

Board 130: Continuous Improvement of a Mechanical Engineering Senior Seminar Using Student Feedback

Dr. Yucheng Liu, South Dakota State University

Dr. Yucheng Liu (PhD, PE, FASME, FSAE) currently serves as the Department Head of Mechanical Engineering (ME) Department at South Dakota State University (SDSU) and holds the Sander Professor of Entrepreneurial Engineering in the Jerome J. Lohr College of Engineering at SDSU. Prior to joining SDSU in the fall of 2021, Dr. Liu was an Associate/Full Professor in the ME Department at Mississippi State University (MSU) since the fall of 2014. In that department, he served as Graduate Coordinator from 2016 to 2021 and held the Jack Hatcher Chair in Engineering Entrepreneurship in the Bagley College of Engineering from 2018 to 2021. Before joining MSU, Dr. Liu was an Assistant Professor of the ME Department at the University of Louisiana at Lafayette (UL Lafayette). Dr. Liu received his PhD degree from the University of Louisville in 2005 and bachelor's degree from the Hefei University of Technology in 1997, both in Mechanical Engineering. Dr. Liu's research has historically focused on the areas of multiscale material modeling and simulation, high strain rate performance of materials, vehicle systems design and analysis, and hydropower and wave energy technology. His current research interests and activities center on gaining a better understanding of the process-structure-property-performance relations of structural materials through advanced multiscale theoretical framework and integrated computational and experimental methods. To date, Dr. Liu has published nearly 250 peer reviewed publications, including more than 130 peer reviewed journal articles, and received 2 patents. He has been the PI and co-PI for over 40 research projects funded by NSF, DOD, DOE, NASA, FAA, Louisiana Board of Regents, and industry with a total amount over \$15.5M. Dr. Liu has served on review panels for many NSF, DOD, NASA, and DOE programs. Dr. Liu received the Junior Faculty Researcher of the Year of the College of Engineering at UL Lafayette in 2013, the Outstanding Senior Faculty Research Award from the ME Department in 2016, MSU and BCOE Faculty Research Award in 2018; he was named to the Jack Hatcher Chair in Engineering Entrepreneurship in 2018 and promoted to Full Professor in 2019. In his professional societies, Dr. Liu was elected a Fellow of ASME in 2017, a Fellow of SAE in 2019, and received the SAE Forest R. McFarland Award in 2020. Dr. Liu is a Professional Engineer registered in Ohio State and also holds active membership in ASEE and AAAS.

CONTINUOUS IMPROVEMENT OF A MECHANICAL ENGINEERING SENIOR SEMINAR USING STUDENT FEEDBACK

Abstract: A senior seminar course has been taught by the author to mechanical engineering seniors at South Dakota State University since Fall 2021. The student feedback received in that semester was not very positive. A strategy for improving this course was then implemented based on students' critiques and suggestions. More complimentary comments from students were received in the following semesters and the course evaluation score was increased from 3.2 (out of 5.0) to 4.0 in only three semesters. This paper demonstrates the approach for a continuous improvement of this seminar course and the measures taken by the author in promoting student engagement and enhancing the learning experience. Lessons learned from teaching this course will help university teachers to improve the quality of seminar courses and make them more "useful" for college students.

Keywords: Curriculum design, mechanical engineering students, senior seminar, classroom instruction, student feedback

Introduction

A senior seminar is a class that students take during their last year of study in college. The ultimate goal of the senior seminar is to prepare seniors for their careers by sharpening their employment readiness skills, helping them choose their career path and set career goals, enhancing their awareness of school-to-career experiences, training them to engineer immediately upon graduation, and making them preferred candidates for jobs. It is an important class to prepare young people for the next chapter in their life, whether it is the world of work or a postgraduate education. However, some students view a seminar as an easier course than traditional college classes or just a filler course randomly put in the curriculum.

It is the instructor's responsibility to make such a course helpful, informative, and interesting. The author has taught a senior seminar course to mechanical engineering (ME) seniors at South Dakota State University (SDSU) since Fall 2021 and taken three semesters to achieve intended course learning outcomes through continuous improvement. Student feedback has long been used by many educators as an important tool in evaluating, revising, and improving their teaching [1-4]. In the past, student feedback was utilized to improve a mechanical vibrations and controls course by adding laboratory and modeling/simulation components into its curriculum [5-8]; renovate a ME senior design class through implementing industry-sponsored group projects [9, 10]; revamp a programming course via teaching C# and MATLAB to ME students [11]; enhance an engineering design course by designing a group project for this course [12]; and make the topics in a thermodynamics course easy to understand by developing instructional courseware for that course [13, 14]. Moreover, Liu and Baker designed a new course assessment tool to effectively collect student feedback through a mixture of closed- and open-format questions, formative and summative questions, and Likert scales [15, 16]. This paper illustrates how the author developed and implemented a plan to improve the ME senior seminar based on the course evaluation results.

About ME Senior Seminar

The ME senior seminar is a highly focused and topical course. Its purpose is to acquaint students with a sufficiently broad spectrum of policies, practices, procedures, and ethics in mechanical engineering. It is a one credit course so a 50-min session per week is devoted to lectures, but two to three hours of outside classwork per week are required. The author joined SDSU in July 2021 and started to teach this class in the fall semester. It is worth mentioning that the author had never taught such a class before.

Based on the ultimate goal of senior seminars and industry expectations for mechanical engineering graduates, objectives of this course were decided as: (1) prepare students to be effective in presenting their abilities and accomplishments to prospective employers; (2) prepare students to communicate with others properly and effectively in a professional business environment; (3) instill a basic understanding of proper professional conduct and ethical behavior. (4) provide students with an introduction to the variety of career paths available and develop an understanding of the potential processes and importance of professional development and on-going learning. (5) encourage a practice of critical analysis of ideas, concepts and information. Aligning with the course objectives, a set of learning outcomes were decided, which includes: (i) a well-prepared resume and professional electronic media presence; (ii) ability to successfully navigate perform well in a personal employment interview; (iii) ability to differentiate acceptable vs. unacceptable conduct in a professional setting; (iv) ability to successfully resolve a problem solving professional ethics; (v) ability to identify standards and/or codes applicable to a particular device or system; (vi) a proposed career plan with a professional development/continuing education strategy; (vii) an awareness and understanding of the ways engagement with diverse groups of people leads to a large variety of design solutions and, ultimately, a better solution than a single perspective would allow.

Since this is a one credit course, projects and exams are not used for assessment. Students will be evaluated on their performance in homework assignments.

Topics Taught in Fall 2021 and Student Feedback

To achieve the course objectives and student learning outcomes, the author selected following topics for the class in his first semester at SDSU (Table 1):

Table 1. Course schedule in Fall 2021

Week	Topics
1	Introduction and social media presence
2	Graduate school
3	Resume basics and LinkedIn profile
4	Interview skills and process
5	Career fair
6	Professional ethics and ethical considerations
7	Technology innovation and engineering entrepreneurship
8	Spring/fall break
9	Career goals and professional development
10	Professional communication and workplace expectations
11	Codes and standards

12	Literature on the value of diverse composition of project teams
13	Professional licensing, continuing education and related topics
14	Internship presentations
15	Course wrap-up

Out of the author’s expectation, the student feedback collected by the end of that semester was overall negative. The average evaluation score was only 3.2 out of 5.0 and the author received quite harsh comments from his students, such as:

“This course has unnecessary work which is pain to do and he (the instructor) grades strenuously.”

“As it is now, this course is a waste of time and does little to aid future engineers.”

“For a one credit seminar class, your (the instructor’s) grading on the homework/quizzes was harsher than most students felt it should have been.”

“You (the instructor) have minimal experience at a company...”

Apparently, this course failed to achieve its goals and objectives and needed significant changes.

Upon reflection, the author found that the students’ critiques had mainly focused on three aspects: (1) the coursework was excessive for a one credit seminar class; (2) the grading was too harsh; (3) the instructor (author) did not have the experience and credibility to some contents such as interview skills/process, professional development, workplace expectations, etc. Based on the feedback analysis, the author developed a plan to improve this course in 2021 winter break.

Course Redesign in Spring 2022 and Student Feedback

In regard to the first and second point, the author pondered if the coursework could be reduced, and a lenient grade scale could be applied. After weighing all pros and cons, the author decided not to reduce the coursework because as a one credit college-level course, students are requested to devote two to three out-of-class hours per week to this class and the amount of coursework aligned well with this guideline. In terms of grading, instead of lowering the requirements on students’ assignments and quizzes, the author would create a positive environment to help his students complete their homework assignments independently and earn good scores. For example, the author implemented an open-door policy to encourage the students to ask questions and request clarifications whenever they needed, either in person or through emails. If a student turned in his/her homework before the deadline, the author would evaluate that homework, send it back to the student with his comments, and allow the student to revise and resubmit his/her work before the deadline. In addition, the author would accept late work with a late penalty of 5% for each day it was late.

With respect to the third point, the author removed some topics not very relevant to the objectives of this course and replaced them with invited lectures by guest speakers, who were senior engineers and engineering managers with abundant experience in engineering. A revised list of topics for this seminar in Spring 2022 is displayed in Table 2.

Table 2. Course schedule in Spring 2022

Week	Topics
-------------	---------------

1	Introduction and social media presence
2	Graduate school
3	Resume basics and LinkedIn profile
4	Interview skills and process
5	Career fair
6	Professional ethics and ethical considerations
7	Invited talk by a research engineer from Raven Industries (20+ years of experience)
8	Spring/fall break
9	Career goals and professional development
10	Invited talk by a manager from Daktronics (30+ years of experience)
11	Codes and standards
12	Invited talk by a technical fellow from Collins (25 years of experience)
13	Professional licensing, continuing education and related topics
14	Invited talk by a manager from 3M (30+ years of experience)
15	Course wrap-up

In the invited talks, the guest speakers shared their background, introduced new developments in mechanical engineering, and provided information about different career paths in mechanical engineering, as well as general insight into overcoming challenges critical to being an engineer in today's world. The author thought that the course must have been greatly improved through those changes and the student feedback in this semester (Spring 2022) should be much better than the one in the last semester (Fall 2021).

However, despite a slight increase, the new student feedback was not so good as expected. On the positive side, the average evaluation score slightly increased from 3.2 to 3.4 and a number of positive comments were received, which reflected the students' recognition for the instructor's attitude toward them and the new grading practices. For example:

"I appreciate the feedback and the opportunities to make up missed points before the deadline."

"...I appreciated all of the energy Dr. Liu put into the class every week, ..."

"This course was excellent, and our instructor was great and very helpful."

"Again, I want to reiterate the Dr. Liu was awesome!"

Among those complimentary remarks, the following comments drew the author's attention and the author keenly realized that the key to make this course a successful one lied in those comments.

"While I actually enjoyed this course, I cannot help but feel as though my time and money were wasted this semester."

"It might be nice to get some insight on personal finance or healthcare plans or retirement packages as we enter the working world."

"It just didn't feel like I learned anything that will prepare me for graduation and my future as an engineer."

Course Modifications in Fall 2022

From the student comments it was found that one critical thing to achieve the course learning outcomes is to make the lectures more “useful” for the students to graduate and start their career as an engineer. On inspecting the synopses and notes of lectures listed in Table 2, the author found that the notes for “engineering ethics” (lecture 6) and “codes and standards” (lecture 11) were dry and further from reality. In one-on-one meetings some students admitted that they were perplexed about the purpose and use of those lectures and therefore got bored and unengaged in the classroom.

To make those lectures “useful” and increase the students’ interest in those subjects, the author converted those lectures to Fundamental Exam (FE) review sessions. Instead of recounting concepts and principles in engineering ethics and codes and standards which were out of touch with reality, the author would relate those principles to the problems selected from past FE exams and elucidate how to apply the fundamental concepts and principles in solving those FE exam problems in engineering ethics and codes and standards. It is worth mentioning that all SDSU ME students are required to take the FE exam during their final undergraduate semester and the FE exam is used as a direct measure to assess the ABET student outcome 4 (an ability to recognize ethical and professional responsibilities in engineering situations and making informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts). Thus, the students could take advantage of those classes (review sessions) when studying for their FE exam.

In regard to the comment on the guest speakers’ background, the author invited an HR benefits specialist from a local company to talk about healthcare plans and retirement packages available in industry and provide guidance for personal financial management in Fall 2022. Table 3 presents a revised list of topics for the seminar in Fall 2022.

Table 3. Course schedule in Fall 2022

Week	Topics
1	Introduction and social media presence
2	Graduate school
3	Resume basics and LinkedIn profile
4	Interview skills and process
5	Career fair
6	FE exam review: Engineering ethics
7	Invited talk by a research engineer from Raven Industries (20+ years of experience)
8	Spring/fall break
9	Career goals and professional development
10	Invited talk by a manager from Daktronics (30+ years of experience)
11	FE exam review: Codes and standards
12	Invited talk by an HR benefits specialist from Daktronics (10+ years of experience)
13	Professional licensing, continuing education and related topics
14	Invited talk by a manager from 3M (30+ years of experience)
15	Course wrap-up

Results

The implemented course modifications received great positive feedback from the students. Student comments were overwhelmingly positive and complimentary of the author's teaching style and the content and value of this course. The average evaluation score also dramatically increased from 3.4 to 4.0. Selected student comments for the course taught in Fall 2022 are listed as follows:

"Great class, I liked all the real-world grounding you gave us."

"Not that I'm the best overall student, but the way you taught this course has been great!"

"Dr. Liu did an excellent job of relating the coursework to real world examples which I greatly appreciated."

"I believe Dr. Liu did a great job in this course by showing us the big picture of how an engineering career looks like."

"Dr. Liu definitely makes a filler course like this very enjoyable and rewarding."

"Now I've learned a lot about resume writing and job interview and I am planning to apply the skills and knowledge learned in this course in my job search."

Conclusions

This paper describes the continuous improvement of the Senior Seminar course for SDSU ME seniors through three semesters.

Important lessons that that author have learned from this project, which are critical to keep students engaged in this one credit class are: (1) display a caring attitude to students and always be supportive and understanding; (2) invite guest speakers to visit the classroom to share real-world experiences, motivate students, and keep the class sessions fresh and interactive; (3) make the lessons more personal relevant by teaching students applicable knowledge and skills. In summary, if the goal of this course is to prepare ME students for graduation and their future careers as engineers, technology innovators, entrepreneurs, and leaders, this course must be student-oriented and the instructor must take into account the student feedback when designing the curriculum.

References

1. S. Hazari and D. Schno, "Leveraging student feedback to improve teaching in web-based courses", *The Journal*, 26(11), 1999, 30-38.
2. L.S. Brew, "The role of student feedback in evaluating and revising a blended learning course", *The Internet and Higher Education*, 11(2), 2008, 98-105.
3. S.P. Quarrie, "Student peer review as a tool for efficiently achieving subject-specific and generic learning outcomes: Examples in botany at the Faculty of Agriculture, University of Belgrade", *Higher Education in Europe*, 32(2-3), 2007, 203-212.
4. P. Seldin, "Using student feedback to improve teaching", *To Improve the Academy*, 16(1), 1997, 335-345.
5. Y.-C. Liu, S. Whitaker, C. Hayes, J. Logsdon, J. McAfee, and R. Parker, "Establishment of an experimental-computational framework for promoting project-based learning for vibration and controls education", *International Journal of Mechanical Engineering Education*, 50(1), 2022, 158-175.
6. Y.-C. Liu, F. Baker, W.-P. He, and W. Lai, "Development, assessment and evaluation of laboratory experimentation for a mechanical vibrations and controls course", *International*

Journal of Mechanical Engineering Education, 47(4), 2019, 315-337.

7. Y.-C. Liu, "Design of instructional tools to facilitate understanding of fluid viscous dampers in a vibration and controls class and course assessment", 2020 ASEE Virtual Annual Conference, June 22-26, 2020.
8. Y.-C. Liu, "Implementation of MATLAB/Simulink into a vibration and control course for mechanical engineering students", ASEE Southeastern Section Annual Conference, Auburn University, Auburn, AL, USA, March 8-10, 2020.
9. Y.-C. Liu, "Renovation of a mechanical engineering senior design class to an industry-tied and team-oriented course", *European Journal of Engineering Education*, 42(6), 2017, 800-811.
10. Y.-C. Liu and Y.-Q. Dou, "Design of an industry-tied and team-oriented course for mechanical engineering seniors", ASEE Southeastern Section Annual Conference, University of Florida, Gainesville, FL, USA, April 12-14, 2015.
11. Y.-C. Liu, "A programming course including C# and MATLAB for mechanical engineering students", *ASEE Computers in Education Journal*, 2(3), 2011, 106-112.
12. Y.-C. Liu, A.J. Artigue, J.D. Sommers, and T.L. Chambers, "Theo Jansen project in engineering design course and a design example", *European Journal of Engineering Education*, 36(2), 2011, 187-198.
13. Y.-C. Liu, "Development of instructional courseware in thermodynamics education", *Computer Applications in Engineering Education*, 19(1), 2011, 115-124.
14. Y.-C. Liu, "Instructional courseware developed for thermodynamics course", 2013 ASEE Gulf Southwest Annual Regional Conference, University of Texas at Arlington, Arlington, TX, USA, March 21-23, 2013.
15. Y.-C. Liu and F. Baker, "A new questionnaire for assessment of a mechanical engineering senior design class", *International Journal of Mechanical Engineering Education*, 46(4), 2018, 289-301.
16. Y.-C. Liu and F. Baker, "A course assessment tool for a mechanical engineering design class", ASEE SE Annual Conference, Embry-Riddle Aeronautical University, Daytona Beach, FL, USA, March 4-6, 2018.