Instructors' Perspectives of Diversity, Equity, and Inclusion Activities in Engineering and Computer Science Courses

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Abstract

In this study, we use the EPIC-I I (exposure, persuasion, identification, commitment, and implementation) framework [1-2] as a lens for viewing instructor perceptions of including diversity, equity, and inclusion (DEI) activities in engineering and computer science undergraduate courses. The results provided evidence of three findings: (a) evidence existed of faculty participation at all levels of EPIC-I, (b) in moving through the EPIC-I framework, the evidence became scanter, and (c) although both groups were small, approximately equal numbers of participants were openly negative as were actively implementing additional DEI supporting activities in their classes. Implications and future work are discussed.

Keywords: engineering education; instructors; diversity

1. Introduction

The engineering and computer science workforce does not look like a cross-section of the US [3]. To address the issues of underrepresentation in engineering and support inclusive environments, we created and implemented multiple activities into existing engineering and computer science courses (funding redacted for blind review). Each of these activities targeted one or more of the following goals: engineering and computer science students should (a) appreciate how diversity strengthens their discipline; (b) know how to promote and engage in inclusive behaviors; and (c) consider how new projects, services, or design may impact diverse populations [4]. Using EPIC-I (exposure, persuasion, identification, commitment, and implementation [1-2]) as the framework assessing integration, the purpose of this present study is to capture the degree to which instructors who used the activities in their courses indicate various elements of the EPIC-I framework.

2. Background

Institutions often espouse a commitment to a diverse and inclusive campus community. But, there sometimes exists a disparity between that commitment and the diversity of the community itself. Several researchers have documented the benefits of working in a diverse environment. Wang et al. found that deep-level diversity in culturally diverse teams positively related to team creativity and innovation [5]. They referenced the work done by Stahl et al. to denote deep-level diversity as those unobservable attributes, including personalities, values, and attitudes [6].

Other researchers have credited a diverse workforce with increasing creativity and improved decision-making process [7-8].

In an effort to improve diversity on campus or within individual departments, higher education administrations are implementing several programs and interventions. One such activity was an effort by the University of Dayton, a member of the Teaching to Increase Diversity and Equity in STEM (TIDES) network. The Computer Science Department implemented a multi-year program to improve its curriculum to reduce the institutional barriers often associated with underrepresented student populations. An aspect of their work was faculty development. They noted that only three faculty members attended the first TIDES Institute at the start of the program, highlighting faculty hesitancy to embrace culturally responsive pedagogy. A noted successful endeavor to change the faculty's culture was support for the entire Computer Science Department to attend a conference focused on teaching. The effect was not only the knowledge gained at the conference but also the sense that their institution highly values pedagogy. Over time faculty became more willing to engage in discussions concerning bias and cultural differences [9].

Similarly, Booker et al. studied the effects of a summer diversity training workshop available to faculty at a large, urban research university [10]. The five-day workshop aimed to encourage faculty to include diversity in their syllabi and curricula. They found that their workshop impacted instructors in three ways: pedagogically, in skill and knowledge enhancement, and in personal development. The main pedagogical change had to do with instructors being more vigilant about not excluding learners in their classrooms. The underlying result is that instructors are now aware they may have excluded some learners in previous instances, albeit unintentionally. The researchers also mentioned barriers to implementation perceived by the faculty. Some participants mentioned not having enough time to incorporate diversity into their course, exhibiting a lack of priority to diversity in the classroom. Another barrier was the instructor's perceived lack of competency to lead discussions in diversity when it is not their area of expertise.

Beyond the barriers discussed above, it is common for faculty efforts related to diversity to go unrecognized and unrewarded [11-12]. Whittaker and Montgomery state that in order for faculty members to be successful in guiding diverse student populations, they need to have support, recognition, and an individual and institutional understanding of diversity and its value [13]. Next, we examine efforts to help instructors promote inclusive classrooms.

2.1 Efforts to Promote Inclusive Classrooms

Perhaps, before instructors can expect their students to value diversity in their discipline and promote inclusion on student teams, the instructors may need to do the same in their classrooms. Many universities have further sought to support faculty in developing inclusive classrooms. In one such example, O'Leary et al. examined the impact of a multi-day immersive workshop to help faculty create an inclusive learning environment. Faculty participants learned about classroom interventions that can be used to highlight social identities of students and explore barriers to learning. These barriers to learning include implicit bias, fixed mindset, and microaggressions. Faculty who completed the workshop reported changed attitudes toward students' abilities as STEM majors and altered their teaching approaches to promote inclusivity. It should be noted that the faculty who were most open to adopting inclusive teaching practices were the ones who initially accepted the invitation to the inclusivity workshop [14].

Further, STEM faculty tend to lack confidence in their ability to practice inclusive teaching. Dewsbury and Brame established a guide to help instructors enact inclusive teaching practices.

The guide states that it is important for teachers to develop self-awareness and empathy for students. The classroom climate contributes to students feeling included, and a supportive classroom environment is linked to student motivation and academic success. The guide notes that inclusivity is a community effort and encourages instructors to engage with local and national networks, especially those geared toward providing student services [15]. Lee et al. studied engineering student perceptions of diversity and its place in their classroom. They state that instructional strategies should explicitly state a relationship between social issues and technical content in order to make diversity a more central theme [16]. While inclusive efforts from instructors are helpful in creating inclusive classrooms, next, we examine how instructors can help students improve their professional skills.

2.2 Efforts to Include Professional Skills in STEM Curricula

Research, rather than teaching, is typically emphasized in the education received by STEM faculty, which may implicitly translate to the exclusion of professional skills being taught in STEM classrooms [15]. However, these skills are often cited as the most important competencies for STEM professionals. A recent study analyzed the importance of 109 skills, knowledge, and activities that were important in STEM careers. The skills that were rated highly important for STEM careers included critical thinking, reading comprehension, active listening, speaking, decision making, writing, and time management [17], but surveys continually show project management, teamwork, and interpersonal skills are lacking in students graduating with STEM degrees [18]. Faculty are teaching how they were taught. If students are not given the opportunities to practice and develop these professional skills, students will continue to enter the workforce without these skills.

To this end, efforts have been made to work with faculty to include content in their courses to teach professional skills explicitly. Beyerlein et al. assessed capstone design courses and found that instructors are unsure how to integrate, teach, and assess professional skills such as teamwork and interpersonal communication [19]. Beyond instructor uncertainty, the lack of space in curricula and professional skills not being viewed as core engineering material contribute to the lack of professional skill instruction in STEM courses. This work incorporated student learning outcomes related to managing project progress and providing constructive feedback to peers [20]. Cajander et al. label professional skills as threshold concepts. Threshold concepts are a new way of thinking about something or a transformed way of understanding. Without the threshold concept, a learner cannot progress in their education, and once learned, they are difficult to unlearn [21]. While inclusive behaviors and appreciation for diversity fall under the umbrella of professional skills, our research team was particularly interested in how instructors responded to implementing activities promoting DEI and inclusive behavior in engineering and computer science courses.

3. Theoretical Framework

One framework that has been used for understanding faculty participation in adopting new activities, practices, or ideas in the classroom is EPIC-I: exposure, persuasion, identification, commitment, and implementation [1-2, 22]. In this framework, first, instructors must be exposed to the new teaching practice. Once exposed to the practice, instructors must then be persuaded that the practice is beneficial. While persuasion is necessary, we expect instructors who see the practice's value to identify it as consistent with their teaching approach. Next, instructors who see the value are more likely to express commitment to the practice as opposed to viewing the practice as simply a new technique to use as needed. Finally, instructors who fully integrate the practice into their courses would be in the implementation phase [1]. Each of these phases do not have to occur sequentially (e.g., faculty do not have to first be persuaded before identifying that the new activity is good), but rather these stages should be viewed as a filter and a continuum through which to view the instructor's engagement with adopting new practices.

Prior studies have illustrated how this EPIC-I framework has been helpful to view instructor progression from colorblind to multicultural ideologies as they integrated inclusive practices in their classroom [22]. Further, for the adoption of any new teaching practice, faculty perceptions of support (e.g., colleagues who were invested in the efforts and access to resources) have been more predictive of the implementation of the new teaching practices than the faculty’s own motivation [23].

4. Current study

Most of the research with college-level instructors has been on creating inclusive classrooms (e.g., the focus has been on changing instructor behaviors) and promoting professional skills with students. In this study, rather than improving instructors’ inclusive teaching, we asked instructors to implement activities designed to (a) teach students how DEI was explicitly connected to engineering or computer science or (b) promote students' inclusive behaviors in teams. Specifically, participating instructors either elected to include DEI-related content in their classes or were required to include DEI material as part of a common engineering curriculum. To understand the instructors’ experience implementing these course-based activities, instructors at four institutions were surveyed about their experiences related to implementing grant-funded DEI-promoting activities in engineering or computer science courses. The participating instructors implemented and/or helped develop activities designed to teach topics such as the value of diversity, the importance of inclusive designs, and how to work in diverse teams. Due to the nature of instructor participation (i.e., voluntary versus required), we anticipated instructors would display evidence across the entire continuum of the EPIC-I framework and may provide a cross-section of typical engineering departments— with some instructors actively wanting to include DEI and others who may be hesitant or even resistant to such curricular efforts. Our overarching research question was: To what degree do engineering or computer science instructors who are involved in DEI-promoting activities in their courses indicate the various elements of the EPIC-I framework?

5. Methods

5.1 Participants

A total of 29 instructors from four universities responded to this survey during the spring of 2021. The responses from five participants who opened the survey and filled out some demographics but did not complete other survey items were removed. Responses from an additional four participants were also removed due to them not integrating any activity into their course. Thus, the final sample contained 20 participants. Three of the institutions are classified as R1, and one is classified as M1. Instructors' use of the activities was optional for some and required for others, depending on the institution and program.

5.2 Measures and Procedures

The study was deemed exempt by the lead institution's IRB. Instructors' perception of the impact of the activities on themselves was measured by focusing on assessing instructors' comfort level addressing DEI issues in class, satisfaction with the activities, perception of their effort spent on the activities, and learning from students' feedback about activities. We conducted a pilot of the survey with 2019-2020 instructors, and then we revised and re-administered the survey in spring 2021.

5.3 Plan of Analysis

The EPIC-I theoretical framework is used in this study as a filter to view survey responses. To this end, we employed a descriptive approach in analyzing both the quantitative and qualitative data. For quantitative data, we used descriptive statistics. The qualitative data were analyzed following a qualitative content analysis approach that described the responses along with the corresponding frequency [24].

6.0 Results

6.1 Exposure

Exposure was measured using a binary choice question asking, “Have you implemented any of the following activities?” Among the 20 respondents, 19 instructors (95%) had implemented project activities. One instructor (5%) did not implement any project activities but implemented another inclusive activity.

6.2 Persuasion

Persuasion was measured by exploring how the instructors viewed the activities as value-added or detrimental to the overall course objectives, what feedback they received from the students and the instructor’s perception of the impact of the activities on class dynamics. Instructors who felt the new teaching practices were beneficial would have a positive attitude across the items. We found mixed responses. Most instructors perceived the activities as valuable to course objectives, while a smaller percentage indicated the activities were neutral or harmful to the achievement of course objectives, see Fig. 1.

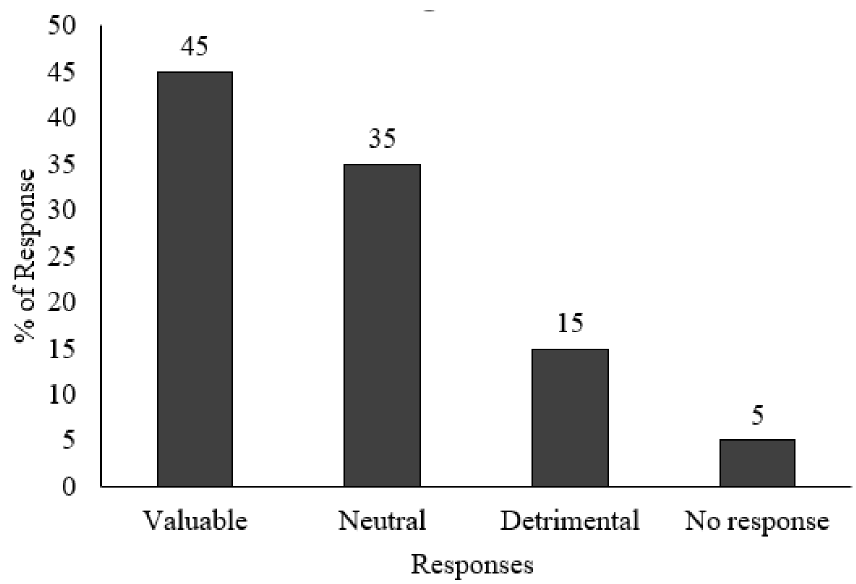

Fig. 1. Percentages of responses on "Were instructors satisfied with the time spent on activities as value-added or detrimental to the overall course objectives?"

Next, instructors were asked to indicate the type of feedback they received on the project activities, see Fig. 2.

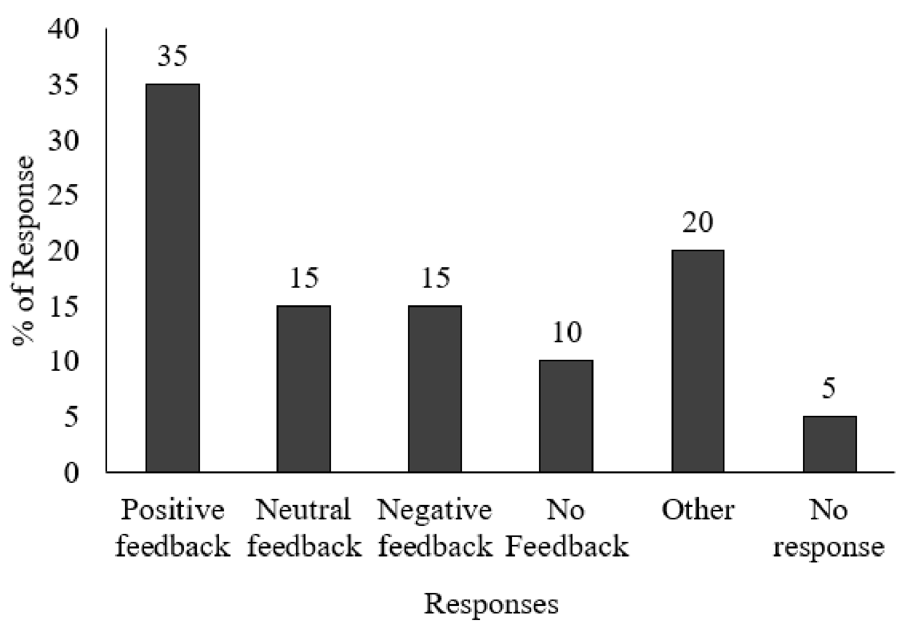

Fig. 2. Percentages of responses on the survey item "What feedback, either formal or informal, have you received from your students related to the activities?"

Ten participants responded to an open-ended follow-up question focusing on students' feedback related to the activities. Two instructors reported that the feedback evaluation was in process. Three instructors noted mixed feedback, and three reported positive feedback. Table 1 displays examples of faculty feedback related to mixed and positive feedback.

Table 1. Exemplar Quote Demonstrating Mixed or Positive Feedback from Students Related to Activities

Feedback Classification	**Exemplar Quotes**
Mixed Feedback	"*All of the above; there were students with each of the options: negative, positive, neutral, and no feedback*." "*Some students complained to me [about] the assignments but then wrote how they enjoyed the activities in the assignments. I'm very puzzled about their true attitudes towards those activities and surprised to see how they gave feedback differently when it's formal vs. informal. If all the assignment questionnaires are conducted anonymously, will the response be very different from what we got by now?"*
Positive Feedback	*"The activity provides a real-world perspective to a problem that the vast majority of the students did not know existed. It allowed many students to bring their own experiences into the discussion."* *"No students gave negative feedback, and several students enjoyed discussing these topics in class."*

Many instructors responded that the activities positively impacted class dynamics, some were unsure about the impact, and a few instructors responded to other options like the activities had a neutral or negative impact (Fig. 3).

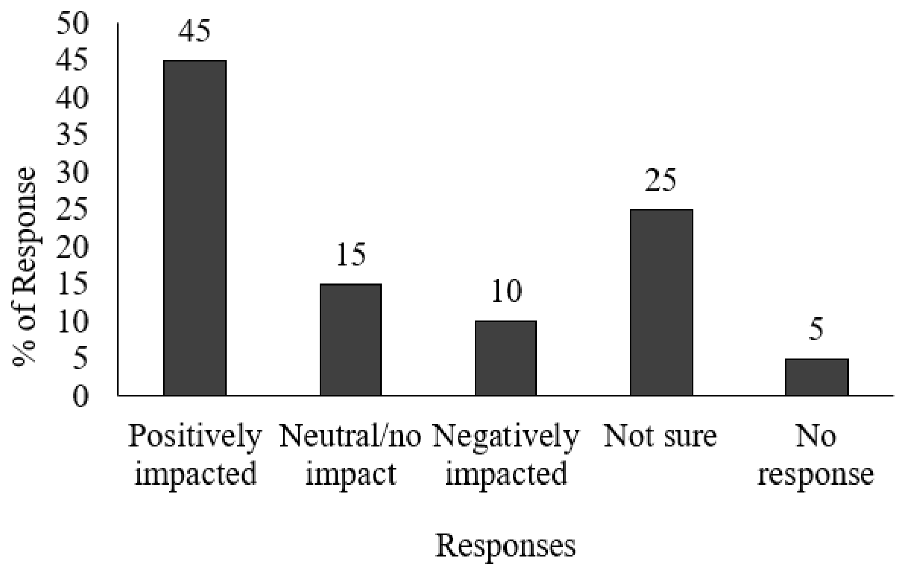

Fig. 3. Responses on "How did incorporating these activities impact the class dynamic?"

A follow-up question retrieved ten explanations on the question, "How did incorporating these activities impact the class dynamic?" Four were related to the 'positively impacted' response, and two qualitative responses were related to the 'negative impact' of the activities. Four qualitative responses indicated 'neutral/no impact' of the activities. The 'neutral/no impact' responses were concerned about limited interaction, lack of clarity, and unsure how it impacted. Exemplar quotes are shown in Table 2.

Table 2. Exemplar Quote Demonstrating Positive and Negative Responses Related to Activities' Impact on Class Dynamic

Feedback Classification	**Exemplar Quotes**

Positively Impacted	"*Obviously this is conjecture, but I think the students were more engaged because of the activity.*" "*It was helpful for student awareness on inclusion to increase.*"
Negatively Impacted	*"Most students find the activities either pointless or it gives them negative attitude toward others."* *"'Implicit Bias' [assignment] may be a negative impact. There were more discrimination sentences towards my background in my teaching evaluation in the sections implementing the Implicit Bias compared to the section that didn't implement it in the same semester. Suspect it's due to the Backfire effect or Boomerang effect or belief polarization."*
Neutral Impact	*"The class was online in the fall and hybrid now with a limited number of students in person. The no impact is due to the limited personal interactions with the students and not due to the activity itself."* *"The class already includes addressing issues along numerous dimensions (social, economic, psychological, ethical, ...) so it is hard to know how this particular activity impacted the dynamic."*

6.3 Identification

Identification was assessed using a two-part question. In the survey, we asked the instructors how much time they spent on grant-related activities over their recent semester and how satisfied they were with that time. Table 3 shows instructors' estimation of time on grant-related DEI activities.

Table 3. Response to time spent (in minutes) on the course activities

	n	Mean (*SD*)	Median	Minimum	Maximum
Creating the activities	13	160.77 (280.185)	25	0	840
Revising the activities	15	65.00 (109.691)	30	0	420
Grading the assignments	17	289.71 (732.266)	60	5	3060
Discussing content in class	15	34.80 (26.764)	30	10	112

Further, we asked instructors if the time they spent on the activities was appropriate. Most of the responses were "neither too much nor too little," which we interpret as corresponding to a medium identification. A few responses were noted as "far too much," indicating that some instructors did not identify with the activities.

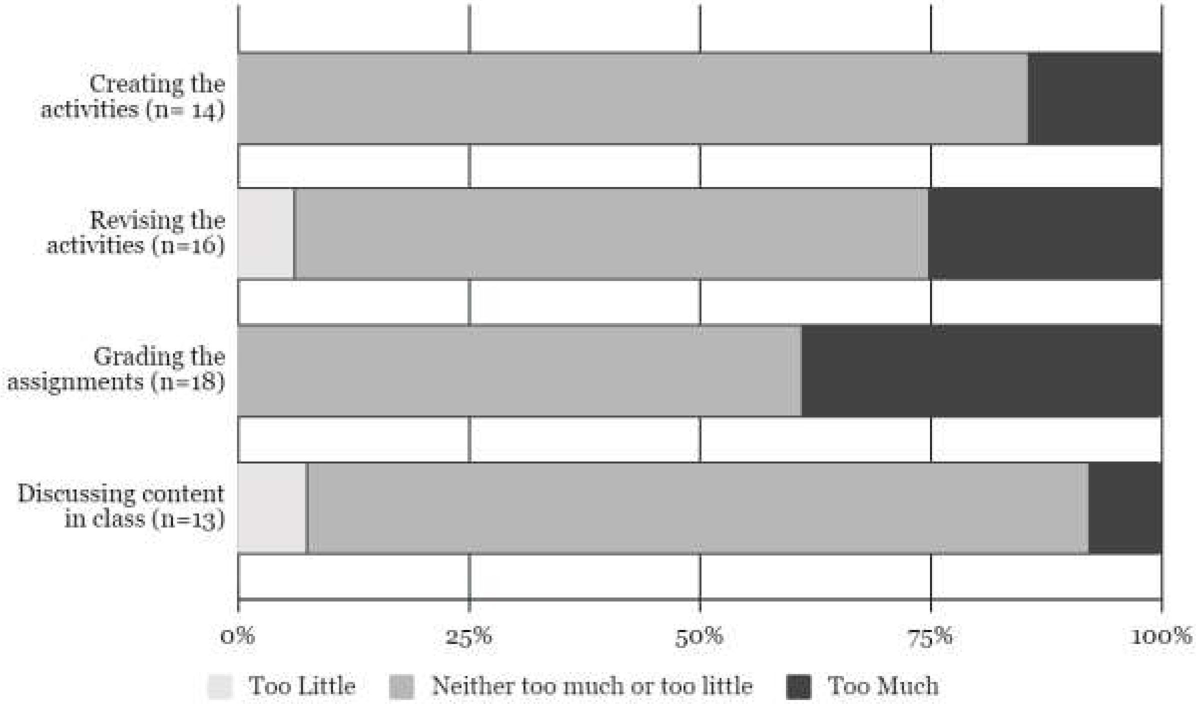

Fig. 4. The proportion of instructors who indicated whether the time spent engaged with activities was too little, neither too little or too much, or too much.

6.4 Commitment

Commitment was assessed by a multiple-choice survey item asking whether their instructional practices changed over time as their involvement with the activities with an open-ended follow-up question requesting an explanation of their choice. We assumed that instructors would report changes in their instructional practices if they identified with the activities and committed to changing or modifying their instructional beliefs. Most instructors (45%) reported that their instructional practices changed over time as they implemented the activities. A few instructors were uncertain about the changes (15%), which indicated a neutral stand on the commitment spectrum. A few instructors' (15%) lack of commitment was observed as they reported that their instructional practices did not change (Fig. 5).

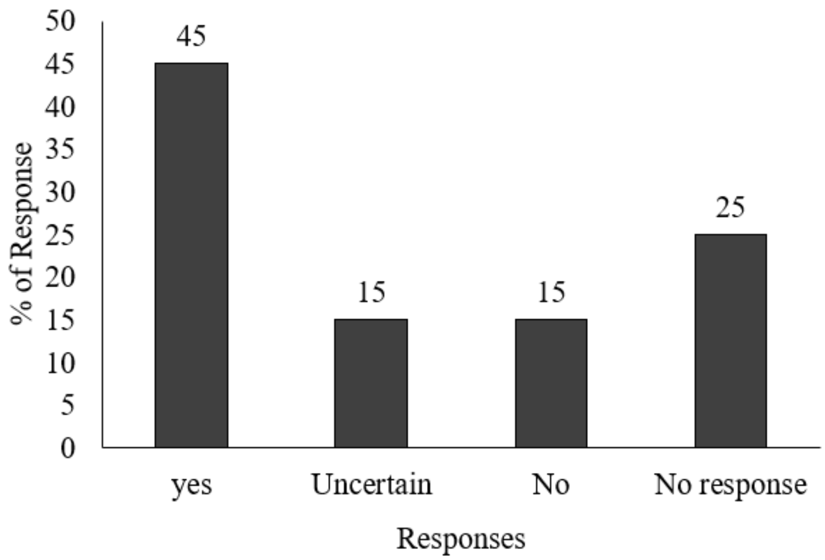

Fig. 5. Percentages of responses on whether instructors' instructional practices related to DEI changed over time as they implemented the activities

The follow-up question retrieved nine explanations of their responses on the change of instructional practices related to DEI over time. No responses overtly expressed a *Lack of commitment;* thus, we highlight *neutral* and *committed* responses. Examples of neutral and committed quotes are shown in Table 4.

Table 4. Exemplar Quotes Demonstrating Neutral and Committed Responses Related to Change in DEI Instructional Practices

Feedback Classification	**Exemplar Quotes**
Neutral	*"I believe my instructional practices continually change. I chose "uncertain" because there appears to be an implication in the question of a relationship between implementing the activities and the changes. I have no evidence that the rate or nature of change is directly related to specific activity implementations."*

Committed	*"Each year I am trying to create assignments that allow students to inject more of 'their voice' into their assignments."* *"Spend more time overall on these topics, incorporate them in discuss throughout the semester."*

6.5 Implementation

The final stage of the framework is the *Implementation* stage. We assessed this construct by asking instructors if they had implemented any *additional* DEI activities. Three respondents (15%) noted that they implemented DEI activities besides the project-related ones—although one instructor implemented a project activity in another class that was not officially participating in the study. Thus, 10% is a more accurate representation of instructors with evidence of implementation.

7.0 Discussion

The EPIC-I framework: exposure, persuasion, identification, commitment, or implementation, was applied to the survey responses. The results provided evidence of three critical findings: (a) evidence existed of faculty participation at all levels of EPIC-I, (b) in moving through the EPIC-I framework, the evidence generally became scanter, which may indicate fewer faculty are engaged at the higher levels, and (c) although the number was small, approximately equal numbers of participants were openly negative as were actively implementing additional DEI supporting activities in their classes.

The majority of respondents (95%) incorporated one or more of the activities into their classes (exposure); between 35% and 45% of respondents reported a positive response when asked about the amount of time spent on activities, the class dynamic, and formal and informal feedback from students (persuasion); 55-65% responses indicated that instructors felt they spent just the right amount or too little time on the activities (identification); 45% of respondents indicated that they were certain when asked if their DEI instructional practices had changed (commitment); and the majority of respondents (90%) have not implemented any DEI related content beyond the activities (implementation). A small percentage of respondents ($n = 2$, 10%) appeared not to value DEI-related content and responded negatively to all questions. However, there was evidence from two instructors (10%) of engagement at the highest level, full implementation.

Some instructors in this work indicated that time was a concern when implementing DEI-related activities in the classroom; Booker et al. noted similar concerns by faculty, indicating that they did not have time to incorporate diversity-related topics into their courses [10]. O'Leary et al. found that faculty who were most open to adopting inclusive teaching practices were the ones who initially accepted an invitation to an inclusivity workshop [14]. Although we did not examine the data by why they implemented activities, we suspect the faculty who volunteered to participate in the study may have responded more positively than instructors who were required to participate based on a common curriculum adopted by their program.

The EPIC-I framework provided a practical framework through which to view instructors' participation in grant-funded diversity-promoting activities. Some instructors were just beginning to be aware of the need for diversity to be explicit in their curriculum, while others were actively seeking out other ways to engage students in meaningful DEI experiences. We also want to highlight that in the absence of perceived support for inclusive activities, even well-intentioned, motivated faculty are less likely to implement changes [23]. And similarly, faculty in supportive environments may be more likely to engage in inclusive efforts even if they are not as motivated. Thus, the teaching environment matters. Although these activities were implemented at only four campuses, we suspect similarly disposed faculty to be present on nearly all college and university campuses. It may be helpful for university administrators and researchers to view faculty responses to DEI-promoting efforts through the EPIC-I framework [1-2].

7.1 Limitations

As with all research studies, there are limitations. Survey responses related to DEI may be influenced by social desirability bias [25]. The sample size for this study was also limited due to the structure of the grant, which funded the activity implementation and development. Instructors who volunteered to participate likely already valued DEI and were somewhat committed to implementing the content into their classes. But due to potential issues with anonymity (e.g., one campus required participation, and some campuses had a small number of instructors participating), responses were not further broken down by campus. Additionally, future research should explore instructors' experiences based on mandatory or voluntary participation.

8.0 Conclusions and Recommendations

Instructor perspectives on incorporating DEI activities in their curriculum tend to be diverse. The EPIC-I framework was used to gauge these perspectives, and the progression through the different stages reflects this diversity of views. Nearly all respondents reached exposure by including an activity. Still, only 10 percent of instructors provided evidence of reaching implementation, which was identified by the instructor incorporating some additional DEI activity in their curriculum. But it does not appear that this small number of respondents who reached implementation was due to a negative perception of the value of DEI-related content in engineering and computer science curricula. Only two respondents had consistently negative responses to the posed questions.

Therefore, although the EPIC-I framework may help gauge perception, it is insufficient to rely on the successful propagation through all stages to determine a positive perception of incorporating DEI activities within the classroom. Additional aspects, such as teaching experience, personal value of DEI, and recognition of the need for DEI inside engineering or computer science courses, may affect where faculty tend to fall relative to the different stages of the framework. Future work should attempt to collect this data to identify such corollaries. Further, another corollary may be faculty knowledge of the individual experiences and stories of their students, which may impact the degree to which faculty engage with and implement DEI-related content. Perhaps, faculty will be more likely to engage at higher levels of the EPIC-I framework the more they know their students' personal narratives and experiences. Thus, it may be worthwhile to explore the interaction of aforementioned faculty experiences, the personal value of DEI, and faculty knowledge of their student’s experiences and stories alongside the EPIC-I framework.

Being aware of the spectrum of engagement with and value of DEI activities in a classroom is essential for anyone wanting to improve the DEI climate in their classrooms, departments, colleges, and universities. It is necessary to meet instructors where they are and provide opportunities for collaboration to let them take ownership of the content. While the majority of instructors were open to incorporating DEI activities in their classrooms, a small percentage were resistant. Integrating DEI-promoting materials into the classroom is one practical way to positively influence the chilly climate in engineering and computer science. But this work is difficult, with successes sometimes far apart. As evidenced in this study, not everyone will quickly adopt and integrate DEI efforts. In short, those looking to enact change should keep in mind that they are playing a long game.

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