

Course and Syllabus Change to Incorporate Aspects of Diversity in Engineering and Engineering Technology Courses

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Abstract

An initiative in the Civil Engineering Technology (CET) department involving the re-design of the transportation course, to be more inclusive in terms of diversity, has been undertaken at the University of Pittsburgh at Johnstown (UPJ). The initiative was in response to the recently developed UPJ diversity statement urging faculty to find opportunities within the curriculum to address diversity. The idea of course transformation was initiated in a two-week faculty diversity seminar sponsored by the office of the Provost at the University of Pittsburgh. The mission of the seminar was to provide an experience that will assist faculty in making their courses more inclusive in terms of diversity both in content and pedagogy.

This paper describes the pedagogical aspects of developing and teaching a course in transportation to reflect aspects of diversity and diverse perspectives. The paper discusses efforts by UPJ to address diversity issues and the mission of the recently organized faculty diversity seminar. The focus of the paper is on course transformation and implementation. Course outcomes, syllabus and sample assignments are also discussed. Finally, feedback from students is presented and discussed. The experience gained from the course re-design process may provide useful guidance to those considering ways to update existing courses in engineering or engineering technology to address diversity issues.

Introduction

Multicultural course change is aimed primarily at preparing students to function in a multicultural society and in a globally connected world. The change will also allow courses to better meet the educational needs of all students by providing an honest view of reality with respect to diversity issues including diversity in the work place. The reasons for such course change include but are not limited to providing more comprehensive, accurate, intellectually honest views of reality; prepare all students to function in a multicultural society; and better meet the learning needs of all students, including those who are diverse.⁽¹⁾

Course and pedagogy development as part of institutional change for responding to cultural diversity and combating racism is an ethical imperative for campuses with diverse student bodies but it has equal relevance for more homogeneous campuses.⁽²⁾ For this institutional change to succeed, it must be part of its culture. An organization's culture is reflected in what is done, how it is done, and who is involved in doing it. It concerns decisions, actions on an instrumental and a symbolic level.⁽³⁾

It is important to note that the process of change can make a faculty member somewhat uncomfortable at the beginning but that is normal. People will not venture into uncertainty unless they or others appreciate that difficulties are a natural part of any change scenario and if people do not venture into uncertainty, no significant change will occur.⁽⁴⁾ In addition change efforts are most successful when they are guided by a vision of the future.⁽⁵⁾

Accreditation Board for Engineering and Technology (ABET) outlined in the technology criteria 2000 that ET programs must demonstrate that graduates have a respect for diversity and a knowledge of contemporary professional, societal and global issues.⁽⁶⁾ Transforming a course to be more inclusive in terms of diversity will help achieve this ABET accreditation criteria.

Universities and colleges across the country are responding to these issues through increased emphasis on multiculturalism in the curriculum.⁽¹⁾ A survey of 196 colleges and universities found that over one third of all such institutions have multicultural general education requirements; that over half have introduced multiculturalism into their departmental course offerings, most frequently through the addition of new material to existing courses.⁽⁷⁾

The UPJ Diversity Working Group (DWG)

The University of Pittsburgh at Johnstown (UPJ), led by President Dr. Albert Etheridge has responded to the challenge of addressing diversity issues. The President appointed a Diversity Working Group (DWG) for the purpose of exploring ways to promote and enhance campus diversity. The DWG is made up of faculty, staff and students and is chaired by the president himself who charged the DWG with tasks including:

- Meeting on a regular basis to discuss ideas, share data and information, and draft specific proposals.
- Advising the President on matters of importance pertinent to campus diversity issues.
- Assisting in developing programs, which have the potential to enhance diversity awareness.
- Focusing on diversity as a campus-wide issue.
- Developing and distributing campus-wide goals and objectives.
- Assisting with developing strategies for incorporating goals and objectives into the UPJ's five-year plan.

The DWG has completed the phase of developing goals and objectives and is currently in the second phase that entails the examination of ways to achieve the objectives. The strategic goal has been that UPJ will foster an environment which actively celebrates and encourages diversity. A number of strategic initiatives were also developed as follows:

- UPJ will work to generate greater sensitivity to and a better understanding of diversity.
- UPJ will continue to recruit and strive to retain students, faculty, and staff from underrepresented groups.
- UPJ will prepare students to function in a diverse and dynamic workplace.
- UPJ will prepare students to function in an international environment and globally connected and changing world.

A number of objectives were developed to support each of the strategic initiatives in order to facilitate achieving the stated goals. The president has also established working subgroups with responsibilities to review and examine the developed objectives and to determine how they can be executed.

One of the tasks under study was reviewing opportunities to incorporate diversity within the curriculum. Course transformation has been identified as a way for faculty to address this task. This paper presents an example of incorporating diversity issues into an existing ET course.

The Faculty Diversity Workshop

Since 1995, the Office of the Provost with assistance from the Advisory Committee for the Faculty Diversity Seminar and the Center for Instructional Development and Distance Education (CIDDE), at the main campus in Pittsburgh, has been sponsoring a two-week faculty workshop aimed at giving faculty members an opportunity to review and revise courses to reflect issues of diversity.

Members of the DWG have been encouraged to participate in the workshop to bring back and share with the UPJ faculty the experience that may assist those interested in making their courses more inclusive, primarily in terms of gender and race in both content and pedagogy.

Faculty members from a variety of disciplines within the University have participated in this two-week program. The seminar has been designed to enable participants to:

- Increase their awareness of diversity.
- Identify ways that diversity issues may be addressed through teaching and learning activities.
- Transform the curriculum for one course to incorporate content related to diversity.

The author participated in the two-week seminar, which was intense and conceptually applied with a rich schedule of daily activities. Some highlights of these activities included:

1. Daily discussions of assigned reading materials. The seminar coordinators Dr. Audrey Murrell and Dr. Valire Copeland facilitated the discussions allowing participants to use their varying communication styles and taking ownership of opinions stated. Some of the main topics discussed were:
 - A Rationale and Framework for Course Change
 - Curricular Transformation
 - Conceptualizing Curricular Change
 - Curricular Transformation and Design
 - Creating The Climate for Diversity
 - Assessment of Student Learning
 - Organizational Change
2. An active session by the Associate Director for Instructional Design and Faculty Development. The hands-on session was especially helpful in learning how to write course outcomes including multicultural ones.

3. Individual consultations with CIDDE instructional designers who have a great deal of experience in course transformation and re-design.
4. Discussions with previous seminar participants.
5. Preparation and presentation of revised syllabi.

Course Transformation and Implementation

Transportation (CET-1123) was selected for transformation. Transportation is a required course at the junior level in the Civil Engineering Technology (CET) department at UPJ. Only Civil Engineering Technology (CET) students take the course which is preceded by two sophomore-level courses in surveying.

The transportation course is design and problem solving in nature. It develops students' ability to use mathematical formulas, specifications and guidelines by design agencies, assumptions and finally common sense to recommend solutions for a given transportation problem. The transportation class contained 39 students. The class was made of predominantly white students. Female and older students were the most visible forms of diversity in this class and also at UPJ in general.

The major steps followed in the transformation process included a literature review of articles and books dealing with aspects of diversity in the classroom; design of course outcomes, and multicultural goals; deciding on the nature and level of change in the course content, instruction, assessment, and class dynamics; and implementation.

The idea of course transformation for the transportation course was challenging because most topics covered were technical in nature with little emphasis on diversity or social issues. It was expected that course transformation may affect one or more of the four course components: content, instruction, assessment, and class dynamics. In reality, it is difficult if not impossible to separate out these components. Therefore, course changes are addressed in the following paragraphs without referring to a specific course component.

The course outcomes were written to include both the technical and the multicultural outcomes. Selected outcomes along with the ones related to diversity (shown in *italic* style) are given below:

- Define the demand and supply curves for a transportation facility.
- *Define the human perception-reaction process.*
- Calculate the resistance forces affecting the operation of a vehicle (air, rolling, grade, and curve).
- *Develop a set of trip generation curves from social and economical data.*
- Determine trip generation and attractions of zones.
- Conduct traffic studies including fieldwork, data analysis and report writing.
- *Function in diverse teams and diverse environments.*
- *Understand the importance of functioning in a globally connected and changing world.*

For instance, drivers and pedestrians are humans and the diversity of their physical characteristics affects the analysis and design of transportation facilities. The discussion of this topic brings in the issue of physical disabilities and age as forms of diversity. Students need to value and gain an understanding of the role these forms of human diversity have in our lives and in engineering design.

The lecture schedule and course policy in the syllabus also had added content related to diversity including the following examples:

- *Characteristics of the Driver, the Pedestrian, the Vehicle, and the Road.*
- *Examples of US and world Transportation Projects.*
- *Guest Speaker (from a minority group).*
- *In the lab, diverse teams will be formed by the instructor to resemble a real world situation in transportation engineering practice.*

The teamwork as it relates to diversity was addressed in the lab portion of the course. Cooperative learning was used as the instruction style in the lab. Cooperative learning is defined as instruction that involves working in teams to accomplish an assigned task and produce a final product, under conditions that include the elements: Positive Interdependence, Individual Accountability, Face-to-Face Promotive Interaction, Appropriate Use of Teamwork Skills, and Regular Self-assessment of Team Functioning. ⁽⁸⁾ The term “team” is used here and not “group” because in teamwork, activities span for a long time (weeks or whole semester) while activities span for a short time for group work. Also, teams are formed carefully while groups are formed spontaneously. ⁽⁹⁾ The students worked in teams of three or four and were carefully formed by the instructor. Academic research indicated that instructor-formed teams performed better than totally self selected teams. ⁽¹⁰⁾

At the beginning of the semester, students were asked to fill out a student data sheet in which they provided information about their technical background and experiences inside and outside of school as well as their interests. The student data sheet provided feedback on each student’s prior learning to help determine the “starting” point of instruction. ⁽¹¹⁾ The student data sheet also included information that will help the instructor in team formation. One of the considerations in team formation was that each student was given the opportunity to name another student whom he/she wished to work with and another student, if any that he/she did not like to work with. ⁽¹²⁾ Students were told that their choices will be taken into consideration but can not be guaranteed because of feasibility problems such as the case when many students name one student whom they wish to work with. The instructor distributed female students and older students such that each team included an element of diversity to the extent possible.

Emphasis was placed on team members to respect each other and to find ways for effective communication. Another consideration was that students with background or previous experience in traffic studies, gained from summer internships or part time jobs, were distributed throughout the teams to maximize sharing of experience. Grading student performance and teamwork was done such that individual accountability was considered in the grading. With each submission, students rated each team member with respect to the degree to which each member has fulfilled his/her responsibilities in completing the lab assignment. ⁽¹⁰⁾

Lab handouts were also redesigned to incorporate issues of diversity when possible. A summary of selected added content from lab assignments is given below:

- *Each individual locate an Internet site of an active organization or association in transportation and briefly describe its role, responsibilities, and its diversity issues and policies. You may choose from the list below. Each individual submits her/his summary of the role, responsibilities, and diversity policies of an active transportation organization or association.*
- *Comment on the influence of human diversity on traffic accidents.*
- *Pedestrians: Observe and record the number of pedestrians crossing each leg of the intersection. Report on the level of diversity in the pedestrian population. Record the number of pedestrians in each category (children, senior citizens, women, physically disabled, people of color etc)”*

In addition, the requirements of a term paper were reviewed to allow students to examine diversity as it relates to transportation issues. Students were given suggestions for topics to choose from but they were also allowed to choose a topic of their own. The instructor directed students to make efforts to understand and value diversity issues in a variety of ways including:

- Obtaining technical design requirement for the physically disabled as they relate to parking and signal design.
- Being aware of the diversity of the population from field visits to areas of diverse population that students perhaps do not usually visit.
- Allowing students to freely pick topics that relate to diversity and discuss them in class.
- The team approach gave students an opportunity to deal with, understand and hopefully value the diversity within their teams before addressing diversity issues in the larger population.
- Giving some open-ended problems allowing students to discuss alternate design solutions to transportation problems. This also sent a message on the importance of having a vision of flexibility and acceptance of diverse technical solutions and diverse perspectives.

In order for the change or transformation to succeed, the instructor has made every effort not to make diversity an independent topic in the course but rather gradually integrated diversity issues in the course as they naturally relate to the different technical topics. For example, diversity issues were not emphasized in class the way they were in this paper. Also assignments did not show diversity related material in italic style as they appeared in this paper.

In class, the instructor made every effort to encourage equity among students in their participation and unbiased behavior by the instructor. Female students and male students from underrepresented groups such as older students were generally quiet in class and did not take a major role in class discussions. Therefore, unbiased class interaction between the instructor and all students was very important from diversity standpoint. The instructor also used his background and significant experience working in diverse environments in the US and overseas to emphasize to students the importance of functioning in a diverse work place and in an international environment. Students were told directly and indirectly that in the real world they do not choose their teammates. Therefore, they must find ways to effectively and successfully communicate with their teammates in order for the project and for them to succeed.

The Director of Engineering Technology and Vice President for Academic and Students Affairs, Dr. Jerry Samples wrote in support of the author attending the Faculty Diversity Seminar *“In the area of Engineering Technology, there is a need to add a sense of diversity to the curriculum. Graduates of the program have generally stayed within the state, and often within the immediate counties that surround UPJ. More of our graduates are venturing across these boundaries and are finding a world that is different from the one in which they were raised. Diversity issues are new to many of them and it is important that we bridge this gap in their social education”*.

In the process of preparing the students for the reality of working in a diverse domestic workplace or perhaps in an international environment, the instructor shared with students aspects of his own experience working in diverse environments. The instructor also shared with students some of the lessons learned from the experience of being part of a majority population at times and then becoming part of a minority population during other times. For example, an American white male pursuing a job in engineering in a country overseas is likely to become a member of a minority group in that country. Many of the US international companies design and execute engineering projects overseas. They essentially require their employee to be able to effectively communicate with other foreign nationals in companies overseas. One example the instructor discussed with students was a project executed in United Arab Emirates with collaborative efforts by three offices of an international company in the US, England and Australia.

Feedback from Students

A questionnaire was administered at the end of the semester to obtain feedback from students on their abilities to achieve the course outcomes listed in their syllabus. The list consisted of 21 outcomes, which included both the technical, and diversity related outcomes. The answer format was multiple-choice such that the range of responses was from "0" meaning *"No Understanding of the outcome listed or I have never heard of this concept"* to "5" meaning, *"I feel that I have mastered this outcome and I understand the concept completely"*. The intermediate ratings 1, 2, 3 and 4 were given without specific wording. Students were asked to rate their level of understanding and mastery of each concept and select a corresponding rating between 0 and 5. Figure 1 shows that the transportation class consisted primarily of juniors and seniors. The course was recently made a required course for the junior class. Although the current senior class was not required to take this course, a significant number of senior students took the course as a technical elective.

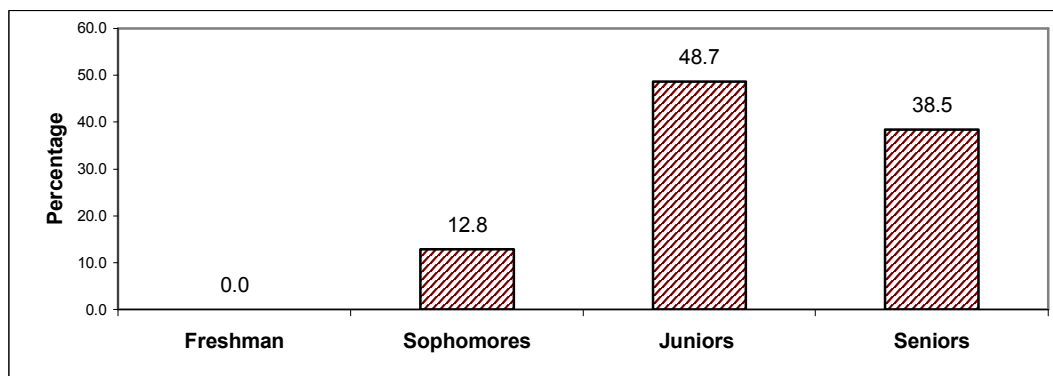


Figure 1. Course Academic Level

Table 1 presents the student responses with respect to their abilities to achieve the course outcomes listed in the syllabus. The average student response has been used to quantify the response by students to these questions as shown.

Table 1. Student Responses to Questionnaire

No.	Course Outcome	Average Response *
O1	Define the demand and supply curves for a transportation facility.	3.7
O2	Define the human perception-reaction process	4.6
O3	Calculate the resistance forces affecting the operation of a vehicle (air, rolling, grade, and curve)	4.3
O4	Calculate the minimum radius of a circular curve.	4.4
O5	Calculate the braking, stopping, and passing sight distances.	4.7
O6	Analyze traffic accident data and compute accident rates.	4.3
O7	Develop and sketch speed-flow-density relationships.	4.0
O8	Apply the principles of queuing theory to solve traffic problems.	3.8
O9	Identify the different traffic control devices and the different types of conflict points at intersections.	4.4
O10	Design traffic signals using Webster and HCM methods.	4.2
O11	Determine the level of service (LOS) of a highway facility.	4.6
O12	Design a freeway facility (number of lanes in each direction) using the HCM procedures.	4.5
O13	Utilize the Highway Capacity Software (HCS) in the analysis and design of highways.	4.4
O14	Develop a set of trip generation curves from social and economical data.	3.8
O15	Determine trip generation and attractions of zones.	4.0
O16	Apply the gravity model to compute trip interchanges between zones (trip distribution).	3.9
O17	Compute modal splits using (auto vs. transit) using Logit models.	4.0
O18	Assign trips to a highway network using all or nothing approach.	4.3
O19	Conduct traffic studies including fieldwork, data analysis and report writing.	4.7
O20	Function in diverse teams and diverse environments.	4.7
O21	Understand the importance of functioning in a globally connected and changing world.	4.7

* Zero (0): No Understanding of the outcome listed or I have never heard of this concept.
 Five (5): I feel that I have mastered this outcome and I understand the concept completely.

It can be seen from both Table 1 and Figure 2 that the three course outcomes related to diversity (in bold) all received high scores from students. Perhaps diversity related issues are not as challenging to understand compared to the technical outcomes but the scores still indicate that students took notice of the issues. The response to the last two outcomes in particular is an indication that students feel they were better prepared, after the course, to work in teams in diverse places and in diverse environments. The response to the last question also indicates that students have gained better understanding of the importance to function in a globally connected and changing world. On the other hand, most technical outcomes also received high marks indicating that no sacrifice of technical content occurred from including diversity issues.

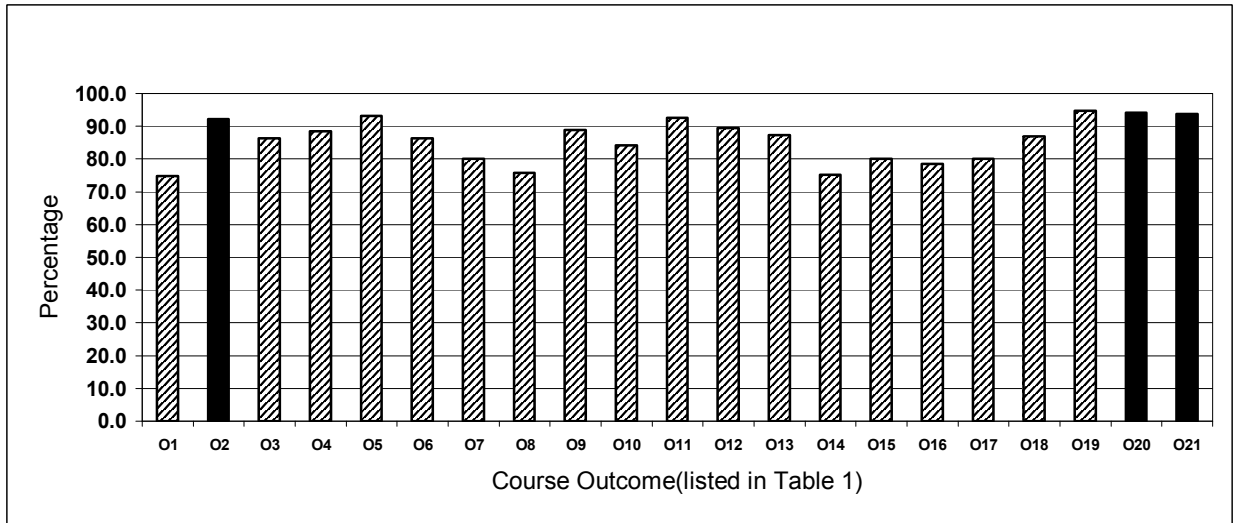


Figure 2. Student Responses to Questionnaire

It should be noted that the mastery of course outcome questionnaire was not administered in previous course offerings. Consequently, it was difficult to examine if there were changes in student competence with respect to the technical aspects of the course. But student course evaluations were very positive and consistent with those in previous years indicating no negative feedback from students on the teaching process of the course when diversity issues were included.

Summary and Conclusions

An initiative involving the transformation of the transportation course, to be more inclusive in terms of diversity, has been undertaken in the Civil Engineering Technology department at UPJ. The initiative was in response to a recently developed UPJ diversity statement urging faculty to find opportunities within the curriculum to address diversity. The process of course transformation was initiated in a two-week faculty diversity seminar sponsored by the office of the Provost at the University of Pittsburgh.

- Course transformation can help prepare students to function in a multicultural society and in a globally connected world.
- Course transformation is likely to change one or more of the four course components: content, instruction, assessment, and class dynamics.
- For the change to have significant effect on the students other faculty members need to consider transforming their courses as well and the process should become part of the university culture.
- The existence of both the UPJ Diversity Working Group and the Faculty Diversity Seminar made it possible for this pilot project to materialize.
- Most students in this class expressed with confidence their ability to work in diverse teams and in diverse environments. They also indicated having better understanding of the importance to function in a globally connected and changing world.
- Transforming technical courses in engineering technology, to make them more inclusive in terms of diversity, is not an easy task but can be done and is worth the try.

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