

Benefits and Challenges of Teaching a First-Year Engineering Experience Course at a Small Campus

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Full Paper: Benefits and Challenges of Teaching a First-Year Engineering Experience Course at a Small Campus

Abstract – This work, covers our experience teaching a first-year engineering course at a small campus and our continuous effort in improving the course. The paper covers the main objectives of the course, which has remained constant over the years, but the methodology has changed to accommodate the external changes related to students' culture and the technology. Instructors who have taught this course have adopted the same course objectives but have used different approaches. The paper includes experiences from different instructors who have taught the course at our location, the changes that we have introduced and the reasons behind them, as well as a brief literature review. The paper also discusses challenges associated with offering the course from faculty and students prospective.

Introduction

Many of today's engineering educators have recognized the need to develop a first-year engineering course [1]-[8], which would help students in areas such as: making a successful transition from high school to college; recognizing the importance of academic performance; stimulating interest; initiating the development of important engineering skills such as teamwork, leadership, and communications; making an informed decision regarding their major, and improve retention [9]-[13]; introduction to engineering design [14]-[17] and appreciating the role of engineers in society [18]-[20]; as a sample. This need was also recognized by our engineering department, more than fifteen years ago, when we had only 50 students enrolled in our engineering program and has continued with a current enrollment of around 150 students in the program. This work describes our experience teaching such a course, describing our teaching and learning objectives, and our recommendations.

Course Structure

The first-year seminar (FYS) course has been offered as a one-credit-hour course required for all freshmen engineering students. The course has no prerequisites, and a full-time faculty teach it. In the beginning, we only offered one section of the course, and with the increased enrollment in the engineering program, we are now offering three sections. A different faculty teach each section with the same learning objectives but with different approaches, such as different course project. Classes will meet once a week for fifty minutes. Student assessment is based on the following components.

- Class participation
- Individual homework assignments
- Team-based homework/project assignments/reports
- Team-based presentation

Our teaching objectives were shaped by our desire to enrich the lives of our students by helping them to obtain necessary skills that would help them in their study and their life. We realized

that to accomplish our goals we need to make sure that our students have an in-depth knowledge of their major field of study, broad understanding of the engineering and its impact on society, skills in communication and critical inquiry, multi-cultural and global perspectives, active participation in professional communities, and a clear understanding of ethical choices inherent in human development. To accomplish these objectives, the following topics, with the anticipated outcomes, were developed:

Topics Covered:

1. Keys to success in Engineering Study
2. Success in the Classroom
3. Problem Solving
4. Personal Growth and Development
5. Teamwork
6. Project Management
7. Engineering Design
8. Communication Skills
9. Ethics and Engineering
10. Robotic (Arduino) Project

The main consideration, while preparing these topics, was that the focus of the course was not to make the students understand all the details from each topic. Instead, the objective was to expose them to these topics, a sample schedule is included in this paper.

Anticipated Outcomes

1. Develop academic success skills such as time management, study techniques, working in teams, and study groups.
2. Develop a peer network to maximize academic success.
3. Obtain and enhanced understanding of different engineering fields and associated jobs.
4. Recognize the role of good communication (listening, verbal, written and electronic) skills in engineering.
5. Be able to develop teamwork and leadership skills by means of active and positive participation as a team member.
6. Recognize the importance of educational and career planning.
7. Obtain a clear understanding of the importance of ethics in engineering.
8. Be able to define engineering design and explain the basic design process.
9. Be able to effectively apply problem solving and design processes in a project.

Discussions & Recommendations

In this section, we present a short discussion regarding the role and usefulness of a first-year seminar course in a small program including some recommendations and future direction.

Our primary motivation behind the development of an FYS course came from the desire to help our students with their academic performance, based on consistent observations that confirmed lack of or weak study skills as a major contributor and not being satisfied with the outside classroom services to remedy such issues. We believe our student population can benefit

significantly by helping them to improve their study and time management skills. While most universities provide student services that would cover these skills, but our experience shows that a good number of students who need such help would not contact the related offices or would contact them late, after few semesters of poor academic performances. We see many benefits with this early intervention as part of the curriculum and would even recommend a follow-up course, under general education category, in the sophomore year.

We have also used this course to introduce students (or re-introduce depending on the major) to the engineering design methodology and expect them to apply the engineering design principal to the course project and demonstrate that in their project report. We have used a variety of projects in this course such as Lego robotics, 3D printing-based object design, and Arduino-based projects. We believe more exposure to the engineering design methodology would be very beneficial to students, and it can also enhance their systems thinking skills [21].

The course also includes assignments that would ask students to research other engineering fields, besides their initial interest as well as developing a comprehensive “guide” that would exhibit the required courses for each semester until they graduate. This will provide them with a better understanding of the consequences of dropping a course or not taking a course when they are expected.

We have used different textbooks, [22]-[23], teaching this course as well as not using a textbook. Our experience shows that if the topics are covered with adequate discussions, using a textbook is not a crucial factor. Having said that we realize that there are many benefits to adopting a textbook, and two out of the three sections, offering the course, use a textbook.

We believe a first-year seminar (or experience) course can play an important role in filling up the gap that exists between engineering programs expectations regarding soft skills, such as time management and study skills, and the reality. Learning or mastering these skills are generally left to the student services, which our experience has shown not to be very successful. Moreover, an FYS would provide an ideal platform to talk about and practice teamwork and ethics in a formal setup. Although, engineering design may be covered in other freshman engineering courses, due to the importance of the subject we believe repetition is going to be beneficial. We all the benefits that are associated with an FYS course, we believe a three-credit course format, rather than a one-credit format would be more valuable. This would provide more time to cover the subjects and as students would take the material more seriously. We understand that this is not going to be an easy task especially for large programs but can be done in a smaller program [24] and deserves more attention, given the very clear associated benefits. We believe such an addition will further strengthen the implementation of a “cornerstone-capstone” approach [25].

Finally, although this course includes a Student Rating of Teaching Effectiveness (SRTE) survey at the end of the semester, given its potential role in helping students to choose an appropriate major and improving their soft skills and their impacts, which would not be fully realized until long after the completion of the course, we are recommending (additional) student survey(s), after a year and/or two of completing this course. The survey(s) would focus on student learning

(e.g., performance in design task and problem-solving) and affect changes (e.g., confidence in their selection of the major). We believe this approach would provide us with early detection and possible opportunity for intervention with huge associated benefits.

References

- [1] Meyers, K., et.al., "Perspectives on first year engineering education," *Proceeding of the 2008 American Society of Engineering Education Annual Conference, Pittsburgh, PA.*
- [2] Kuh, G.D., J. Kinzie, J.H. Schuh, and E.J. Whitt. *Student success in college: Creating conditions that matter.* San Francisco: Jossey-Bass, 2005.
- [3] Ochoa, H.A, and Mukul Shirvikar, "An Update: The Engagement and Retention of Electrical Engineering Students with a First Semester Freshman Experience Course," *Proceeding of the 120 Annual American Society of Engineering Education, Atlanta, GA, 2013.*
- [4] Paretti, Marie, and Kelly Cross, "Assessing First-year Programs: Outcomes, Methods, and Findings", *Proceeding of the 2011 American Society of Engineering Education Annual Conference, Vancouver, British Columbia.*
- [5] Argow, et.al., "Introduction to Engineering: Preparing First-Year Students for an Informed Major Choice," *Proceeding of the 2012 American Society of Engineering Education Annual Conference, San Antonio, TX.*
- [6] Gartner, J. B., & Van Wie, B. J., & Reinkens, K. A., & Pitts, S. A. (2016, June), Impacts of Engineering Engagement Activities for First-Year Students Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana.
- [7] Brake, N. A., & Curry, J. C. (2016, June), The Impact of One-Credit Introductory Engineering Courses on Engineering Self-Efficacy: Seminar v. Project-Based Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana.
- [8] Murad, M. M. (2016, June), Making Early Positive Impact on Freshmen through Engineering Technology Seminars Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana
- [9] VanDeGrift, T., & Liao, S. (2017, June), Helping First-Year Engineering Students Select a Major Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio.
- [10] Brown, O., & Hensel, R. A., & Morris, M. L., & Dygert, J. (2018, June), An Integrated Supplemental Program to Enhance the First-year Engineering Experience Paper presented at 2018 ASEE Annual Conference & Exposition, Salt Lake City, Utah.
- [11] Darbeheshti, M., & Edmonds, D. R. (2018, June), A Creative First-year Program to Improve the Student Retention in Engineering Paper presented at 2018 ASEE Annual Conference & Exposition, Salt Lake City, Utah.
- [12] Loughmiller, K., & Keen, J. A., & Benton, K. M. (2018, July), Improve Recruitment and Retention Based on Student Interests Paper presented at 2018 FYEE Conference, Glassboro, New Jersey.
- [13] Chapman, E. A., & Wulsch, E. M., & DeWaters, J., & Moosbrugger, J. C., & Turner, P. R., & Ramsdell, M. W., & Jaspersohn, R. P. (2015, June), Innovating Engineering Curriculum for First-year Retention Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington.
- [14] Azemi, A., and I. Esparragoza. Problem-based collaborative projects in and between freshman and sophomore engineering courses, *Proceedings of the 2005 ASME International Mechanical Engineering Congress and Exposition, Orlando, Florida.*
- [15] Veltman, Tiffany, and William Rosehart, "Work in Progress-Design in First Year Engineering," *Proceedings of the 40th Frontiers in Education Conference, Washington, DC, 2010.*
- [16] Ghosn, B., & Volz, T. (2015, June), Using Project-Based, Experiential, and Service Learning in a Freshman Writing Intensive Seminar for Building Design and Technical Writing Skills (Work in Progress) Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington.
- [17] Talley, K. G., & Ortiz, A. M., & Novoa, C., & Sriraman, V. (2016, June), Integrating an Introduction to Engineering Experience into an University Seminar Course Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana.
- [18] Reid, Kenneth, and Daniel Ferguson, "Work in Progress-Enhancing the Entrepreneurial Mindset of Freshman Engineers," *Proceedings of the 41st Frontiers in Education Conference, Rapid City, SD, 2011.*
- [19] Brake, N. A., & Curry, J. C. (2016, June), The Impact of One-Credit Introductory Engineering Courses on Engineering Self-Efficacy: Seminar v. Project-Based Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana.
- [20] Holloway, E., & Oakes, W. C. (2017, June), Innovative Manufacturing Education Experience for First-Year Engineering Students: Using a Seminar Course and Volunteerism to Enhance Manufacturing Skills Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio.
- [21] Azemi, A., "Promoting Innovation and Entrepreneurship as part of an Engineering Curriculum," *Proceedings of the 2018 Frontiers in Education Conference (FIE), San Jose CA.*

- [22] Landis, R. Studying Engineering: A Road Map to a Rewarding Career, fourth edition, Discovery Press, 2013.
- [23] Oaks and Leone. Engineering Your Future, A Brief Introduction to Engineering. Sixth Edition, Oxford University Press, 2018.
- [24] Chapman, E. A., & Wultsch, E. M., & DeWaters, J., & Moosbrugger, J. C., & Turner, P. R., & Ramsdell, M. W., & Jaspersohn, R. P. (2015, June), Innovating Engineering Curriculum for First-year Retention Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington.
- [25] Gipson, K. G., & Henriques, J. J., & Sequeira, S. (2015, June), Development and Implementation of a Cornerstone Course: Engineering Opportunities Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington.

Sample Schedule

Week	Activities
1	Course outline; Syllabus; Project; Team formation Keys to success in Engineering Study;
2	Discussion Topic: Succeeding in the Classroom (Chapter 4) Teams are finalized
3	Labor Day Holiday
4	Discussion Topic: Succeeding in the Classroom (cont.) Teams are finalized Team HW#1 is assigned Textbook HW #1 is assigned
5	Discussion Topic: Problem Solving (chapter 5) Description of the course project Steps required for design, building, and testing of a robot
6	Team HW#1 discussion Textbook HW #1 due Textbook HW #2 is assigned
7	Discussion Topic: 1. Personal Growth and Development (PowerPoint file) Robotics Progress Report #1 is due HW: Attend engineering job presentation Wednesday 10/11: Auditorium (8:00-8:50) Need to submit a one-page summary
8	Discussion Topics: 1. Teamwork (chapter 7) 2. Project Management (PowerPoint file) Textbook HW #2 is due Team HW#1 report due

	Job presentation panel homework from 10/11
9	Discussion Topics: 1. Project Management (PowerPoint file) 2. Engineering Design (chapter 8) Textbook HW #3 is assigned Team HW#2 is assigned
10	Discussion Topics: 1. Communication Skills (chapter 9) 2. Ethics and Engineering (chapter 10) Textbook HW #3 is due Textbook HW #4 is assigned Robotics Progress Report #2 is due
11	Team HW#2 discussion
12	Final robotics project demonstration Textbook HW #4 due
13	Final robotics project demonstration Team HW#2 report due
	Thanksgiving Holiday
14	Final robotics project demonstration Robotics project report due (documentation, programs, photos, etc.) Optional EURECA poster due
15	If needed: Final robotics project demonstration