WIP: Initial Development of a Faculty Survey Tool to Measure Instructor Attitudes about Learning and Teaming in Engineering Coursework

Campbell J. McColley
Meinig School of Biomedical Engineering
Cornell University
Ithaca, NY, USA
cjm396@cornell.edu

Alexandra Werth
Meinig School of Biomedical Engineering
Cornell University
Ithaca, NY, USA
amw438@cornell.edu

***Abstract*—This work in progress research category paper describes the development of a faculty survey tool for instructor mindsets on teamwork and learning. Teamwork is an important aspect of engineering education in many contexts such as laboratory courses and capstone projects. However, this ill-defined umbrella term often conflates distinct teaming related environments and objectives, such as teamwork skill development and collaborative learning. For example, collaborative learning encourages students to work together to co-construct knowledge while teamwork skill development focuses on specific skills to be successful in achieving a shared goal. While similar, these two teaming related terms have different pedagogical implications and desired outcomes. As there has been this increased interest in incorporating teaming into undergraduate engineering curricula, it is crucial to be able to have a better contextual understanding of these settings and the pedological decisions that inform them. While studies show the importance of imparting teamwork-based skills and collaborative processes in engineering classrooms, there is an additional lack of specific teamwork-based motivations, objectives, and goals apart from the ABET criteria in STEM collaborative learning literature. Creating an environment that fosters collaboration and a socially shared regulation of learning has also shown positive impacts on both student experience and performance in STEM courses. However, there is not a shared agreement on what specific attributes may promote successful teaming related professional development in engineering. This presents a significant challenge to prepare engineering students to successfully work and navigate in team-based environments post-graduation. In this work we discuss the initial development of a nationwide faculty survey tool to aid in 1) understanding what teaming related contexts, skills, challenges, and mindsets faculty have in engineering and related learning attitudes and beliefs instructors have that may inform pedological decisions, and 2) the distinction and correlation of these teaming environments to both faculty learning attitudes and course type. This survey tool will be in the form of Likert and open-ended responses from instructors as well as syllabi of courses that incorporate teamwork. Instructor beliefs, motivations, and mindsets about learning and incorporating teaming in undergraduate courses will be explored. Specific teaming skills and objectives, challenges, and assessment practices will also be assessed.**

Keywords*—*Faculty attitudes, motivation, teamwork formatting

I. Introduction

In recent years, there has been an increased interest in incorporating professional skills into undergraduate engineering curricula. Collaboration, in particular, has been shown to be crucial in both engineering education as well as practice through the use of laboratory classes and capstone design projects [1], [2], [3]. These settings provide opportunities for students to improve in oral-communication, goal setting, and other collaborative skills desired by employers [1], [3], [4]. Correspondingly, the Accreditation Board for Engineering and Technology (ABET) requires that students have, "An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty" [5]. However, the term "teamwork" often conflates distinct and unique teaming related objectives like teamwork skill development versus collaborative learning. Collaborative learning encourages students to work together to co-construct knowledge while teamwork skill development focuses on specific skills to be successful in achieving a shared goal like goal setting, conflict resolution, and effective communication [6], [7]. While similar, instructors may prioritize these two teaming related items differently in their course requiring different pedagogical decisions and support to facilitate these distinct goals.

Additionally, instructors may have different epistemological beliefs and values around teaming in the classroom as well as what makes an effective team [6]. It is also important to identify the priorities different types of courses (i.e., capstone, lab based, traditional classrooms) present in terms of collaborative work and learning for instructors. Contextual evaluation of team-based motivations, objectives, and goals is presently lacking. To this end, it is first necessary to gain a better understanding of faculty member learning beliefs and motivations for teamwork as well as associated challenges implementing and assessing team environments.

The purpose of this paper is to describe the development of this survey tool that aims to explore the diverse motivations, mindsets, and beliefs surrounding teamwork in engineering classroom. We model this survey off a framework that shows how internal beliefs of learning and external influences on instructors or Instructional Landscape (IL), shape instructor motivations and resulting pedagogical decisions and practices in the classroom as depicted in Fig. 1.

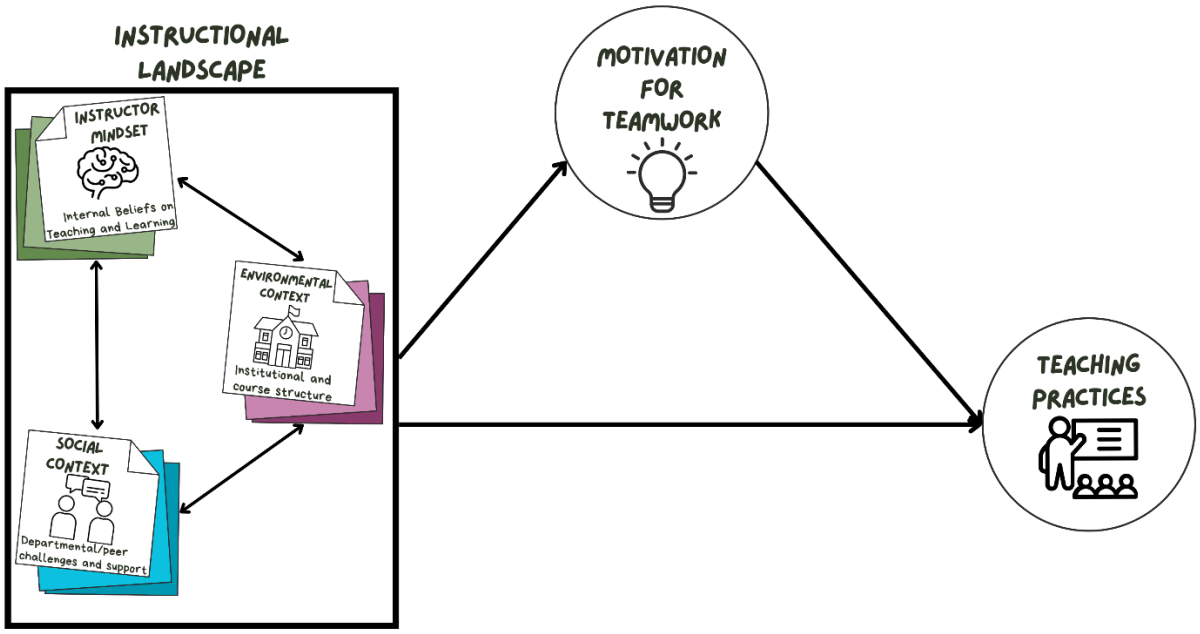

Fig. 1 Engineering instructor teamwork motivation conceptual framework

With this survey we hope to identify 1) what are the specific motivations instructors have in incorporating teamwork; 2) what are the learning attitudes and beliefs instructors have that may influence pedological decisions; 3) what are the impacts of external influences on teaching mindset and motivations; 4) how do these areas dictate instructional decisions and outcomes, and 5) how do engineering discipline and institution type impact instructor motivations, beliefs, and teaching. This work will be accomplished in two main phases: 1) pilot survey and development at Cornell University, and 2) survey dissemination nationwide.

II. Background

A. Teamwork in Engineering Education

In a collaborative learning setting, the role of the instructor is a facilitator who guides the learning process but ultimately, the primary objective is for the students to navigate the shared task and co-construct knowledge for a deeper understanding of the material. Creating an environment that fosters collaboration and a socially-shared regulation of learning has positive impacts on both student experience and performance in STEM courses [7], [8], [9], [10]. Malmberg et al. found that computer based groups that engaged in strategies that possessed a socially-shared regulation of learning such as recognizing social challenges in their group performed at a higher level than groups that did not [7].

For teamwork skill development, the learning environment is structured to practice specific skills, like giving constructive feedback in a group project, where the instructor presents an example or an expectation of what the teamwork skill should be and students then practice it. There have been numerous studies and recommendations on what specific teamwork skills make a successful team. For example, Johnson and Johnson, has listed five guidelines in effective teamwork where an effective team exhibits the ability to create clear, operational goals, have effective communication, distribute leadership and power amongst the group, engage and challenge each other to solve problems, and manage conflict constructively [6].

While studies show the importance of imparting teamwork-based skills and processes to successfully collaborate, there is a lack of specific teamwork based motivations, objectives, and goals apart from the ABET criteria in STEM collaborative learning literature for instructors [11], [12]. There is a need to understand the range and diversity of goals surrounding teamwork to give meaningful and purposeful, evidence-based recommendations of best practices. For example, McGoldrick et al., has shown positive outcomes implementing a multidisciplinary program that incorporates communication and teamwork-based skills in a second year undergraduate chemistry course [9]. Here, weekly activities are paired with specific learning objectives such as establishing group identity and agreeing expectation; critiquing information generated by peers; and assessment of individual strengths and weakness [9]. While some literature outlines skills and mindsets that make an effective engineering team and promote successful collaboration, instructors still face various challenges to incorporate this professional development in their classrooms [6], [12].

B. Faculty Mindsets

Additionally, instructors may have different epistemological beliefs and values around learning in the classroom [13], [14], [15]. Dweck developed a theoretical mindset framework that describes beliefs about the nature of intelligence [16], [17]. Here, individuals with a “growth mindset,” believe intelligence can be developed and cultivated through learning as opposed to individuals with a “fixed mindset,” who see intelligence as more static and unchanging [16].

Studies have also shown that certain instructional decisions are influenced by these intelligence and learning beliefs of faculty [18]. Ferrare found through extensive instructor interviews and classroom observation that observable instructional practices corresponded to beliefs about student learning in STEM courses [19]. Rattan et al. found that instructors with fixed mindsets had lower expectations of underperforming students. As a result, they utilized teaching strategies with low student engagement [20]. For example, strategies such as advising students to drop classes or pursue different careers were directly related to instructors' beliefs. This further highlights the importance of instructor attitudes and motivations about learning on instructional decisions and student learning outcomes.

III. Methods

A. Particpants

The targeted participants of this survey are engineering instructors who have taught an engineering course within the past three years that has incorporated teamwork in any capacity. This includes professors and instructors at all levels across various disciplines for both phases. Multiple institution types (public, private, 2-year, 4-year, etc.) are targeted during phase 2 of the study allowing for a full perspective of engineering instructor motivations and experiences nationwide. The survey will be administered electronically to engineering department heads and through engineering organization listservs.

Piloting of the initial survey will be conducted May 2024. This process involves think-aloud interviews of engineering faculty to validate and refine survey question items interpretability. After question refinement, the survey will be distributed through engineering departments and engineering organization listservs nationwide June 2024.

B. Themes Covered in Survey

Participants are first asked to consider one specific course that incorporates teamwork in any capacity. With that in mind, instructors are asked a series of survey items that can be categorized into six main themes including: 1) internal mindsets of student learning and intelligence, 2) external institutional and course contexts that structure a teaching and learning environment, 3) social support and challenges for instructors, 4) current teaching practices and experiences in the classroom, 5) motivations and attitudes towards teamwork, and 6) demographic information.

Internal mindsets of student learning and intelligence. The first theme of the survey, we utilized a modified Dweck's Mindset Inventory (DMI). Here, we are interested in the degree in which instructors believe student intelligence can be developed through instruction or is fixed [15]. In this section, we measure the level of growth versus fixed mindset of participants by their level of agreement with the 8 modified DMI items from "strongly disagree – 1" to "strongly agree – 5." These items were changed similarly from, "Your intelligence is something very basic about you that you can't change very much," to, "A student's intelligence is something very basic about them that they can't change very much," as we are interested in the faculty mindsets of student intelligence as opposed to their own self-mindsets.

External institutional influences on teaching and learning environment. The second construct involves external influences on the structure of the learning environment. Here, instructors are asked to report institutional and course related information. We ask:

- Type of institution (e.g., public, private, 4-year, 2-year)
- Engineering discipline (e.g., mechanical, chemical, biological, electrical)
- Course structure (e.g., lab course, capstone course)

As the structure and design of student teams may impact the learning environment, we also ask how teams are formed, how large are they, and who do they consist of. We hope to gain any other course related information through uploaded syllabi of the course they instruct.

Social support and challenges for instructors. The third theme involves influences, challenges, and support for teaching at their institutions. We ask participants to reflect on challenges concerning collaborative learning and teamwork. For example, participants will be asked to what extent they agree with statements such as, "Colleagues in my department need to be convinced about benefits of collaborative learning and teamwork teaching practices," and, "Colleagues in my department are resistant to new teaching practices." Survey items such as these will glean a better understanding of the teaching environment instructors are situated in beyond institutional data. Participant satisfaction with different aspects of their work environment such as workload, departmental support, and freedom of teaching are also probed in this section. These survey items have been adapted from the "Faculty Survey on Teaching, Learning and Assessment" (FSTLA) developed by the Nation Center For Postsecondary Improvement [21]. Some survey items have been rephrased to focus on teamwork, and teaming environments as opposed to assessment.

Current teaching practices and experiences in the classroom. Instructors are also asked to reflect upon current teaching practices and experiences both generally and related to teamwork throughout the survey. Frequency of teamwork related teaching practices, assessment use, student performance reflection, and self-efficacy in general teaching practices are covered in this theme in the form of closed, five-point Likert-scale questions. Survey items from FSTLA, the Approaches to Classroom Assessment Inventory (ACAI), and the surveys developed by Richardson et al. were utilized to explore participants' frequency and self-efficacy of teaching practices and assessment use [21], [22], [18]. For our purposes, items from ACAI were adapted for postsecondary education contexts. We also utilized the two survey tools developed by Solnosky et al. focused on assessing multidisciplinary team dynamics in an engineering capstone course [23]. As both of the surveys target student self-reflection, we have modified survey items in order to obtain how instructors' perceive the teamwork related experiences of their own students by their level of agreement from "strongly disagree – 1" to "strongly agree – 5.". For example, "When working in teams, I believe my students … Need guidance on how to work with others effectively… Create specific and reasonable group goals… Rather work independently than in a group."

Motivations and attitudes towards teamwork. The fifth major theme involves motivations and beliefs towards having teamwork and collaborative learning in the classroom. First, instructors are asked, "In the most recent course that included teamwork in some form, why did you choose to have students work in teams?" in the form of an open-ended response. Possible motivations for teamwork in the classroom may include:

- To develop teamwork skills (e.g., goal setting, conflict management)
- To improve communication skills
- To adhere to ABET criteria (Student Outcomes - Criteria 3)
- Limitations of resources (e.g., time, equipment, instructor availability) for students to work individually
- For students to learn from their peers (e.g., collaborative learning)
- To follow how the course has been taught previously
- To emulate a real-world engineering experience
- To successfully complete an engineering project that could not be accomplished individually

Later in the survey tool, this question is paired with Likert-scale, closed form questions ranking the importance of these specific teamwork motivations. Additionally, participants are asked to reflect upon barriers and challenges which might deter instructors from incorporating teamwork in the classroom. Through this design, we hope to illuminate diverse motivations of engineering instructors without biasing them to specific motivations.

Demographic Information. We also collect participants' current rank, years of teaching, course information, gender, and race in the survey tool. We ask participants to optionally upload a syllabus from the teamwork involved course that is reflected in their survey answers for further contextual information. In total, this survey should take 15-20 minutes to complete.

IV. Analysis and Expected Results

Exploratory factor analysis (EFA) often used in research to analyze survey data will be used as statistical analysis for understanding the relationships between different variables measured in the survey [24]. As we believe the various survey themes may correlate to some extent with one another, we are interested in determining which relationships are strongest. The data will be used to create correlation matrices to determine if the 5 variables shown in Fig. 1 are independent of one another. Do the variables within Instructional Landscape significantly influence one another? Are instructor motivation or teaching practices dependent on a certain subset of IL? Can either an instructor's mindset, motivation, or environment or combination of the three be used as a predictor of certain pedagogical decisions? Multivariate regressions will be utilized to better understand the relationships between these constructs.

In this exploratory survey, we expect to see a diverse data set of various motivations for teamwork in the classroom, a possible mediating factor between Instructional Landscape and Teaching Practice that has not been investigated previously. Additionally, instructors may not have explored their own motivations for teamwork in depth before. We expect to be able to articulate this introspection by qualitatively coding the open responses surrounding teamwork and comparing to the closed-form survey item data to gauge the amount of instructors who have thought about these issues and to what extent. As some of the survey items were used and adapted from previous survey tools, we will also compare our findings with these other results and contexts. We will be using these results to create a framework of all of these diverse teaming motivations in order to inform tailored research and recommendations of the best practices for each motivation.

V. Concluding Remarks

As this is a work in progress, conclusions about instructor mindsets and motivations on pedagogical decisions and influence of engineering discipline and environment cannot be drawn at this time.

Acknowledgments

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

[1] 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.

[2] M. Poženel, "Assessing teamwork in a software engineering capstone course".

[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] D. A. Canelas, J. L. Hill, and A. Novicki, "Cooperative learning in organic chemistry increases student assessment of learning gains in key transferable skills," *Chem. Educ. Res. Pract.*, vol. 18, no. 3, pp. 441–456, 2017, doi: 10.1039/C7RP00014F.

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

[6] D. W. Johnson and F. P. Johnson, *Joining together: Group theory and group skills, 5th ed.* in Joining together: Group theory and group skills, 5th ed. Needham Heights, MA, US: Allyn & Bacon, 1994, pp. xiv, 609.

[7] J. Malmberg, S. Järvelä, H. Järvenoja, and E. Panadero, "Promoting socially shared regulation of learning in CSCL: Progress of socially shared regulation among high- and low-performing groups," *Comput. Hum. Behav.*, vol. 52, pp. 562–572, Nov. 2015, doi: 10.1016/j.chb.2015.03.082.

[8] 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.

[9] N. B. Mc Goldrick, B. Marzec, P. N. Scully, and S. M. Draper, "Implementing a Multidisciplinary Program for Developing Learning, Communication, and Team-Working Skills in Second-Year Undergraduate Chemistry Students," *J. Chem. Educ.*, vol. 90, no. 3, pp. 338–344, Mar. 2013, doi: 10.1021/ed200643g.

[10] S. Ucan and M. Webb, "Social Regulation of Learning During Collaborative Inquiry Learning in Science: How does it emerge and what are its functions?," *Int. J. Sci. Educ.*, vol. 37, no. 15, pp. 2503–2532, Oct. 2015, doi: 10.1080/09500693.2015.1083634.

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

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

[13] O. R. Aragón, S. L. Eddy, and M. J. Graham, "Faculty Beliefs about Intelligence Are Related to the Adoption of Active-Learning Practices," *CBE—Life Sci. Educ.*, vol. 17, no. 3, p. ar47, Sep. 2018, doi: 10.1187/cbe.17-05-0084.

[14] C. Jeffs, N. Nelson, K. A. Grant, L. Nowell, B. Paris, and N. Viceer, "Feedback for teaching development: moving from a fixed to growth mindset," *Prof. Dev. Educ.*, vol. 49, no. 5, pp. 842–855, Sep. 2023, doi: 10.1080/19415257.2021.1876149.

[15] F. Brown and K. Cross, "Engineering Faculty's Mindset and The Impact on Instructional Practices," in *2020 IEEE Frontiers in Education Conference (FIE)*, Oct. 2020, pp. 1–5. doi: 10.1109/FIE44824.2020.9274185.

[16] 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.

[17] L. M. Rubin, E. A. Dringenberg, J. J. Lane, and A. J. Wefald, "Faculty Beliefs about the Nature of Intelligence," *J. Scholarsh. Teach. Learn.*, vol. 19, no. 4, Art. no. 4, Feb. 2019, doi: 10.14434/josotl.v19i4.24158.

[18] 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.

[19] J. J. Ferrare, "A Multi-Institutional Analysis of Instructional Beliefs and Practices in Gateway Courses to the Sciences," *CBE Life Sci. Educ.*, vol. 18, no. 2, p. ar26, 2019, doi: 10.1187/cbe.17-12-0257.

[20] A. Rattan, C. Good, and C. S. Dweck, "'It's ok — Not everyone can be good at math': Instructors with an entity theory comfort (and demotivate) students," *J. Exp. Soc. Psychol.*, vol. 48, no. 3, pp. 731–737, May 2012, doi: 10.1016/j.jesp.2011.12.012.

[21] E. Dey and S. Hurtado, "Faculty Survey on Teaching, Learning, and Assessment," *Natl. Cent. Postsecond. Improv.*, 2000.

[22] 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.

[23] R. Solnosky, "Survey Tools for Faculty to Quickly Assess Multidisciplinary Team Dynamics in Capstone Courses," 2017.

[24] N. Shrestha, "Factor Analysis as a Tool for Survey Analysis," *Am. J. Appl. Math. Stat.*, vol. 9, no. 1, pp. 4–11, Jan. 2021, doi: 10.12691/ajams-9-1-2.