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Faculty Espoused versus Enacted Beliefs on Teamwork in Engineering Education: Results from a National Faculty Survey

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Introduction

Teamwork is a cornerstone of engineering education, equipping students with the necessary skills and experiences to navigate the complexities of engineering practice [1], [2], [3]. While studies show the importance of imparting teamwork-based skills and processes to successfully collaborate, there is a notable gap in literature regarding specific teamwork-related motivations, objectives, and goals beyond those outlined by the ABET criteria [4], [5]. This gap presents a significant challenge in preparing engineering students to successfully work and thrive in team-based environments post-graduation.

Furthermore, it is critical that we expand our understanding of teamwork goals, beyond accreditation purposes, to give evidence-based, meaningful recommendations for best practices [6], [7]. Instructors' epistemological beliefs and values about teamwork in the classroom may vary, influenced by course type (e.g., capstone, lab-based, lecture-based courses) and the unique challenges inherent in those contexts. To address this, it is first essential to gain a better understanding of what teamwork skills, challenges, and mindsets faculty have in engineering classrooms, along with the broader contexts shaping these factors, to better support their specific motivations and teaching practices.

Research Questions

In this paper, we present a subset of results from a national faculty survey tool used to investigate instructor attitudes and beliefs about learning and teaming in engineering courses. The primary focus of this work is to better understand and connect teamwork motivations and enacted practices, answering the following research questions:

1. What are the diverse motivations of engineering faculty for incorporating teamwork into their classes?
2. How do specific practices and learning objectives link instructors' espoused beliefs about teamwork to their classroom practices and experiences?

Background

The educational benefits of teamwork are widely recognized in educational research, highlighting increased motivation, enhanced creativity, and deeper reflection, along with the development of critical conceptual knowledge and communication skills [8], [9]. However, implementing effective teaming related learning environments can prove challenging in engineering education and may diminish said benefits. Students can struggle with issues such as the unequal distribution of workload, difficulties in coordinating schedules, and conflicts arising from differences in work styles or perspectives [10], [11].

Instructors also face complex difficulties when designing, guiding, and evaluating teamwork activities. They must navigate the complex task of structuring teamwork activities, assigning roles, providing appropriate guidance and feedback, and assessing individual contributions within a team setting while also addressing the needs and challenges students experience [12], [13], [14]. Many faculty members and instructors must tackle these challenges, often without adequate training or resources, directly impacting the quality of student learning environments and outcomes.

Additionally, while many faculty members are motivated by various reasons to have students work in teams, it is crucial to link specific educational contexts with targeted learning outcomes to effectively evaluate and refine teamwork teaching methods. For example, work by Borrego et al. (2013) systematically explored how team-based projects are utilized in engineering education to meet various "professional" learning outcomes [15]. This study explored the professional learning outcomes aimed at by team projects and identified common negative team behaviors that educators tried to reduce. It highlighted a gap between the desired educational outcomes and the use of research-based methods to achieve them. This further emphasizes the need to better understand the motivations and learning objectives within specific teamwork contexts to inform pedagogical decisions.

Methods

Survey Development and Dissemination

To explore the landscape of teamwork in engineering classrooms, a survey tool was developed and administered nationally in Summer 2024. This tool aimed to investigate the dynamics between internal beliefs about learning, external influences on instructors, and the motivations behind instructional decisions, as well as the resulting pedagogical choices [16]. The survey tool consisted of open and closed form questions following 6 main themes described in Table 1. For more details pertaining to survey development, see McColley et al (2024) [16]. The survey was shared through a Qualtrics anonymous link through engineering organization list servs (e.g., ASEE, AIChE) and emails to engineering departments nationwide. This research study was approved by Cornell University's Institutional Review Board (IRB0148612).

Table 1 Survey themes and details

Theme	Details
Mindsets	Adapted Dweck's Mindset Inventory [17], growth vs. fixed mindset, faculty mindsets
Institutional contexts	Information about the institution/course, type of institution, discipline, course structure, team formation, syllabus upload
Support	Influences, challenges, support, satisfaction with workload, adapted from Faculty Survey on Teaching, Learning and Assessment (FSTLA) [18]
Teaching practices	Frequency of teamwork practices, reflection on student performance, adapted from FSTLA [18], the Approaches to Classroom Assessment Inventory (ACAI) [19], and the surveys developed by Richardson et al [20].
Motivations	Open-ended response on motivations, Likert-scale questions, reflection on barriers.
Demographics	Rank, years of teaching, gender, race/ethnicity

Participants

The participants of this research were engineering instructors who have taught an engineering course that incorporated teamwork in some capacity within the past three years. This includes professors and instructors of all ranks across various disciplines and types of institutions (public, private, 2-year, 4-year, etc.). Table A1 in the Appendix summarizes the demographic information for the survey respondents.

Data Analysis

For the purposes of this paper we focused on survey items related to motivations for teamwork as well as uploaded syllabi of courses that included teamwork. In the survey, participants first answered an open-ended question, "*In the most recent course that included teamwork in some form, why did you choose to have students work in teams?*" This was later followed by the statement, "*Including teamwork in my classroom is important…*" which was accompanied by 11 motivations for teamwork. These motivations were rated on a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree.

Likert plots were generated using R statistical software to compare participants response to the closed form survey item. Next, open-ended responses were qualitatively coded using an *a priori* coding scheme shown in the Appendix (Table A2) and then compared to the closed form data.

We qualitatively coded the submitted syllabi (n = 67) for specific learning objectives, course activities, and outlined policies that aligned with the two of the most common motivations: teamwork skills development and collaborative learning. We then compared these syllabi to respondents' open-ended motivation responses to determine whether an instructor's motivations or goals for teamwork aligned or misaligned with the syllabus contents.

Results and Discussion

Closed vs Open Motivations for Teamwork

Engineering instructors were asked to rate the importance of various motivations for incorporating teamwork in the classroom (e.g., ABET accreditation, improving communication skills). Figure 1 illustrates the results for each survey item.

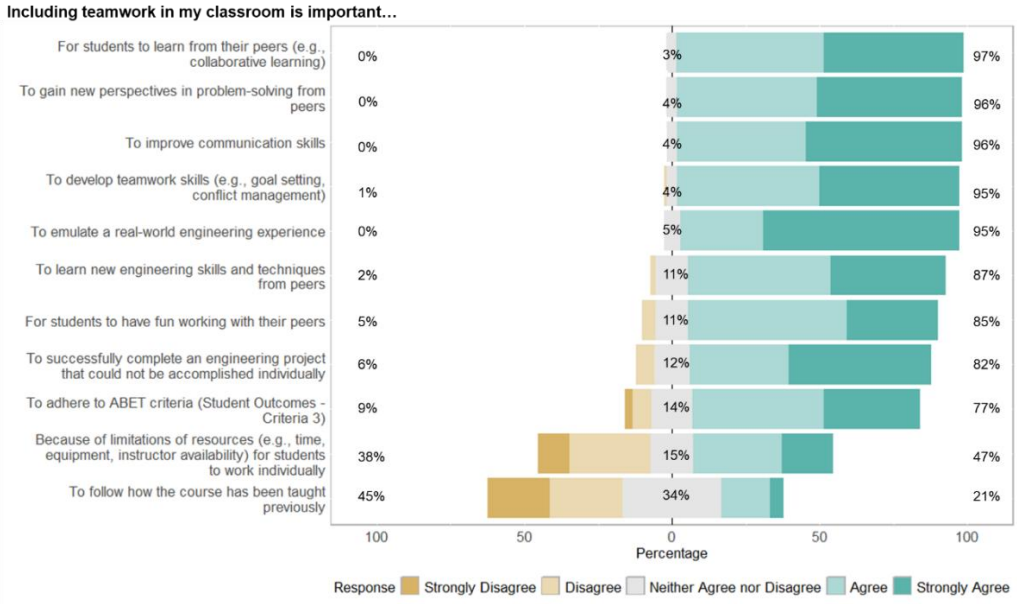

Figure 1 Distributions of responses to the statement, "Including teamwork in my classroom is important…" on a 5-point Likert scale from 1 – Strongly Disagree to 5 – Strongly Agree (n = 110).

Overall, instructors agreed with most of the listed motivations for incorporating teamwork. However, these motivations often require distinct---and potentially conflicting---pedagogical

approaches. For instance, if the motivation for teamwork is to help students learn and practice conflict management skills, faculty may prefer to guide students through conflict resolution rather than stepping in immediately. On the other hand, if the goal is for students to learn collaboratively, it might be more effective for an instructor to intervene at the first signs of conflict to maintain a productive learning environment.

Instructors acknowledged the importance of teamwork for various reasons in their classrooms. The open-ended responses revealed a wide range of motivations, with the most common themes and their occurrences listed in Table 3.

Table 3 Code occurrence for instructor motivation open responses (n = 110; Some responses had multiple motivations coded).

Open Motivations	**Occurrences**
Teamwork skills	39
Emulate Real Engineering	37
Collaborative Learning	26
Complete an Engineering Project	26
Following Previous Course	28
Limitations of Resources	25
New Problem Solving	21
Fun/Social Engagement	18
ABET Accreditation	16
Communication Skills	11
Engineering Skills	1

The most frequently cited motivation in the open-ended responses was *teamwork skill development,* followed by *emulating a real engineering environment* and *collaborative learning*. This differs compared to the closed form Likert results in Figure 1, where the top motivation for teamwork was *collaborative learning* followed by *gaining new problem-solving perspectives* and *communication skills*. Notably, many motivations that instructors agree with are important in the multiple-choice closed-response item, such as communication skills, were not expressed in their open-ended responses. This discrepancy suggests that instructors may not have thoroughly considered their motivations for including teamwork in their classrooms.

Motivation Alignment with Syllabus Content

Some participants submitted the syllabus for the course they described in the survey. The specific learning objectives and course policies from these syllabi were reviewed and compared to the participants' open-ended responses about their motivations for including teamwork. For this research brief, we focus on two common motivations: *teamwork skill development* and *collaborative learning.* The alignment or misalignment between these motivations and syllabus content is presented in Tables 4 and 5.

Table 4 Teamwork skill development motivated syllabus content

	Teamwork Learning Objectives	Course Policy
Aligns with Open Response	Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	"This course uses the team-based learning method. Most of the content is introduced outside of class as readings and pre-application exercise problems, and most of the application activities, conventionally done as homework and outside-of-class group projects, are done in teams during class."
Misaligns with Open Response	No specific teamwork Learning Objectives	"You may (and are encouraged to) work in groups on problem sets. However, what you submit must be your own work. Assignments that are obviously copied will receive no credit"

Table 4 presents the learning objectives and course policies from syllabi from courses motivated by *teamwork skill development*. The first syllabus, from a Chemical Engineering Design course, aligns well with this motivation. Both the learning objectives and course policy support efforts for students to develop teamwork skills. Some of these skills were explicitly written in the learning objectives such as being able to establish goals, plan tasks, and meet objectives. Additionally, the course was structured so that most class time was dedicated to teamwork, allowing students ample opportunity to practice these skills. However, the next syllabus shown in Table 4, from a core Chemical Engineering course, did not explicitly emphasize teamwork skill development. While the course policy encouraged students to work in groups on problem sets, there was no other mention of teamwork or teamwork skills in the syllabus. This may be due to the nature of the course not being as team-centric as compared to the design course cited before. However, in response to the open-ended motivation question, the participant stated that one reason for forming teams is that teamwork is essential for solving engineering problems. It is important that this belief is reflected in their learning objectives and policies to clearly communicate its importance to students. This also allows for better evaluation and a more structured approach to teaching these skills.

Table 5 Collaborative Learning motivated syllabus content

	Teamwork Learning Objectives	Course Policy
Aligns with Open Response	Develop individual and team communication skills through written, oral, and visual modalities. Function effectively on a team to engage in collaborative and inclusive engineering practice.	"One of your best resources for success in this class is each other! I strongly encourage discussions between classmates at any time and on any work…Any work by others must be clearly labelled as such, and the work you submit must be predominantly your own."
Misaligns with Open Response	No specific teamwork Learning Objectives	"Unless stated otherwise, all work submitted for grading must be done individually. While we encourage you to talk to your peers and learn from them, this interaction must be superficial with regards to all work submitted for grading."

Table 5 presents the learning objectives and course policies from syllabi from courses motivated by *collaborative learning*. The learning objectives in the first syllabus, from an introductory engineering course, clearly lists functioning effectively on a team, engaging in collaborative practices. Collaboration and its importance to this class is then clearly highlighted as an important resource, fully aligning with the participant's open-ended response. The next syllabus, from a Computer Science elective course, does not list any learning objectives relating to teamwork. The course policies also seemingly discourage students from working together effectively. Here, they express students are "encouraged" to talk and learn from their peers but this level of collaboration, "…must be superficial with regards to all work submitted for grading," directly in contrast to the introductory engineering course above. It is important to note however that similar thoughts on grading can be seen between these two cases where graded and submitted work must be students' own work. The prior course, however, included in their policy that any work by others should be clearly labelled, further supporting efforts for students to work collaboratively with one another. The second, on the other hand, is clearly showing a case where an instructor's beliefs about the importance and reason for teamwork and collaborative learning are not only missing in course policies, but pedagogical decisions explicitly challenge those espoused beliefs.

Conclusion

This work aims to clarify the motivations and methods that current engineering instructors nationwide use to incorporate teamwork into their coursework. Faculty have various reasons for placing students in teams, ranging from ABET accreditation to fostering new problem-solving skills through peer interaction. Comparing open-ended responses with closed-form questions suggests that some faculty may not have deeply considered the role of teamwork in their courses. Additionally, while many aspects of teamwork in courses are beneficial, some motivations may conflict with one another, underscoring the need for a thorough understanding of why students are placed in teams and the specific learning objectives involved.

Understanding instructor motivations is a crucial first step in effectively implementing teamwork in engineering classrooms. It is then important to align these beliefs with pedagogical decisions to ensure that students can practice teamwork in an environment that supports the intended learning outcomes. Course learning objectives are crucial for structuring a class to emphasize the importance of teamwork and achieving specific goals through team-based learning. Additionally, course policies and activities should be thoughtfully designed to reinforce these objectives. Without such alignment, the potential benefits of teamwork and collaboration may not be fully realized, undermining efforts to prepare students for complex, team-based engineering challenges.

Future Work

As this paper presents only a subset of the survey data, future research will explore several areas. First, we will examine survey participants' responses in relation to their beliefs about learning, such as fixed versus growth mindsets. Additionally, we will conduct a deeper investigation into the alignment between learning objectives and team motivations, focusing on the context of teaming environments and practices, such as the type of course.

To complement these survey findings, follow-up interviews are planned to gain a more complete understanding of faculty pedagogical choices. Ultimately, this research will evaluate teaming and collaborative practices in the classroom to support faculty efforts in preparing students to navigate complex engineering practices in the future.

References

[1] 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)*, Dec. 2017, pp. 24–28. doi: 10.1109/TALE.2017.8252298.

[2] G. A. Mosher, "Enhancing Team-Based Senior Capstone Projects: Opportunities and Challenges," *2014 ASEE North Midwest Sect. Conf.*, vol. 2014, no. 1, Art. no. 1, Oct. 2014, doi: 10.17077/aseenmw2014.1002.

[3] A. Nuñez-Thompson, A. Saterbak, C. Rincon, J. Stelling, G. Allen, and M. Wettergreen, "Participation in a team-based, first-year engineering design course associated with improved teaming skills during senior capstone engineering design," *Adv. Eng. Educ.*, vol. 11, no. 3, 2023, doi: 10.18260/3-1-1153-36046.

[4] M. Mostafapour and A. Hurst, "An Exploratory Study of Teamwork Processes and Perceived Team Effectiveness in Engineering Capstone Design Teams".

[5] T. Chowdhury and H. Murzi, *Literature Review: Exploring Teamwork in Engineering Education*. 2019.

[6] "ABET 2024-2025 Criteria." Accessed: Feb. 01, 2024. [Online]. Available: https://www.abet.org/wp-content/uploads/2023/05/2024-2025_ANSAC_Criteria.pdf

[7] J. A. Mynderse, A. L. Gerhart, and L. Liu, "Assessing ABET Student Outcome 5 (Teamwork) in BSME Capstone Design Projects," presented at the 2021 ASEE Virtual Annual Conference Content Access, Jul. 2021. Accessed: Mar. 12, 2024. [Online]. Available: https://peer.asee.org/assessing-abet-student-outcome-5-teamwork-in-bsme-capstone-design-projects

[8] D. W. Johnson and R. T. Johnson, "An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning," *Educ. Res.*, vol. 38, no. 5, pp. 365–379, Jun. 2009, doi: 10.3102/0013189X09339057.

[9] E. Panadero and S. Järvelä, "Socially Shared Regulation of Learning: A Review," *Eur. Psychol.*, vol. 20, pp. 190–203, Jan. 2015, doi: 10.1027/1016-9040/a000226.

[10] P. C. Blumenfeld, R. W. Marx, E. Soloway, and J. Krajcik, "Learning with Peers: From Small Group Cooperation to Collaborative Communities," *Educ. Res.*, vol. 25, no. 8, pp. 37–40, 1996, doi: 10.2307/1176492.

[11] P. Van den Bossche, W. H. Gijselaers, M. Segers, and P. A. Kirschner, "Social and Cognitive Factors Driving Teamwork in Collaborative Learning Environments: Team Learning Beliefs and Behaviors," *Small Group Res.*, vol. 37, no. 5, pp. 490–521, Oct. 2006, doi: 10.1177/1046496406292938.

[12] R. M. Gillies and M. Boyle, "Teachers' reflections on cooperative learning: Issues of implementation," *Teach. Teach. Educ.*, vol. 26, no. 4, pp. 933–940, May 2010, doi: 10.1016/j.tate.2009.10.034.

[13] I. Ruys, H. V. Keer, and A. Aelterman, "Examining pre-service teacher competence in lesson planning pertaining to collaborative learning," *J. Curric. Stud.*, vol. 44, no. 3, pp. 349–379, Jun. 2012, doi: 10.1080/00220272.2012.675355.

[14] C. McDowell, L. Werner, H. E. Bullock, and J. Fernald, "Pair programming improves student retention, confidence, and program quality," *Commun ACM*, vol. 49, no. 8, pp. 90–95, Aug. 2006, doi: 10.1145/1145287.1145293.

[15] M. Borrego, J. Karlin, L. D. McNair, and K. Beddoes, "Team Effectiveness Theory from Industrial and Organizational Psychology Applied to Engineering Student Project Teams: A

Research Review," *J. Eng. Educ.*, vol. 102, no. 4, pp. 472–512, Oct. 2013, doi: 10.1002/jee.20023.
[16] C. J. McColley and A. Werth, "Work in progress: Initial development of a faculty survey tool to measure instructor attitudes about learning and teaming in engineering coursework," *2024 IEEE Front. Educ. Conf.*.
[17] C. S. Dweck, *Mindset: The new psychology of success*. in Mindset: The new psychology of success. New York, NY, US: Random House, 2006, pp. x, 276.
[18] E. Dey and S. Hurtado, "Faculty Survey on Teaching, Learning, and Assessment," *Natl. Cent. Postsecond. Improv.*, 2000.
[19] C. DeLuca, D. LaPointe-McEwan, and U. Luhanga, "Approaches to Classroom Assessment Inventory: A New Instrument to Support Teacher Assessment Literacy," *Educ. Assess.*, vol. 21, no. 4, pp. 248–266, Oct. 2016, doi: 10.1080/10627197.2016.1236677.
[20] D. S. Richardson, R. S. Bledsoe, and Z. Cortez, "Mindset, Motivation, and Teaching Practice: Psychology Applied to Understanding Teaching and Learning in STEM Disciplines," *CBE—Life Sci. Educ.*, vol. 19, no. 3, p. ar46, Sep. 2020, doi: 10.1187/cbe.19-11-0238.

Appendix

Table A1 Percentage Demographics for Survey Participants (n = 110).

Gender	Man	Non-Binary		Woman	Prefer not to say			
	49.1	0.9		42.7	7.3			
Race or Ethnicity	Amer Indian or Alaska Native	Asian or Asian Amer	Black or African Amer	Hispanic or Latino/a	Middle Eastern or N. African	White or European	Other	Prefer not to say
	0.9	9.1	3.6	3.6	2.7	75.5	26.4	9.1
Primary Engineering Discipline*								
BME / BioE	ChemE	CivE	Comp Sci / CompE	EE	EnvE	Engr Ed	Industrial E	MechE	Other
13.6	16.4	9.1	7.3	7.3	2.7	7.3	3.6	15.5	17.3

*Participants were asked to choose one primary department or discipline (If they had a dual appointment, enter the department they consider primary)

Table A2 Codebook for qualitative coding of survey open responses

Code	Definition
Teamwork Skills	Teamwork is included so that students can obtain and develop specific teamwork related skills (e.g., goal setting, conflict management)
Communication	Teamwork is included so that students can improve communication skills with their teammates.
ABET Accreditation	Teamwork is included to meet the ABET criteria for accreditation
Limitations of Resources	Teamwork is included due to lack of resources (e.g., time, equipment, instructor availability) that makes individual work difficult.
Collaborative Learning	Teamwork is included due to lack of resources (e.g., time, equipment, instructor availability) that makes individual work difficult.
Following Previous Course	Teamwork is included to follow how the course was previously taught.
Emulate Real Engineering Experience	Teamwork is included to emulate a real-world engineering experience for students.
Complete an Engineering Project	Teamwork is included to successfully complete an engineering project that could not be accomplished individually.
Engineering Skills	Teamwork is included to learn new engineering skills and concepts from their peers
Fun/Social Engagement	Teamwork is included for students to have fun working with their peers or to strengthen relationships or belonging.
New Problem-Solving Perspectives	Teamwork is included to learn new perspectives in problem-solving from their peers.