Addressing Diversity in a Problem Based Learning Team Assignment

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Abstract

Many companies now require diversity training of their employees and expect them to be aware of issues related to equity, diversity and inclusion in the context of engineering practice. The Engineering Accreditation Commission of ABET is also considering adding issues of diversity and inclusion into the engineering accreditation criteria in the near future. Including such issues into an engineering curriculum can be problematic, however, as few engineering programs have a full course devoted to either diversity issues or engineering ethics. A Problem Based Learning (PBL) set of assignments has been developed to address concepts of diversity and inclusion, which can be included in engineering courses such as a freshman introduction to engineering course or a capstone design course. This paper includes details of the assignments, how they can be included in a variety of courses, and how they can be used for ABET assessment.

Keywords

Engineering ethics, diversity, inclusion, ABET

Introduction

More universities and engineering organizations are recognizing the desirability of a diverse workplace, and ABET has articulated its commitment to

- promoting diversity and inclusion in accreditation operations and governance through the work of staff, volunteers, and leadership;
- encouraging diverse talents to be used in accreditation operations and ABET governance; and
- promoting inclusive practices and diversity in our accredited educational programs.[1]

However, it can be difficult to make room for such non-technical elements in already crowded engineering curricula. The series of assignments described here has been developed over multiple years, and has been implemented in classes at the University of Tennessee at Chattanooga and at High Point University. They can be adapted for use in multiple existing engineering courses, and can be used in ABET assessment of elements of required outcomes such as 3, 4, 5 and 7. As most of the work is carried out by student teams outside of class time, this does not place a substantial additional burden on already overstretched curricula.

Problem Based Learning

Problem Based Learning is a learner-centered educational approach, which shifts the focus of education to empowered students conducting self-directed learning. In this methodology, the "...learner is mentored and encouraged to conduct research, integrate what is learned, and apply that learning to develop a viable solution to an ill-defined problem."[2] Problem Based Learning has been in used in medical education in the U.S. for more than thirty years, and has been adopted by many other disciplines, including engineering. Some characteristics of PBL are

- Students ...have the responsibility for their own learning.
- Problems ... must be ill-structured and allow for free inquiry.
- Collaboration is essential.
- What students learn during their self-directed learning must be applied back to the problem with reanalysis and resolution.
- A closing analysis of what has been learned from work with the problem and a discussion of what concepts and principles have been learned are essential.
- Self and peer assessment should be carried out at the completion of each problem ....[2]

Issues of equity, diversity, and inclusion are often amorphous and ill-posed, making them well suited for this type of approach. The project has been designed to include all of the above characteristics, including collaboration, self-directed learning, reflection and peer- and self-assessment.

The Assignments

The 3-week series contains a team-based component, consisting of a group research project, including interviews with persons expected to have differing viewpoints on the issue chosen, and an oral presentation to the class. Different groups select different aspects of diversity to investigate, based on approval of the instructor, and have, in the past, included topics such as the gender pay gap, age-related differences in computer use, and third world access to technology. Groups must take and defend an ethical engineering position on their issue, justifying their stance based on relevant engineering codes of ethics.

Before the beginning of the project, students are divided into teams of five or six students, selected based on heterogeneous personality traits, to ensure that each team has a variety of skills and viewpoints. The set of assignments includes both team and individual assignments. Individual assignments include pre- and post-reflections on the issue addressed by the project, and interviews with persons expected to have differing views on the topic. The main team assignment includes extensive research and culminates in an oral presentation, which can be either in person or by recorded video. As the majority of the work takes place outside the classroom, it does not require a significant amount of class time.

Preliminary Assessment

After each team has selected, and had approved, its research topic, each student is asked to write a preliminary reflection on the matter, giving his or her initial opinion on the issue and whether or not it is an ethically significant problem. As this assignment occurs before the research phase

of the project, it is meant as a baseline against which changes in student views caused by the assignment series can be assessed.

Main Assignment

Each team of five or six students selects an aspect of equity, diversity and/or inclusion in STEM fields to investigate and present to the class. Examples of appropriate issues might include items such as the gender gap in technology, issues affecting students for whom English is a second language, the digital divide, design of products (or lack of such products) usable by persons with physical handicaps, or effects of online education on students at or below the poverty level. This assignment requires extensive research, as well as interviews, using questions developed by the team. All members of the team must use the same questions, allowing the group to compare and contrast results. The results of the project are presented to the class in some manner, and must include written documentation (such as PowerPoint slides and references) turned in to the professor for grading.

The goal of the project is to determine possible causes for the issue, whether it is really a problem, and if so,

- How would an ethical engineer regard this issue?
- Are we ethically compelled to address it?
- How?

Individual grades are based on the inclusion of all required materials, classmates' evaluation of the team's content and presentation, and the team's assessment of each person's contribution to the project.

The documentary research required by these projects is quite extensive, including current events, demographics, government studies, social science studies, etc. Students are also required to investigate potential solutions to the issue, which the group must prioritize. A different form of research required for the project is interviews with people relevant to, or knowledgeable about, the issue. Each person on the team must conduct at least two interviews, one each with persons that could reasonably be expected to have opposite views on the issue; so, for example in a project on the gender gap, each person might interview a man and a woman relevant to STEM fields. To foster a diversity of opinion, no more than four of the 10 to 12 interviews per team are allowed to be people associated with High Point University, forcing the students to reach out to a larger community.

Interviews both developed and conducted by the teams forms a significant part of the exploration of the issue in this project, and many students cite the interviews as being the part of the project that most affected them personally.

Groups are instructed to thoughtfully consider what they hope to learn from the interviews, and plan their questions accordingly. They are also advised to be sure to include follow-up questions—one former interviewee for a group studying the Gender Gap said that she was asked if she had ever suffered from discrimination, and though she said "yes," she was not asked when, where, in what manner, effects., etc. Each interview must use the same questions.

Each student is required to write and turn in a summary of each interview, including a description of each person interviewed, giving details of the situation or position that makes this person relevant to the project. For each interview, students are asked for their reflections on the most important thing learned in the interview, the most surprising thing learned, and what was learned that is most relevant to the group project. Since each student must interview at least two people who might be assumed to have differing views on the issue, he or she is asked to compare and contrast the responses of the two interviewees, and discuss thoughts on reasons for any differences observed in the two sets of responses. Students also include a list of any additional questions raised by the interview and how they will be addressed with the team.

The interview reflections count as a homework grade, with three times the weight of a typical assignment.

It has been observed in all iterations of this project that students are much more likely to be convinced that an issue is actually a problem that we are ethically compelled to address if a person being interviewed tells the student how he or she has been personally affected, as compared to evidence from the document research. For example, one student in the spring 2021 semester did not believe that the gender gap was a problem, in spite of all the evidence his team had uncovered to the contrary, until his own mother told him that she didn't go into surgery because of the "boys club" that controlled the profession. Inclusion of the interview element also enabled the course including this at the author's former university, the University of Tennessee at Chattanooga, to be given the special designation as a "Beyond the Classroom" active learning course.

The majority of the grade on the project comes from an oral presentation of approximately 15 minutes. Groups are evaluated on inclusion of all required material, originality, making the audience think, whether conclusions match evidence, presentation mechanics, and proper referencing. The grade on this presentation counts for 40 of the 50 points on the project grade. Presentations can be given as part of class time, or groups can be required to upload videos of their presentations. While presentations in class can lead to valuable discussion, requiring videos makes documentation easier if this set of assignments is being used for ABET assessment.

Follow-up assignments

The final assignment in this series is a reflection at the end of the project. Students are asked to answer and/or discuss the following questions:

- What is the most interesting (and/or transformative) thing that you discovered in researching your own team's project?
- What was the most interesting (and/or transformative) thing that you heard in one of the other team's presentations?
- What was the item (in your project or another team's) that surprised you the most?
- What was the possible solution to the issue that you believe to be the most promising? Why?
- Based on your ethical viewpoint (rather than just your opinion), are we ethically compelled to address the issue?
- Has this project changed your views on the issue at all, and if so, how?

- How satisfied were you with the performance of your team?
- How could the team aspects of this project be improved?

Note that a distinction is made here between students giving an opinion on the issue, such as "On this issue, I think that…," with basing this opinion on their ethical worldview. The purpose of this is two-fold. First, many of the students have never actually considered what their own ethical viewpoint is, or should be, preferring to "go with my gut" or "do what seems right at the time." Having to briefly describe his or her own ethical worldview forces the student to at least consider whether ethical issues that could affect the public or the engineering profession deserve greater thought and consideration. Second, what students claim as their ethical worldview often conflicts with their opinions on particular issues. Requiring them to make the connection highlights this disconnect, and again invites them to reflect on, and refine, their ethical viewpoints.

Requiring both pre- and post-project reflections allows evaluation of the impact these activities have had on student awareness of issues relevant to equity, diversity and inclusion in technical fields. Asking students which items in their own and others' presentations also gives an interesting window into the types of evidence that students find interesting or compelling. This is used to shape future discussions about evaluating sources of information for both applicability and credibility.

Student accountability

A typical flaw of group projects is lack of accountability for students who do not contribute appropriately. In this case, students are required to evaluate their team members in terms of strength of contribution, originality, cooperativeness, timeliness of work and whether the person was critical to the success of the project. Each student also rates both his or her own, and others', main contribution to the project, and these are compared—i.e., what a student thinks his/her main contribution to the project was, and what his or her teammates' perceptions are. The combination of student reviews determines 20% of each student's grade on the project. After the projects are graded, students receive their rating forms from their team, but with no names attached to the reviews. In addition, if a student consistently makes no contribution at all to the team project, the team is allowed to "fire" the student, who must then do an individual project.

Lessons learned in earlier iterations

An earlier version of this set of assignments was developed at the University of Tennessee at Chattanooga specifically to address issues of non-inclusion based on gender in that venue.[3] Some elements of the assignments were similar, and were honed based on student responses and results. It was during these earlier iterations that it was observed that while students seemed to be able to rationalize documentary evidence and remain convinced that there was no significant gender issue in STEM fields, they were more likely to be swayed by the personal experiences of people they regarded as peers—this led to the inclusion of the formal interview element in the project. Historically, the interviews are the part of the assignment that students are most likely to cite in their final reflections as being transformative.

The series was also streamlined for ease of grading—by having the major element of the teamwork as an oral report rather than a written one, most of the grading can actually be done during the presentations, so that it is not burdensome to faculty.

The current iteration of the project at High Point University was broadened to include multiple elements of equity, diversity, and inclusion, and was implemented as described here in spring 2021. Three teams participated in the project, and the topics were the gender gap in STEM fields, the age gap in technology usage, and Third World access to technology. Only 27% of the students in the final reflections said that their opinions of the issues were unchanged by the project. Eighteen percent said that the project, specifically the interview portion, had completely changed their views of the issue, and the remainder said that their basic position was unchanged, but that it was more urgent than they had previously thought, or that they didn't understand the severity, or didn't understand all the issues involved.

Since some students come to conclusions that do not match their evidence, this can be used as an opportunity to discuss "engineering judgment" and the importance of evaluating and applying information sources appropriately in making decisions, whether or not they are technical in nature.

Adapting this assignment to different courses

This set of assignments can be used as-is in courses such as engineering ethics, introduction to engineering, or history of engineering courses. For capstone design courses, the questions could be tailored slightly to better address design concerns—for example, relating to inclusion of a diverse group in the design process as either designers or customer representatives. These assignments could also be relevant to an engineering economics course, with topics such as possibly providing special funding opportunities for minority-owned businesses or differing credit access based on race or gender.

Using these assignments in ABET assessment

While the EAC of ABET is currently discussing addition of specific elements of equity, diversity and inclusion into the engineering criteria, which these assignments would address, they can also be used in assessment of the existing criteria. Specifically, these assignments can be used in the evaluation of Criterion 3 outcomes such as

> 3. an ability to communicate effectively with a range of audiences
> 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments….
> 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.…
> 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.[4]

Both the required interview element of the project and the culminating oral presentation can be used to assess effective communication with a variety of audiences. The entire focus of the

project is recognizing ethical responsibility and making informed judgement based on a variety of (possibly conflicting) information, and certainly requires acquisition and application of new knowledge. Although this project as presented is only three weeks long, it also contains significant team elements which can also be assessed here, and the mandatory assessment of team members includes elements related to the inclusive nature, or lack thereof, in the team. Additional diversity elements can easily be added by tweaking the focus of the assignment.

Concluding thoughts

The set of assignments described here requires little class time, but can be used for explorations of aspects of equity, diversity and inclusion in a variety of engineering contexts, and can lead to valuable discussions on these issues. The series can easily be used in assessment of several parts of the current ABET Engineering Accreditation Commission outcomes. Including Problem-Based Learning and requiring active learning elements as well as traditional literature research gives students valuable experience in acquiring and evaluating different types of information, forming them into a coherent whole, and drawing appropriate conclusions based on all factors.

References

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