AC 2007-1276: DIVERSITY IN ENGINEERING TEACHING – VIEWS FROM FUTURE ENGINEERING FACULTY

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Diversity in Engineering Teaching – Views from Future Engineering Faculty

Abstract

This current paper uses a qualitative analysis approach to explore the conceptions of diversity as expressed by future engineering educators. Engineering graduate students and post-docs (future engineering educators) wrote a statement of diversity as it relates to teaching engineering as a component of a teaching portfolio. We then interviewed these participants about the processes they used for this writing task. During the interview, they reflected on their processes in writing the diversity statement; they also discussed their personal experiences with diversity issues and through these discussions revealed their attitudes, beliefs, and conceptions of diversity. In this exploratory study, we focus our analysis on these interviews and present our findings on three emergent themes across four case studies.

Introduction

Even though diversity issues have not always been addressed in engineering education, they have become central and critical to the engineering education community in recent years. Addressing diversity has emerged as an important issue in the engineering education community as the student population in colleges and universities has become increasingly more diverse. Despite these changes in student populations, attrition from engineering programs remains a significant issue across all groups. For underrepresented minority groups, recruitment and retention in the engineering programs is especially critical because significantly fewer engineering degrees were awarded to these students in the last decade. The current number of minorities and women in student populations represented in engineering programs are still well below parity with their distribution within the higher education population[1]. The engineering education community has acknowledged the importance of addressing diversity in recent publications from the National Academy of Engineering (NAE),[2, 3] the National Action Council for Minorities in Engineering (NACME)[4], and Journal of Women and Minorities in Science and Engineering[5, 6]. The National Science Foundation (NSF) has allocated funding to address diversity issues through specific requests for proposals related to increasing diversity in science and engineering. NSF has also included diversity explicitly in the broader impacts criteria for all NSF proposals[7].

As colleges and universities strive to recruit and retain a more diverse student population in engineering, faculty need to become more aware of how to handle diversity issues within their classrooms. Therefore, it is important to encourage faculty to think more broadly about diversity issues. As researchers, we believe there are various ways to encourage educators to think and discuss the topic of diversity in engineering. Many universities offer campus-wide discussion forums and workshops that address the topic of diversity. Engaging in discussions about diversity issues is one method that shows promise in raising awareness of these critical issues within the engineering education community. Encouraging discussions about difficult issues has been established as an effective faculty development method. In Scandinavia, science and engineering faculty are encouraged to share their personal experiences regarding supervising doctoral students by writing narratives about their experiences and then discussing these narratives with their peers[8]. Based on Linden's work, writing and sharing individual diversity statements represents one such

strategy to encourage engineering educators to direct their efforts to address diversity in their teaching.

Diversity issues do not magically get addressed in engineering teaching, but rather they get addressed conscientiously by educators purposefully taking these issues into account. Some engineering faculty may find it difficult to relate the broad topic of diversity to specific aspects of their classroom teaching. This may be because the connection between teaching and diversity is not well-defined. But how do engineering educators conceive of diversity and how do they go about considering these issues in their teaching? Very little has been published about the attitudes, beliefs, and conceptions of diversity held by engineering educators and how these attitudes, beliefs, and conceptions influence their teaching.

While most educators recognize the importance of raising engineering educators' awareness of diversity issues, the lack of published research regarding the ways in which engineering educators think about diversity makes this goal difficult. We hope that by characterizing the attitudes, beliefs, and conceptions of diversity that participants in our study revealed, others in the community will benefit by increasing their awareness of diversity in engineering education and by recognizing their own experiences in diversity as being relevant to their work as engineering educators.

In this exploratory study, we analyzed a subset of our interview data from a larger qualitative study in order to understand and begin to characterize engineering educators' attitudes, beliefs, and conceptions of diversity. We focused our analysis on characterizing participants' background and experiences in teaching through a case study approach. We then identified themes that were relevant to diversity issues.

In the following sections, we will first describe our research methodology. Then, we will present four case studies. Next, we will present three major themes that emerged from these four case studies. Finally, we will provide recommendations and suggestions for new engineering educators that can help them to think their own attitudes, beliefs, and conceptions of diversity issues and how they might address them in their teaching.

Methods

The context of this diversity research was situated within a larger qualitative study of future engineering faculty at a large, public research university on the West Coast. These future engineering educators created teaching portfolios during an 8 session workshop in which they had the opportunity to examine, reflect, and revise their beliefs and goals as teachers through a series of exercises, writing tasks, and group discussions. In the first of two workshop sessions about diversity, graduate students and post-docs were asked to write a diversity statement after a facilitated discussion about diversity issues in engineering education. In the subsequent session, they shared these written statements and discussed them with other workshop participants in a peer review activity.

After the conclusion of this workshop, participants were interviewed for an hour about the processes that they used in constructing their teaching portfolios and the outcomes and impacts that creating a teaching portfolio had on them. In this study, we do not focus on the written

diversity statements themselves. Rather, we focus the core of the analysis on the exit interview data, specifically what participants reported about the processes they used while writing their diversity statements. In this portion of the interview transcripts, participants reflected about the processes they used to create their diversity statements and their thoughts about diversity issues as related to teaching engineering.

These exit interviews were semi-structured, which allowed the interviewers to use probing questions and prompting to elicit participants' attitudes, beliefs and conceptions about diversity in their teaching. Through these questions, we gained an understanding of how participants articulated their thoughts about diversity issues, their reactions when discussing these issues, and how they reported addressing or not addressing these issues in their teaching.

We purposefully selected four interviews from the larger dataset in order to characterize the various attitudes, beliefs, and conceptions of diversity held by participants. We chose to conduct an in-depth analysis of four interviews in order to find significant themes that can be tested against the rest of the dataset. We first used a case study analysis to characterize each participant. We then used thematic analysis to identify themes related to diversity. The core of this analysis was to characterize how these study participants thought about diversity as it relates to engineering education and where and how they formed their ideas. In order to preserve and protect the confidentiality of our participants, we replaced participant names and other identifying information with a random subject code, for example YI109. We referred to participants by these random subject codes in the findings section.

Findings I - Case Studies
In this study, participants wrote a diversity statement and discussed these statements with their peers. We then interviewed them about this process. This technique was extremely productive in eliciting opinions, thoughts, and reflections related to diversity from participants. Even though some participants reported having little experience with diversity, most participants reported that they had thought about diversity issues and were able to articulate their thoughts and opinions about this issue as it related to their engineering teaching during the interviews. This section first presents four case studies illustrating the range of perspectives that participants described. These perspectives are summarized in the case studies. We chose these participants from the overall dataset of 24 exit interviews to illustrate the breadth of this range.

All of the four participants represented below were in departments within the College of Engineering. Two participants were male and two were female. At the time of the interviews, two were post-doctoral associates and two were advanced PhD students. Two participants mentioned that they were members of, as one participant described it, "over-represented minority groups," and two were Caucasian. The first two cases illustrated critical incidents that the participants reported as influencing their attitudes, beliefs, and conceptions of diversity; YI104 described a critical incident that positively impacted his views on diversity, and JI102 described a critical incident that negatively impacted her views on diversity. The third participant, YI110, described his perspective of diversity from the standpoint of an "over-represented minority" in engineering. The fourth participant, YI105, discussed in depth a common concern of most participants regarding the need to be "politically correct" when speaking and writing about diversity. These themes will be revisited in the section following the case studies, which are presented below.

Participant YI104
Writing the diversity statement helped YI104 better understand his feelings about diversity. YI104 classified diversity in two distinct categories. The first category he referred to as service, in which he included issues related to recruiting and retaining more minorities in engineering. He believed the service aspect of diversity did not belong in a teaching portfolio because it did not directly relate to teaching. His second category referred to ways to handle diverse groups of people in the classroom. YI104 chose to not include his diversity statement in his teaching portfolio because he did not like it and felt that diversity was more of a service responsibility, rather than explicitly related to teaching diverse groups.

YI104's diversity views were greatly influenced by a childhood experience. When he was growing up he asked his grandfather if he knew Tagalog and his grandfather responded, 'you're American, speak English". This caused YI104 to treat everyone the same regardless of any differences. Rather than recognizing diversity as differences, he considered everybody to be American and therefore held to the same standard. This experience influenced how he treated women during his military service as an non-commissioned officer. Unlike most platoons, he expected the women in his platoon to do the same work as men. This equality led to the others members of his platoon giving the women more respect. According to YI104, "Everyone should be respected and treated the same."

In academia, YI104 has taken the approach that everyone is different and every person learns differently, yet everyone should be held to the same standards. Everyone should have the same basic understanding, regardless of who they are or what their future plans may be. He strives not to make assumptions about students or stereotype them.

He felt that everyone's diversity statements were unique and no single statement could sum up the views of the entire group. These unique statements came from different experiences, emphases, attitudes, approaches, and values. He claimed that the diversity statement was actually a good exercise because he felt that diversity is becoming more of an issue, even though he chose not to include his diversity statement in his teaching portfolio.

Participant JI102
JI102 had a negative experience with diversity, which influenced how she communicated about diversity. During a university wide workshop discussion about diversity a panelist misunderstood what she was trying to say, then reacted harshly toward JI102 causing JI102 to be "traumatized." This experience caused JI102 to be cautious with her words and "tiptoe" around writing the diversity statement. When she wrote it, she had to make sure she was "politically correct." This experience made JI102 more timid about writing a diversity statement and more cautious with her words. The incident not only impacted JI102, but the rest of the group as well. During the workshop in which this incident occurred, she reported that the group dynamics changed after the harsh reaction from the workshop panelist and the group was more defensive and was not able have a productive conversation about diversity. The defensiveness of the group after the incident resulted from an awareness of past offenses and potential future offenses related to diversity.

When JI102 attempted to write her first draft of the diversity statement she did not know what to say. She emphasized that she did not think it was very good. When she brought her diversity statement to the peer review and discussion session it was not a priority for her to have the group read it and comment. JI102 stated that these feelings of inadequacy about her diversity statement stemmed from her previous experience. She was unaware of how much the incident that occurred during the previous diversity workshop had negatively impacted her. The teaching portfolio workshop allowed her to discuss her previous experience and get some sympathy and agreement. The smaller group setting allowed people to get to know each other better, which she felt allowed for a more constructive discussion. This small group setting offered a sense of comfort, support, and encouragement.

At first JI102 struggled with the diversity statement, but in the end was pleased with her results. JI102 claimed that writing the diversity statement was challenging, interesting, and a really positive thing to do. In the end she took away a more concrete diversity statement. She claimed that she had never worked directly with minority outreach and did not have concrete experience working with diverse populations. However, at the end of the interview JI102 mentioned that she had spoken a few times with outreach groups focused on recruiting and retaining more women in engineering and science, and had tutored occasionally for a support program for underrepresented groups in engineering.

Participant YI110
YI110 focused heavily on the aspects of diversity related to different learning/teaching styles, and student needs at various levels of experience. He recognized that all students have different needs; therefore understanding how to handle diverse needs was necessary. He identified distinct differences between undergraduate students and graduate students. He claimed that undergraduates needed more encouragement and beginning graduates need a little less encouragement. Whereas, with post-docs the lines of communication were much more open. While working with post-docs, he more freely gave his opinion, whereas with less advanced students and colleagues he made a deliberate effort to be always encouraging, even when giving critical feedback. Through this, he hoped to develop students who are able to think critically.

YI110 was passionate about working with and helping minority students, as seen through his interaction with his supervisor. When his principle investigator (PI), or research mentor, asked him to take another student he said he was too full. YI110's PI was adamant about finding a way to keep the student in her lab, but she did not demand that YI110 take responsibility for this undergraduate student. She said that the student was a woman and a minority, therefore the PI, who was also female, felt even more compelled to help the student. When YI110 saw how much this outreach meant to his PI, his view of her changed positively. He respected her for working towards what she believed in: encouraging minorities and women to participate in undergraduate research in engineering.

YI110's experience as, in his own words, "an over-represented minority" influenced his perspective and made him more aware of opportunities and situations surrounding diversity. This influenced how he wrote his diversity statement. YI110 felt that excluding minority groups limits perspectives. When speaking about diversity, YI110 was cautious of his words. He stated that he

didn't know if this was "political." He also spoke about trying to frame diversity in the correct way, so that people can understand.

When discussing diversity issues, YI110 stated that people should not have to think about diversity; rather the awareness of differences between people should come naturally. According to YI110, if people were naturally aware of diversity issues they would not be worried about filling quotas. When discussing the issue of diversity he stated that people shouldn't even notice differences between people. He also believed that all people should have a sense of belonging within the engineering community rather than feeling excluded.

Participant YI105
In general, the teaching portfolio workshop caused YI105 to think more about diversity. Through the workshop, YI105 had the opportunity to think more about how she was going to put her diversity plan into action. Diversity had always been important to her, but she felt that sometimes this belief was not reflected through her actions. By thinking more about diversity issues, YI105 was very conscious of how her teaching statement and her diversity statement were complementary of one another. She wanted these two statements to tell a complete story, rather than standing as two separate documents. After writing her diversity statement she went back and edited her teaching philosophy statement, so that the two statements were complementary to each other. YI105 made sure to support the views that she articulated in her teaching statement and diversity statement through supporting artifact that provided evidence of these views in her teaching.

When writing and talking about her diversity statement, YI105 was cautious of her words. She claimed that as she progressed though academia, she built a language and a way of speaking about diversity. This language stemmed from participating in other diversity discussions. When people did not use the "politically correct" vocabulary during these other discussions, she felt surprised.

In the following sections, we will examine some of the themes that arose from the interviews. These case studies form a foundation for the themes that we will now present in the next section.

Findings II - Themes
Three main themes that arose from this in-depth study included: (1) the use of narratives/story telling to describe their views of diversity; (2) the self reporting of a critical incident (positive or negative) involving diversity; and (3) the use of politically correct terms when talking about diversity. The use of narratives to describe diversity views was very personal and concrete. When participants discussed a critical incident they used narratives to describe and reflect about a specific personal experience. Many times in telling their stories, participants were cautious of their words and acknowledged needing to be politically correct, frequently using the acronym PC for "politically correct". Many participants described one or more of these diversity themes when talking about their experiences of writing their diversity statements.

The role of narratives
When discussing writing the diversity statement, many participants used narratives to describe their diversity views. When participants use narratives, their stories are personal and specific, and they form their views of diversity through their personal experiences. When describing their

personal stories, the participants allowed the interviewer to see more closely the ways in which their diversity views were shaped. Most participants used narratives throughout their discussion of diversity; however, the use of narratives was most noticeable for those participants who discussed a critical incident that impacted their diversity views, as seen in the interviews with YI104 and JI102.

The role of critical incidents

Several participants discussed how a life incident impacted their views on diversity and how that incident in turn influenced how they responded to diversity issues in and out of the classroom. These critical incidents impacted these future engineering faculty members' attitudes, beliefs, and conceptions of diversity. One participant's experience occurred when he was a young child while another person had a life changing experience when participating in a diversity workshop.

For example, a childhood experience significantly shaped YI104's diversity views. When he was growing up he asked his grandfather "if he knew Tagalog and he responded, you're American, speak English." If the participant had reacted to this statement differently, this critical incident during his childhood could have been negative. Rather, the incident caused him to treat everyone equally regardless of differences—to him everyone was considered American and held to the same standard. This childhood critical incident influenced how he treated women in the military. YI104 explained how he treated women when he was a non-commissioned officer in charge of a platoon:

> "And, I mean, she -- her first drill she goes, um, where do the women run? I go, you're a member of my platoon. You run with my platoon. You will keep up. And we drug (sic) her, but she kept up."

Unlike most platoons, women in YI104's platoon were expected to do the same work as men. The woman Marine was held to the same requirements as the male Marines; therefore, she was treated as an equal among her fellow Marines. Her fellow Marines never called her a woman; rather, they showed her respect by calling her by her last name, like everyone else. According to YI104, "Everyone should be respected and treated the same." As seen through the participant's actions in the Marines, this belief that all people should be held to the same standard was something he strongly believed in and lived by. As YI104 has entered academia he has taken the approach that everyone is different and every person learns differently, yet everyone should be held to the same standards. When teaching, YI104 believes that all students should have the same basic understanding, regardless of who they are or future plans. This strong belief caused him to strive not to make assumptions about students (e.g., stereotypes). As seen through his actions in the military and academia, YI104's critical incident positively influenced how he views diversity.

Not all critical incidents influenced individual's views positively. One participant had a negative experience with diversity, which influenced how she communicated about diversity in subsequent interactions. During a university wide workshop discussion about diversity a panelist misunderstood what she was trying to say, then reacted harshly toward JI102 causing her to be "traumatized." When asked about what she gained from the teaching portfolio class, JI102 described her growth through the following narrative:

> "Yeah, and I think it was -- it was very useful for that. I got really helpful

feedback from people about the teaching statement and diversity statement, and, um, I had written the teaching statement before but hadn't written a diversity statement at all, and was sort of tiptoeing around that, because in the [university wide diversity discussion] I had a bad experience on the day that we did -- we talked about diversity. We had this panel, and, um, that was just a very tension-filled day in that class…

And I felt like I got jumped on for -- by one of the panelists for trying to tactfully bring up a potentially difficult situation that my group -- so I was -- we talked in small groups before we started talking as a whole class with this panel of two people, and, um, my group was basically just a couple friends, a couple computer sciences, a couple electrical engineers, and talking about this issue definitely my -- some of my friends in electrical engineering and her advisor had experienced, and she talked about it with her advisor and some of her students, and there seems to be a lot of cheating in certain EE classes or what is construed as cheating sort of under the faculty -- what the faculty lay out in the beginning of the quarter and what my friends's advisor had explained that he had found is that some of it is related to really strong cultural differences in -- so it's kinda the thing that no one wants to say is why do all Vietnamese students cheat, and it's not that the Vietnamese students think it's okay to cheat, it's that the Vietnamese students have a very different idea of family and in-group, and you help your family and you help your in-group, and that's just what you do. And so it's not that they think it's okay to cheat, and it's -- but there's just very different cultural norms about helping each other and just what is appropriate to do.

And when I tried to tactfully bring this up in front of the class as something that, you know, here's a hard issue we face, can we talk about this, somehow I managed to not articulate it as well as I could have, I guess, and got this -- this woman on the panel jumped down my throat about -- about having -- she wanted to just clarify and be sure she understood what I had said, because she thought that what I had said was that there are cultural norms that it's okay to cheat, and, you know, that what I was saying was that in Asian cultures it's okay to cheat, which is not at all what I had said -- or meant to say.

And I felt like she had taken what I said and twisted it in the worst possible interpretation, and it -- I mean I understand that I was not as clear as I should have been, but I also felt like she was not taking this in the spirit of let's try and have a helpful discussion about these hard issues that some of us don't understand how to deal with, and instead she had taken like what's the worst possible interpretation she could come up with, and, I don't know, talking about it later with sort of the group of people that had only been having the small group discussion, one of my friends sort of concluded she had a -- she seems to have a pretty big chip on her shoulder.

The participant described the incident as traumatic saying "That I had been traumatized by this woman who jumped down my throat for, you know, saying the wrong thing while trying to be -- have a useful discussion." JI102 had a "traumatic" experience with diversity that significantly impacted her feelings surrounding diversity issues. Everything she discussed about diversity seemed to stem from the recent wound from the university wide diversity discussion. She was

more sensitive when communicating about diversity, as seen through the words she uses to describe diversity issues (e.g., trauma, politically correct, tactfully, etc.). This negative experience left her with baggage and a scar she was unaware of. Through the engineering teaching portfolio workshop she was able to discuss her negative critical incident, which allowed for a healing process to begin.

On being PC

Negative experiences with diversity influence each person differently; therefore, each person has to deal with the situation in their own way. JI102's negative experience caused her to be cautious with her words and "tiptoe" around writing the diversity statement. When she wrote her diversity statement, she had to make sure she was "politically correct." This experience caused JI102 to be more timid about writing a diversity statement and more cautious with her words. JI102 was not the only participant who described being politically correct when discussing writing the diversity statement. When YI105 was asked "how did the teaching portfolio workshop help you think about diversity", she responded with:

> "YI105: Well, I think a big part was just purely the exercise of having to write out a statement to try and put something on paper, um, I mean I think it's certainly beneficial to have -- to have read other people's diversity statements or engaged in the conversation to just hear what other people think about when they think about the term "diversity." Yeah, there -- I think there is a couple cases where some of the views that other people expressed were kind of surprising to me or maybe not quite as PC as what I'm used to, and so it was --
>
> INTERVIEWER: What's PC?
>
> YI105: Politically correct.
>
> INTERVIEWER: Oh, I see. Okay.
>
> YI105: Yeah. Not quite as politically correct. Just -- you know, I've attended different workshops and stuff that have to do with diversity where I've heard other people express their views about diversity and education, just haven't articulated my own views. But in attending all these workshops, I think I've kind of built up this model of, you know, the politically correct way to talk about it (laughter) and to interact with other people who may be -- I don't know, just sometimes it was surprising to me, and so thinking about how to -- how to talk to other people who haven't attended all of those workshops --
>
> INTERVIEWER: Yeah, I see.
>
> YI105: Which I think is very relevant for future career stuff, to interact with people who -- who -- yeah, I mean have really good intentions, but maybe have slightly different view that to me surprises me."

YI105 claimed that she was used to a certain "politically correct" way of discussing diversity and when people diverged from the norm she was surprised. When YI105 first spoke about diversity, she used the acronym PC for politically correct. She also spoke about trying to frame diversity in the "correct" way, so that people can understand. Several other participants talked about being

politically correct when writing or discussing diversity issues.

Summary and Suggestions

Although much has been written regarding best practices in including diversity in engineering education contexts, little has been published about the attitudes, beliefs, and conceptions of diversity held by engineering educators. This paper presented findings from an exploratory study in which graduate students and post-docs interested in faculty careers in engineering were asked to write diversity statements, and then discuss the issues and reflect on their process of writing the diversity statements during semi-structured exit interviews.

These interviews provided a powerful lens for developing a better understanding of the participants' attitudes, beliefs, and conceptions of diversity as related to teaching science and engineering at the post-secondary level. The data suggests that most participants had thought about diversity issues and had formed opinions or strategies for addressing diversity in engineering education. While some participants had direct experiences with diversity because they were members of "over-represented minority groups" in engineering, others had experience with diversity issues through campus workshops or other forums. Based on the case studies, all of the participants in this sample had formed opinions of diversity based on their personal experiences that flavored their attitudes, beliefs, and conceptions of diversity when they thought about these issues in terms of engineering teaching.

We also presented three of the themes related to diversity that emerged from this analysis of our data. First, participants gravitated towards discussing their views on diversity in the form of narratives. Participants reported sharing stories about their experiences with diversity with their peers through narratives during the discussion and peer review activities during the workshop, and shared some of these narratives with researchers during the exit interviews.

Secondly, some participants shared narratives in which they described critical incidents that shaped their attitudes, beliefs, and conceptions of diversity through these personal experiences. The examples illustrated that these narratives of critical incidents influenced the individuals involved in how they addressed diversity issues after the incident. In one example, the critical incident described by the participant involved the participant's grandfather encouraging the participant to assimilate to American culture by speaking English rather than the grandfather's native language. While the participant indicated that this incident had emotional overtones, the incident seemed to have a positive effect on him. In contrast, another participant described an incident in which a negative reaction from a panelist during a workshop on diversity issues had a "traumatizing" effect which led the participant to avoid dealing with diversity issues until being faced with writing a statement as part of this workshop.

The third theme illustrated that all participants were cognizant that diversity issues can be highly sensitive and chose their words carefully when discussing diversity issues. Some participants who were comfortable with discussing diversity were surprised by the thoughts and opinions of their peers about diversity issues, and then reported being more mindful of voicing their thoughts and opinions with others based on this experience.

Based on these findings, we have the following suggestions for engineering educators who want to

consider diversity issues in their teaching, and faculty developers who provide resources for helping engineering educators consider diversity issues:

1. Recognize that everyone brings to the table their own thoughts and opinions about diversity; many of these thoughts and opinions are rooted in their personal experience.
2. Recognize that everyone will have different experiences with diversity and choose to address this issue in different ways.
3. Any dialogue or reflection with colleagues, students, and other stakeholder groups is helpful.
4. Broaden your own conceptions of diversity to include things like learning styles in addition to more traditionally recognized diversity issues (e.g., race, ethnicity and gender) by asking other people about their stories and experiences with diversity issues.
5. Narratives are a powerful method of discussing and contextualizing learned experiences, and workshops in which faculty participants share their experiences with their peers through narratives has been shown to be very effective in getting faculty members to recognize issues.

Acknowledgements

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