Developing New Instructor Training and Mentorship to Enhance Mechanical Engineering Program

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Abstract

Often, new faculty begin their careers as educators with little to no experience in course instruction, accreditation, and policy requirements. University-wide orientations may not encompass the nuances in policy for colleges and departments, and (often optional) teaching workshops may be too general for effective engineering instruction. Thus, this mechanical engineering program is developing a structured mechanism by which to orient faculty with policy, accreditation requirements, and teaching guidelines, as well as to initiate a strong mentorship system for new faculty and to assess teaching effectiveness. This is done through a departmental orientation session before the onset of the semester and by utilizing a network of senior faculty, all skilled instructors, to oversee courses and teaching assignments within a particular facet of the mechanical engineering curriculum. These committees ensure course consistency and teaching effectiveness. The mentorship structure as well as the oversight and assessment processes for teaching effectiveness are discussed forthwith.

Keywords

teaching mentorship, training, effective instruction

Introduction

It is not uncommon for new faculty to begin their careers with little-to-no formal instructional training, and sometimes also without teaching experience[1]. This can especially be true in the case of traditional/tenure-track faculty, where research may be the dominant driver in hiring[2], but can even be the case among instructional or adjunct faculty. Furthermore, many research institutions rely heavily on graduate students to instruct lower-level courses, who are by default inexperienced and who receive highly variable levels of training prior to teaching. Generally, teaching effectiveness is learned through primarily through experiential mechanisms[3]. Not only does this practice suggest a cultural attitude diminishing the importance of undergraduate education[4,5], which can substantially hinder students' educational experience, the authors suggest it can also lead to unethical practices from struggling faculty members, such as knowingly inflating grades to receive higher student evaluations of teaching (SETs). Furthermore, when multiple sections of the same courses are taught by different faculty members, course consistency can be difficult to regulate, and student experiences may vary wildly. Thus, this mechanical engineering department is seeking to implement structured faculty training and mentorship with the threefold purpose of improving teaching effectiveness, enhancing course consistency, and fostering an attitude underscoring the importance of undergraduate education. The largest obstacles to fulfilling a mission of improving instruction among engineering faculty is in cultivating teaching as part of professional identity[6] and in demonstrating the need for

improvement. This paper focuses on establishing the policies, structures, and practices necessary to implement this goal, with longer-term studies required to assess the effectiveness of each measure implemented.

Background and Motivation

At this research institution's primary location, the mechanical engineering department houses roughly 1,000 undergraduate students with 21 full-time faculty in the department (47.6 nominal student-to-faculty ratio), 16 of whom are tenured or tenure-track faculty who may not teach consistently due to research demands. Thus, instructional faculty and graduate teaching assistants are heavily utilized to fulfill undergraduate teaching demands. Due to various factors including covid impacts, faculty turnover, and research buyout of courses, unacceptable variations in instruction, particularly among new faculty and graduate assistants, have recently been identified, and a new role of teaching director, which is an expansion of undergraduate coordinator responsibilities, has been created in part to address these discrepancies. Much of this is due to a lack of formal mentorship or training of new faculty. Pre-covid, this mentorship tended to happen organically with traditional on-campus social interaction among junior and senior faculty. However, amidst the transitions brought forward by online covid measures and lingering issues, the organic social interactions between faculty at all levels has greatly diminished. Thus, the variations in instructional effectiveness, rigor, and course consistency have been highlighted, and a clear need to provide mentorship and policy has been identified.

The mentorship structure implemented builds off of an existing set of committees within the department, termed Course Standardization Committees (CSCs), as shown in Figure 1. Previously, the primary role of CSCs was simply to set ABET criteria within courses and collect ABET/SACS assessment data. However, the new structure of the CSC includes a strong mentorship on all things related to teaching, including ABET responsibilities. CSC Chairs are also now responsible for implementing evaluations of teaching and assessments of teaching effectiveness, as well as identifying inconsistencies. All CSC committee chairs have been selected by the Teaching Director to meet the following criteria: (a) have institutional knowledge and a strong understanding of university, college, and departmental policy (b) are skilled instructors proven to uphold rigor while effectively engaging students (c) experts in the subject area governed by the CSC (d) are actively involved with undergraduate education at this institution and prioritize it. The CSCs in this department include: Energy Systems, Thermodynamics, System Dynamics, Machine Design, Materials, and Laboratories, and each CSC is responsible for the management of several courses under its purview (e.g., the system dynamics CSC manages a numerical engineering analysis course, a system dynamics course, and a vibrations course and ensures appropriate pre-requisite topics and ABET outcomes are met within the CSC framework). These are the historical subject areas for our CSCs, however, the subject areas and number of CSCs required will go under review next semester.

Implementation

At the onset of the semester, all new faculty and graduate student instructors were required to attend a workshop conducted by the teaching director and senior faculty. This workshop outlined all expectations required of faculty to maintain course consistency (while maximizing autonomy of instruction style); to meet accreditation practices, which, in our department, requires

compliance from all faculty teaching any undergraduate course; and to adhere to university, college, and departmental syllabus procedures. Additionally, the training clarified the structure of CSCs, Fig. 1, and discussed important topics related to teaching responsibilities and effectiveness, including adherence to the syllabus. Senior faculty shared teaching tips and experiences, and procedures for advising students, reporting cheating and troubling behavior, and handling student absences and disability accommodations were all addressed. Most importantly, the new faculty training brought forward a personal connection between senior and junior faculty and made clear delineations for who can provide the best mentorship to the faculty member on a particular topic. It also made clear that for course instruction, faculty members are accountable to their CSC chairs and the teaching director, and they are encouraged to bring all teaching-related questions and concerns forward to these individuals.
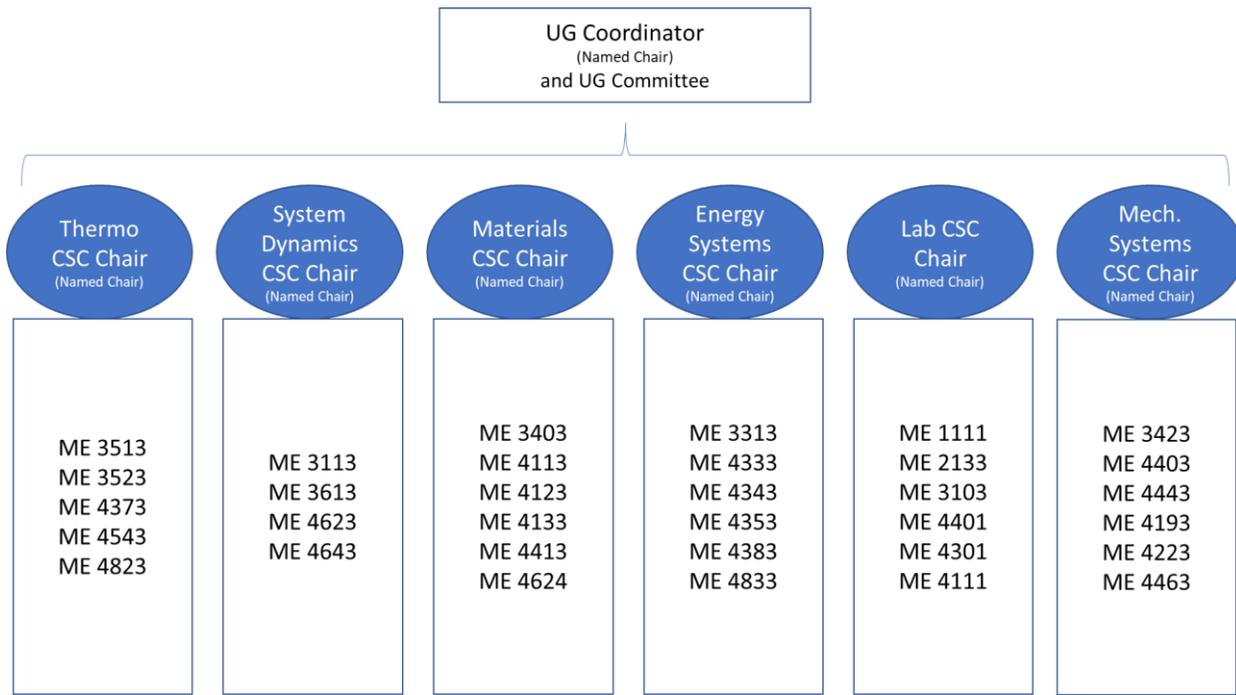

Figure 1. Course Standardization Committee Structure

After establishing faculty training, the next step is providing feedback to them regarding their instruction. An assessment of instruction, shown in Fig. 2, was given to CSC chairs, who were required to send a senior evaluator to observe classes of each new faculty member. The assessment is designed only to be constructive, not punitive. It is designed to establish feedback for faculty beyond SETs, which is beneficial to both the department and to the new faculty who are assessed. It allows faculty to include these "peer" assessments of teaching effectiveness in annual evaluations and in P&T considerations. An overarching goal of this assessment is to reduce the dependency on SETs for promotional considerations, and therefore reduce the incentive to inflate SETs by inflating student grades/reducing course rigor.

Course Evaluated: _____　　　Date of Evaluation: _____

Instructor Evaluated: _____

Evaluator: _____　　　Evaluator Rank: _____

Please rate the following components on a scale of 1 to 5. Use the following guidelines for scoring:

　　1 – Poor/Unacceptable/Needs Significant Improvement
　　3 – Average/Acceptable/Meets Minimum Standards
　　5 – Outstanding/Exceeds Expectations/Exemplary

Clarity

Speech Volume	1 2 3 4 5	or N/A
Speech enunciation/pronunciation	1 2 3 4 5	or N/A
Notes given – legible and readable	1 2 3 4 5	or N/A

Organization

Course pacing　　　　　　　　　　1 2 3 4 5 or N/A
Starts on time, ends on time, enough time for questions, allows students time to process, etc.

Preparation　　　　　　　　　　　1 2 3 4 5 or N/A
Clear topic for discussion, familiar with lecture material

Material is conveyed effectively　　　1 2 3 4 5 or N/A
Use of instructional resources, breaking down topics for student audience, etc.

Lecture review, overview, and/or summary　1 2 3 4 5 or N/A

Class Leadership

Students are respectful and responsive	1 2 3 4 5	or N/A
Instructor displays confidence	1 2 3 4 5	or N/A
Instructor is professional in interactions	1 2 3 4 5	or N/A
Instructor is able to keep student attention	1 2 3 4 5	or N/A

Competence

Instructor is knowledgeable of subject area	1 2 3 4 5	or N/A
Instructor responds appropriately to questions	1 2 3 4 5	or N/A
Students seem to comprehend material	1 2 3 4 5	or N/A

Likeability

Instructor relates well to students　　　1 2 3 4 5 or N/A
Gives relevant examples, is in tune with student interests, able to lighten environment with attitude, etc.

Students do not seem intimidated　　　1 2 3 4 5 or N/A
Ask questions readily, open for discussion engaged in course

Please list the primary strengths in instruction:

Please list the primary weaknesses in instruction:

Follow-up observation suggested after feedback given? YES　　　NO

Figure 2. Peer Assessment of Teaching

After implementing the peer evaluations of teaching, it is necessary to address subtler metrics of teaching effectiveness, those that may not be evident from simply attending the course. These finer points include student comprehension of material, fairness of testing/assignments (appropriate amount of time given for completion), and accessibility to students. These hard metrics can also serve to extrinsically motivate faculty toward instructional improvement by teaching them to recognize the need for improvement as well as give them tools and mentorship to do so[5].

In order to address student comprehension, each CSC chair will implement a standardized or committee-created assignment/quiz/exam to be given in one of the core courses under their purview across all sections and semesters. The frequency of standardized assignments will be left to the purview of the CSC. It is expected for courses with direct perquisite courses (i.e. Thermodynamics I and Thermodynamics II), a pretest of perquisite material will be given early in the subsequent course. To address fairness, self-assessments of teaching will be implemented with this component addressed by each faculty member, after mentorship from CSC chairs and teaching director regarding reasonable expectations of students across each level of the curriculum. This mentorship will be added in to subsequent new teacher training sessions and reiterated inside the CSC meetings, which are required to meet every semester within the first three weeks of the semester to ensure a group mentorship component early in the semester. To address accessibility, departmental standards for maintaining office hours are being implemented, as currently no guidelines or requirements are in place.

Finally, at the end of each semester, CSC chairs and the teaching director will look at course reports for each section of a course and analyze student performance across sections as well as assess coverage of and student comprehension of course topics to the extent that can be backed up by collected data. Any "red flags" such as highly skewed grade distributions for the subject (such as all As or all Fs) or extra-normal parameters will result in one-on-one meetings with faculty to correct such issues, and will likely require the faculty member to attend pedagogical training outside of the department. While all of these measures are intended to help faculty grow in teaching and to enhance the educational experience for undergraduate students, there must be accountability measures in place for those who may refuse to accept constructive feedback or fail to adhere to syllabus/policy. In the case of graduate teaching assistances, these major failures can (and have) led to removal from teaching the course and loss of assistantship. For full-time faculty, the reports are included in annual evaluations and can inhibit promotion and tenure obtainment. Additionally, faculty who refuse to follow protocols may be moved into less desirable, but more standardized, courses, such as lab classes that take large blocks of time but are generally designed to be turnkey implemented. However, the first step before any such drastic or punitive measures are taken is of course intensive coaching, pedagogical training, and written feedback for tangible and readily-implementable improvement techniques.

Feedback and Initial Results

At this time, the faculty training workshop, mentorship structure, faculty resource guides (directing new faculty to appropriate senior faculty and programs throughout the university), and peer evaluations of teaching have been implemented. In the fall 2021 semester, three new faculty and several graduate TAs were hired and required to attend. The faculty response to these measures has been one of overwhelming gratitude, and they have readily been approaching their mentors for guidance as needs arise, especially in cases regarding student conduct. On the whole, student complaints regarding these faculty (excepting one graduate student) have been trivial and within expectations, and all (excepting one graduate TA who had to be let go and replaced by senior faculty) have followed policy, stayed true to their syllabuses, and covered course topics effectively. Gaps identified in student pre-requisite understanding due to online environment and previously defined conditions have been substantially narrowed, and student performance, on the whole, has improved over the course of the semester. Individual conversations with students indicate that the newest faculty are well prepared for their courses, fair, and competent. Feedback from peer evaluations indicates that the new instructors are rising to the challenge, with only minor improvement needs indicated (such as increasing clarity, claiming more control over the classroom, etc.)

CSCs are currently in the process of identifying the best assessment techniques for their courses to yield some standardized assessment of student performance across sections and semesters, and that assessment should be implemented in the spring semester. All new faculty have already submitted mid-semester self-evaluations and will submit end-of-semester self-evaluations, as well. The goal of these self-evaluations was for new faculty to report how their courses were going, their workload, and overall comfortableness with how the semester was going. These self-evaluations, in general, indicated that while the learning curve may have been steep at first, the new faculty did find balance and effective strategies by the midpoint of the semester. One new instructor indicated that she was overwhelmed at first and struggled to keep up with the demands of her course load, but that after seeking mentorship and implementing some suggested

strategies, she improved drastically. This particular new faculty member was teaching alongside an emeritus faculty member who brought years of experience with both the material and teaching. Balancing the pressures of conveying the material as effectively as the veteran faculty member and establishing rapport with students was overwhelming. Affirmations were given to the faculty member. While she may not know as much as the veteran faculty member, she did know more than the students and had the skillsets to convey the information to them. Strategies relevant to this new faculty member were practicing conveying confidence (not arrogance) and communicating a desire for growth to students. This improvement is reflected in student assessment (see Table 1), as students have indicated that the semester started out a little rocky but that the instructor has grown into one of their best! Similarly, one of the graduate TAs had a very difficult start to the semester, with substantial student complaints. After mentorship from the teaching director and discussions with her peer teaching evaluator, this teaching assistant has improved substantially, and the department has not received any more student complaints about her since midterm. Similarly to the new faculty member, the TA was competent in the material but was lacking in confidence, which unfortunately got misconstrued as a lack of material knowledge by the students. After coaching in conveying confidence, this TA saw greater success in the classroom. The one graduate assistant who had to be removed was not following policy and in breach of syllabus; this student seemed to have a significant lack of motivation toward teaching the class. Scenarios like this are being rectified by clearly indicating to graduate students that they must, at a minimum, uphold policy and conform to syllabus to remain funded. Also, graduate teaching assistants are being hired at an earlier stage such that subsequent assistantship awards will be dependent on their performance, recognizing that everyone needs time to learn, grow, and improve, but not tolerating failure to meet a minimum standard or to adhere to policy/syllabus. At the end of every semester, each instructor submits a report to the undergraduate coordinator that includes ABET outcomes assessed, topics covered, grade distributions, and narratives (small self-evaluation). The CSC chairs are now responsible for thoroughly reviewing these reports prior to sending to undergraduate coordinator, and for addressing any troubling statistics immediately with the faculty member(s) under supervision from the teaching director.

This semester, three new instructors were hired and two TAs were utilized, all of whom underwent training and mentorship. Most of these new faculty improved over the course of the semester, and that was typically reflected in the evaluations. Of course, there is more coaching needed, and "subject fit" of the instructors needs to be adjusted, but there is definitely room to achieve strong teaching success with all of the new hires given further training. Table 1 presents some representative comments for each of the faculty members (used with permission) from their student evaluations. Since one TA was removed from the position due to lack of motivation/policy adherence, that TA is not included in Table 1.

Table 1. Representative Student Evaluation Comments

Instructor	Representative student evaluation comments
A	The course improved as the semester went on. I know this was [Name]'s first time teaching this course, and with that in mind I think it went pretty well!
	The class and professor immensely improved the second half of the semester. The professor seemed to adapt and learn. At the beginning of the semester I would probably not have recommended her, however, now I would.
	[Name] is a great teacher and clearly wants her students to succeed.
B	The professor was easy to reach and was very supportive.
	In the beginning the class was a little rocky, but after the instructor got her feet under her, the class went very well. Overall, I am very pleased with this class!
C	[Name] was very available to students and was willing to help teach principles
D	You will become a great professor soon.
	[Name] has been an excellent professor in this course. Every assignment/resource was organized in a manner that allowed for quick finding of necessary material. His work was structured in a way that made for solving problems significantly less hard than textbook note's explanations. His methods allowed for clear understanding of topics and his formatting helped to infer potentially unknown solutions. I would recommend any student to be a part of his future classes. He is also one of the few professor's I have taken that makes you feel like he not only cares about his position, but also makes you feel like he genuinely cares about your well-being as well as your success as a student. An all-around amazing professor and human being!

Conclusion

While working to improve departmental instruction and student experiences, engineering faculty administration encounter the obstacles of cultivating teaching as part of professional identity and demonstrating the need for improvement. The purpose of this study is to present a plan for overcoming these obstacles within the mechanical engineering department to better serve our undergraduate population. With appropriate support from administration at the department and college levels, measures can be taken to structure a formal mentorship and oversight team to guide new faculty, and graduate teaching assistants, toward greater competency in the arena of engineering education. While the process requires commitment from administrators and several senior faculty members, it can be streamlined after the initial preparation work is fulfilled. Initial implementations have seen success, with instructors improving in teaching skills, and the need for consistency being addressed.

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