreted their role, reactions, and limitations. Abstract Conceptualization emerged when students derived broader understandings about engineering, teamwork, and responsibility. Active Experimentation was evident when students translated those understandings into intentions for future practice. Across the four stages, a recurring feature of the reflections was that students framed engineering work not only as technical activity, but as work embedded in teamwork, community context, and social consequence.

### *Concrete Experience: Direct Engagement in Technical and Community-Based Tasks*

Consistent with the operational definition of Concrete Experience, students' reflections frequently began with direct encounters with tasks, responsibilities, and project demands. These accounts emphasized participation in real design and development work rather than abstract discussion of learning. Students described firsthand involvement in coding, interface design, team roles, and interaction with the community partner, suggesting that learning began through tangible engagement in the project itself.

In many reflections, direct experience was grounded in specific technical responsibilities. One student wrote, “Working on this project, I took on frontend development tasks like building and adjusting resource cards, refining mobile and web layouts, and even designing a new logo.” This kind of description reflects the experiential basis of the project. The student was not speaking in general terms about engineering, but recounting concrete involvement in shaping a product. Other students similarly described participating in communication, programming, and coordination roles that made the project feel like real engineering work rather than a classroom exercise.

At the same time, these experiences were rarely framed as purely technical. Students often situated their participation in relation to the partner organization and the people the app was intended to support. One student explained, “After visiting [site name] the staff expressed how impactful the website would be for directing homeless people to resources on their end and for adding resources.” Here, the direct encounter is not only with the design task but also with the setting in which the tool would matter. Another student made this dual focus explicit, writing, “Helping [Project Partner] through EPICS links my individual good with the common good, since I can get experience making the website, working in teams, working for a third party, and course credits to better myself, and the community gets our website to help them find the resources they need.” The student viewed the project as mutually beneficial, linking their own growth and learning to a meaningful benefit for the community partner.

Taken together, these reflections show that Concrete Experience in this course was defined by active participation in technically specific tasks that were simultaneously connected to community need. In terms of the coding definition, students’ learning began through direct involvement in situations and challenges that were both practical and socially situated. This firsthand engagement provided the experiential basis for later reflection and interpretation.

***Reflective Observation: Looking Back to Interpret Growth, Tension, and Role***

Reflective Observation was evident when students shifted from describing what they did to considering what those experiences revealed. In alignment with the operational definition, these reflections paid attention to details, reactions, and personal responses in order to interpret the experience from one or more viewpoints. Rather than simply recounting activities, students often examined how teamwork, communication, and role expectations shaped what they learned.

A common feature of these reflections was that students looked back on the semester as a point of comparison. One student wrote, “I know I am still lacking in a lot of areas of design, but reflecting back on the beginning of this semester and then further still to the beginning of last semester, it is crazy to see how far I have come.” This excerpt illustrates observation as an interpretive act. The student is not merely reporting progress; they are evaluating their present self against an earlier version of themselves. In this way, reflection served as a way to notice change and make sense of development.

Other reflections emphasized tension and self-awareness within collaborative work. One student explained, “There were multiple times where I learned about my strengths when working together as a team, but I learned that one of my weaknesses was how to communicate the work we have done as a group." This kind of statement shows that students were attending not only to successful moments, but also to difficulty and limitation. Reflection here involved looking back at experience from more than one angle. Teamwork was both a source of strength and a setting in which weaknesses became visible.

Some students also used reflection to interpret their experiences in relation to an emerging professional identity. As one student noted, "especially through my work on the [project] team and as an EPICS Ambassador, I've had the chance to better understand my strengths, identify areas for growth, and reflect on the kind of engineer and person I want to become." This excerpt suggests that reflection contributed to identity development by helping the student connect project experience to an evolving sense of self, both professionally and personally. Across these accounts, Reflective Observation extended beyond description; it involved examining experience closely enough to interpret its significance for one's growth, role, and participation in collaborative engineering work.

***Abstract Conceptualization: Forming Broader Understandings About Engineering Practice***

Abstract Conceptualization appeared when students moved beyond interpreting a particular experience and began articulating broader ideas or principles derived from it. In line with the operational definition, these reflections involved thinking, integrating, and generalizing. Students were no longer focused only on what happened or how they felt about it; instead, they used reflection to formulate more portable understandings about engineering, teamwork, and social responsibility.

One recurring feature of this stage was that students moved from describing teamwork in a specific project to articulating broader ideas about engineering practice. For example, one student wrote, "Teamwork is important because it allows members to check each other's work, share tasks, and build habits that will carry into future projects and careers." Here, the student extends beyond the immediate team experience and frames collaboration as a durable feature of engineering work. Another student similarly reflected, "I realized that product development requires effective teamwork so members can combine their expertise and perspectives to develop the best solution." This statement likewise shows abstract conceptualization by turning a project-based experience into a broader principle about how collaborative engineering leads to stronger outcomes. Together, these reflections demonstrate conceptualization through generalizable ideas about shared expertise, coordination, and collective problem solving.

Students also developed broader understandings about the purpose of engineering itself. One student wrote, "This experience reinforced my belief in designing for equity and accessibility, and it helped me see how engineering can go far beyond technical performance." Another reflected, "I gained a deeper understanding of how my technical skills can directly impact community-focused projects." In these excerpts, students are not simply evaluating a single project. They are theorizing engineering as a practice shaped by values, context, and responsibility.

These reflections show that Abstract Conceptualization in this study involved more than summarizing lessons learned. Students transformed concrete experiences and reflective insights into broader explanations of what engineering requires and what it should accomplish. In doing so, they constructed general principles that could guide their understanding beyond the immediate project.

### *Active Experimentation: Extending Learning into Future Practice*

Active Experimentation was evident when students used newly formed ideas to imagine future action. In keeping with the operational definition, these reflections focused on applying insights to later situations, decisions, and practices. The language of this stage was often forward-looking, as students described how they would act differently in future projects, teamwork settings, or engineering roles.

Many students applied their new understandings by identifying specific changes they wanted to make in future collaboration. One student wrote, “Moving forward (next fall, that is), I will focus on fostering more open communication and creating space for every team member to share their ideas and strengths.” This statement reflects more than a general intention to improve. It shows the student taking an insight from prior teamwork and projecting it into a concrete future practice. Another student similarly wrote, “In the future, I plan to use my new teamwork skills to work more efficiently from the start of any project, making sure that everyone have what they need to succeed, including me, so everyone is as productive as possible and helping each other when they need.” Here, reflection leads directly to an applied strategy for future work.

Other students extended their learning by rethinking how they would approach design problems themselves. One student stated, “In the future I will ask more critical questions about who I’m designing for, what barriers they face, and how I can reduce those barriers.” This excerpt is especially important because it shows the application of newly formed concepts about users and accessibility. The student is not only planning to do more work; they are planning to approach design differently by incorporating a more critical and user-aware process. Another student extended this future orientation to a broader social frame, writing, “In the future, combining these bigger efforts with practical tools like the resource hub could create a more complete solution to homelessness.” This suggests that some students were applying their learning not just to immediate project decisions, but to a wider sense of how technical interventions relate to larger social problems.

Across these accounts, Active Experimentation was visible when students translated reflection and conceptual understanding into intended future action. Their reflections suggest that learning was extended not only through plans to improve efficiency or teamwork, but through a broader reorientation toward communication, accessibility, and socially responsive design practice.

## Discussion

This study used Kolb’s experiential learning cycle as a deductive lens to examine what students’ structured final reflections revealed about learning in a community-engaged engineering course. While the reflections showed evidence of all four stages of the cycle, the value of the findings lies less in confirming the presence of those stages and more in clarifying how experiential learning was expressed in this particular context. In these reflections, learning was not represented as a purely individual or technical process. Instead, students described engineering work as shaped by community context, collaborative demands, communication challenges, and questions of responsibility. The findings therefore suggest that when students reflect on community-engaged engineering, they often represent experiential learning as sociotechnical in character rather than as a simple movement from task completion to skill acquisition [11].

One contribution of this study is that it shows how direct participation in community-engaged engineering can make the social dimensions of technical work more visible to students. The reflections suggest that students did not treat design and development as self-contained activities. Rather, they understood those activities in relation to use, access, stakeholder needs, and the consequences of design decisions. This matters for engineering education because it suggests that authentic project settings may do more than provide practice opportunities; they may also reshape what students notice about engineering itself. In this study, structured reflection appeared to surface that broader awareness by making students articulate not only what they did, but why the work mattered and for whom. For engineering education, this is important because it points to reflection as a mechanism through which students may begin linking technical action to contextual and social meaning [6]. A second contribution is that the reflections revealed not only learning through success, but learning through tension. Several students used reflection to make sense of difficulty, particularly around communication, contribution, and role clarity in team settings. These moments are important because they complicate an overly smooth reading of experiential learning. Rather than suggesting that learning emerged simply from participation, the reflections indicate that challenge and discomfort were often central to how students interpreted their growth. In this sense, community-engaged engineering did not appear as a setting in which students merely applied prior knowledge. It also functioned as a setting in which they encountered limits in their communication, teamwork, or confidence and were prompted to reassess themselves through those experiences.Relatedly, the findings suggest that structured reflection can make visible an early form of professional self-positioning [12]. Students' reflections frequently turned toward questions of who they were within the project, what they contributed, what they still needed to improve, and what kind of engineer they hoped to become. The significance of this point is not that the study formally measured identity development, but that identity-related thinking surfaced even though the prompts were not exclusively designed around identity. For engineering education research, this suggests that structured reflective writing may offer insight into how students interpret their place within engineering practice, especially in settings where design work is collaborative and socially consequential. The study therefore contributes to ongoing conversations about professional formation by showing that final reflections can reveal more than technical learning or generalized personal growth; they can also expose how students begin to position themselves in relation to professional responsibility, teamwork, and service.

The findings also refine how Kolb's model may be understood in community-engaged engineering settings. In many applications, the cycle can appear as a relatively general learning process. In this study, however, each stage was inflected by the nature of the project context. Experience was bound up with real partner needs, reflection often centered on interpersonal and ethical dimensions, conceptualization extended toward broader understandings of accessibility and responsibility, and future action was framed in terms of more inclusive and socially responsive practice. This does not challenge Kolb's framework, but it does suggest that the content of experiential learning matters. What students learn from experience is shaped by the social and organizational setting in which that experience occurs. The study therefore adds to the literature by showing that a deductive Kolb-based analysis can still yield insight beyond theory confirmation when attention is given to the character of the experience being reflected upon. At the same time, the study has clear interpretive limits. Because the dataset consisted of end-of-semester reflective writing, the analysis captures retrospective sensemaking rather than developmental change across the semester. The findings therefore should not be read as evidence of how students progressed step-by-step through Kolb's cycle or as proof that reflection alone caused particular forms of learning. Instead, they show how students synthesized and represented their learning when invited to interpret the project as a whole. This boundary is important because it clarifies the contribution of the study as this work does not claim to document the process of development over time, but rather to illuminate what students foregrounded when reflecting on a sustained community-engaged engineering experience at the end of the course.

Overall, this study suggests that structured final reflection can do important analytic and pedagogical work in community-engaged engineering education. Analytically, it can reveal how students connect technical activity with communication, community context, responsibility, and future practice. Pedagogically, it can prompt students to articulate those connections in ways that may otherwise remain implicit. For engineering educators, the key takeaway is not simply that reflection should be included in project-based courses, but that reflection can help make visible the broader forms of learning such courses are often intended to support, including sociotechnical awareness, professional self-assessment, and a more responsible orientation toward engineering practice.

**Implications for Engineering Educators**

The findings offer several implications for engineering educators designing project-based and community-engaged learning environments. First, reflection should be treated as an intentional part of course design rather than a final add-on. If educators want students to connect technical activity with broader engineering judgment, they need structured opportunities to interpret what happened, why it mattered, and how it should inform future practice. Second, reflection prompts should explicitly encourage students to connect technical decisions with user context, teamwork, assumptions, and social responsibility. In this study, students' richest reflections emerged when they made connections among design work, communication, accessibility, and community impact. Prompts that encourage such connections may help students move beyond describing tasks toward articulating how engineering functions as sociotechnical practice. Third, educators should recognize that authentic community-engaged projects can support more than technical skill development. They can also prompt students to grapple with communication challenges, shared responsibility, and the human consequences of design decisions. These dimensions should not be treated as secondary outcomes. Instead, they can be explicitly incorporated into learning goals, reflective assignments, and assessment strategies. Finally, the study highlights the importance of aligning claims about learning with the kinds of reflection data collected. End-of-semester reflections are especially valuable for capturing students' synthesis of learning and the meanings they attach to project experience [6]. However, when the goal is to understand how students' thinking changes over time, final reflections should be paired with in-semester reflections, observations, or design artifacts. Making this distinction can strengthen both instructional design and engineering education research.

## Limitations and Future Work

This study should be interpreted within several important boundaries. First, the analysis draws on reflections from 15 students in a single EPICS course and one community partnership, so the findings are intended to provide analytic insight rather than broad generalization. Second, because the dataset consisted of end-of-semester reflections, the study captures retrospective accounts of learning rather than direct evidence of how students' thinking changed over time. Third, written reflections are shaped by what students choose to emphasize and may privilege articulated insight over uncertainty, contradiction, or experiences that remained difficult to express in writing.

Future work could build on this study by incorporating multiple reflection points across the semester, interviews, observations, or design artifacts to examine how experiential learning unfolds over time in community-engaged engineering settings. Comparative work across different project types, community contexts, or institutional settings could also clarify which features of community-engaged learning most strongly shape students' reflective sensemaking. In addition, future research could examine how particular instructional supports, such as reflective prompts, peer discussion, or partner interaction, influence the kinds of learning students are able to articulate.

## Conclusion

This study examined how students made sense of a community-engaged engineering experience through structured final reflection. Using Kolb's experiential learning cycle as a deductive lens, the analysis found that students' reflections made visible all four dimensions of experiential learning while also revealing the sociotechnical character of that learning. Students connected technical work not only to project tasks and teamwork, but also to accessibility, community context, responsibility, and future engineering practice. Rather than showing only that experiential learning occurred, the study demonstrates what students foregrounded when asked to interpret a meaningful engineering experience in writing. For engineering educators, these findings emphasize the value of structured reflection as a means of helping students articulate how technical practice is intertwined with human and social concerns.

## References


[1] J. L. Huff, C. B. Zoltowski, and W. C. Oakes, "Preparing Engineers for the Workplace through Service Learning: Perceptions of EPICS Alumni," *J. Eng. Educ.*, vol. 105, no. 1, pp. 43–69, Jan. 2016, doi: 10.1002/jee.20107.

[2] A. Acero, M. C. Ramirez-Cajiao, and C. Baillie, "Understanding community engagement from practice: a phenomenographic approach to engineering projects," in *Frontiers in Education*, Frontiers Media SA, 2024, p. 1386729. Accessed: Sep. 24, 2025. [Online]. Available: https://www.frontiersin.org/articles/10.3389/feduc.2024.1386729/full

[3] J. Walther, M. A. Brewer, N. W. Sochacka, and S. E. Miller, "Empathy and engineering formation," *J. Eng. Educ.*, vol. 109, no. 1, pp. 11–33, Jan. 2020, doi: 10.1002/jee.20301.

[4] C. B. Zoltowski and W. C. Oakes, "Learning by doing: Reflections of the EPICS program," *Int. J. Serv. Learn. Eng. Humanit. Eng. Soc. Entrep.*, pp. 1–32, 2014, Accessed: Dec. 01, 2025. [Online]. Available: https://ojs.library.queensu.ca/index.php/ijsle/article/view/5540
[5] D. A. Kolb, *Experiential learning.*, vol. 41. Englewood Cliffs, NJ: Prentice Hall, 1984.
[6] J. A. Turns, B. Sattler, K. Yasuhara, J. L. Borgford-Parnell, and C. J. Atman, "Integrating reflection into engineering education," in *2014 ASEE Annual Conference & Exposition*, 2014, pp. 24–776.
[7] K. Bissett-Johnson and D. F. Radcliffe, "Engaging engineering students in socially responsible design using global projects," *Eur. J. Eng. Educ.*, vol. 46, no. 1, pp. 4–26, Jan. 2021, doi: 10.1080/03043797.2019.1674785.
[8] J. Hirsch, R. Yow, and Y.-C. S. Wu, "Teaching students to collaborate with communities: expanding engineering education to create a sustainable future," *Eng. Stud.*, vol. 15, no. 1, pp. 30–49, Jan. 2023, doi: 10.1080/19378629.2023.2176767.
[9] E. J. Coyle, L. H. Jamieson, and L. S. Sommers, "EPICS: A model for integrating service-learning into the engineering curriculum.," *Mich. J. Community Serv. Learn.*, vol. 4, pp. 81–89, 1997, Accessed: Dec. 01, 2025. [Online]. Available: https://eric.ed.gov/?id=EJ581999
[10] V. Braun and V. Clarke, "Thematic analysis," in *APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological*, in APA handbooks in psychology®. , Washington, DC, US: American Psychological Association, 2012, pp. 57–71. doi: 10.1037/13620-004.
[11] R. Pucha, C. J. Thurman, R. Yow, C. R. Meeds, and J. Hirsch, "Engagement in practice: Socio-technical project-based learning model in a freshman engineering design course," in *2018 ASEE Annual Conference & Exposition*, 2018. Accessed: Apr. 10, 2026. [Online]. Available: https://peer.asee.org/30390.pdf
[12] Z. Liu and A. Olewnik, "From Engineering Students to Student Engineers: Reflections, Identity, and Positioning in Co-curricular Activities," in *2023 ASEE Annual Conference & Exposition*, 2023. Accessed: Apr. 10, 2026. [Online]. Available: https://peer.asee.org/from-engineering-students-to-student-engineers-reflections-identity-and-positioning-in-co-curricular-activities