Exploration of the Impact of a Two-Quarter Learning Community Experience on First-Year Students' Motivation, Identity, and Belongingness

Prof. Eric Davishahl, Whatcom Community College

Eric Davishahl serves as professor and engineering program lead at Whatcom Community College in northwest Washington state. His current project involves developing and piloting an integrated multidisciplinary learning community for first-year engineering. More general teaching and research interests include designing, implementing and assessing activities for first-year engineering, engineering mechanics, and scientific computing. Eric has been an active member of ASEE since 2001. He was the recipient of the 2008 Pacific Northwest Section Outstanding Teaching Award, chaired the PNW Section 2017-2019, served on the ASEE Board of Directors as Zone IV Chair 2022-2024. and currently serves as Program Chair for the Two-Year College Division.

Anna Wolff, Whatcom Community College
Seth Greendale, Whatcom Community College

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Abstract

This complete research paper presents findings from a systematic thematic analysis of reflective essays written by first-year engineering students who participated in a two-quarter learning community. The Engineering in Context (EiC) learning community features coordinated instruction across English composition, precalculus, history, and introductory engineering courses with explicit emphasis on the sociotechnical dimensions of engineering work woven through all courses. Using a constructivist epistemology and systematic thematic analysis, we analyzed students' final reflections to assess the program's impact on three key socioemotional constructs: motivation, identity, and sense of belonging.

Retention of engineering students, particularly those entering at the precalculus level, remains a persistent challenge in undergraduate engineering education. While learning communities have shown promise in supporting student success, less is understood about how integrated first-year experiences specifically influence students' socioemotional development. Self-determination theory suggests that supporting students' autonomy, competence, and relatedness can enhance intrinsic motivation and persistence. Similarly, research on engineering identity formation emphasizes its importance in shaping students' trajectories. This study examines how participation in an integrated learning community designed around sociotechnical engineering education influences these developmental domains.

We employed a six-step systematic thematic analysis framework to code and analyze 19 student essays from two cohorts (2023-24 and 2024-25) written at the conclusion of the two-quarter EiC experience. Students were prompted to reflect on their development as writers, learners, and aspiring engineers, with specific attention to their engineering identity, moral and social responsibilities, and learning processes. The research team worked collaboratively with a large language model (Claude Opus 4.5) to conduct the analysis, with the LLM serving as an analytical assistant to identify patterns, generate initial codes, and track code frequency across essays while the researcher maintained interpretive control, verified findings against source material, and made final analytical decisions. Student essays remained on the researcher's local computer via Model Context Protocol (MCP) and were never uploaded to external servers. Following familiarization with the data, we generated keywords using established criteria for salience and meaning, developed 10 consolidated codes organized around motivation, identity, belongingness, and integrated experience themes, and synthesized these into four overarching themes.

Four themes emerged from the analysis: (1) Becoming an Engineer Who Makes and Matters (84% of essays), capturing dual-pathway identity development through both maker/problem-solver orientation and social impact awareness grounded in purpose-driven motivation; (2) Building Confidence Through Community (79%), describing how self-efficacy develops within the supportive cohort structure through normalized struggle and collaborative learning; (3) Finding Belonging Amid Uncertainty (74%), revealing that belonging and identity uncertainty coexist productively, with students finding connection through peers and faculty while openly questioning their engineering futures; and (4) Learning How to Learn in Context (79%), addressing metacognitive development through integrated, contextualized curriculum.

These findings suggest that integrated learning communities emphasizing sociotechnical dimensions of engineering can effectively support first-year students' socioemotional development across multiple domains simultaneously. The coexistence of increased confidence and productive uncertainty suggests the program creates space for identity exploration. The strong presence of peer collaboration and support networks provides evidence that cohort-based structures successfully address belongingness, a critical factor in engineering retention.

Introduction

Students entering engineering programs at the precalculus level face significant challenges in persisting to degree completion. At community colleges, where many students begin their engineering pathways, those who start in precalculus or lower mathematics are substantially less likely to complete engineering degrees compared to peers who enter at calculus level [1] [2]. This pattern is not unique to any single institution; the fact that students starting in precalculus or lower mathematics are less likely to succeed in engineering is well documented across a variety of educational contexts [3]. In contrast to students further along in their academic progression who naturally form communities around shared upper-division coursework, students earlier in their academic path are often diffuse across 100-level math, physics, and chemistry courses that serve multiple STEM majors and include no direct instruction on how course content connects to their career goals.

In response to this challenge, we developed the Engineering in Context (EiC) learning community at Whatcom Community College, a two-quarter integrated experience designed to welcome and support precalculus-level students entering the engineering academic pathway. The program, described in detail in our earlier work [4] [5] [6], synthesizes multiple high-impact practices including a first-year experience course sequence, community-engaged learning, course-based undergraduate research experiences, and place-based integrated instruction across engineering, mathematics, English composition, and Pacific Northwest history. The curriculum is organized around essential questions about the role of engineers in society, with particular attention to themes that connect abstract concepts to students' lived geographic and cultural contexts. The integrated cohort structure provides 18 contact hours per week of shared coursework across three linked courses for each quarter.

This paper presents findings from a systematic thematic analysis of student reflective essays collected at the conclusion of the two-quarter EiC experience. The analysis addresses the following research question:

> *RQ1: How does students' participation in the Engineering in Context learning community impact their academic skills/attitudes and socioemotional development, specifically their motivation, engineering identity, and sense of belonging?*

By examining students' reflections on their experiences, we seek to understand the mechanisms through which this learning community experience supports the academic and socioemotional development of participating engineering students.

Theoretical Framework

Three interconnected theoretical constructs guide this research: sense of belonging, motivation, and engineering identity. These constructs are well-established in engineering education research as predictors of student persistence and success.

Sense of Belonging

The concept of sense of belonging generally relates to self-perceptions of fit within a given context [7], [8]. Strayhorn [9] defines belonging as students' perceived sense of connectedness—the feeling that they matter to others and are cared about. Walton and Cohen [10] introduced the concept of belonging uncertainty, describing how students may question whether "people like me" belong in academic settings. Building a sense of belonging, connection, and community is important to persistence and student success in college, particularly in STEM fields [11], [12]. Hausmann et al. [11] found that sense of belonging predicts institutional commitment and persistence even after controlling for other factors.

Motivation

The construct of motivation relates to self-determination theory and posits that in general people wish to develop themselves and may do so both for extrinsic reasons (desire for praise or reward) and intrinsic reasons (the need to fulfill an interest) [13]. Self-determination theory posits that intrinsic motivation is supported when three basic psychological needs are satisfied: autonomy (sense of volition and choice), competence (feeling effective), and relatedness (connection with others). Bandura's [14] self-efficacy theory emphasizes students' beliefs in their capability to succeed at specific tasks, which influences effort, persistence, and achievement. Increasing engineering students' intrinsic motivation may lead to a desire for deeper learning as opposed to a surface approach focused primarily on grades [15] and can be promoted by giving students opportunities to engage in independent, self-directed learning [16].

Engineering Identity

The concept of identity is commonly framed around "the kind of person one is seeking to be and enact in the here and now" [17] and, in the context of students still defining future goals and career paths, can also be thought of in terms of a future time perspective considering the kind of person a student envisions becoming [18]. Carlone and Johnson [19] proposed a model of science identity comprising three dimensions: competence (knowledge and understanding), performance (social performances of relevant practices), and recognition (being recognized by others as a "science person"). Godwin et al. [20] validated this model for engineering contexts, finding that recognition is the strongest predictor of engineering identity. Development of a professional engineering identity has been tied to retention in the engineering field [21] and can be weaker for engineering students compared to other science majors [22]. Cultivating students' development of engineering identity is important to increasing participation rates in engineering by women and underrepresented minorities [23]. Importantly, Verdín et al. [24] found that these constructs interact: engineering identity affects belonging, and belonging mediates the relationship between identity and persistence intentions.

Curriculum Context and Reflective Writing Assignment

The English 101 course for the EiC Learning Community is part of the second quarter. Typical English composition course outcomes are developed in an engineering context with emphasis on understanding sociotechnical dualism and the social context of engineering. Students read both academic and journalistic articles concerning these topics, and work through a series of writing projects: the first is a fairly typical analytical response paper to the first few readings, the second is a Problem Exploration Project, and the final project is the reflective essay that is the focus of our analysis in this paper. The Problem Exploration Project (PEP), the largest of the writing projects, asks students to explore a problem that matters to them for which engineering could be part of a solution/improvement. Importantly, this project does not ask students to solve or find an improvement for the problem they choose. Rather, the focus is on deep exploration of both the social and technical aspects of whatever problem they choose. This project also explicitly requires students to choose a problem connected to their final team research and development-oriented design project in the engineering course. Students are also required to analyze their rhetorical situation and choose the best audience, genre, and medium for the purpose they find in the project and produce a final draft within that context. The structure of the PEP requires students to hone their rhetorical awareness while simultaneously synthesizing connections to their engineering design project.

English 101 culminates with two weeks of careful work on the Final Reflection: “Who are you as a writer, a student, and an aspiring engineer?” The Final Reflection explicitly asks students to reflect on both their own learning processes and how their development as students and engineers was supported (or not) by the Learning Community. From a pedagogical standpoint, the purpose of this assignment is to require students to practice metacognition and to prepare for transferring the skills and abilities they have developed to future rhetorical situations (personal, academic, and professional) [25]. From our research perspective, the assignment provides us with a wealth of qualitative data to help us address Research Question #1.

The Final Reflection consists of five sections: Reading Process, Writing Process, Math and Programming Process, Engineering Identity, and Student Identity. For each section, students participated in structured brainstorming activities, drafting, self- and peer-review, engaged with instructor feedback, and revised and edited their work. The assignment also requires students to use and analyze specific evidence from their own work and from course texts across the two-quarter learning community to develop and support their reflections on their learning processes and the development of their identities as students and engineers. Besides the term “identity”, the reflection prompts did not use terms from our theoretical framework (e.g., belonging or motivation). Instead, students were asked open-ended questions such as “Why do I want to be an engineer?” and “When you are in the process of learning something new, what strengths do you bring to that new learning?” Students received formative feedback on clarity and development but not on content alignment with any of the socioemotional constructs of interest to this study. Finally, the assignment’s parameters encourage students’ engagement with several of the EiC’s essential questions, most notably, "What is my process for improving as a learner?" “Why do I want to be an engineer?” “How do engineers make decisions”? and “What is the role of engineers in society?” In other words, the Final Reflection is not a quick, informal afterthought to the class, but rather a rigorous assignment central to the curriculum and students’ writing development.

Study Design

We employed systematic thematic analysis following the six-step framework articulated by Naeem et al. [26], [27]. This approach provides a rigorous, transparent methodology for qualitative analysis that moves systematically from raw data to thematic interpretation. The six steps are: (1) selection of quotations from the data, (2) selection of keywords from quotations, (3) development of codes from keywords, (4) development of themes from codes, (5) conceptualization of themes, and (6) development of a conceptual framework. For this study, we completed steps 1-4, stopping at theme development given the exploratory nature of the work and the modest sample size.

We took an abductive approach to analysis, moving iteratively between the data and our theoretical framework (belonging, motivation, identity) while remaining open to emergent patterns not anticipated by existing theory. Table 1 summarizes the analysis steps and associated prompts adapted from [26].

Table 1. Summary of Analysis Prompts by Step.

Step	Key Prompt Elements	Quality Criteria	Output Format
1. Quotations	Research question, theoretical constructs with sub-dimensions, essay data	Relevance to constructs; coverage across essays	Numbered list with source ID, construct tag
2. Keywords	Extracted quotations, 6 Rs framework	Realness, Richness, Repetition, Rationale, Repartee, Regal	Keywords per quotation with justification
3. Codes	Keywords, 6 Rs coding framework	Robust, Reflective, Resplendent, Relevant, Radical, Righteous	Code labels with definitions and keyword mappings
4. Themes	Consolidated codes, 4 Rs framework	Reciprocal, Recognizable, Responsive, Resourceful	Themes with constituent codes and descriptions

Our interpretation of Naeem et al's 6 Rs for keyword selection is summarized as follows:

1. Realness: reflecting genuine student experiences
2. Richness: meaningful, powerful
3. Repetition: appearing across multiple essays
4. Rationale: connecting logically to research questions
5. Repartee: linked to place-based engineering education context
6. Regal: crucial to understanding the experience

We interpret the 6 Rs for Code development as:

1. Robust: comprehensive enough to enable interpretation
2. Reflective: of actual data
3. Resplendent: rich and conceptually powerful
4. Relevant: to research questions
5. Radical: offering new contributions
6. Righteous: ethical and contextually appropriate

Theme development is guided by 4 Rs:

1. Reciprocal: connecting codes meaningfully
2. Recognizable: reflecting student voices
3. Responsive: addressing research questions

4. Resourceful: rich enough to tell the complete story

Example of Analytical Progression

To illustrate the systematic progression from raw data to codes, Table 2 presents an example of how a student quotation was processed through the analytical steps.

Table 2. Example of analytical progression from quotation to code.

Analytical Step	Content
Step 1: Quotation	*"I aspire to be an engineer because I want to create. To build things both for me and others in ways beneficial for all and fulfilling for myself."*
Step 2: Keywords	create, build, beneficial, fulfilling
Keyword Justification	Realness: Authentic student voice; Repetition: "create" appeared in 6 essays, "build" in 8; Richness: Core to engineering self-concept; Rationale: Directly addresses identity development
Step 3: Code Assignment	C1: Maker-Problem Solver Identity
Construct Alignment	Primary: Engineering Identity (self-identification); Secondary: Motivation (intrinsic value)

AI-Assisted Analysis

We employed AI-assisted analysis using Claude Opus 4.5 (Anthropic) as a tool to support the systematic progression through the analytical steps using analogous process and prompts to that described in [27]. The AI was provided with the theoretical framework and detailed prompts based on the Naeem et al. methodology for each analytical step. The lead researcher reviewed all AI-generated outputs at each step, providing feedback, requesting revisions, and making final decisions about quotation selection, keyword identification, code consolidation, and theme development. This iterative human-AI collaboration allowed for efficient processing of the qualitative data while maintaining researcher oversight and interpretive authority.

Importantly, student essays remained on the lead researcher's local computer throughout the analysis process. We manually removed all identifying information from each essay and saved them in a series of plain text files to minimize the context size for the AI chat. We used Model Context Protocol (MCP) [28], which allows the AI to access and analyze files stored locally without those files being uploaded to external servers. Additionally, the researcher has not opted in to Anthropic's optional program that uses conversation data for model training. These measures were taken to protect student privacy and address potential ethical concerns about using AI in qualitative research involving student data. We provided more detail on data preparation and prompt development as well as the complete analysis prompts in [29].

Initial coding produced 29 codes organized by theoretical construct. Upon reviewing the frequency distribution, the researcher noted that approximately half of the codes appeared in only 26% or fewer of the essays. This level of granularity fragmented the data, potentially obscuring robust patterns and weakening evidentiary support for theme development. Based on this assessment, the researcher directed consolidation of conceptually related codes. For example, codes related to creating, building, problem-solving, and intrinsic enjoyment of engineering work were combined into a single "Maker-Problem Solver Identity" code. This consolidation reduced the scheme to 10 codes, with most appearing in 35% or more of essays, providing a stronger foundation for theme development.

Study Population and Context

This study was conducted at Whatcom Community College, a public two-year institution in northwest Washington state. Data were collected from two cohorts of students who completed the EiC program: 13 students in the 2023-24 academic year and 6 students in the 2024-25 academic year, yielding a total sample of N = 19 reflective essays. EiC students are precalculus-level engineering majors; the majority of students in our sample are first-generation college students. The primary data source consists of final reflective essays written by students as a culminating assignment in ENGL& 101: English Composition, which is integrated into the EiC curriculum. Essays ranged from approximately 1,000 to 2,500 words in length.

Results and Analysis

The first step involved extracting relevant quotations from the 19 student essays. The LLM identified 116 quotations that addressed the research question about how EiC participation impacts students' motivation, identity, and belongingness. Quotations were tagged with the theoretical construct(s) they addressed, guided by the framework described above. Table 3 presents the distribution of quotations across theoretical constructs, while Table 4 shows how quotations were distributed across individual essays.

Table 3. Distribution of extracted quotations by theoretical construct.

Construct	Quotations	% of Total
Engineering Identity	34	29.3%
Motivation	23	19.8%
Sense of Belonging	23	19.8%
Academic Development	19	16.4%
Challenges/Barriers	10	8.6%
High-Impact Practices	7	6.0%
Total	**116**	**100%**

Table 4. Distribution of extracted quotations by student essay.

Essay ID	Cohort	Quotations	Primary Constructs
2024-1	2024	7	Belonging, Identity, Self-Efficacy
2024-2	2024	7	Identity, Academic Dev., Motivation
2024-3	2024	4	Self-Efficacy, Academic Dev.
2024-4	2024	10	Identity, Belonging, Academic Dev.
2024-5	2024	4	Identity (Ethics), Motivation
2024-6	2024	3	Self-Efficacy, Motivation, Belonging
2024-7	2024	9	Identity, Motivation, Academic Dev.
2024-8	2024	5	Identity, Belonging, HIPs
2024-9	2024	1	Academic Dev.
2024-10	2024	2	Academic Dev., Challenges
2024-11	2024	10	Identity, Belonging, Academic Dev.
2024-12	2024	8	Identity, Motivation, Belonging
2024-13	2024	9	Identity, Belonging, Challenges
2025-1	2025	5	Identity, Academic Dev.
2025-2	2025	11	Belonging, Self-Efficacy, Identity
2025-3	2025	6	Identity, Belonging, Reflection
2025-4	2025	9	Identity, Belonging, Challenges
2025-5	2025	4	Identity, Self-Efficacy, Belonging
2025-6	2025	2	Identity, Academic Dev.
2024 Subtotal	**n=13**	**79**	*Mean: 6.1 per essay*
2025 Subtotal	**n=6**	**37**	*Mean: 6.2 per essay*
Total	**N=19**	**116**	***Mean: 6.1 per essay***

Table 3 organizes quotations into six categories that reflect the abductive nature of our analysis. Engineering Identity, Motivation, and Sense of Belonging were deductively derived from the theoretical framework established in the literature review. However, as we extracted quotations addressing the research question, three additional categories emerged inductively from the data: Academic Development captured students' metacognitive reflections on their learning processes; Challenges/Barriers documented obstacles students encountered; and High-Impact Practices reflected students' responses to specific program elements such as the cohort structure, hands-on labs, and place-based curriculum. Consistent with abductive reasoning, we moved iteratively between these emergent patterns and our theoretical framework, ultimately incorporating Academic Development into the final thematic analysis while consolidating the Challenges/Barriers and High-Impact Practices content into other categories during code consolidation (see Table 5).

Several patterns emerged from the quotation extraction. Engineering Identity yielded the most quotations (29.3%), with self-identification and ethical/social responsibility being particularly rich sub-dimensions. Motivation and Sense of Belonging were equally represented (19.8% each), aligning with the theoretical framework's emphasis on their interconnection. All 19 essays contributed quotations, though yield varied substantially—from 1 quotation (essay 2024-9) to 11 quotations (essay 2025-2). Notably, Recognition (being recognized by others as an engineer) was the least represented sub-dimension within Engineering Identity, which may reflect students' early-stage identity development at the start of their engineering studies. Note that the six initial coding categories shown in Table 3 were consolidated for keyword analysis. Specifically, the Challenges/Barriers and High-Impact Practices categories, which together represented only 14.6% of quotations, were merged into a Program-Specific Elements category for Table 5, as keywords from these quotations primarily described specific curricular elements rather than distinct theoretical constructs. Additionally, Table 4's 'Primary Constructs' column uses abbreviated labels (e.g., 'Self-Efficacy' as a component of Motivation, 'Ethics' as a dimension of Identity) to indicate the specific aspects most prominent in each essay.

Keyword Selection

The second step involved extracting keywords from the 116 quotations using the 6 Rs framework [26]. This process yielded 84 keywords organized by theoretical construct, as shown in Table 5.

Table 5. Keywords identified by theoretical construct.

Construct	Keywords	Examples
Engineering Identity	24	create, problem solving, make a difference, responsibility, impact, benefit others
Motivation	18	enjoy, confident, challenge, growth, rewarding, struggle, stuck
Sense of Belonging	16	collaborate, learning community, help, together, mutual support, welcoming, included
Academic Development	14	understand, break down, step by step, strategies, reflect, blending of concepts
Program-Specific Elements	12	Roads to Nowhere, Dobot robotic arms, Pico labs, cohort, two quarters
Total	**84**	

Table 6 presents the most frequently occurring keywords, showing strong representation across essays. The keyword "help/helped" appeared in 14 essays (74%), reflecting the centrality of mutual support in students' learning community experience. "Problem solving" appeared in 8 essays (42%), underscoring its role in students' engineering self-concept.

Table 6. Most frequently occurring keywords across student essays.

Keyword	Essays (n)	Primary Construct
help/helped	14	Belonging/Motivation
understand/understanding	12	Identity (Competence)
challenge/challenging	11	Motivation
collaborate/collaboration	10	Belonging
enjoy/enjoyable	10	Motivation (Intrinsic)
struggle/struggling	10	Self-Efficacy
Roads to Nowhere	9	Identity (Ethics)
responsibility	9	Identity (Ethics)
problem solving	8	Identity
benefit others	8	Identity (Ethics)

The keyword analysis revealed several patterns that informed subsequent code development. Identity keywords clustered around two dimensions: a maker/problem-solver orientation (create, problem solving, figure out) and a social responsibility orientation (benefit others, responsibility, impact, make a difference). Belonging keywords clustered around the cohort structure (learning community, same group, classmates) and reciprocal support behaviors (collaborate, mutual support, help). Motivation keywords included both positive indicators (enjoy, confident, growth) and productive struggle indicators (challenge, stuck, struggle), suggesting that students experienced difficulty as part of a growth-oriented process rather than as purely negative. Program-specific keywords such as "Roads to Nowhere" (a curriculum reading about infrastructure inequity) appeared frequently, but we note that an assignment requirement was to cite at least one of the required course readings in support of their discussion about engineering identity.

Code Development

The analysis yielded 10 consolidated codes organized into four interconnected themes. Table 7 presents the consolidated codes with their frequency across essays, primary theoretical construct alignment, and theme assignment.

Table 7. Consolidated codes with frequency, construct alignment, and theme assignment.

Code	Code Name	n	%	Primary Construct	Theme
C1	Maker-Problem Solver Identity	11	58%	Identity	1
C2	Engineering for Social Impact	11	58%	Identity	1
C3	Navigating Identity Uncertainty	6	32%	Identity/Belonging	3
C4	Purpose-Driven Motivation	9	47%	Motivation	1
C5	Confidence Development & Persistence	10	53%	Motivation	2
C6	Cohort Connection & Normalization	3	16%	Belonging	2, 3
C7	Collaborative Learning & Mutual Support	11	58%	Belonging	2, 3
C8	Faculty Connection & Institutional Belonging	5	26%	Belonging	3
C9	Metacognitive Development	14	74%	Academic Dev.	4
C10	Integrated Contextualized Learning	6	32%	Academic Dev.	4

To provide additional transparency into the coding process, we present a detailed description of one code. Code C2 (Engineering for Social Impact) captures students' awareness that engineering work carries social and ethical responsibility. This code consolidated original codes addressing socially conscious engineering, ethical commitment, and sociotechnical awareness. The code draws on keywords including: make a difference, make society better, impact, responsibility, ethical, moral, help others, and community. The code appeared in 11 of 19 essays (58%), with representation from both cohorts. The 6 Rs justification is as follows: **Robust**—captures the social dimension of engineering identity that emerged strongly in data; **Reflective**—uses students' own language about making a difference; **Resplendent**—connects to sociotechnical engineering education literature; **Relevant**—directly addresses identity development research question; **Radical**—demonstrates early-stage social conscience development often assumed to emerge later in engineering education; **Righteous**—honors students' ethical concerns without imposing external values.

Theme Development

Table 8 presents an overview of the four themes, their constituent codes, and coverage across the 19 student essays. Themes were derived by examining patterns of code co-occurrence across essays. Codes that frequently appeared together and addressed related aspects of student experience were grouped thematically. For example, C1 (Maker-Problem Solver Identity), C2 (Engineering for Social Impact), and C4 (Purpose-Driven Motivation) consistently co-occurred in essays describing identity development, forming Theme 1.

Table 8. Theme summary with constituent codes and coverage across student essays.

Theme	Theme Name	Codes	Coverage
1	Becoming an Engineer Who Makes and Matters	C1, C2, C4	84%
2	Building Confidence Through Community	C5, C6, C7	79%
3	Finding Belonging Amid Uncertainty	C3, C6, C7, C8	74%
4	Learning How to Learn in Context	C9, C10	79%

Theme 1: Becoming an Engineer Who Makes and Matters

The most prevalent theme in the essays (84% coverage) captures how students develop engineering identity through two intertwined pathways: as makers and problem-solvers who create tangible things and find intrinsic satisfaction in engineering work, and as socially-conscious professionals who understand engineering's power to impact communities and feel responsibility to use that power ethically. These pathways are grounded in purpose derived from family obligations, practical goals, and personal meaning.

Students articulated strong maker identities rooted in the desire to create and build. One student explained: "*I aspire to be an engineer because I want to create. To build things both for me and others in ways beneficial for all and fulfilling for myself.*" Another described a lifelong trajectory toward engineering: "*I've always loved to create things from Legos to cardboard weapons, so picking engineering as something I want to do in the future is sort of obvious. But, as I've progressed through my education, I've noticed I'm good at and enjoy things like math and physics. So the combination of liking to make things, and liking math is basically what an engineer is.*"

Alongside this maker identity, students developed awareness of engineering's social dimensions through engagement with EiC curriculum. Several students described transformations in their understanding of why they want to be engineers. One wrote: "*I've changed my mind about why I would like to be an engineer... I would also like to make a difference by making society better.*" Another connected this social awareness to specific curriculum content: "*Roads to nowhere is an example of what we as engineers should strive to avoid. Realizing that we have real impact on the world with our work and taking responsibility for both the good and bad it can create.*" A third student demonstrated deep engagement with sociotechnical thinking: "*My identity as an engineering student and a future engineer strongly resonates with the question posed in 'Self-Reflection for Activist Engineers': 'Who are you leaving out of your consideration, and why.'*"

Theme 2: Building Confidence Through Community

The second theme (79% coverage) describes how self-efficacy develops within the supportive structure of the cohort. Students build confidence through experiencing and overcoming challenges together, with the cohort providing a context where struggle is normalized and help-seeking is enabled. The consistent peer group across integrated courses creates conditions for psychological safety, reciprocal academic support, and collaborative problem-solving.

Students described the value of collaborative learning within their cohort: "*Working with others allows me to bounce ideas off them and gain new knowledge into the problem.*" The normalization of struggle was particularly important: when students recognized that their peers also found material challenging, difficulty became a shared experience to work through rather than evidence of individual inadequacy. One student noted that "*Even spending time around people who are learning creates a learning environment. Being in that space will always make individual learning more productive.*"

Confidence developed through persistence and accumulated success. Students described growing belief in their abilities through hands-on accomplishments, particularly in engineering labs where they could see tangible results of their work. One student captured this: "*I enjoyed figuring out how to build circuits for pico lab assignments because it's really challenging and fun at the same time.*" The immediate feedback from hands-on work—seeing a circuit function or a program run—provided concrete evidence of competence that built self-efficacy.

Theme 3: Finding Belonging Amid Uncertainty

The third theme (74% coverage) reveals a nuanced finding: belonging and identity uncertainty coexist productively in the EiC context. Students—particularly those navigating non-traditional pathways such as career changers, returning students, and first-generation college students—experience genuine uncertainty about whether engineering is right for them, yet find belonging through cohort relationships, faculty connections, and institutional inclusion. Critically, belonging does not require resolved identity; rather, belonging emerges through connection even amid questioning.

Students openly expressed uncertainty about their engineering futures: "*Taking these classes made me realize what an engineer actually is, and I have doubts about if this is really what I want to do.*" Another student wrote: "*So yes, I may have my doubts and may feel like I'm not smart enough to do engineering but at the end of the day I have goals ahead of me.*" A returning student described: "*Coming back to school was a large challenge for me... I definitely worried a lot about atrophied habits.*"

Yet these same students found belonging through multiple sources. One explained: "*It's also about making connections to make yourself more comfortable and feel more included at* *school.*" Faculty relationships proved particularly important: "*I visited Seth's office hours after a decent bit of hesitation, but they were extremely helpful and pushed me towards the answers I was looking for without telling me outright. We also had a fun conversation about tabletop games, a shared interest, which helped to make their class feel more welcoming in future.*" This quotation illustrates how personal connection with faculty—including recognition of shared interests beyond academic content—contributes to belonging.

Importantly, the learning community structure appeared to create conditions where uncertainty could be openly expressed and worked through rather than suppressed. One student wrote: "*These questions were helpful to me because it made me second guess if this is the career I truly want to be in and I'm still not 100% sure about it. Having the chance to sit and deeply think about the answers to these questions makes you realize more than you have before.*" This suggests that belonging provides a secure base from which students can productively explore difficult questions about their future.

Theme 4: Learning How to Learn in Context

The fourth theme (79% coverage) addresses academic skill development, particularly metacognitive awareness. The integrated, contextualized curriculum develops students' understanding of how they learn—not just content knowledge but strategic approaches to complex problems. Students recognize that connecting concepts across courses and applying them to authentic contexts enhances understanding.

Students demonstrated sophisticated metacognitive reflection. One wrote: "*In these 2 quarters I have realized that writing whatever is in your mind at the moment is way better than overthinking the problem looking for the perfect solution at the first try.*" Another described developing problem-solving strategies: "*When I get stuck on a question and am completely lost, I will break the problem into manageable pieces.*" A third showed awareness of learning as an ongoing process: "*My learning process is still evolving, how I learn now may be different compared to how I might learn in a month.*"

Students also recognized the value of integrated instruction. One described: "The blending of the concepts, like when we reinforced our understanding of polar coordinates with the Dobot robotic arms, to be the most beneficial to my learning." Another noted the benefits of contextualized learning with immediate feedback: "I found it much easier to grasp the programming ideas of coding on the Pico than the precalculus ideas like kinematics, because of the real time feedback." These reflections suggest that students not only learned content but developed awareness of learning conditions that support their understanding.

Study Limitations

There are limitations to this study that we should acknowledge. First and foremost, the sample of 19 essays from a single community college limits generalizability. We will not read too much into precise frequency differences between themes because of the small sample size; rather, we focus on patterns that emerged consistently across essays. The data are self-report reflections written as course assignments, which may not fully represent students' experiences or behaviors and may reflect what students believed instructors wanted to hear. However, the substantial presence of acknowledged struggles and uncertainties suggests that the reflective prompts elicited honest self-assessment rather than purely performative responses. Additionally, the study lacks a comparison group, making it difficult to attribute findings specifically to the EiC intervention versus other factors such as student self-selection into the program or general maturation over two quarters of college.

The use of AI-assisted analysis, while increasing efficiency and consistency, represents a methodological approach that requires continued examination. We took precautions to maintain researcher interpretive control and to protect student data privacy, but acknowledge that norms for AI use in qualitative research are still developing.

Implications for Instruction

The results of this study have implications for instruction in first-year engineering programs. We find that students in the EiC program developed engineering identity through dual pathways—both as makers/problem-solvers and as socially responsible professionals. This suggests that curriculum emphasizing sociotechnical dimensions of engineering can shape how students conceptualize their future roles without diminishing their connection to the technical aspects of engineering work. Potential approaches include incorporating readings and discussions about engineering's social impacts, using place-based projects that connect engineering to local community issues, and framing essential questions that prompt students to consider whose interests engineering serves.

The finding that belonging and identity uncertainty can coexist productively suggests that programs need not resolve all student doubts to be effective. Creating conditions where students feel safe expressing uncertainty while maintaining connection to peers and faculty may be more valuable than pressuring premature identity foreclosure. More generally, we propose that instructors could think more explicitly about how cohort structures, faculty accessibility, and recognition of students' non-academic interests contribute to belonging.

While it may be difficult to replicate the full integrated learning community model in other contexts, we believe that the ideas presented here can be adapted. Even without formal learning communities, instructors can normalize struggle, build collaborative learning opportunities, and make explicit connections between course content and engineering's social dimensions.

Conclusion

This paper presents findings from a systematic thematic analysis of student reflective essays to understand how participation in a place-based, integrated learning community impacts first-year engineering students' motivation, identity, and belonging. Four themes emerged from analysis of 19 essays across two cohorts: (1) Becoming an Engineer Who Makes and Matters, capturing dual-pathway identity development; (2) Building Confidence Through Community, describing self-efficacy development within the cohort structure; (3) Finding Belonging Amid Uncertainty, revealing that belonging and identity uncertainty coexist productively; and (4) Learning How to Learn in Context, addressing metacognitive development through integrated curriculum.

These findings suggest that integrated learning communities emphasizing sociotechnical dimensions of engineering can effectively support first-year students' socioemotional development across multiple domains simultaneously. Our ongoing research and program assessment is also examining longitudinal outcomes for EiC participants compared to matched peers who completed prerequisites through traditional course sequences. Of particular interest is whether the identity development, belonging, and metacognitive awareness cultivated in the learning community persist and predict success in subsequent engineering coursework and eventual degree completion.

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