

Board 356: Providing and Implementing Inclusive Practices in Engineering Classrooms: Final Reflections from Three Partner Institutions

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Abstract

Historically marginalized and minoritized students often have negative racially charged and discriminatory experiences in their classrooms that impact their achievement and persistence. Research demonstrates the positive impacts of prioritizing and improving inclusivity in the classroom in order to improve student experiences and belonging. Though these impacts are well studied, faculty in technical disciplines such as engineering have had difficulty finding actionable and relevant guidance. This study aims to address this gap through providing both tools and community to faculty who seek to improve inclusivity in their classrooms.

In the first two years of this study, we developed and piloted the inclusive engineering practices menu and its accompanying matrix, the inclusive learning communities (ILC) for the faculty participants, and both the student and faculty assessments. This presentation will focus on communicating the cumulative data collected from both student and faculty participants and include results from faculty interviews at one of the partner institutions. We will also discuss how the archetypes of the ILCs may have impacted the experiences in the learning communities and with the study overall as well as the lessons learned from implementing this study across three institutions. We will also link these essential pieces to strategies for supporting the successful implementation of inclusive practices in engineering classrooms.

Introduction

Student success can be adversely affected by instances of racism and discrimination on campus, especially for historically marginalized and minoritized students [1], [2]. Ong et al state that as the demographics of the United States continue to shift, educational institutions have both the obligation and motivation to develop learning environments that benefit students of all backgrounds [3]. The classroom experience is a pivotal piece of a student's collegiate experience, and research has demonstrated the positive impacts of prioritizing and improving inclusivity in the classroom to improve student experiences and belonging [1], [2], [4], [5]. This is especially important in the context of the Science, Technology, Engineering, and Math (STEM) classrooms, and more specifically engineering classrooms, because historically, the lack of diversity in engineering has been commonly addressed through a deficit perspective, assuming those with marginalized identities lack the educational acumen to be as successful as their peers and assign systemic problems to an individual rather than the system itself [6]. Hartman et al urge that STEM educators must take ownership of their roles in constructing and transmitting the culture of STEM and how that frames the interactions within educational settings [4]. Though the positive impact of prioritizing inclusion and belonging in the classroom is well-studied, faculty in STEM disciplines have had difficulty finding actionable and relevant guidance on how to incorporate them into their classrooms [1], [2], [6], [7], [8]. This study has aimed to address this gap by providing both tools and community to faculty who seek to improve inclusivity and belonging in their classrooms.

Project Overview

This National Science Foundation (NSF) Improving Undergraduate STEM Education (IUSE) project aimed to broadly answer two research questions: 1) What are the most effective practices to promote an inclusive engineering classroom? And 2) How do different learning communities (LC) foster and support inclusive engineering classrooms? This work is grounded in Henderson, Beach, and Finkelstein's Theory of Change model which describes change strategies in higher education through four quadrants: disseminating curriculum and pedagogy, developing reflective teachers, enacting policy, and developing a shared vision among stakeholders [9]. In the first year of this study, we developed a list of inclusive engineering practices (herein referred to as the 'menu') informed by a review of literature and teaching and learning center websites over the last ten years [10], [11]. Our menu, unique to other inclusive teaching practices resources, utilizes two categorizations to organize the practices for users. The first categorization groups the practices by the timing of the traditional collegiate semester: Pre-Semester, Syllabus, In-Classroom Engagement, and Discussion Tools. These timeframes were chosen to aid faculty and instructors in using the menu's inclusive practices at times during the semester when they could be most effective. For example, one of the Pre-Semester practices was to ensure a physically accessible and usable classroom for all students and to pre-plan for any accommodations for students whose needs are not fully met by a course's instructional design. The second categorization groups the practices using the Aspire Alliance's inclusive professional framework core domains: identity, intercultural, and relational [12]. We chose these domains to further categorize the strategies because they contextualized the practices for specific situations or focuses. For example, the practices in the intercultural domain focused on supporting student connections to content, encouraging students to be their authentic selves, and creating opportunities for peers to connect [12].

We also developed a supporting decision matrix from this menu and feedback from faculty-focused workshops during the duration of the project [13], [14], [15]. This decision matrix utilizes Qualtrics Survey Software to create an interactive version of the menu that prompts users to answer a few questions on the types of inclusive practices they are interested in trying. Two of these questions address the two menu categorizations while others ask about their class modality and what level of difficulty they would like to engage in with the practices. The class modality options include in-person, online synchronous, and online asynchronous. The difficulty level, on the other hand, includes easy, medium, and complex which were developed based on how many participating faculty utilized each of the practices. For example, if a practice had more than 70% use throughout the study, that was labeled an 'easy' practice because of its high use among participants and most likely did not need extra prep work or learning to incorporate it into their course(s). Though the structure of the menu aids faculty in choosing the most effective inclusive practices for their classrooms based on semester timing and focus, the decision matrix provides faculty with a more personalized version of the menu based on their goals as an instructor.

To support participating faculty and to answer the second research question, we convened inclusive learning communities (ILC) at three institutions either through a new or existing LC which aligned with the goals of the project. Though each partner institution's ILCs had similar goals and embodied the core ideas of an LC from the Center for the Integration of Teaching and Learning (CIRTL), they each developed different institutional archetypes: department-, school-, and institution-wide [16]. Because these ILCs developed this way, we analyzed both the ILC development and faculty data from each institution by their ILC archetypes (department, school,

institution) to determine how that may have impacted the faculty participant experience. For this paper, we report on the connections between the menu, the student and faculty survey results, and ILC interviews for the departmental ILC archetype.

Summary of Data Collection and Analysis

In order to test the impact that the inclusive engineering practices' menu as well as the ILCs had on participants, we developed both student and faculty assessment plans approved by each institution's Institutional Review Boards (University of Pittsburgh and Colorado School of Mines #STUDY20050402 and Arizona State University #14693). The student assessment plan consisted of a student survey comprised of twenty-three Likert-style questions from a combination of existing survey instruments used to assess the classroom and university environment as well as peer and instructor interactions [17], [18], [19]. All of the student survey questions can be sorted into three focused sections: Instructor Course, Peer, and Department/University questions in order to elucidate the student's in-classroom and larger university experiences. Some of these questions included asking students whether they felt a spirit of community in the classroom, to rate their interactions with their professor, and whether they felt judged when they participated in class. There were also thirteen fill-in-the-blank and multiple-choice questions focused on course and demographic information. The student data was first analyzed in aggregate to determine any trends across the student participants and was visualized using tables and graphs. Following this initial analysis, we analyzed the student data using a two-sample hypothesis test using two demographic data points: self-identified race and self-identified gender. This analysis allowed the authors to draw comparisons between groups of students to see how similar their classroom and university experiences were considering their instructors intentionally used inclusive practices in their classrooms. To analyze the data by race and gender identity, the student data was then grouped into "Majority" and "Non-Majority" and "Male" and "Non-Male", respectively. The "Majority" group included any student who self-identified their race as White or White with another race and the "Non-Majority" group included the students who did not self-identify as White and chose different races or a combination of others and were given a binomial value of zero and one, respectively. The "Male" group included any student who self-identified as Male and the "Non-Male" group included students who did not identify as Male and were also assigned binary values of zero and one, respectively. The results from the two-sample hypothesis test on the student data will be discussed in forthcoming publications [20].

The faculty assessment plan was two-fold: a faculty survey and structured interviews. The first portion of the faculty survey asked participating faculty to select which practices they employed in each of the menu categorizations. The results from this portion of the faculty survey were analyzed in aggregate to determine which inclusive practices were utilized the most by faculty participants. The remaining three questions on the faculty survey were open-ended asking them about other inclusive practices they used in their classrooms, their experience in the ILCs, and any suggestions or improvements they would make to the ILCs to make them more impactful. To analyze the open-ended survey questions, particularly the last two on overall ILC experience and suggestions for improving the ILCs, we utilized thematic coding in order to group similar responses and determine if there were any trends in the data. The voluntary structured interviews, the second piece of the faculty assessment plan, were conducted either in person or via Zoom between the Fall 2022, Spring 2023, and Fall 2023 semesters at each partner institution. The interview protocol was designed to illicit faculty participant's experiences in

their ILCs through a series of seven questions asking about their ILC's activities, what gains or benefits the ILC has provided, and what they learned about LCs that they want to share with others looking to begin their own communities. Thematic coding was done to analyze the results of these interviews using both descriptive and in vivo coding. The first two authors, individually and collaboratively, utilized three coding cycles to iteratively develop codes that described the interviews from each institution.

Selected Results and Lessons Learned

Though this study was a collaboration among three partner institutions, in this paper we report on selected results from the Department-wide ILC archetype from three participating perspectives: Students, Faculty, and Facilitator.

Students

From four semesters of data at the Department-Wide ILC Institution, Fall 2021, Spring 2022, Fall 2022, and Spring 2023, there were a total of thirty-nine students who completed the student survey. We excluded incomplete surveys resulting in a final sample size of $N = 34$. Most student respondents were in their third or fourth undergraduate year (54%), self-reported their grade point average above 3.0 (85%), and self-identified their race as White (79%) (Table 1). There was almost parity in gender identity between females and males (47 and 44%, respectively) most respondents reported their sexual orientation as heterosexual (76%) (Table 1).

Table 1. Student Demographics from Department-Wide ILC Institution (n=34).

Characteristic	No. (%)	Characteristic	No. (%)	Characteristic	No. (%)
Class Year		Race		Sexual Orientation	
1st year	0 (0)	Black or African American	2 (6)	Straight	26 (76)
2nd year	5 (15)	White	27 (79)	Bisexual	5 (15)
3rd year	9 (27)	Latinx or Hispanic	0 (0)	Gay	1 (3)
4th year	9 (27)	Middle Eastern	0 (0)	Lesbian	0 (0)
5th or more year	4 (12)	Another Race	3 (9)	Queer	1 (3)
1st year graduate student	6 (18)	Multiple Races	2 (6)	Asexual	1 (3)
GPA Entering Semester		Prefer not to respond	0 (0)	Questioning	0 (0)
3.50+	15 (44)	Gender Identity		Other	0 (0)
3.00-3.49	14 (41)	Female	16 (47)	Prefer not to respond	0 (0)
2.50-2.99	4 (12)	Male	15 (44)	International Student	
2.00-2.49	1 (3)	Non-binary	3 (9)	Yes	4 (12)
1.99 or below	0 (0)	Another identity	0 (0)	No	30 (88)
		Prefer not to respond	0 (0)	First Gen. Student	
				Yes	3 (9)
				No	31 (91)

One portion of the student survey asked students to 'indicate the extent to which they agreed with' different statements asking them about how they felt about their classroom experience. Students' responses to these statements could help the authors learn more about how students' felt about their classroom climate where inclusive practices were being intentionally employed. Overall, the students indicated they strongly agreed or agreed that they felt

encouraged (92%), felt a spirit of community in their classroom (70%), and felt connected to others in their classes (80%) (Figure 1). Students also strongly disagreed or disagreed with negative statements asking if they felt uneasy discussing gaps in their knowledge (73%), felt reluctant to speak openly in class (68%), or if they felt wary of trusting others in their class (77%) (Figure 1). Overall, from four semesters of data collected, the students from the Department-Wide ILC Institution reported feeling positively about their classroom climate.

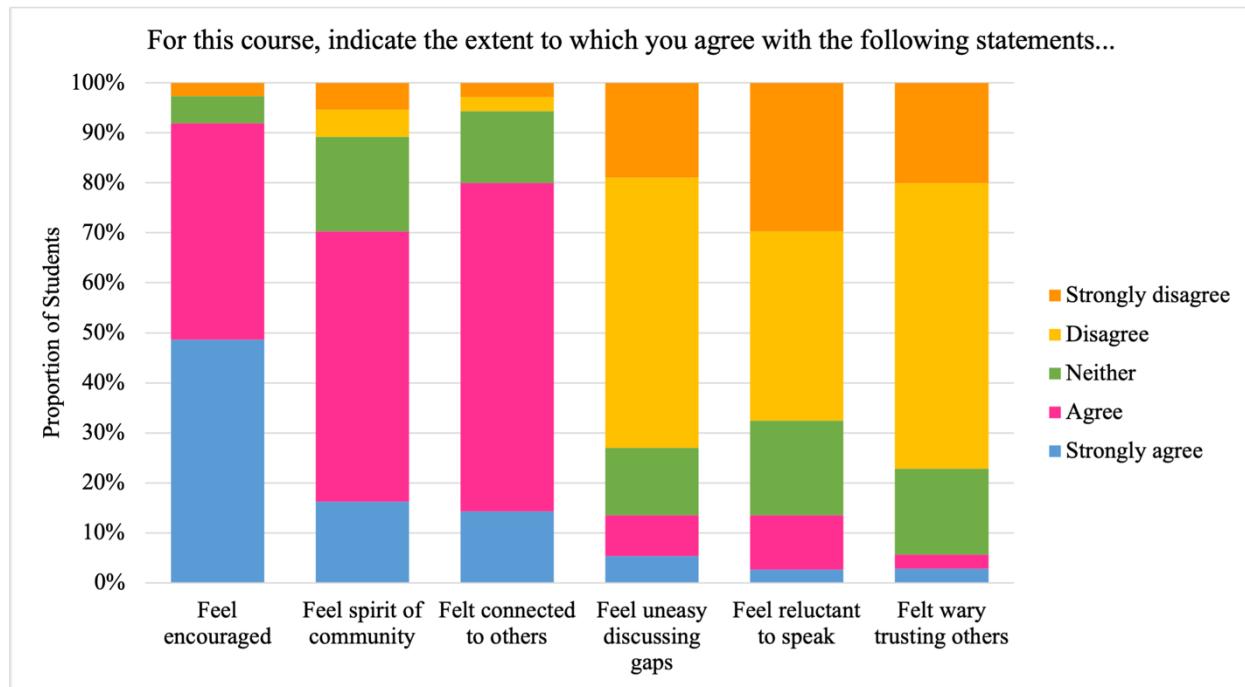


Figure 1. Student Survey Responses on Classroom Climate (n=34) from Department-Wide ILC Institution Only.

In addition to analyzing the student data in aggregate, the data was also analyzed by two demographic groupings: race and gender identity. As described earlier in the methods, the student data was analyzed into two racial groups: Majority (M) which included any students who self-identified their race as ‘White’ or ‘White, Another Race’ and Non-Majority (NM) which included any students who self-identified their race as any of the other options. It is important to note that since this data is from one institution, the data represents a total of thirty-four students and twenty-nine identified as Majority ($n=29$) and five as Non-Majority ($n=5$). For most of the statements, the students in both the Majority and Non-Majority groups answered similarly (Figure 2). For example, most of the students in both groups agreed that they felt encouraged, felt a spirit of community, and felt connected to others. However, for two of the statements, which asked students if they felt reluctant to speak openly in class and if they felt wary trusting others in their classroom, the Non-Majority students agreed more with those statements as compared to their Majority peers (Figure 2). This shows that the Non-Majority students felt more reluctant to speak openly in class and felt more wary of trusting others in their course. Though this is a small sample size for only one institution, this finding indicates there may still be a difference in classroom climate for different groups of students even when inclusive practices are intentionally employed.

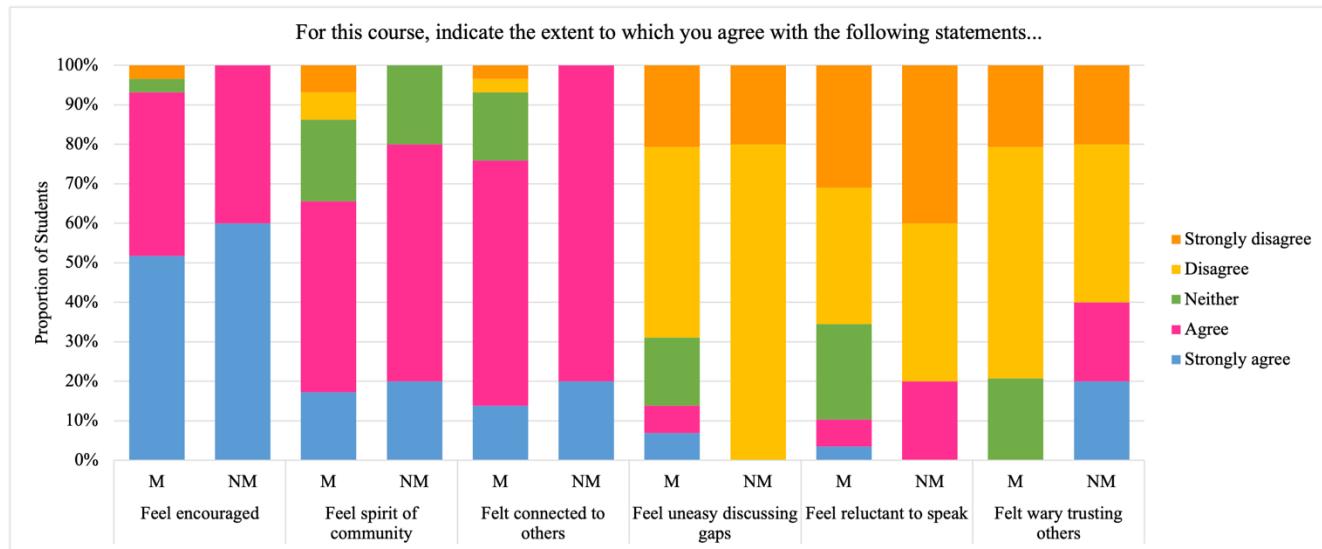


Figure 2. Selected Student Survey Responses on Classroom Climate by Race Group (n=34) from Department-Wide ILC Institution only. Note: M - Majority (students who identified as White or a combination with White) NM – Non-Majority (students who identified as any other race other than White).

The second demographic grouping, gender identity, organized the students into two groups: Male-identifying which included any student who self-identified their gender as Male, and Non-Male which included any student who self-identified as any of the other options. For this institution, there were fifteen students in the Male identified group (n= 15) and nineteen in the Non-Male identified group (n=19). Like the race organization, the students from both groups answered similarly to one another in each of the statements (Figure 3). However, the major difference between the Male and Non-Male students was that the Male students' answers varied more as compared to the Non-Male students (Figure 3). For example, though most of the Male and Non-Male students agreed with feeling a spirit of community in the class (60% and 73.7%, respectively), there was a larger proportion of Male students who either disagreed or were neutral in response to that statement compared to Non-Male students (40% and 26.4%, respectively). This finding, similar to the racial grouping of students, shows that students of different groups reported differently on their classroom climate even when inclusive practices are intentionally employed.

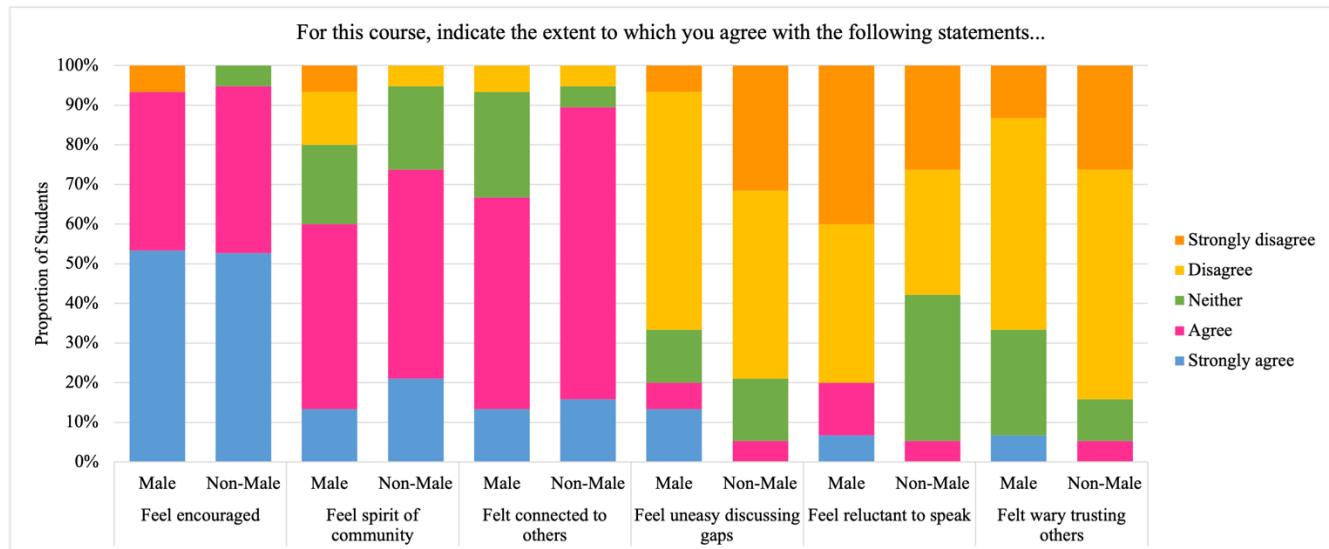


Figure 3. Selected Student Survey Responses on Classroom Climate by Gender Identity Group (n=34) from Department-Wide ILC Institution only. Note: Male (students who identified their gender as Male) Non-Male (students who identified as any other gender identity other than Male).

Most students reported positively about their classroom climate overall in response to these survey questions, however, there was some variability when analyzing the data by group. This finding necessitates further exploration and analyses comparing the different experiences among student groups which will be explored in future publications on this study [20]. These findings will be strengthened by combining and analyzing all of the student data from each institution throughout the duration of the study in a forthcoming publication.

Faculty

The faculty assessment plan, as mentioned earlier in the Summary of Data Collection and Analysis section, was two-fold: a faculty survey that asked faculty about which practices they employed from the inclusive engineering practices menu and briefly about their experience and feedback on the ILCs and structured interviews to gather more information about the ILC experiences participating faculty had. In total across four semesters of data collection, there were eleven faculty participants who responded to the faculty survey (n=11). In terms of which practices faculty utilized from the inclusive engineering practices menu, there were six practices that were employed by more than 90% of the Department-Wide ILC's participants across all four semesters of data collection, some of which can be seen in Figure 4. These practices were the most across the semester timing categories and there was representation from each of the Aspire Alliance inclusive core domains (Identity, Relational, and Intercultural).

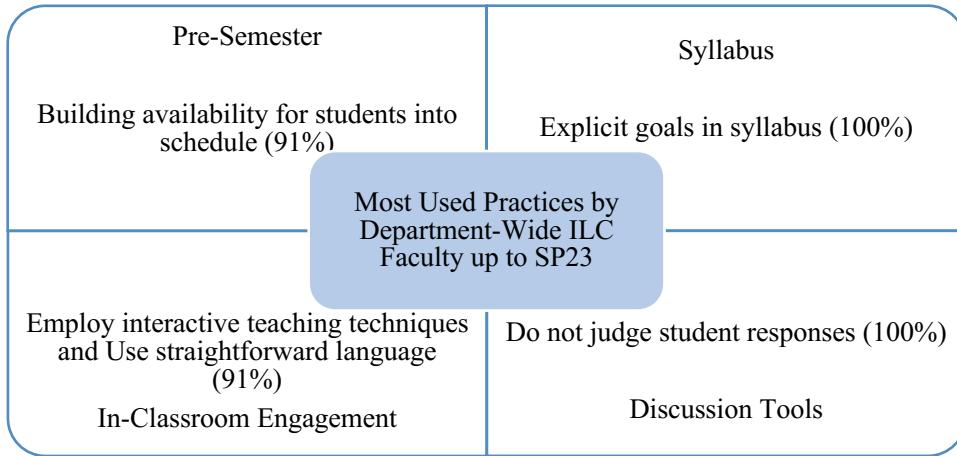


Figure 4. Most Used Practices by Department-Wide ILC's Faculty (n=11).

Though there were some practices utilized by almost each participant in the Department-Wide ILC, there were also a few practices utilized by less than 40% of the participating faculty (*Figure 5*). In the Pre-Semester timing, all of the practices were used by more than 50% of the participating faculty. For “Discussion Tools,” it is presumed that the practice, “Interrupt blatantly racist behavior and Counter-stereotypic imaging,” was not utilized because it did not occur in the classroom. However, there was at least one practice in each of the other timings and they were all in the Relational category from the Aspire Alliance’s framework. Overall, it was positive that each of the practices on the menu was utilized by at least one participating faculty member, however, there may be additional information that can be added to the menu to increase the use of some of the lesser used practices.

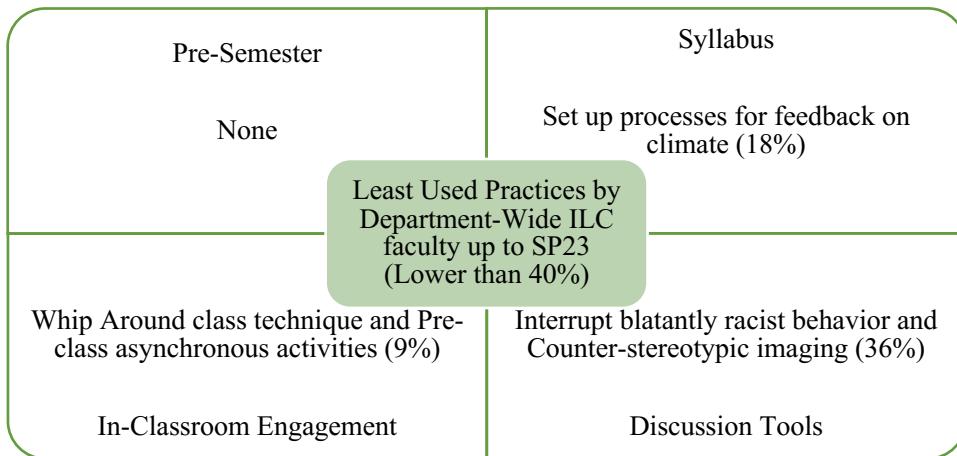


Figure 5. Least Used Practices by Department-Wide ILC's Faculty (n=11).

In addition to asking about which practices the participating faculty in the Department-Wide ILC employed, the survey also elicited feedback on the ILCs as well as any suggestions or changes that could be made to improve the ILCs. Two major themes emerged from faculty’s responses on their ILC experiences: classroom application and ILC-specific feedback. Five of the faculty’s responses centered around utilizing the practices in their classrooms and talked about how they could be used in future classroom applications for their own courses. On the

other hand, four of the faculty's responses talked about how positive their participation in the ILC was and they were thankful for the community and being able to learn about inclusive practices. Overall, faculty reported having learned more about inclusive practices and had positive experiences in their ILC.

One of the other open-ended questions asks faculty for suggestions or changes that could make the ILC experience more impactful for them. From this question, three major themes emerged from the faculty responses: their students, their course(s), and the ILC. The four responses that focused on students mentioned wanting to see student survey results on the student experience in the classroom as well as wanting to share inclusive resources with their students to illicit their feedback and opinions on them. One of the other faculty responses focused on applying a specific inclusive practice to their future course(s) while the final two responses mentioned wanting more inclusive resources, more time in the ILC meetings, and more participants. These responses from participating faculty showed overall that faculty are interested in seeing the student data from the study as well as wanting more inclusive classroom resources and want to open up the ILCs to more members. This feedback not only provides more context to faculty's experiences in the ILC, but also provides information on how to sustain these communities past the duration of this study.

The final piece of the faculty assessment plan included voluntary structured interviews conducted via Zoom or in-person for each partner institution. For Department-wide ILC, two faculty members volunteered to participate in an interview, one of which was a participant of the ILC while the other was a participant as well as a co-facilitator. One of the themes that emerged from Department-wide ILC interviews was that the meeting cadence adapted throughout the course of the study. There were semesters when the meetings were bi-weekly but then they shifted to monthly based on its participant's schedules. This change could be seen as a positive characteristic of the Department-wide ILC because it is flexible and can adapt over time, however, this could also be a cause of inconsistency which could impact the faculty and community building experience necessary for a successful ILC. One of the other themes that emerged when asked about a barrier to participation was that there were both active and passive participants in the ILC. The interviewees explained that some of the same people contribute actively to conversations across all meetings while others do not participate as heavily which can lead to people feeling excluded and the space becoming an "echo chamber" as opposed to a space of growth and sharing among all participants. These interviews helped to provide even more context and detail to the open-ended survey questions asking participants about their ILC experience and also provided the authors overall feedback on how to improve both the study's ILCs and LCs in general to help make them sustainable.

Facilitators

The participating faculty and the associated students are both important groups whose experiences are necessary to capture in this study. However, another group that provides an essential perspective in this study is the facilitators of the ILCs at each institution. The facilitators are both participants in the study and help to lead or co-lead the ILC meetings, so they have a unique perspective as compared to faculty participants who are members of the ILCs. For the Department-Wide ILC in this study, the co-facilitator, who was also a faculty participant and one of the co-authors, volunteered to participate in the structured interviews and some

notable themes emerged from their interview from their positional perspective. One of the major themes was the responsibility they had and felt as one of the leaders of the ILC. As a co-facilitator, they had to determine the focus and goals of the ILC and effectively communicate that to members through the activities they engaged everyone in. They mentioned that in the beginning, formative stages of the ILC they utilized icebreakers that would *“allow people to be more comfortable and [provide] the space to develop trust and shared experiences”*. This theme of responsibility was unique to the facilitator role because they act as a leader among the members while also being a full participant of the ILC itself. Another theme that exists alongside responsibility for the co-facilitator was also agility and adaptability. Since this ILC existed at the department level and was co-led by a faculty member, they were able to adapt the ILC to participant feedback quickly. This theme could be unique to the department ILC archetype because it does not exist within the confines of a larger entity that may have requirements or obligations that could impact how and when changes can occur. Further analysis of the other facilitator interviews from all of the ILC archetypes in a future publication will allow for comparison among themes to see what some of the possible benefits and barriers to ILCs at various institutional levels are.

One of the final themes that emerged from this co-facilitator interview was the evolution and sustainability of the ILC. In response to the interview question asking about what they would like to share with others interested in running their own LC, they shared that LCs *“evolve over time and you need to be able to evolve with them”*. They mentioned the importance of this in relation to making progress and accomplishing goals as a community and the need to engage members differently due to fatigue and waning intensity. Another key piece to evolving with the community also includes being able to lead difficult conversations and confronting vulnerabilities alongside other ILC participants. This can be especially challenging when discussing inclusivity and belonging and the experiences that everyone brings to the community.

Conclusion and Future Work

Overall, the facilitator perspective, in addition to the student and faculty participants perspectives, help to contextualize and provide a full view of how inclusive practices and ILCs can impact and improve the engineering classroom experience as well as provide more information on how to maintain and sustain inclusive-focused LCs. In aggregate, the student participants reported positively about their classroom climate, however, when exploring the data by demographic group, race and gender identity in this case, there were some disparities, both positive and negative. This trend aligns with one of the least used inclusive practices from the menu, setting up processes to get feedback on the classroom climate. The other least used practices also included classroom techniques that could encourage participation from all students more often, which could also improve the in-classroom experience. Some of the most used practices from the menu included not judging student responses which directly contributes to the classroom climate. However, some of the other highly used strategies focused on elements of the course outside of the classroom experience such as creating availability to meet with students and having explicit goals in the course syllabus. The open-ended responses from the faculty survey expressed that faculty were grateful for the experience, but they also wanted more inclusive teaching resources which could help them employ some of the practices that could directly improve their classroom climate for their students. The faculty participants also mentioned wanting to be provided with student survey results, which could also aid them in selecting the most appropriate and impactful inclusive teaching practices for their course(s).

Another connecting theme across the results was the evolution of how people and groups can change, particularly in response to the changing landscape of inclusivity and belonging. The differences in the results on classroom climate among the student demographic groups shows that even when implementing inclusive practices intentionally, there may be other elements of the classroom experience at play that impact students' experiences. Exposing the ILC to more inclusive classroom resources, as faculty suggested, could be helpful in combatting this as well as increasing the ILC's membership. Through increasing membership, not only does the community continue to evolve and grow, the breadth of perspectives and experiences shared among faculty participants also widens which can help improve participation and encourage sharing and learning among the community. As a leader of the community, the facilitator of the ILC not only helps to guide the community through this evolution but they also continue to learn more about inclusivity and how they can positively impact their own classroom environment(s) as a participant of the community. Through analyzing the data by participant group (students, faculty, and facilitators) as well as together in aggregate, this study shows that there is not a simple solution that any one group of people can solely do to improve inclusivity in the classroom. But instead, this study shows how each group, individually and in tandem, has a responsibility in how the classroom climate develops and is maintained while prioritizing inclusivity and belonging.

This study focused on providing faculty and instructors with a categorized menu of inclusive engineering classroom practices as well as implementing inclusive learning communities (ILCs) at three institutional levels to support participating faculty and instructors. This presentation is a culminating view of selected data from Department-Wide ILC archetype at one of the three partner institutions and provides an overview of the study design and some of the student, faculty, and facilitator data collected during the study period. The final semester of data collection was the Fall 2023 semester and the authors are currently analyzing the data from all three institutional ILC archetypes (department, school, and institution-wide). The authors will culminate this study through forthcoming journal articles to further discuss the student and faculty data as well as refining the inclusive engineering practices menu and accompanying website for public dissemination.

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