Examining Teamwork through Gender Minority Perspectives in a First-Year Engineering Course

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Abstract

Teamwork plays a central role in engineering education, shaping students' experiences as they learn to collaborate, communicate, and apply technical knowledge. Prior research on teamwork has found that gender-minority students are often steered toward support roles, judged by gender communication norms, and excluded from full design participation. In the first-year context, when students are still developing their sense of belonging and engineering identity, teamwork becomes a critical site where the participation of students with marginalized gender identities can be either reinforced or undermined.

This study asks: How do first-year engineering students who self-identify with gender identities historically marginalized in engineering (UGM) experience teamwork in a project-based engineering course. Specifically, we examine what UGM students find encouraging or discouraging, how team experiences shape their developing engineering identity, and what team dynamics they see as supportive or limiting. Students in a two-semester introductory engineering course at a large, public, mid-Atlantic R1 institution responded to end-of-semester reflection questions about their experiences working in design teams. Qualitative analysis of reflections from 72 consenting UGM students was guided by Godwin's framework of engineering identity [1] and Hesse-Biber's feminist research approaches [2] to examine what team dynamics they perceived as supportive or discouraging.

Themes emerged around access to design versus administrative work, recognition of contributions, and the influence of team dynamics on students' developing views of themselves in engineering. UGM students reported feeling most encouraged when tasks were distributed equitably; their opinions were respected, and they were able to participate meaningfully in design work. They felt most discouraged when administrative labor was disproportionately assigned to them or when access to design opportunities was limited. These findings highlight how first-year teamwork can shape UGM students' understanding of their place in engineering and suggest the importance of pedagogical strategies to foster more equitable and supportive team structures.

Introduction

Teamwork is central to first-year engineering design courses, where students learn not only project-based skills but also how to participate in engineering spaces. Prior research suggests that teamwork can be experienced differently by women and other gender-minority students in engineering [3]. Despite growing attention to inclusive teamwork practices, less is known about how gender-minority students themselves interpret and make sense of their early teamwork experiences in first-year engineering contexts. This study addresses that gap by examining how first-year engineering students who identify with marginalized gender identities (UGM) describe teamwork in a project-based introductory engineering course and how these experiences relate to their developing sense of belonging and engineering identity.

Review of prior literature

Engineering functions not only as a technical field but also as a cultural system shaped by historically gendered norms that privilege particular ways of knowing and practicing engineering. Its technicist ideals of logic, control, and dispassionate objectivity align more closely with dominant forms of masculinity [4]. Within academic contexts, these values are often framed as neutral or universal, yet they implicitly privilege particular ways of knowing and participating in engineering [5]. These norms shape who leads, whose contributions are recognized, and who persists in engineering [6], [7].

Research demonstrates that gendered norms shape how competence is interpreted and valued within engineering teams. Even when women demonstrate high levels of technical skill, their contributions are not always recognized by peers, weakening their sense of belonging and identification with engineering [8]. Communication norms further reinforce gendered dynamics, as speech acts associated with women, such as expressing uncertainty or framing contributions relationally, may be interpreted as signs of lower competence regardless of expertise [9].These interactional patterns contribute to systematic differences in teamwork experiences, with women and other minoritized students more likely to report exclusion from technical decision-making and undervaluation of their contributions, despite institutional narratives positioning teamwork as inclusive [10]. Although collaborative and relational competencies are frequently emphasized by women as central to engineering practice, these skills remain weakly associated with engineering identity and career advancement, reinforcing marginalization within team contexts [11]. Taken together, this work shows that teamwork experiences are shaped by gendered norms of competence and recognition.

First-year engineering (FYE) design teams are particularly important sites for examining teamwork because they serve as students' entry points into engineering culture. FYE programs commonly rely on collaborative, open-ended design projects that position teams as the primary context through which students develop communication, collaboration, and problem-solving skills. Participation in design teams has been shown to support students' intellectual development by promoting critical and reflective thinking [12]. Engaging in engineering design more broadly works toward meeting industry expectations for engineers to be capable of addressing complex, ill-structured problems, and this work is typically carried out in teams [13].

Prior research has identified gendered patterns in first-year and project-based teamwork contexts. Keogh et al. [14] found that women often valued active-learning group work because it supported long-term retention, problem solving, and confidence building, yet these women also reported being pressured into administrative roles and described team dynamics that made design participation harder to access for them. Zarske et al. [15] similarly found that women in first-year project teams were more often associated with administrative roles such as facilitator or communicator, than with expert or leadership-oriented roles. Further, supportive and team-oriented roles were often perceived as less valuable than leadership and technical roles, even when students still reported positive overall team experiences. In combination, these studies make clear that inequities in teamwork are present in the very courses meant to introduce students to engineering through collaboration.

At the same time, much of this literature has focused on role distributions, peer evaluation patterns, confidence outcomes, or the effectiveness of team structures and interventions [16]. These studies offer important evidence into the gendered inequities that persist in collaborative settings, but they do not fully capture how UGM students themselves interpret and make meaning of those experiences in FYE design teams. Team-level analyses can also obscure unequal experiences within the same group. For example, prior research on inclusive team design and psychological safety has shown that women may report less safety or recognition in interactions with male teammates even when aggregate team-level measures appear comparable [17], [18], [19]. This points to the need for work that centers UGM students' own accounts of teamwork and examines how everyday interactions, such as role distribution, recognition, and interpersonal dynamics, shape their developing sense of themselves as engineers.

This study addresses this gap by examining how first-year engineering students identify with marginalized gender identities experience and interpret those inequities. To do so, the study draws on engineering identity frameworks and feminist research methodology. Engineering identity scholarship builds on earlier science identity work that conceptualized identity through competence, performance, and recognition, emphasizing the importance of being recognized by others as someone who belongs in the field [20]. Engineering identity frameworks adapt these ideas to engineering and often conceptualize identity through interest, performance/competence, and recognition [1]. Feminist research methodology complements this lens by centering participants lived experiences and attending to how broader gendered structures shape both those experiences and their interpretation [2]. Together, these frameworks allow us to examine what happens within first-year design teams and how UGM students connect these interactions to engineering identity development.

Specifically, we addressed the following research questions:

RQ: When prompted to reflect on teamwork broadly, what aspects of their teamwork experiences do UGM students identify as encouraging or discouraging? In what ways do those experiences shape how they see themselves as engineers, and what team structures or classroom dynamics do they perceive as supportive or limiting?

Encouraging experiences were those that increased interest, bolstered feelings of competence, or led to increased recognition or respect, either from self or others. Discouraging experiences were those that caused students to withdraw from or resent engineering, question their competence, or feel like their contributions were invalidated.

Methods

Study design

This study employed a qualitative thematic analysis approach to examine how first-year UGM students experienced and made meaning of teamwork in an introductory engineering design course. Rather than analyzing teams as bounded units, we centered individual students' written reflections as the primary analytic material. This approach is consistent with Hesse-Biber's feminist methodological commitment to foregrounding participants' own accounts of their experiences [2].

Quantitative data from the broader student population were used to contextualize the qualitative findings, identify broader trends, and triangulate the qualitative findings. The study remained primarily qualitative; quantitative analyses were conducted independently and used only to support the qualitative findings. This study was approved by an Institutional Review Board.

Study context

This study took place at a highly selective, research-intensive, mid-Atlantic institution. In the fall semester, students completed three short design projects with rotating teams. In the spring semester, students worked in one team on a semester-long, client-based project culminating in a technical report and public presentation.

Data used in this study were collected during the 2024-2025 academic year. A survey was administered to all students at the beginning of the fall semester, then again at the end of the spring semester. These surveys included questions about demographic information (e.g., gender identity), teamwork and collaboration attitudes, engineering identity constructs (competence/performance, recognition, interest), and perceptions of leadership roles. We did not collect additional demographic data directly from the reflection responses; however, institutional-level survey data indicated that 36% of first-year engineering students at the university were female and 64% were male, 13% were underrepresented racial minorities, defined as American Indian or Alaska Native, Black or African American, Hispanic, or Native Hawaiian or Other Pacific Islander. Further, 16% were first-generation students.

Data included students' written final reflections from the end of the spring semester. Teamwork-related prompts generally asked students to (1) Describe what they liked about working in engineering design teams. (2) Explain the biggest challenges they experienced in teamwork. (3) Reflect on what they wished they knew about teamwork earlier, and (4) Identify training or instructional actions that could improve collaboration. Students in some sections of the course addressed all four prompts, while some students in other sections addressed a subset of these prompts, varying by instructor. Reflections typically ranged from one to two pages, providing sufficiently rich narrative detail for qualitative coding.

Over 700 students enrolled across 20 sections of the introductory engineering course, producing diverse team configurations. In Spring 2025, there were over 150 project teams, formed based on students' reported project interest, optional requests to work with or avoid certain teammates, and an instructor effort to avoid isolating UGM students. Due to uneven project demand and the cohort's gender distribution, some students inevitably became the sole UGM member on their team. These team formations created a natural variation that supports thematic comparison across participants.

Quantitative participants and analysis

A total of 385 first-year engineering students consented to allow their survey data to be used in this study. Survey responses were analyzed using ANOVA and Mann-Whitney tests to identify pre-post changes and differences between UGM and Male students. We assumed that Likert scale survey responses had equal intervals to allow comparisons and statistical testing. In this

paper, we use selected quantitative results to contextualize and support the qualitative themes, particularly around gender identity, team experiences, leadership roles, and engineering identity constructs.

While we attempted to characterize the gender composition of all 153 teams, this proved difficult in practice as not all students consented to the use of their data. Further, students self-reported their gender identity by selecting one of four options: male, female, non-binary, or prefer not to say. Because 108 teams included at least one member who did not consent to the study or selected "prefer not to say," the gender composition of those teams could not be reliably determined. As a result, team gender composition could be confirmed for only 45 teams — fewer than a third of the total.

Qualitative participants and analysis

Of the subset of students who consented to allow their written reflections to be used as data in this study, 72 self-identified as UGM and their reflections form the qualitative dataset for this study. All qualitative data were de-identified before analysis.

Qualitative analysis proceeded through three structured phases, coding, analytic categorization, and connecting to the research question, which are consistent with Miles et al [21].

Phase 1: Coding. Researchers created and applied deductive codes informed by Godwin's engineering identity framework [1] and inductive codes that emerged from recurring patterns in students' descriptions of teamwork experiences.

To ensure analytic rigor, the first author developed the initial codebook. Two additional authors then independently coded a shared set of 20 excerpts using this codebook. Each coder labeled excerpts with the codes using qualitative coding software. The authors met to compare interpretations, refine code definitions, and reach consensus on all codes, consistent with Miles et al.'s emphasis on negotiated meaning [21]. After reaching agreement about the code definitions, the first author independently coded the remaining data using the final codebook (Table 1).

While the codebook included all three constructs of Godwin's engineering identity framework [1], competence/performance and recognition appeared most frequently in students' reflections and drove the final themes. Some level of interest was assumed of all participants, as all participants self-selected into an engineering major and had a say in the project they were working on; however, interest was rarely expressed in the reflections and thus was rarely coded.

Phase 2: Analytic Categorization. Next, the research team collaboratively grouped codes into broader conceptual categories, shown in Table 1. These categories identified salient patterns across the data and showed how codes overlapped in students' descriptions of teamwork.

Phase 3: Connecting to Research Question. Coded excerpts were then organized into emergent themes based on observed patterns across participants and connected back to the research question.

Table 1. Final Codebook

Category	Code	Definition
+/- Teamwork Experiences	Negative	Students describe difficulties, conflicts, or challenges in teamwork
	Positive	Student describes supportive or successful teamwork
Engineering Identity Constructs	Competence/ Performance	Students demonstrate engineering ability through task completion, problem-solving, technical reasoning, or effective collaboration.
	Recognition	Students recognize their own competence, growth, or contributions or are recognized by others.
	Interest	Students show enthusiasm or curiosity about engineering topics.
Contributions to the Team	Administrative Contribution	Writing reports, updating notebooks, scheduling, or organizing teamwork.
	Design Contribution	Hands-on tasks, such as using CAD, coding, testing, or applying engineering tools/methods.
	Building Friendship	Students talk about making friends with teammates or wanting closer connections with them.
	Leadership	Students describe taking initiative, guiding others, or shaping team direction and decisions.
Other	Wanting to be More Outspoken	Student expresses a desire to speak up, be more active, or take on a bigger role in the team.

Limitations

Several limitations must be acknowledged in this study. First, the end-of-semester reflections may be influenced by hindsight bias or selective memory and may provide only a partial picture of teamwork across the semester. Additionally, UGM students who consented to participate may have had particularly positive or negative experiences that motivated them to share their perspectives, introducing possible self-selection bias. Further, some reflection prompts may have encouraged a more positive framing of teamwork experiences (e.g., "what did you like?"), which may have led students to underrepresent conflict or harm. Additionally, while engineering identity was a guiding theoretical lens, the reflection prompts did not consistently elicit identity-related language, and findings therefore speak more directly to teamwork experiences than to identity development in a formal sense.

Positionality

The lead author identifies as a UGM student in engineering and has previously taken the same introductory course sequence being studied in this work. Her own challenges with teamwork during the course motivate the study and shape her sensitivity to issues of belonging, recognition, and contribution experienced by UGM students. This positionality provides insight into the nuanced ways UGM students describe conflict, self-doubt, or limited recognition, while also requiring critical reflexivity to avoid over-identifying participants' experiences.

Other members of the research team include two instructors on the course and two teaching assistants for the course who also had previously completed the course and have first-hand experience navigating its teamwork structures. Their dual perspectives as former students and current educators enrich the interpretation of results.

Findings

Positive teamwork experiences of UGM Students

UGM students described especially positive teamwork experience when they had access to multiple roles and felt safe sharing ideas. These included roles of varying technicality, including brainstorming and design, fabrication, and writing. For example, Participant 195 said:

> I played many roles on my team and think my contributions were very effective. One of the jobs that was naturally assigned to me was photographer and meeting minutes writer, especially during fabrication…However, I was also an active team member as I was one of the brainstormers who helped create and think of ideas during the design and fabrication process….Additionally, I was also very active in discussions and helped make decisions.

Importantly, the participant described taking an active role in idea generation and participating in team decision-making, describing her experience of having her design contributions recognized and incorporated.

Beyond role distribution, UGM students also emphasized the importance of feeling safe to speak up and share ideas freely. One example came from participant 447, who reflected that her positive teamwork experience gave her confidence she hoped to carry into future work in a male-dominated industry:

> I was able to share my ideas without fear of judgement and with confidence that they were valuable opinions. In a male dominated industry, I hope this is something I can carry through into the future, regardless of who else I may work with...I was the biggest creative lead in the project as I came up with the original chosen design and helped discuss many issues when it came to manufacture and testing.

Her reflection connects psychological safety with technical leadership: being heard allowed her to lead design decisions and participate in technical discussions. She also noted that this experience stood in contrast to her expectations of future work in a male-dominated industry, suggesting that her team provided a supportive environment that enabled her to lead design decisions and participate actively in technical discussions.

A third condition that supported positive experiences was equitable for workload distribution. For example, Participant 466 reflected on how her team's approach to splitting work evenly created space for both contributing and listening:

> "I think our group did a good job of splitting up our project very evenly between the five of us... I made sure to be vocal about my ideas and things I thought could be added or changed about our project, but at the same time I also was able to sit back and listen to my other partners' ideas and understand their perspectives."

This reflection highlights how equitable workload distribution created conditions where the participant felt both confident contributing to her own ideas and genuinely included in the collaborative process.

Negative teamwork experiences of UGM Students

When UGM students described especially negative teamwork experiences, they often described encountering unequal task distribution, with administrative tasks disproportionately delegated to them. Participant 188, for example, described playing a "supporting role" through documentation, notebook updates, chapter reports, and the final report. This pattern of being steered toward organizational rather than design work appeared across multiple accounts**.** Participant 483 reflected similarly:

> While I did not possess the technical skills to work on the software or hardware components, my contributions came in the form of my communication, organizational, and leadership skills… Though this seems less important than the technical work, I feel as though we would not have achieved anything on time without my contributions, so I can therefore leave the project proud of my achievements.

Although the participant valued her contribution, her reflection shows how UGM students often had to defend organizational work as meaningful in comparison to design work.

Other participants were more frustrated when describing documentation and writing tasks as disproportionately assigned to them. For example, Participant 585 explained, "The biggest challenge I faced was the unequal distribution of effort, especially on deliverables such as writing reports/drafts. While coding tasks were more collaborative, the writing and final formatting were often left to me." Her frustration came from writing and formatting being left to her while coding remained more collaborative.

This imbalance in distribution of effort on writing tasks is especially discouraging when roles do not match students' interests or skills. For example, participant 277 said: "I also didn't like getting thrown most of the documentation work; I had hoped to be more hands-on with the designing." Her frustration shows how documentation work became discouraging when it displaced hands-on design opportunities. Across participants, administrative work was not inherently negative; it became limiting when it restricted access to technical learning.

Beyond frustration with task distribution, these dynamics had a deeper effect — they made some UGM students feel less safe speaking up at all. Participant 239 explained: "I sometimes hesitated to speak up because I didn't want to disrupt the flow or cause conflict." This reflects reduced psychological safety: the participant self-silenced to avoid conflict, even without explicitly gendered exclusion.

Notably, this pattern of self-silencing was not exclusive to any team configuration. Participant 606, whose team included mostly female and unknown-gender members, described a similar experience: "While it is important to listen to others' ideas and opinions, I feel like I could have had a bit more of a voice and it possibly could have made us more productive as a team...we were very quiet at the table when not actively building our project." Her reflection suggests that self-silencing was not only a product of being outnumbered by men but might also reflect broader participation dynamics across team contexts.

Team gender composition may have shaped UGM students' experiences, but composition could be determined for only 45 of 153 teams. Within the subset, UGM students more frequently described positive teamwork experiences in teams with greater UGM representation, though this trend should be treated as exploratory rather than conclusive. Further research is needed to examine this relationship more rigorously.

Teamwork challenges shape identity and belonging

Beyond shaping day-to-day teamwork dynamics, these experiences had a deeper effect — they influenced how UGM students began to see themselves as engineers. Role distribution shaped how students wrote about competence/performance, recognition, and belonging. Many UGM students want to develop their technical skills but feel frustrated when they lack the opportunities to contribute to design, building, fabrication, or technical decision-making.

For example, participant 462 reflected:

> As a teammate, I wish I had taken more initiative to learn how to use physical tools like the soldering iron earlier in the project...Moving forward, I want to become more comfortable with tool-based tasks so I can support both the planning and building sides of the design process more effectively.

This quote demonstrates how limited participation in hands-on design work shaped the participant's sense of competence as an engineer. Although the participant expressed a strong interest in developing technical skills, her reflection suggests that she did not fully recognize herself as capable of contributing to engineering practices during the project.

Additionally, Participant 215, who also took on a mix of general and support tasks, described a similar tension between contributing to the team and questioning their value as an engineer:

> In a sense I don't feel effective since I'm used to being the essential team member who plans everything, takes the lead on the most technical and specific parts, and has a hand on every aspect… It made me wonder if I mattered to the project or if it would have been the same without me, but I know I contributed even if I did just a lot of brunt writing and editing and cutting/sawing work that lightened the project load for the team."

This reflection shows how competence/performance and recognition intersect: even while contributing meaningfully (performing), the participant questioned whether they mattered (recognition) when positioned away from central design decisions.

Not all identity experiences were discouraging, however. Participants described feeling encouraged when they were included in design work, even if their main responsibilities were administrative. For example, participant 473 explained: "Even though I was primarily focused on documentation, I also had the chance to contribute ideas during technical planning sessions". Her reflection shows that even when students held administrative roles, inclusion in technical planning could support recognition and belonging.

Another participant emphasized how recognition from teammates supported their confidence in contributing design ideas. Participant 384 reflected:

> Sometimes I will have an idea that I'm unsure or wary of, but discussing it as a group and getting other opinions on it can make me more confident in it… our hypothesis about the frequency of the paddle and degradation was an idea that I was wary of suggesting, but the rest of the group found it very curious and ended up being the reason we explored it.

This quote illustrates how recognition through peer validation, such as having an idea taken up and pursued by the team, reinforced the participant's confidence and sense of legitimacy as an engineering contributor. Being heard and taken seriously transformed initial self-doubt into participation in core technical decision-making.

Although limited access to hands-on design work often corresponded with diminished self-recognition as engineers, some UGM students described feeling effective and valued through roles centered on coordination, communication, and team organization. For example, Participants 278 and 239 both framed time management, task distribution, and accountability as essential to team success, suggesting that facilitative roles can support engineering identity when they are recognized as central to engineering work.

Together, access to design work and inclusion in decision-making helped UGM students feel like legitimate members of their teams. When participants lacked such access, they described distancing themselves from the identity of "engineer" even when they remained interested and engaged in the project.

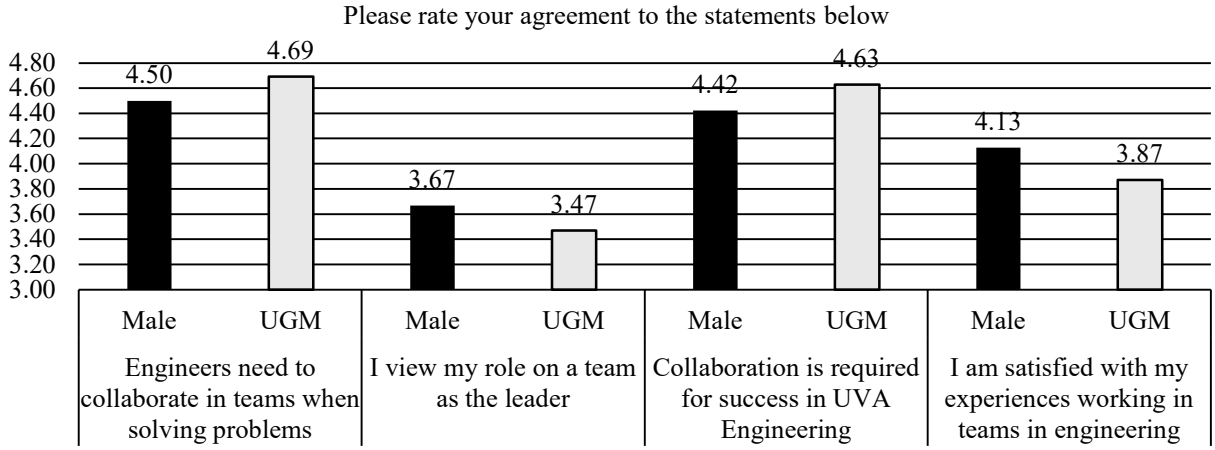
Quantitative Findings

Quantitative survey trends contextualized the qualitative findings. UGM's reported perceptions of imbalanced task distribution is similarly reflected in quantitative data where men (n = 235, M = 3.66) agreed more strongly than UGM students (n = 135, M = 3.44) that their role on their team was as a leader (U =17883.5, p = 0.033; Figure 1).

Interestingly, while UGM students agreed more strongly that engineers need to collaborate when solving problems (n_{UGM} = 136, M_{UGM} = 4.68, n_{male} = 235, M_{male} = 4.49, U = 13574.0, p = 0.005), and that collaboration is required for success in UVA engineering (n_{UGM} = 136, M_{UGM} = 4.63,

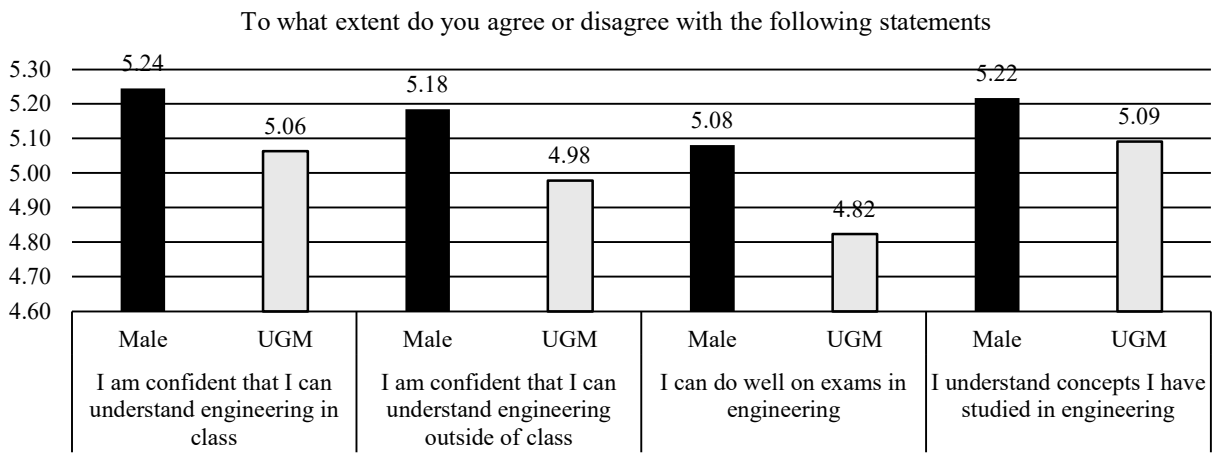
n_{male} = 235, M_{male} = 4.41, U = 13145.0, p = 0.001), men agreed more strongly that they are satisfied with their teamwork experiences (n_{UGM} = 136, M_{UGM} = 3.85, n_{male} = 235, M_{male} = 4.12, U = 18401.0, p = 0.008; Figure 1).

Figure 1: Gendered differences in perceptions of teamwork in first-year engineering



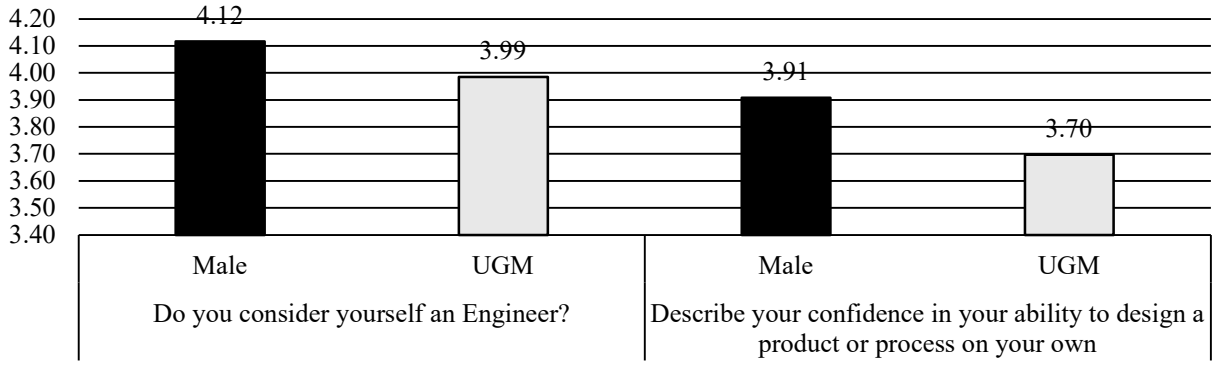
In addition to significant differences in perceptions of teamwork experiences and the role of teamwork in engineering, our quantitative data also reveal that UGM students self-reported significantly lower scores than men for questions related to engineering competence. Specifically, UGM students reported lower confidence in their ability to understand engineering in class (n_{UGM} = 139, M_{UGM} = 5.04, n_{male} = 238, M_{male} = 5.24, U = 18764.0, p = 0.019), their ability to understand engineering outside of class (n_{UGM} = 138, M_{UGM} = 4.96, n_{male} = 238, M_{male} = 5.18, U = 18962.0, p = 0.007), their ability to do well on exams in engineering (n_{UGM} = 139, M_{UGM} = 4.80, n_{male} = 238, M_{male} = 5.07, U = 19618.5, p = 0.001), and their understanding of the concepts they have studied in engineering (n_{UGM} = 139, M_{UGM} = 5.07, n_{male} = 238, M_{male} = 5.22, U = 18401.5, p = 0.048; Figure 2).

Figure 2: Gendered differences in reported competence in engineering



Men expressed greater confidence in their ability to design a product/process on their own (n_{UGM} = 135, M_{UGM} = 3.70, n_{male} = 233, M_{male} = 3.91, U = 18011.5, p = 0.013). Finally, men significantly more strongly identified themselves an engineer than UGM (n_{UGM} = 138, M_{UGM} = 3.98, n_{male} = 238, M_{male} = 4.12, U = 18414.5, p = 0.029; Figure 3).

Figure 3: Gendered differences in reported engineering identity and design confidence



Discussion

Consistent with prior scholarship on engineering as gendered cultural system [4], [5], [6], [7], [16], this study shows that a first-year engineering design course is not a neutral learning experience. This study contributes insight into how UGM students interpret teamwork experiences in their own words at a moment when engineering identities are still forming.

With respect to the research question, UGM students identified equitable role distribution, design access, and peer recognition as encouraging, while administrative labor, limited design opportunities, and self-silencing were discouraging.

Among the small subset of teams where gender composition could be confidently determined, some suggestive patterns emerged, and these should be interpreted with considerable caution given by the limited sample. When UGM students were in the majority, they more often described contributing across both design and administrative roles, participating in technical decision-making, and feeling comfortable sharing ideas. These experiences align with research suggesting that inclusive team environments can disrupt dominant norms of engineering and support broader participation [3]. In contrast, mixed or male-dominated teams more frequently appeared to reproduce gendered divisions of labor documented in prior engineering education research [6], [9], [10]. In these teams, UGM students frequently describe being disproportionately assigned documentation or organizational tasks and, in some cases, hesitating to speak up to avoid conflict. Because gender composition could not be reliably determined for most teams, these patterns are exploratory and should be treated as directions for future research rather than conclusions.

Viewed through Godwin's [1] engineering identity framework, the findings reflect how team roles shaped competence/performance and recognition. Design access supported students' sense of competence, while peer recognition shaped whether they saw themselves as legitimate contributors. This is consistent with how engineering culture operates — design work is

implicitly coded as the marker of legitimate engineering, so exclusion from it sends a signal, however unintentional, that some students belong more than others.

This extends the findings of Zarske et al. [15], who documented that women were most frequently associated with administrative rather than leadership roles in first-year engineering teams. While Zarske et al. identified gendered role patterns, this study shows how UGM students interpret those roles and connect them to belonging. This pattern is further supported by the quantitative data, where men reported significantly stronger agreement that their role on the team was as a leader ($M = 3.66$) compared to UGM students ($M = 3.44$, $p = 0.033$), suggesting that the qualitative accounts of unequal role distribution reflect a broader population-level trend.

Unequal role distribution signaled to some UGM students that they were less legitimate as engineers, undermining competence even when they remained interested in the project. At the same time, UGM students agreed more strongly that collaboration is essential to engineering but reported lower satisfaction with teamwork, suggesting that they value teamwork while not being equally served by it. Importantly, because this study centers students' own accounts rather than team-level metrics, it reveals dynamics that aggregate measures often miss, particularly the way that self-silencing and identity questioning can occur even when overall team performance appears functional.

Taken together, differences in team structure shaped whether UGM students experienced teamwork as supportive or discouraging, with task distribution and inclusive participation affecting competence, recognition, and belonging. While instructors cannot control every team's interaction, they can shape the conditions under which teams operate. For example, instructors can implement structured role rotation protocols, requiring teams to formally reassign design and administrative responsibilities at each project milestone, so that no student defaults on documentation across the entire semester. Instructors can also build psychological safety explicitly into team structures such as requiring team charters that include participation norms, or by incorporating peer feedback checkpoints mid-semester that surface unequal dynamics before they become entrenched. These interventions matter because early teamwork experiences can either reinforce or disrupt dominant norms in engineering.

Future Work

Several directions emerge from this study. First, future research should examine how team gender composition moderates UGM students' teamwork experiences more rigorously. Data limitations in the present study, particularly the high rate of "unknown" responses, precluded reliable classification of most teams, and future work with more complete gender identity data would allow for stronger conclusions. Second, collecting data from entire teams rather than individual UGM students would allow researchers to examine how dynamics are perceived differently across gender identities within the same team. Finally, longitudinal research tracking UGM students across multiple semesters would help clarify whether early teamwork experiences have lasting effects on engineering identity development and persistence.

Conclusions

This study examined how underrepresented gender-minority students experienced teamwork in a first-year engineering design course and how those experiences shaped their developing engineering identities. The findings show that teamwork is not a neutral learning environment: differences in team structure, role distribution, and participation shape students' access to design work, recognition, and psychological safety. While these findings align with prior research on gendered patterns in engineering teamwork, their replication in a first-year context matters because this is when engineering identity begins to form. Decades of research have pointed to these dynamics, and yet they persist — a clear sign that awareness alone is not enough, and that deliberate action is still needed. By documenting these patterns in a first-year context, this study strengthens the case for structural and pedagogical changes that support equitable role distribution, inclusive participation, and psychological safety.

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