2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #51365

Navigating Teamwork and Conflict in First-Year Engineering Design Teams: A Qualitative Analysis of Student Reflections

Mr. William Harry Keenan, University of Virginia

William Keenan is a 3rd year undergraduate student at the University of Virginia majoring in Systems Engineering. His main research explores teamwork and conflict in first-year engineering design teams.

Dr. Anne Marguerite McAlister, University of Virginia

Dr. Anne M. McAlister is an Assistant Professor in the First Year Engineering Center at the University of Virginia. She has her PhD in Education and MS in Systems Engineering from the University of Virginia, and her BS in Chemical Engineering from The Ohio State University. Her research focuses primarily on identity and qualitative research methods.

Benjamin Goldschneider, University of Virginia

Benjamin Goldschneider is an Assistant Professor of Engineering Foundations at the University of Virginia. He holds a PhD in Engineering Education from Virginia Tech, as well as a BS in Industrial Engineering from Purdue University. His research interests include students' sense of belonging, socialization, program development, and pre-college introductions to STEM material.

Emily Shuhui Wang, University of Virginia

Emily Wang is a first-year student at the University of Virginia majoring in Computer Engineering with a minor in Science, Technology, and Society. Her academic interests include gender inequality in STEM, technology and public policy. Outside of the classroom, Emily enjoys hiking, volunteering, and making music.

Melis Ozdemir Ms., University of Virginia

Melis Ozdemir is an undergraduate student in biomedical engineering at the University of Virginia. She conducts research in engineering education and global health and has coauthored multiple peer-reviewed publications and conference papers. She serves as a teaching assistant in first-year engineering and has held leadership roles in student organizations focused on civic discourse and mentorship. Her interests lie at the intersection of technology, policy, and engineering education, particularly in the context of health and societal impact.

Navigating Teamwork and Conflict in First-Year Engineering Design Teams: A Qualitative Analysis of Student Reflections

Abstract

This complete research paper details a qualitative study of first-year engineering (FYE) students' teamwork conflict and support experiences across a two-semester introductory engineering design course sequence. Prior studies have explored conflict in engineering teams, but few have examined teamwork conflict in the FYE design team context. By better understanding FYE students' teamwork experiences, educators can better prepare students for their futures where collaboration skills will be necessary. FYE students at a large, mid-Atlantic Research University responded to reflective prompts about their teamwork at the mid- and endpoints of a semester-long team-based engineering design project. Researchers examined 296 written reflections and then synthesized the qualitative codes under broad themes of conflict types, conflict sources, and tools for teamwork success.

Differing levels of commitment, uneven work distribution, miscommunication, and lack of accountability emerged as the most common conflict sources in FYE students' reported teamwork experiences. Among these, differing levels of commitment was the most common issue participants discussed. Further, participants regularly mentioned feeling underprepared in communication and teamwork strategies, and not knowing the importance of timely, effective communication and delegation strategies. Students adopted both technical strategies, such as a shared online team notebook and other cloud-based file sharing platforms, and social strategies, such as group chats and open communication, to improve their collaboration and coordinate work. These findings highlight instructional opportunities for strengthening teamwork preparation.

Introduction

First-year engineering (FYE) students are immediately expected to engage in teamwork in engineering classrooms. The purpose of practicing teamwork in the classroom is to prepare students for professional engineering practice, where they will be expected to engage in effective collaboration, communication, and shared decision-making. Despite the prevalence of team-based work in early engineering education, there is limited understanding of how FYE students experience and navigate conflict. This study explores the nature of conflict in FYE teams, the strategies FYE students reported as useful to successful collaboration, and the teamwork strategies FYE students reported that they wanted to better understand.

Background

While teamwork education is known to be a cornerstone of professional preparation in engineering, classroom practice often prioritizes the act of working in teams over learning about how to effectively engage in teamwork. Tuckman & Jensen described how teams may go through 5 phases of small-group development: 1) forming, 2) storming, 3) norming, 4) performing, and 5) adjourning [1]. Teams "form" when they are first created, they "storm" when differences arise, and "norm" when moving beyond those differences. Teams "perform" when

they do the work, and they end with “adjourning” as they conclude their time together. This prior work highlights the reality that teams do not work perfectly out of the gate; working through conflict as a team is a standard and essential part of the teamwork experience. Teams that are able to move through conflict in healthy ways often perform more successfully.

ABET accreditation criteria require students to function effectively on a team to meet objectives [2]. The distinction between learning and practice of effective teamwork is consequential because there is evidence that students do not learn how to operate within teams through practice alone, and prior research calls for the need to teach students how to work effectively as a team member [3]. A systematic review of teamwork in engineering design programs revealed that teamwork skills are highly contextual and are shaped by individual, team, and project-level factors such as planning and management, communication, contribution, team formation, team dynamics, feedback, personality type, identity, and motivation [4]. Requiring students without a strong foundation of teamwork skills to work in teams without considering any of these factors may inadvertently reinforce counterproductive behaviors.

The concern that engineering students are not being taught to effectively work in teams is reflected in prior research which shows that students within teams may not actually be interacting with each other. In this study, most students felt as though their teammates simply did their own individual assignments, while making some effort to listen to their teammate's thoughts and opinions [3]. However, formal instruction on group dynamics and teamwork principles may improve students’ attitudes and effectiveness in collaborative settings [5]. In prioritizing teamwork practice without explicit teamwork education, programs risk normalizing ineffective team dynamics rather than cultivating the competencies necessary for meaningful and effective collaboration. This is dangerous preparation for future engineers, especially when engineering graduates ranked teamwork competencies as the most important skill for professional practice [6].

Within the FYE context, students are very optimistic and often overstate their abilities to work within engineering design teams [7]. In comparing student perceptions of teamwork in the first and second year of an engineering education experience, Ercan & Khan found that students in their first year reported higher confidence and satisfaction within teams. First-year students may not have much experience with teamwork in academic settings, and as such may have inaccurate perceptions of their own teamwork abilities.

Frameworks

This study is guided by the works of Neumeyer & McKenna [8], Jehn [9], and Mondisa et al.[10]. Neumeyer and McKenna identified many sources of conflict and strategies for successful teamwork in FYE courses through surveys given to first-year students in an introductory engineering course that evaluated student teamwork experiences and interviews with faculty members that explored instructional contexts and common team challenges. Results showed that ill-conceived team meetings (such as unplanned times/locations), uneven work distribution, scheduling conflicts, lack of commitment, perseverance, self-motivation, dedication, and burden of responsibility were all common sources of conflict amongst FYE students. Additionally, “shared goals, trust, socializing, even distribution of labor, establishing relationships, motivation,

variety of ideas, learning how to manage, and team members" were reported as positive aspects of FYE teamwork [8]. We build on this prior work by operationalizing these previously identified sources of conflict to identify and typify the conflict present in FYE students' end of semester reflections on teamwork experiences. While Neumeyer and McKenna identified these sources from survey data, we aim to explore these sources from the student perspective in more nuance through a qualitative examination of reflection data.

To operationalize existing frameworks for our study, the conflict sources and positive aspects identified in Neumeyer and McKenna's framework were grouped as follows (Table 1). We grouped these themes to consolidate overlapping themes and accurately represent these themes as they appeared in our data. Because the written reflections were brief and often did not dive into detail, some of the constructs suggested by Neumeyer and McKenna were not able to be disentangled, or disentangling these constructs was not essential for our purpose.

For example, uneven work distributions are shown to be a common source of team conflict [7], and for our purpose Neumeyer and McKenna's constructs of uneven workloads and uneven contribution loads were nearly impossible to disentangle and thus were combined into the single category of uneven work distributions (Table 1). Similarly, commitment is seen across several different studies as an indicator of team success [7], [8], [11]. In Neumeyer and McKenna's study, they refer to "differing levels of commitment" as one of the most frequently perceived team conflicts seen [8]. For the purposes of our study, we combined both "lack of commitment" and "lack of dedication to the final goal" into the single category of commitment (Table 1), because these ideas were impossible to disentangle from this larger idea of commitment.

Accountability is seen as an important attribute in teammates [7], [11], because an accountable team member relieves others of the burden of responsibility. Neumeyer and McKenna's "lack of self-motivation" and "burden of responsibility" both reflect breakdowns in individual ownership of work. We combined these ideas, along with "lack of trust," into a single construct for accountability, which students described more broadly without the nuance of addressing their individual motivations (Table 1). "Lack of trust" was included in this category because repeated accountability failures eroded teammate's confidence that work will be completed, which we viewed as a downstream effect of accountability failures rather than a separate phenomenon.

Communication is also a cornerstone of success in all teams [4], [7], [11]. However, some engineering design teams have trouble with communication [3], which was reflected in our data through broad claims of communication issues, and more specifically happening in the form of Neumeyer and McKenna's concepts of "scheduling conflicts" or "ill-conceived team meetings" (Table 1). We framed communication-related themes as parallel categories: miscommunication on the conflict side, and communication on the positive side (Table 1), recognizing that the same underlying construct produces problems when absent and benefits when present. Notably, "scheduling conflicts" from Neumeyer and McKenna relates to both miscommunication and time pressure, as student reflections suggested scheduling difficulties could appear in two different ways: as breakdowns in communication or as compressed timelines that produced stress. The former was coded as communication, while the latter was coded as "time pressure" which was a code we formed to connect to different prior research that indicates that time management is an important individual skill for teammates to work on for team success [4].

Finally, we grouped establishing relationships, even division of labor, motivation, learning how to manage team members, and shared goals under the broader category of strategies, as each represents a deliberate practice or approach teams can adopt to work well together, rather than an outcome or state of the team itself. Further analysis could code for these specific strategies, but we did not code to that level of nuance in this paper. Finally, socializing, trust, and variety of ideas were constructs from Neumeyer and McKenna that were not necessarily strategies but states of the team. These constructs were not commonly discussed but we saw them as features that both support and emerge from positive communication within a team, which was the idea that was expressed in more detail.

Table 1. Translation from Neumeyer and McKenna to our study

Category	**Our Study**	**Neumeyer and McKenna [8]**
Conflict Sources	Uneven work distribution	Uneven workloads
		Uneven contribution loads
	Commitment	Lack of commitment
		Lack of dedication to a final goal
	Accountability	Burden of responsibility
		Lack of trust
		Lack of self-motivation
	Miscommunication	Scheduling conflicts
		Ill-conceived team meetings
	Time pressure	(Not from N & M)
Positive Team Aspects	Strategies	Establishing of relationships
		Even division of labor
		Motivation
		Learn how to manage team members
		Shared goals
	Communication	Socializing
		Trust
		Variety of ideas

To complement our understanding of the sources of conflict occurring within FYE design teams, we also sought to understand the type of conflict that was occurring, drawing from Jehn [9]. Jehn set out to understand conflict types through observational analysis and semi-structured interviews with members of six different organizational teams in the household- goods-moving industry, resulting in a set of three team conflict types in organizational groups: task conflict, relationship conflict, and procedural conflict. In 2012, Mondisa et al. [10] built on Jehn's work to observe conflict occurring in engineering design teams. The resulting conflict types were conflict with partner (interpersonal conflict), conflict with information (task conflict), conflict with process (procedure conflict), and conflict with certainty [10]. We operationalized these conflict types for our study as shown in Table 2. Our study further builds on this prior work as we operationalize these frameworks to examine conflict occurring in our FYE context.

Table 2. Translation from Jehn and Mondisa et al. to our study

Category	Our Study	Jehn [9] & Mondisa et al. [10]
Conflict Types	Task Conflict	Disagreement about a work-related matter
	Interpersonal Conflict	Negative interpersonal relations between team members
	Process Conflict	Disagreements about specific decisions made during project discussions
	Certainty Conflict	When a teammate requests clarification for something someone else has said or previously discussed

Research Questions

This study builds upon previous work in the FYE context by incorporating and centering student perspectives. Many institutions across the country incorporate teamwork into their introductory engineering course learning objectives [12]. This shows that most FYE students are actively engaging in some aspects of teamwork. However, few studies examine FYE students' perceptions of teamwork and conflict. We seek to fill this gap in addressing the following research questions:

RQ1. What conflicts, if any, do first-year engineering students encounter while working in teams?
RQ2. What strategies, if any, do first-year engineering students describe as supporting effective teamwork?
RQ3. What forms of support do first-year engineering students believe would improve their future teamwork experiences?

Methods

We used an embedded single-case study design [13] to examine teamwork experiences from the perspective of first-year engineering students. The bounded case is a two-semester introductory engineering design course sequence, and each consenting student in this course serves as an embedded unit of analysis. Data include students' end-of-year written reflection assignments regarding their teamwork experiences in the course, as well as CATME Peer Evaluation tool [14], [15], [16] reflections of team effectiveness.

Context and participants

This study took place at a large, public, mid-Atlantic, highly selective, research-intensive University that requires all first-time FYE students to take a two-semester introductory engineering course sequence before they declare their engineering major. The courses are taught by a team of 7 instructors who designed the course content together. The content between sections was the same, but delivery may have varied by instructor. In the first semester, students worked in three different design teams on three different projects that introduced skills, such as Arduino wiring & coding, reviewing prior literature, technical writing, presenting, and working with Computer-Aided Design (CAD) software. In the second semester, students exercised those same skills throughout a semester-long engineering design project, where students worked in teams of three to five to solve an authentic problem for a client. Students were sorted into their

team at the beginning of the semester based on their reported interest in the available problems. For each engineering design project, student teams were required to maintain a shared online engineering notebook in which they documented daily objectives, progress, and goals along with team assignments, important links and files, and scheduling tools. Participants include students from all sections of the Spring 2025 second semester course who consented to participate. This study was reviewed and approved by the institutional review board.

Data collection

Data included a total of 296 written reflection assignments and 83 CATME_teamwork reflections completed in the Spring 2025 semester of the introductory engineering course sequence. All students were required to complete the written reflection assignments and CATME teamwork reflections for a grade, and data used in the study only includes these artifacts from students who gave informed consent to have their data included. The prompts provided to students for the written reflection assignments varied according to instructor, but generally asked things such as, "describe a challenge you encountered with your team," or "what do you wish you knew about teamwork before this semester?" These written reflections were completed at the mid-point and at the end of the semester. Only 141 written reflection assignments (48%) had evidence of conflict or strategies for effective teamwork, so while 296 written reflection assignments were reviewed, qualitative codes were applied to only 141.

The CATME Peer Evaluation tool was used at the end of the semester, when students were asked to evaluate each of their team members and themselves, including written comments to the professor about each teammate and how their team operated. Again, only 56 CATME reflections (67%) contained evidence of conflict or strategies for effective teamwork. All responses were de-identified for analysis and reporting.

Analysis

We qualitatively coded the written reflection assignments and CATME reflections using a codebook of both a priori and inductive codes. A priori codes were derived from the conflict sources and conflict types identified in Neumeyer and McKenna [8], Jehn [9], and Mondisa et al. [10]. Inductive codes arose from the data as the need to capture additional patterns in participants' reporting of teamwork arose.

Three authors individually coded a subset of the data (20 total documents) then met to discuss agreements and disagreements and refine the code definitions. Codes from separate authors were hidden when conducting individual coding to prevent bias, and all the three authors reached 100% agreement on the 20 documents to ensure strong inter-rater reliability. The final code definitions are shown in Table 3. After reaching agreement on code definitions, the first author coded the remaining data. All qualitative coding was done using qualitative coding software. To transition from codes to themes and concrete findings, we analyzed patterns in the codes to reveal specific themes across conflict types, conflict sources, and strategies/support for better teamwork. Code frequencies were used to determine most common challenges, and frequency of codes, wording within excerpts, and code co-occurrence data were used to support findings.

Table 3. Final Codebook

Group	Code	Definition
Conflict Sources	Accountability	Student expresses that teammates (or self) lack accountability.
	Commitment	Student expresses differing levels of commitment to the project/team that leads to conflict (e.g., unexplained absences, initiative, lack of enthusiasm, overbearing attitude).
	Miscommunication	A student expressing a lack of knowledge regarding students intended contributions or completed contributions, or a general lack of communication between teammates.
	Time Pressure	Student expresses frustration with a lack of time to complete work.
	Uneven work distribution	A student expressing uneven contributions to the project.
Conflict Types	Certainty	A team member challenges a previous decision made by the team.
	Interpersonal	A team member doesn't like another team member for reasons separate from the project.
	Process	Team members do not agree on how to do something (macro scale).
	Task	Team members do not agree with an element of a project/idea/concept/execution (micro scale).
Inductive Codes	Communication	Communication that supports effective teamwork.
	Future Support	What tools students would want to be better informed of in the future.
	Obstacles	Items/ideologies/events that set back teamwork (often external to the team itself, not in their control).
	Strategies	Tools that students used to effectively work in teams. Concrete, actionable tools.

Limitations

One limitation to this study is that reflection questions varied as different instructors provided different prompts for students' written reflection assignment. Some professors had several questions asking about the challenges students faced in their team settings and their strategies for success, others simply asked students to reflect on their teamwork experiences broadly. This led to variation in the amount of detail present in student responses. Priming may have influenced responses; certain prompts explicitly asked about teamwork challenges, possibly increasing mention of conflict.

Further, participants may not have been completely honest about the conflicts they experienced in their teams. For example, students working with friends in their team may not say negative things and damage their friendship or their friend's grade. Students also may have thought of teamwork conflicts as a part of their team's lifecycle and not felt the need to reflect on it. Finally, we only have written reflections and were not able to follow up with participants for clarification or additional detail. We were limited to what was on the page.

Positionality

As both a Teaching Assistant for the introductory engineering course and a former student of the course, the first author is personally familiar with the experiences about which our participants are reflecting. Additionally, the other authors are instructors for the course, have completed the

course, or are also TAs for the course. Because the authors have experienced this course as educators, students, or both, and care about the course and the students, the authors may be more attuned to noticing instances of conflict and have empathy for the participants experiencing conflict in their teams. The authors worked to mitigate biases through consensus meetings to discuss coding and a clearly defined codebook to reduce mis- or over-interpretation of codes.

Findings

Participants primarily discussed conflict in the CATME comments, which tended to be more specific and candid, and less polished and manufactured than the final written reflections. The written reflection questions were not well-positioned to capture information about team conflict, as many of the prompts focused on what the team did well or what a student would learn from their experience. Differences between these two reflection assignments highlighted the utility of the CATME reflection as a tool for revealing conflict occurring in the FYE design teams. Additionally, not all participants reported experience of conflict, and as a result, many reflections did not have any codes applied. Specifically, 110 final written reflections, 31 mid-point reflections, and 56 CATME reflections contained evidence of conflict or mention of strategies for effective teamwork.

RQ1: What conflicts do first-year engineering students encounter while working in teams?

We observed the expected conflict types based on the work of Mondisa et al. [10] and Jehn [9]. Interpersonal and process conflict types were most frequently found in the data, while certainty and task conflicts were each only discussed once (Table 4). Certainty and task conflicts are specific and require deep reflection from the participant about an exact moment of conflict. Thus, interpersonal and process conflicts may have more commonly appeared in our data because they could be described more broadly, not necessarily referring to any one specific action or situation.

Participants may not have described specific conflict that occurred in detail because it could be difficult to revisit a frustrating moment or they did not find the details of any specific instance of conflict necessary to include in their reflection. For example, participant 492 explained that one teammate, “disagreed with the team a lot but didn’t provide other options.” If participant 492 had reflected more specifically on what disagreements occurred, either a task conflict or a certainty conflict may have been an appropriate label, but as is, unspecified disagreements regarding the proceeding of the project was coded as process conflict. In an additional example, participant 366 explained in their final reflection,

> I was quick to dismiss small design suggestions from teammates if I didn’t immediately see their value. Moving forward, I want to focus on creating a more psychologically safe environment by listening more openly, considering others’ ideas fully before responding, and making sure everyone feels comfortable contributing without fear of judgement.

While this was not a task conflict in the sense of the participant identifying a specific moment of conflict, their reflection on a trend of specific actions may have led to more growth than reflection on one specific instance of, for example, task conflict. Many participants reflected on overarching trends regarding their team interactions, rather than individual instances of conflict.

Table 4. Examples and Frequency of Conflict Types

Conflict Type	Example Quote	Participant Quoted	Code Frequency
Certainty	He was very unreliable throughout the whole project, missing a significant number of classes and almost never doing work that he agreed to. When he was in class, he was sometimes critical of the decisions that others had made while he was absent.	407	1
Interpersonal	[Teammate] is a very sweet girl for the most part, however, I do fear that she just sometimes can't exactly grasp the impact of what it is she's saying. I remember at the very beginning of this project, when others would suggest possible solutions, she would audibly laugh and say "well that's stupid," which I think just personally is what made the rest of us get off on a bad foot with her.	477	17
Process	[Teammate] frequently would overstep and take over other people's portions of work or heavily change and edit them to his liking. Which never ended badly, and he would typically stand down if the rest of the team asked him to do so, but not if one person in particular requested him to step down.	608	15
Task	I feel like the biggest challenges are trying to get the entire team to understand without escalating. Since every member is a strong-minded individual, when members feel strongly against the ideas of another, its inefficient and difficult to get the two to agree.	246	1

In our data, we observed the conflict sources we expected to see based on the work of Neumeyer and McKenna [8]. Each conflict source caused stress to teammates or the team as a whole.

Commitment was the most commonly co-occurring conflict source, in that it most often appeared alongside the other conflict sources. One example of commitment as a source of conflict occurred when teammates held the success of the project at differing levels of importance. For example, if one teammate held their project as their number one priority and another was focused on extracurricular activities, conflict may have arisen due to the two teammates being differently committed to the project. For example, this happened in the case of participant 529, who explained in their CATME reflection that:

> [Teammate] didn't help much at all in the beginning because he was pledging his fraternity, and he would almost always be late or not show up to class. He volunteered to help but wouldn't do much work in class.

This reflection shows how a difference in priorities can shift the way two people perceive a situation. Participant 529 felt like their teammate was not contributing enough, but that teammate may have been contributing as much as they had capacity to while prioritizing their fraternity pledge process. Another example of struggles with commitment differences is shown in participant 544's CATME response, shown in Table 5 Commitment example. Participant 544 felt like their teammate was not committed to the project and was struggling to contribute in meaningful ways. The CATME reflection from that teammate provided additional insight into the differing levels of commitment. Participant 544's teammate, Participant 371, said:

> I feel that I did not contribute to the project as much as I would have liked. I also feel that I lacked the skills necessary to contribute and that this was the wrong project for me.

With differing levels of commitment to the project, both participants were frustrated about different things. Participant 544 was frustrated about their teammate not doing any work, and Participant 371 was frustrated with their own performance and choice of project.

Accountability conflict within teams appeared when a teammate claimed that they would complete a task by a specific deadline, but in the end did not complete the task communicate with their team. Accountability conflict was often complex and commonly appeared alongside miscommunication, varying levels of commitment, and uneven work distribution conflicts. Often, we saw accountability conflict reported by a teammate who had to complete work that another teammate had not completed, as shown in the Table 5 Accountability example.

Table 5. Examples and Frequency of Conflict Sources

Conflict Source	Example Quote	Participant Quoted
Commitment	Unfortunately, I found that [Teammate] lacked a sense of willingness or desire to contribute in a meaningful way. During class, I noticed that [Teammate] would often gaze into his computer and rarely joined our discussion on our project. He would also almost never offer his assistance on any task and was difficult to communicate with outside of the classroom.	544
Accountability	[Teammate] would be assigned one thing per phase of the project. He would repeatedly say that he was on track and working hard as the deadline for sections approached. Unfortunately, on 3 separate occasions, [teammate] entirely failed to deliver on the night of the due date. [Teammate] promised to write half of the lit review as well as the gaps section and did not touch the document.	618
Time Pressure	I did not enjoy how little time we had to work on the project, the timeline was very tense since we did not get the bulk of our materials until early April despite ordering them before spring break.	277
Uneven work distribution	[Teammate] didn't contribute to the project itself at all really, he would just write a little. He definitely contributed the least in my opinion, but he communicated with the group better than [another teammate]. Overall, he contributed the least to the project, but it was because he just doesn't understand programming and didn't try to understand.	529
Miscommunication	[Teammate] was frequently absent without telling us. At first, he would be absent without telling, not respond and then not complete any assignments. Then he began to respond, say he would complete assignments, but then either not complete them or do them at low quality.	451

Conflict due to time pressure was observed when participants felt like they were running out of time. Sometimes, issues regarding planning, material delivery, or the amount of time required to complete some tasks caused this conflict. Even when participants tried to plan (for example

ordering materials early, as shown in the Table 5 Time Pressure example), teams still ran into timeline issues that caused conflict within the team.

Uneven work distribution was seen in the data from two different perspectives; either a participant reported that they felt like they had contributed to the project more than their peers, or, less commonly, a participant reported that that they hadn't contributed as much to the project as their teammates. The example of Uneven work distribution conflict shown in Table 5 is that of a participant who was frustrated by how little their teammate worked on the project. They did reflect on why that might be the case as well as what they brought to the table, as they had less programming skills than the rest of the team but still was communicative. This example reflects a hybrid case where perceived uneven contribution stemmed from limited technical capacity rather than disengagement, complicating simplistic contribution narratives.

Miscommunication conflict occurred primarily if a student felt they were not able to reach or get in contact with a teammate, or if that teammate was simply not descriptive with their communications. This became an issue most commonly when a teammate would be delegated work or take on a part of an assignment and not communicate with the team about an inability to complete the work until after the timeline had passed.

Q2: What strategies do first-year engineering students describe as supporting effective teamwork?

Participants described using both technical and social strategies to support their teamwork experiences. Technical strategies included the use of an engineering notebook, citation management software, and other virtual collaborative tools. The engineering notebook was the most common tool mentioned, with 18 participants discussing the strategy. Participant 366 stated in their final reflection, "Our team has been using the Notebook to complete tasks during class and set work that needs to be done specifically by each person before the next class." Participant 366's notebook thus supported effective teamwork. In addition to documenting work, notebooks helped organize the workflow and facilitate communication between team members.

Citation managers were also mentioned by 4 different participants as a tool that improved their teamwork. In their final reflection, Participant 236 said, "One new tool we introduced for this project was [citation manager], a website and program that helped us manage our references for the literature review." Participant 236 reflected on the fact that this was a *new* tool for them and their team, but learning to use it made it easier for the team to manage their references.

Many participants also reported using additional virtual collaborative tools to support effective teamwork. For example, Participant 365 mentioned using, "a folder on Google Drive to collaborate, upload updated files and store our files and code," along with, "iMessage for quick and prompt communication and updates." The team's Google drive and iMessage strategies allowed team members to collaborate efficiently by improving transparency and communication.

Social strategies that supported participants' teamwork experience included friendship building outside of the classroom context and group-chats that practiced open communication. These

strategies were observed in reflections where students were asked to give advice to future teams. In one reflection, Participant 194 said,

> For future teams, I want to engage more in getting to know my teammates as friends, as I have noticed that understanding the people you work with really helps with team chemistry and deliverable quality. Knowing people beyond simple professionalism can help me understand my teammates strengths and weaknesses better and allow for coordination of roles that emphasize everyone's strong suits.

Participant 194 felt like getting to know teammates outside of the classroom would allow a team to form a deeper bond through a deeper understanding of each other. Relatedly, Participant 506 described how they became friends with their team outside of the classroom, and said, "I can't stress how essential it is to build relationships with your group members whom you'll be working with for an entire semester." Participant 506 felt that becoming friends with their teammates was the most important thing to mention as advice for future students. Their teammates became their friends, allowing an opportunity to improve their overall education experience while simultaneously bolstering the effectiveness of their group.

Participants also described group chats as important to supporting their teamwork. Group chats were mentioned frequently in response to the question, "What tools were used to facilitate good teamwork?" Participant 477 shared, "Although I was sick for two workdays, I tried to continue to be an effective teammate by […] communicating with my team through an iMessage group chat." This participant's group chat helped prevent miscommunications. Participant 392 also found their group chat to be important to the success of their team, stating that:

> An important tool we used during this phase of the project that helped us be more productive was a group chat with all of us in it. Having open communication with all the members of our group lets us work at our own pace to get what we need to do done.

Participant 392 emphasized the fact that group chats facilitated open communication, which they felt greatly reduced the stress students may feel when communicating with a group of other people. By having a casual way of communicating with each other, teams were able to disseminate information quickly and without the need to put excessive energy into formalities or formatting. Group chats were a tool that helped teams engage in effective teamwork.

Q3: What forms of support do first-year engineering students believe would improve their future teamwork experiences?

Participants reported that they would want more support delegating work, making decisions, and improving communication skills. With regard to making decisions, Participant 246 said, "I wish I knew that we would have trouble agreeing on designs, and that it would be difficult at first to give opinions without sounding pointed and to receive criticism without getting defensive." Teams were having trouble deciding on what to include vs exclude, and how to negotiate these decisions in a way that wouldn't hurt their teammates' feelings. Thus, decision making and communicating effectively were highly intertwined skills.

Communication was also intertwined with delegating work. For example, Participant 250 said, "I wish I had known how important communication and role assigning were in teamwork," and Participant 342 said,

> I wish I knew more about the importance of delegating tasks and creating roles for each member of the team. Splitting up large assignments into small individual roles made the task seem less daunting and allowed us to focus and become proficient in a certain part of the project.

These comments highlight how participants wanted better preparation to effectively delegate and communicate. Participant 541's comment further illustrates the desire for more effective communication strategies as they said, "I wish I had known how to properly communicate research/findings to my teammates so that they could understand it better." Communication in a team setting is not just a way to delegate tasks and give feedback, but it is also essential for sharing information that individuals have learned through personal research and experience. Explaining findings can be challenging, and several participants felt as though they were unprepared to share their own findings and experiences with their teammates in an understandable way. Participant 340 agreed with this sentiment, saying they wished they knew,

> How to convey your goals and visions in a non-aggressive way. How to break down your thoughts into chunks. Because other people might not understand 100% what you are saying. Everyone's thought process is different. Make sure you can communicate your thoughts clearly and transparently.

This builds on what we saw in our findings, and it maps well to the conflict sources seen. Students want to be better educated on how to communicate with one another, explain their individual findings, delegate tasks, work through conflict, and decide on designs. We see these problems when analyzing student reflections across the entire class, but this one student brought up all of these concerns at once.

Discussion

Findings demonstrate challenges associated with teamwork in the FYE setting, strategies that support successful teamwork, and supports that participants reported would better equip them to work in teams. Teamwork skills are highly contextual and shaped by individual and team-level factors [4], and our study provides insights into the some of the team-level factors that helped students succeed. For example, by using tools like shared folders and citation managers, teams communicated more efficiently and reported better outcomes. Simultaneously, by engaging in social strategies like friendship building, teams reported reduced interpersonal conflict and positive teamwork outcomes. Our findings align with Lingard and Barkataki's [3] claim that there are many peripheral skills that students need to exercise to be proficient in teamwork, including communicating and leveraging web-based tools for collaboration.

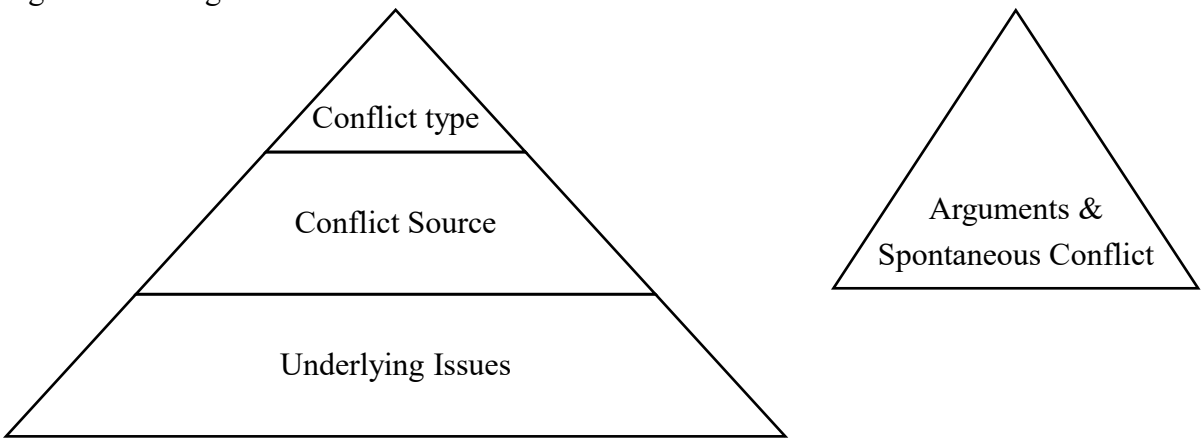
Participants in our study reported experiencing conflicts that align with and expand upon prior research in terms of frequency and experience [9], [10]. Frameworks presented by Jehn [9] and Mondisa et al. [10], emphasized task and certainty conflict in engineering design as two of the

more common types of conflict, but our data showed a higher prevalence of interpersonal and process conflicts. Macro-level disagreement (process conflict) and tension between teammates (interpersonal conflict) were more often reported in their final reflections than instances of disagreement about individual decisions (task conflict). Given that the reflective prompts asked students to look back at a semester's worth of teamwork, it then makes sense that conflicts centering the mechanics of how to work together and the social dynamics of the team were reported more often more than conflicts about the technical aspects of the design project itself.

Our findings illustrate the conflict types and conflict sources that exist in complex ways to drive different teamwork experiences in FYE. To visualize and more deeply understand the conflict sources, types, and underlying issues revealed in our data, we present the "Iceberg of Team Conflict" (Figure 1). This visually represents the different observed layers of team conflict, showing them as a layered conflict with a conflict type that manifests as the result of possible underlying issues/conflict sources. A team which experiences more layered conflict may need to dig deeper to resolve or overcome their challenge, just as someone would need to work harder to break up a larger iceberg. Not all layers are present in every conflict, representing the varied conflicts we observed, some of which were eventually insurmountable for teams while others were minor bumps along the way.

This illustration is intended to be useful for instructors to view conflict and better understand the perspective of students involved. Our visual illustrates the ways that underlying issues which an instructor may not be able to observe on the surface might drive conflict sources and conflict types, creating a larger, more impactful team conflict, which we might view as a metaphorical large iceberg of conflict, as shown in Figure 1. For example, a conflict source such as miscommunication might lead to a process conflict, which is a disagreement on how to proceed. Further, an underlying issue such as a student's mental health struggle, imposter syndrome battle, or lack of interest in the project can transform a simple conflict source into a much larger, more persistent challenge. In contrast, other conflict might exist as a single task conflict with no larger source or underlying issue and thus be a much smaller "iceberg" shown by a single triangle. Importantly, a conflict might exist on a team, but instructors may not see evidence of the additional, deeper issues driving the conflict. In most instances, an instructor would need to dig deeper to reveal the layers behind the conflict, which may be hidden like the layers of an iceberg. What rises to the surface might look like a smaller issue.

Figure 1. Iceberg Model of Team Conflict



We were inspired by the non-linear middle phases of Tuckman and Jensen's [1] team development process, where phases are all important aspects of group development, but some groups may not enter all these phases in a linear fashion. Our results suggest that team conflict also develops non-linearly.

The Iceberg Model might help instructors categorize student experiences into varying sizes of icebergs. Small icebergs represent isolated instances of conflict, such as a small argument over a specific project detail, or a one-time miscommunication that is easily resolved. If any one team is assumed to behave like a boat, navigating towards their destination or goal, they are bound to run into conflict, here represented by a series of icebergs. What is most easily visible and recognizable for both the team and the supporting faculty is the conflict type, the actual manifestation of the conflict in the team setting. When it's just this surface level conflict—a disagreement about how to take the next step, someone making an unkind remark when they're having a bad day or finding it hard to agree on a meeting time—and nothing more, many teams can break right through and continue to their destination. However, if the iceberg goes deeper, with more complex sources of conflict and underlying issues, the threat to their teamwork boat becomes much greater. Without recognition and concerted effort by the students, faculty, or both, to address these hidden aspects of team conflict, they can spell disaster for a team's efforts, metaphorically sinking their chances of success. It is impossible to know just how dangerous conflict can be to a team's progress without fully understanding all possible underlying issues and conflict sources. What may seem like a minor disagreement could instead be the representation of a much more serious issue, requiring additional instructor support and investment from the team to address and move past.

Conclusion

Conflict in first-year design teams is a common struggle that will not, and should not, go away. It is important and necessary for FYE students to learn how to navigate conflict in team settings and have conflict in healthy ways. This research is not a guide for how to deal with team conflict in the first-year setting, but it is rather a lens that educators can use to understand conflict in their classroom. Many conflict sources may be the result of underlying issues that may never be uncovered, but through open communication and the cultivation of friendships, teams might work out their issues and find success. Ultimately, this work has produced the "Iceberg of Conflict" that may be useful for instructors as a lens to view team conflict through, not as a checklist to go through when issues arise.

Looking to the future, it is clear from this research that students need more teamwork instruction in combination with practice. Putting students into design teams and expecting them to perform well with their peers is not realistic, especially given the vast differences in technical and teamwork abilities that some teams may experience. Without establishing skills like delegation, open communication, and empathy, students may reinforce bad habits through unsupported teamwork practice. Developing good habits early on sets students up for success in their later academic endeavors and beyond.

References

[1] B. W. Tuckman and M. A. C. Jensen, "Stages of Small-Group Development Revisited," *Group Organ. Stud.*, vol. 2, no. 4, pp. 419–427, Dec. 1977, doi: 10.1177/105960117700200404.

[2] ABET, "Criteria for Accrediting Engineering Programs, 2025-2026." ABET. [Online]. Available: https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2025-2026/

[3] R. Lingard and S. Barkataki, "Teaching teamwork in engineering and computer science," in *2011 Frontiers in Education Conference (FIE)*, Rapid City, SD, USA: IEEE, Oct. 2011, pp. F1C-1-F1C-5. doi: 10.1109/FIE.2011.6143000.

[4] C. Kimpton and N. Maynard, "Factors shaping teamwork skills development in tertiary engineering education: a systematic literature review," *Eur. J. Eng. Educ.*, vol. 50, no. 2, pp. 253–280, Mar. 2025, doi: 10.1080/03043797.2024.2357343.

[5] D. Levi, L. Rinzel, and M. Capacit, "Effects of Education and Team Projects on Student Attitudes toward Team Work." ERIC, 1998.

[6] H. J. Passow, "Which ABET Competencies Do Engineering Graduates Find Most Important in their Work?," *J. Eng. Educ.*, vol. 101, no. 1, pp. 95–118, Jan. 2012, doi: 10.1002/j.2168-9830.2012.tb00043.x.

[7] M. F. Ercan and R. Khan, "Teamwork as a fundamental skill for engineering graduates," in *2017 IEEE 6th International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, Hong Kong: IEEE, Dec. 2017, pp. 24–28. doi: 10.1109/TALE.2017.8252298.

[8] X. Neumeyer and A. McKenna, "Conflict Behavior And Its Influence On Engineering Design Teams," in *2010 Annual Conference & Exposition Proceedings*, Louisville, Kentucky: ASEE Conferences, Jun. 2010, p. 15.309.1-15.309.12. doi: 10.18260/1-2--16638.

[9] K. A. Jehn, "A Qualitative Analysis of Conflict Types and Dimensions in Organizational Groups," *Adm. Sci. Q.*, vol. 42, no. 3, p. 530, Sep. 1997, doi: 10.2307/2393737.

[10] J.-L. Mondisa, N. D. Fila, E. Dringenberg, T. Zephirin, and S. Purzer, "Work in progress: A case study of the types and frequencies of conflict in engineering design dyads," in *2012 Frontiers in Education Conference Proceedings*, Seattle, WA, USA: IEEE, Oct. 2012, pp. 1–2. doi: 10.1109/FIE.2012.6462510.

[11] T. Chowdhury and H. Murzi, "Literature Review: Exploring Teamwork in Engineering Education".

[12] A. McAlister, B. Goldschneider, E. Wang, and W. Keenan, "Full Paper: What are we Teaching First Year Students? A Qualitative Analysis of Introductory Engineering Course

Syllabi," in *FYEE 2025 Conference Proceedings*, University of Maryland - College Park, Maryland: ASEE Conferences, Jul. 2025, p. 55252. doi: 10.18260/1-2--55252.

[13] R. K. Yin, *Case study research and applications: design and methods*, Sixth edition. Los Angeles: SAGE, 2018.

[14] A. C. Loignon, D. J. Woehr, J. S. Thomas, M. L. Loughry, M. W. Ohland, and D. M. Ferguson, "Facilitating Peer Evaluation in Team Contexts: The Impact of Frame-of-Reference Rater Training," *Acad. Manag. Learn. Educ.*, vol. 16, no. 4, pp. 562–578, Dec. 2017, doi: 10.5465/amle.2016.0163.

[15] M. W. Ohland *et al.*, "The comprehensive assessment of team member effectiveness: Development of a behaviorally anchored rating scale for self- and peer evaluation," *Acad. Manag. Learn. Educ.*, vol. 11, no. 4, pp. 609–630, 2012.

[16] M. L. Loughry, M. W. Ohland, and D. DeWayne Moore, "Development of a Theory-Based Assessment of Team Member Effectiveness," *Educ. Psychol. Meas.*, vol. 67, no. 3, pp. 505–524, Jun. 2007, doi: 10.1177/0013164406292085.