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# Development of a ”Gender in Engineering and Technology Careers” course

**Dr. Leslie Hopkinson, West Virginia University**

Dr. Leslie Hopkinson is an Associate Professor in the Wadsworth Department of Civil and Environmental Engineering in the Statler College of Engineering and Mineral Resources, specializing in water resources. She received her B.S. in Biological and Agricultural Engineering at Louisiana State University and her Ph.D. in Biological Systems Engineering at Virginia Tech. Her research is related to hydrology, reclamation, ecological engineering, and engineering education.

# Development of a "Gender in Engineering and Technology Careers" course

***Leslie Hopkinson***
*Wadsworth Department of Civil and Environmental Engineering*
*West Virginia University*
*Morgantown, WV 25606*
*Email: Leslie.Hopkinson@mail.wvu.edu*

## Abstract

To excel in their future engineering and technology careers, students will need to navigate in a diverse workforce. This work describes the design and initial implementation of a course that examined gender in engineering and technology careers. Course learning outcomes included discussing influential women engineers and their contributions to engineering and technological accomplishments, identifying and discussing barriers that result in gender inequality in the engineering and technology workforce, and applying professional development skills to move into and to sustain in a diverse engineering workforce. The course was initially delivered to junior- and senior-level civil engineering undergraduate students in a face-to-face format. Course delivery and organization, assessment strategies, and student perceptions are discussed.

## Introduction

Research shows persistent gender inequality in the engineering workforce.[1,2] This paper discusses an undergraduate engineering course that investigated the systematic, societal, and structural barriers that limit gender diversity in engineering and technology professions. Introducing this information in the undergraduate level will help students navigate and promote a diverse workplace. The course has been taught one time to 18 students. Recruitment consisted of a flyer distributed through email and information provided by academic advisors. Course development is ongoing. Course delivery and organization, assessment strategies, and student perceptions are discussed in the following sections.

## Course details

The course was initially delivered to junior- and senior-level civil engineering undergraduate students as an elective in a face-to-face format. Course details including learning outcomes, organization and activities, and assessment strategies are described below.

### *Course learning outcomes*

Course learning outcomes supported ABET student outcomes related to communication and ethical and professional responsibilities. Specifically, students that successfully complete the course will be able to:

1. Discuss influential women engineers and their contributions to engineering and technological accomplishments

2. Identify and discuss barriers that result in gender inequality in the engineering and technology workforce
3. Apply professional development skills to move into and to sustain in a diverse engineering workforce

*Course organization and activities*

To address the three learning outcomes, the first half of the class focused on topics related to gender inequality in the engineering and technology workforce. The second half of the semester focused on topics related to professional development skills to succeed in a diverse engineering workforce. The contributions of influential women engineers were explored throughout the semester (Table 1).

Table 1. List of major topics and assessments by week

| Week | Topic | Assessments |
|---|---|---|
| 1 | Course introduction, women are leaders | |
| 2 | Women in engineering and technology, trends (academia/workforce) | Journal 1: Notable engineer |
| 3 | Prominent women in engineering and technology | Journal 2: Personal reflection |
| 4 | Implicit bias, barriers | Project 1: Women in engineering profile |
| 5 | Imposter Syndrome, engineering identity | Journal 3: Barriers and solutions |
| 6 | Strategies for students in engineering and technology | Journal 4: Pay gap |
| 7 | Network, mentors, and sponsors | Project 2: Structural and cultural barriers |
| 8 | Gendered communication, engineering communication | Journal 5: Elevator speech |
| 9 | Work-life balance, family support, time management | Journal 6: Family-work policies |
| 10 | Job-hunting and gender | Project 3: Job Search |
| 11 | Career path and progress, certification | Journal 7: Professional certification |
| 12 | Professional development and advancement | Journal 8: Professional societies |
| 13 | Resources for women in engineering and technology careers, promoting diverse participation | Project 4: Career plan |
| 14 | Changing the culture | Journal 9: Personal statement |
| 15 | Prominent women in engineering and technology | Journal 10: Notable engineer |
| 16 | Insights from professionals | Journal 11: Personal reflection |
| Finals week | | Project 5: Final course project |

Students in this course were primarily junior- and senior-level engineering students. As this population is often not accustomed to discussion-based courses, a variety of delivery options

were utilized to encourage participation from all learners. Some class activities included:

- A gallery walk[3] was used to provide individual feedback on student work. This activity allowed students to critically review the work of classmates, provide anonymous or named feedback, and incorporate peer feedback in their projects.
- Google Jamboard was used to guide student small-group discussions, record student input, and act as a visual aid to share group thoughts with the class. Jamboard was effective in providing a framework for group discussion, but often students had difficulty when accessing with mobile devices. Often, time was wasted when trying to add their group information to the slides.
- Students completed individual exercises related to topics like implicit bias and career paths. We followed these individual activities with a class debriefing.
- Students created an elevator speech to be used at a career fair. Students presented their speech to a classmate and provided feedback. These pairs were rotated every five minutes so that each student got peer feedback from most of their classmates. They submitted an updated elevator speech, incorporating the peer-feedback, later in the semester.
- TimeMapper[4] was used to map contributions of influential engineers throughout the semester. This product was shared using the learning management system so students could review and expand the database outside of class.
- Word-cloud reflections were made at the end of class using Mentimeter[5]. Students were asked to provide a one-word reflection of the class activities. Results were posted to the learning management system and shared with guest speakers when appropriate.
- Games and ice-breaker activities were used both to create a sense of community in the classroom and to reinforce course topics.
- Think, pair, share activities[6] were used to actively engage the students in course discussion.

This course also included lectures, presentations, and mentoring from professionals in engineering and technology fields. We ended the semester with guest lectures from prominent women engineers in various stages of their career that represented a range of disciplines. Guest speakers addressed topics such as desired qualities when hiring, upcoming industry trends, general career advice, skills for success, and managing work-life balance[7].

*Assessment strategies*

Course grades were primarily computed from weekly journal entries and five course projects. To maintain engagement outside of the classroom, one assignment was due each week. Topics of the assessments reinforced items discussed in class (Table 1).

The journal assignments allowed students to reflect on topics presented in class and express their thoughts. Some journals required students to complete research and report to the class. In general, the journal entries were at least a one-page written response. The journal entries were evaluated based on content, communication, and format.

A series of four individual projects were completed during the semester. One summative, group project was submitted at the end of the semester. Brief project descriptions follow.

- Project 1: Women in engineering profile.

  In support of course learning outcome #1, students completed an in-depth biography and summary presentation of an individual woman or group of women who have contributed to engineering and/or technology. Students self-selected their topics in order of first request and reported their selections in our learning management system. Each student was required to research a different engineer so there were no overlaps in teaching their classmates in their summary presentations. Students researched elements such as personal information, education, career highlights, awards, and achievements. The written biography was evaluated based on purpose, content, organization, tone, writing mechanics, length, use of references, quality of references, and reference style. The presentation was assessed based on completeness, organization, visuals, writing mechanics, and presentation length.

- Project 2: Structural and cultural barriers

  In support of course learning outcome #2, students completed an annotated bibliography and infographic related to one of the structural or cultural barriers women in engineering fields face. Students were required to review at least three primary sources and summarize information in an infographic. They shared their work with classmates in a gallery walk[3]. Annotated reviews were assessed primarily by source type and quality (i.e., peer reviewed), summary points, reflection response, and format. The infographics were assessed primarily based on content, organization, visual appeal, focus, citations, and format.

- Project 3: Job search

  In support of course learning outcome #3, students evaluated five job postings that they may be interested in applying for. Using guidance from University of Massachusetts Lowell[8], students evaluated the job postings based on interest, practical fit, work schedule, work environment/culture, professional development opportunities, compensation, and location. They also identified deliverables needed to apply for the position and reported next steps for them to move forward (e.g., courses they should take, people they should talk to, experience needed).

  The second part of this project required students to prepare a resume in response to one of the job opportunities that they evaluated, update their elevator speech based on classmate feedback, and write a reflection of the job search process. They were prompted to discuss how their qualifications matched the skills, education, and experience need in the job postings; describe strategies to gain needed experience and skills; and reflect on the job postings that they reviewed in terms of personal fit.

- Project 4: Career plan

  In support of course leaning outcome #3, students developed a career plan to identify a long-term vision of professional goals and objectives. Following guidance from Williams

and Emerson[9], students prepared a career plan reporting long-range career objectives; realistic assessment of current strengths; education; experience desired; experiences and type of work to avoid; strategies to incorporate diversity, equity, and inclusion in future career plans; one-, three-, and nine-year goals; and a list of action items to reach their goals.

- Project 5: Final course project

  The final project was intended to be a summative group project in support of learning outcomes 1-3. Students were required to develop some type of product/exhibit to be shared with the class, but the topics were student driven with input from the instructor. The projects were completed in self-selected groups based on common interests. Students developed groups using a silent brainstorming and affinity process[10]. In class, students individually brainstormed project ideas by adding ideas to post-it notes. Then we consolidated topics and product/exhibits into common groups. Students then self-selected their groups and refined their project ideas.

  Student groups prepared a project pitch for instructor approval. Then, they developed a proposal and discussed with the instructor to ensure appropriate project scope. Groups then created a product/exhibit to share with the class. Individually, students were required to complete a written reflection and peer assessment. Example student-driven products included a comic following the experiences of a young girl interested in engineering, brochures addressing implicit bias to a range of audiences, and plans for a videogame examining work-life balance.

**Student perceptions**

A survey was distributed to students in week five of the semester and at the end of the semester that requested feedback regarding student perceptions of diversity in the engineering field. Participants were asked to what extent do you agree or disagree with the statements shown in Table 2. Responses were recorded on a five-point scale.

Generally, respondents agree that there is an interest in learning about diversity in engineering, strongly agree that it is important for engineers to learn about diversity as part of their undergraduate education, and agree that learning about diversity in engineering careers will be useful in a future career as an engineer (Table 2). However, there was a low response rate (10%-17%), suggesting additional feedback is needed.

Table 2. Mean response to student perceptions survey

| | Week 5 | End of semester |
|---|---|---|
| I am interested in learning about diversity in engineering. | 4.0 | 4.5 |
| It is important for engineers to learn about diversity as a part of their undergraduate education. | 4.7 | 5.0 |
| Learning about diversity in engineering careers will be useful to me as an engineer. | 4.0 | 4.5 |

Note: Strongly disagree=1, disagree=2, neither agree nor disagree=3, agree=4, strongly agree=5

## Lessons learned

This course reinforces essential skills related to working in effective teams, communicating in a variety of forms, and participating in a diverse and inclusive professional environment. The use of a variety of facilitation techniques were necessary to keep students engaged in daily classroom discussion and activities. Some of the facilitation techniques like the gallery walk, think-pair-share activities, icebreaker activities, games, and peer-evaluation were especially successful in getting participation from many of the students. In the future, I plan to expand the types of activities to include elements of active learning, collaborative learning, and cooperative learning[11] to help with engagement.

Professional speakers from a variety of fields spoke with our class, providing advice for the future workforce. Because of modern communication tools, we were able to accommodate speakers both in person and by webinar, expanding the access to professional speakers. Due to scheduling, these presentations occurred at the end of the semester. In the future, it would be beneficial to distribute the speakers throughout semester to help with student motivation.

The intent of this class was to help future engineers navigate a diverse workforce. I recognize and made students aware that all issues related to gender and engineering could not be fully addressed. Much of the literature addresses the experiences of women in leadership[1]; therefore, the experience of women engineers was often the focus. With each teaching of the course, I plan to expand the issues as relevant research and literature allows.

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