

AC 2009-58: CHALLENGES OF TEACHING ELECTRICAL ENGINEERING CLASSES TO NONMAJORS

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CHALLENGES OF TEACHING ELECTRICAL ENGINEERING CLASSES TO NON-MAJORS

Abstract

The core curriculum for college degrees comprises a wide range of institutions, different areas of expertise, and levels of teaching. Nowadays, electrical engineering (EE) classes are part of the core curriculum of several other majors such as: mechanical engineering, mechanical engineering technology, computer network and system administration, surveying engineering, among others. Modern technologies are interdisciplinary and often require knowledge of several engineering fields. Students graduating from these majors must have at least a basic understanding of electrical engineering principles, since they will be working with electronic systems and devices in their careers. The students can be motivated by seeing how the EE principles apply to specific and relevant problems in their own field.

Most of us face the challenge of teaching both non-majors and majors, sometimes even in the same classroom. We are confronted by the task of conveying a general knowledge base to non-majors while simultaneously laying the foundation for continued study by majors. Teaching EE courses to non-EE majors may seem a trivial task for any experienced EE instructor. However, from the author's experience, this task is usually more challenging than one may initially assume. If the instructor is not willing and able to do an excellent job of teaching freshman and sophomore engineering students, retention becomes an issue because it is during this critical freshman year that students are most likely to drop out of the system or change majors if they become disengaged with the learning process. In U.S., 50% of the students who enter engineering programs as freshman do not earn an engineering degree.

The purpose of this paper is to discuss the main challenges and to share teaching methods that the author has used to encourage active learning and engagement among non-EE major students. The author addresses the use of technology for teaching, the use of lecture time effectively, the importance of well designed laboratory experiments, and use of basic simulation tools. Assessments of an introductory electrical engineering course taught following the author's guidelines were performed to evaluate the teaching effectiveness, and they indicate that the teaching methods have been successful in meeting their objectives.

Introduction

Nowadays, much is expected from a university professor, not only a professor is expected to teach effectively, but also to manage other responsibilities such as maintaining certain levels of research and other scholarly activities. In some research universities, however, teaching is not appreciated to the same extent as research. Yet if a university does not have instructors willing and able to do put time and energy to teach effectively, retention becomes an issue¹, as does reputation and consequently recruitment in subsequent years. Teaching freshman and sophomore engineering students is even more crucial because it is during this initial period that students are more likely to change majors or drop out of college^{2,3}. Many studies stress the importance of first-year college experience, and indicate the first-year GPA as the best predictor of attrition. The adoption of an active learning format whereby student participation is highly encouraged has the strongest impact on students' academic performance and their attitudes towards engineering profession⁴.

Despite of the fact that many students may have been academically prepared and motivated to study engineering, 50% of students who enter engineering programs as freshman do not earn an engineering degree^{2,3}. The gap between engineers needed annually and the number of graduates available to fill positions is wide. Some experts place the need as high as 117,000 a year, while U.S. colleges produce about 65,000 to 70,000 engineering graduates⁵. This is in agreement with U.S. Bureau of Labor Statistics, which projects job average growth of 13% to all engineering disciplines⁶. The data from the US Bureau of Labor Statistics shown here is not taking into consideration the recent downside in the Global economy but still serves as benchmark for our study.

A change in motivation is perhaps the key factor in students' decision to earn an engineering degree. Positive experiences in introductory electronics courses, for instance, can influence both EE major and non-major students in their career path and in some cases even influence them to change majors. These courses can greatly influence whether a mechanical engineering student will pursue further studies in robotics, or control mechanisms, much needed in the automobile industry and any other automated industry. Thus, a challenge for individual faculty and engineering departments collectively is to find ways to build on these positive experiences and enable students to acquire some knowledge in electronics. However, there is no general agreement on how best to serve diverse student audiences in any discipline and, in some cases, no formal consensus about desired learning outcomes⁷.

In this paper, the author – a junior female faculty – describes the lessons learned from her relatively short time experiences teaching an introductory course in electrical engineering for non-majors in two different medium-size institutions in the Midwestern United States. The course gives undergraduates their first and, for many students, their last formal exposure to some understanding of electrical engineering. Thus, this course might be the only opportunity to provide a basic level of electrical engineering literacy for non-EE major students. With the strong emphasis on application of electrical principles to all the fields of engineering, this course helps build a better understanding of the inter-

relationships between each of the engineering disciplines. The author suggests teaching methods that can help instructors prepare themselves to engage non-majors in a number of ways. The suggestions provided in this paper, while confirming principles and practices described in the literature, provides new insights and ideas. So far, these methods can be considered successful due to the positive and encouraging feedback provided by the students.

Challenges

Historically, introductory courses in electrical engineering not always have been adequate to satisfy the goals of providing a foundation for EE majors, while providing some EE knowledge and tools needed for other majors to support their field of study⁸. At the two institutions that I taught these courses we still continue to face many challenges, even after implementing changes in the design of these courses. We continue to struggle with the task of imparting knowledge to students who often have little interest in the material, and who are very impatient. We also are often faced with the decision of covering only the most basic information on most topics in the syllabus or focus on communicating a comprehensive understanding of a subset of topics. At the same time we struggle to teach substantive knowledge and build critical skills. In addition, we also feel a tension between institutional requirements and the classroom experience, such as teaching more students and measuring learning outcomes that often collide with a fruitful and productive classroom environment. Large classes size, in particular, present a considerable logistical challenge, as well as a number of other challenges³. These challenges are faced not only by instructors of EE classes for non-majors but also by other instructors across disciplines⁹.

Some students hate electronics classes. They believe that the instructor is the reason why they don't understand the material, forgetting how little time they spend to work on extra class assignments and studying. They question why they are forced to take the course; most importantly what is the use of the course content in their major. Many have little idea of why or how electronics may be relevant to their future careers. Many students cross campus and cross institutions are driven by a desire to do something useful or lucrative, not by "truth and beauty". Even worst than that, they want an easy and fast way out of campus. However, to better serve the academic community the key is not to see these challenges as inhibitors but identify ways to overcome them and turn them to advantage. For instance, one can use skill-building exercise to impart substantive knowledge; one can teach a breadth of subjects while allowing students to pursue out-of-class activities that allow a depth of knowledge on particular topics; one can create a small class atmosphere in a large class setting. This point of view is shared by others disciplines^{3,9} and can be fairly easily applied to electrical engineering. Although, the author recognizes that without any doubt applying these ideas places more demands on the instructor, who also is pressured to develop research and other scholarly activities.

In order to tailor teaching methods to better serve non-majors, one needs to address questions such as: – What pedagogical assumptions shape introductory courses and lab experiences? – What does research tell us about course-taking patterns after the introductory course for non-EE majors? – How are learning outcomes for introductory

courses determined? – What is the student background on the pre-requisites needed for the course? Based on these questions and on the author's short time experiences, a set of recommendations was put together by the author, who has been following them and obtaining good feedback from the students.

Teaching methods for effectively teaching non-majors

This section contains the teaching methods used by the author for effective teaching non-EE majors. These guiding principles are based on the author's teaching experiences as junior faculty member at two different Midwest institutions. Teaching philosophy for grading, homework assignments, and exams, are not discussed in detail since the author believes that these topics should be tailored in a case by case basis.

1. Appropriate pedagogy

The traditional order to teach EE is that one must learn about semiconductor junctions before common emitter amplifiers. Wolaver et al.¹⁰, defend the thesis that electrical engineering instruction for non-majors can be greatly improved by taking up many topics in reverse of the usual order. Instruction should follow an order that starts with the broad uses and system components and only then delves further down into such details as transistors and solid state. This methodology is known as "outside-in" or "top-down" approach and is widely applicable and is practiced in many fields, especially by engineers. The advantages of the outside-in approach, includes the motivation to students. Students, especially non-majors, want to appreciate why they are putting effort into learning a specific material that at first doesn't appear related to their majors. They need a better answer than, "Because you will need it later." Another advantage of the outside-in order of study is that, the study can logically stop at whatever level of detail satisfies the need at the moment. The instructor can easily vary the depth to which he or she carries the class from topic to topic, adjusting the time spent on them to suit the instructor pedagogic needs and resources. The main goal is to have both student and instructor thinking in terms of purpose and the specific relations of course elements to each other and to student major field. By achieving this goal, one attempts to minimize or eliminate troubles that have been traditionally accepted as normal to service course teaching, such as unmotivated students, inability of students to perceive the usefulness to their own major of material covered, difficulty in motivating professors to teach this kind of course enthusiastically. The author has follow an approach consistent to the top-down approach, where the application is briefly discussed first and the teaching of the basic principles follows. In addition, the author often makes a mapping between a typical application (physical world) and its representation in circuit analysis domain (electrical schematic).

2. Encourage discussions

The author encourages students to positively interact with those around them. When time permits, students are asked to form small groups of 2 or 3 to solve a particular problem, and they should spend a few minutes discussing about the appropriate answer. Through this engagement, students appear to feel more confident about the material. The author also actively pursues the engagement of the students in the classroom by frequently asking them questions and stimulating them to ask questions to the instructor. Moreover,

the instructor stimulates students to do work on their own, reducing the attitude that everything must come from the instructor, in other words, an instructor should be a facilitator of students success.

3. Use of technology

The author makes extensive use of technology such as PowerPoint presentations, class email list, class website, and educational software such as Blackboard®, Desire-2-Learn®, WebCT®, which are provided by most universities in US. In addition, she gives preference to adopt text books with companion websites. The author has noticed that both majors and non-majors take advantage of these resources; however, they are particularly more relevant for non-majors, as they have the tendency to use these resources more often than EE majors.

3.1) Classroom presentation methods

For college level courses in general, the lecture is still the primary method of instruction. The author's experience in the classroom has led her to explore a number of classroom presentation methods to help engage students on a number of different levels. The presentation method that the author considers particularly useful is a balanced combination of PowerPoint presentations, and traditional lecture on the whiteboard, in which the author often demonstrates how to use the theory to solve practical problems to help the student develop problem solving skills. Students have the tendency to lose concentration just by looking at slides upon slides in the classroom, incorporating breaks into the monotony of slides is very important in getting students to be more engaged and thereby more willing and able to learn the material. Furthermore, the exclusive use of PowerPoint during lecture makes students more tempted to skip lecture, in particular if the instructor makes the PowerPoint presentations available to students afterwards¹¹. The author makes available to students the PowerPoint presentations, and a set of lecture notes with summary of main topics discussed in class and exercises with answers (not solutions) in the last page of each note sheet. The author encourages the students to work on these problems prior and while the material is being covered in class. This set of problems must be solved prior to homework assignments as an additional way for students to learn the material. The author also solves selected problems in the classroom, stimulating students to interact with the author on the right path to the solution.

3.2) Use of examples related to their field

Discuss real-world applications that are straightforward extensions of fundamental ideas. Show students why electrical engineering is relevant to their careers, and involve them in lecture demonstrations. Emphasize “transferable skills” and their relevance to future careers: robotics, information system management. The use of examples relating electronics to their field, for instance, a mapping correlating the electrical circuit of an automobile and an electrical circuit diagram helps students to make a connection between the classroom and their major in the case of Mechanical Engineering students, or the need for electrical cables with different properties to carry out binary data at different data rates for the case of Computer Network & System Administration students.

Students in electronics courses only master a small fraction of the material with which they are presented. Therefore, focus on fundamental concepts and keep the math simple. Even though, the math that trips them up is not calculus but high-school level math. Provide pre- and early-course tutorial support in “elementary scientific mathematics” so that they can focus on learning electronics, not math. This is particularly important if there is a large number of freshman and sophomore in the class.

3.3) Email list

The author creates an e-mail address list for each course, as a way to directly inform students of any announcements and reminders. The author also encourages students to send questions through email, and then sends the answers to selected questions placed by the students to the list.

3.4) Course website

In addition to these software tools, the author also creates a web page for each class, which is frequently updated. The class web site contains syllabus, class schedule, useful Internet links, book info, and any other useful information relative to the class and to the instructor. The class schedule is often updated during the week to reflect the exact material covered in each class. This is one way to keep students informed even if they miss a class. Although, the author frequently reminds students the advantages of attending classes regularly.

3.5) Educational Software

To support classroom activities, the author has extensively used WebCT® system as an educational tool. The author has also used other educational software tools such as: BlackBoard® and DesireToLearn®. WebCT is an extremely helpful teaching tool that can be used to complement classroom instruction in a variety of ways, such as:

- To develop and apply online exams and quizzes;
- To post lecture PowerPoint presentations;
- To post homework assignments;
- To post solutions of homework, exam, and quizzes;
- To obtain statistics of online taken exams and quizzes, such as statistics of each problem, class average, and class standard deviation;
- To provide any class related document;
- To post grades online. WebCT is an excellent tool to post grades as the university are making more strict the students privacy policies, in which the grades can only been seen by each individual students.
- Email a specific student or a group of students, since WebCT contains the email address of all the students registered for the class.

3.6) Book Companion Website

Nowadays, students are more and more technology savvy and technology demanding. The traditional textbooks sometimes are only opened by the students in the assigned homework sections. This behavior is particularly the case for non-EE major students, who wish to spend the least amount of time for an electrical engineering class. With that in mind, the author prefers to assign textbooks that have a companion website where

students can have access to online chapter summary, multiple choice and true or false problems, fill in the blank sentences on the chapter material, and exercises based on software tools such as MultiSim®, Cadence Design Systems' PSpice®, and National Instrument's LabVIEW®. Cadence Design Systems' PSpice (Personal computer version of the Simulation Program with Integrated Circuit Emphasis software) files were developed to assist in circuit analysis. National Instrument's LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) files were developed to introduce rapid methods of computer-aided special-purpose instrumentation and control systems. MultiSim is a schematic capture, simulation, and programmable logic tool used by college and university students in their course of study of electronics and electrical engineering. MultiSim is widely regarded as an excellent tool for classroom and laboratory learning.

3.7) Frequent feedback

While it is important for any class, frequent feedback is particularly important for non-majors. Timely and adequate feedback is important in various forms, such as in class discussions, written comments, graded homework, quizzes, and exams. Depending on the number of students per class, this task may be very time consuming from the instructor stand point. The author has been applying mid-term instruction evaluation as a way to collect feedback from students while there are still several weeks before the end of the semester to make appropriate changes. Educational software, such as BlackBoard or WebCT can help with this process, where electronic feedback can be made, and exams can be graded automatically. In addition, BlackBoard makes available the statistics for any exam taken through BlackBoard. The students can access the class average for each particular problem of an exam and for the entire exam so that he or she can know exactly how they stand with respect to the class average. I have noticed that frequent feedback has a positive impact on class performance for most of the students, and the students show more satisfaction with their electronics course experience. In addition, the evaluations applied to an electronics class should focus on conceptual knowledge, core skills, and applications related to their major.

4. Lab Experiments and simple simulations

It is a common understanding that the laboratory must serve as a learning resource center in which the students not only perform formal lab assignments, but also have the opportunity to use the equipment and computers to strengthen their understanding of the concepts presented in the lecture section⁸. We can't stress enough the value of hands-on learning. The laboratory adds realism and solidity to the large number of topics that are covered in an EE course for non-majors. Students usually enjoy laboratory work, especially as it can be related to some of their own major interests. Therefore, it is imperative to choose experiments that provide students with real life applications that are challenging but achievable, and most importantly that the lab experiments are tightly coupled with lecture. Students' data should be checked before they leave the lab to make sure that the data is at least acceptable to complete the lab assignment, this policy is particularly important for non-EE majors taking possibly their only EE lab session. It is also of great use to have a computer on each bench that can be used for instrument control and data acquisition, data processing and plotting, and circuit simulation. The

author encourages students to simulate simple circuits using software such as Electronics Workbench Multisim® by assigning them simulated lab homework prior to the hand-on lab experiment. The simulations provide a link between the theory learned in class and the actual lab experiment. Computer-based lab experiments speed up student progress in hands-on experiments and make the learning experience in the lab more efficient. However, careful attention should be paid to avoid the use of simulation as a substitute for thinking, as can be the case for some students. Students are also stimulated to make circuit analysis of the lab experiment prior to the lab section; in addition, students should choose a different partner for each lab section. By working with a different partner for each lab section, the students will be forced to change their role instead of constantly doing the same type of task, such as only taking notes or only taking measurements. Students have reported in their instruction evaluation form that the laboratory experiments were valuable elements of their learning process, through meaningful hands-on experience gained in the laboratory.

5. Assessment

One of the main tools for course assessment used in academia is student surveys. To measure the adequacy of the teaching methods, students are given a survey in the beginning of the second half of the semester. This survey is independent of the traditional course evaluations, and is used to solicit students' response to overall course performance and any recommendation that they may have. Informal meetings between the students and the instructor are also conducted. At the end of the semester, in addition to the end of the semester university instruction evaluation surveys, the final exams are also used as a tool for assessment. Of the 67 students enrolled for the spring 2008 class, 56 responded to the class survey.

In Table 1, the author shows the survey questions and students' responses for the student rating of instruction and learning for the class evaluation of spring 2008 in an introductory electrical engineering class with 67 non-EE major students. The rating used for the questions in table 1 was: (5) strong agree, (4) agree, (3) neutral, (2) disagree, (1) strong disagree.

Question	Rating (mean)
1) The pace of this course is consistent with my ability to learn the material.	4.04
2) The instructor is well prepared, and is able to communicate the course material clearly.	4.01
3) The lectures are well organized.	3.91
4) The instructor's grading policies are fair.	4.13
5) You are spending the required amount of time preparing for this class.	3.41
6) You are taking responsibility for this class and keeping yourself up to date with the class material.	3.80
7) The text book and book companion website is helping you learn the course material.	2.88

(Table 1 – Midterm instruction and learning evaluation)

Positive comments of students for the class include, that the laboratory experiments were exciting and a valuable element of their learning process, through meaningful hands-on experience gained in the laboratory. The use of WebCT, and classroom examples were helpful to understand the material. In the negative side, the students found the textbook difficult to follow. The textbook adopted for the class was “Electrical Engineering: Principle and Applications,” by Hambley, Prentice Hall, 2008. The author considers the book by Hambley a very well written and structured textbook, however non-major students’ feedback reveals that they have difficulties to follow the book; some consider the book dense, and difficult to follow math.

Some of the students’ answers to an additional question in the survey follow below:

What about this class is helping you to learn?

“Instructor working problems on the board”

“Instructor keeps pace with all of us”

“WebCT based examinations”

“PowerPoint slides of notes posted online”

“The material in class is similar to what we practice in the lab”

Out of 67 initially registered students, 62 students took the Final Exam. The mean value for the Final Exam was 68.2% with standard deviation of 12.8%. The problem with highest rate of correct answer achieved 98.4%, and the problem with lowest rate of correct answer achieve 21%.

In Table 2, the author shows the summary of student achievement of course objectives and quality of instruction as required by ABET for the class of spring 2008 in an introductory electrical engineering class with 67 non-EE major students. The results show the correlations between the course objective listed in the syllabus and the final exam. Overall, the student performed relatively well considering a comprehensive closed-book final exam with 40 problems. There is still room for improvements, and the author is working on ways to tailor the course to better attend the audience and to provide the material that must be covered for the class. Table 2 also reveals that students have more difficult to work with AC than DC analysis, which is a direct consequence of the lack or weak background in phasor analysis, trigonometric functions, and other related calculations. Extra time is necessary to cover these pre-requisites, and one way of doing that is by providing extra tutoring sections. This issue was previously discussed in section 3.1b of this paper.

Summary of Student Achievement of Course Objectives and Quality of Instruction

<i>Course Objective (See syllabus for the complete statements.)</i>	<i>Relates to Program Outcome(s)^a</i>	<i>Assessment Instrument for This Objective</i>	<i>Standard</i>	<i>Results (assuming final Exam only and average values!)</i>	<i>Acceptable? Y/N</i>	<i>Continuous Improvement Actions Planned</i>
1. Understand how to apply Ohm’s law to calculate current through or voltage across elements of dc circuits.	2b, degree 2 2f, degree 2 8a, degree 2	Cumulative final exam, questions 1, 5, 6, 7 Lab (1,2)	70% of students will score 70% or better on this question block.	91.13% of students scored 70% or better on this question block	Y	None planned at this time.

2.	Know how to apply Kirchhoff Voltage Law and Kirchhoff Current Law to dc circuits.	2c, degree 2 2f, degree 2 8a, degree 2	Cumulative final exam, questions 8, 10,11, 12, 14-17 Lab (3, 4)	70% of students will score 70% or better on this question block.	75.2% of students scored 70% or better on this question block	Y	None planned at this time.
3.	Understand how power, voltage, current, and resistance are related to each other in a dc circuit.	2c, degree2 2f, degree 2 2d, degree 2 8c, degree 1	Cumulative final exam, questions 1, 5, 6, 7, 8, 10-17 Lab (3, 4)	70% of students will score 70% or better on this question block.	80.62% of students scored 70% or better on this question block	Y	None planned at this time.
4.	Know how to obtain equivalent resistance, capacitance, and inductance of series and parallel circuits.	2d, degree 2 2e, degree 1 2f, degree 2 2g, degree 1	Cumulative final exam, questions 18, 21, 23 Lab (3, 4)	70% of students will score 70% or better	68.7% of students scored 70% or better	Y	None planned at this time. 68.7% is within the statistical margin since I used average values.
5.	Understand how voltage and current are related to each other for capacitive and inductive elements.	2d, degree 2 2e, degree 1 2f, degree 2 2g, degree 1	Cumulative final exam, questions 20, 21, 22, 23, 25, 26, 27, 29, 35, 36, 38 Lab (7, 8, 9, 10)	70% of students will score 70% or better	71.3% of students scored 70% or better	Y	None planned at this time.
6.	Know how to calculate and measure peak and rms values of current and voltage in AC circuits.	2d, degree 2 2e, degree 1 2f, degree 2 2g, degree 1	Cumulative final exam, questions 19, 28, 38 Lab (6, 7, 8)	70% of students will score 70% or better	72.58% of students scored 70% or better	Y	None planned at this time.
7.	Know how to calculate capacitive and inductive impedances in AC circuits.	2d, degree 2 2e, degree 1 2f, degree 2 2g, degree 1	Cumulative final exam, questions 25, 26, 27, 29, 38, 39 Lab (7, 8, 9, 10)	70% of students will score 70% or better	60.4% of students scored 70% or better	N	Spend more time on this objective, give exercise list for this objective, give extra tutoring section in the subject, and prerequisites such as vector analysis, trigonometric functions, phasor calculations.
8.	Understand how the phase difference between AC current and voltage related to pure inductive, pure capacitive, or resistive circuits.	2d, degree 2 2e, degree 1 2f, degree 2 2g, degree 1	Cumulative final exam, questions 22, 24, 25, 26, 27, 29, 38 Lab (7, 8, 9, 10)	70% of students will score 70% or better	70.3% of students scored 70% or better	Y	None planned at this time.
9.	Know how to calculate AC power (average, reactive, and apparent power), and understand its relation to power factor.	2d, degree 2 2e, degree 1 2f, degree 2 2g, degree 1	Cumulative final exam, questions 30, 32, 34, 40 Lab (10)	70% of students will score 70% or better	67.5% of students scored 70% or better	Y	67.5% is within the statistical margin since I used average values. However, should spend more time on this objective, give more exercise list for this objective, give extra tutoring section in the subject.

(Table 2, End of course form)

In Table 3, the author shows the survey questions and students' responses for the student rating of instruction and learning for the evaluation for Fall 2006 in an introductory electrical engineering class with 65 non-EE major students. Fall 2006 was the first time that the instructor taught the class and did not introduce the methods discussed in this paper. The rating used for the questions in table 1 was: (5) strong agree, (4) agree, (3) neutral, (2) disagree, (1) strong disagree.

Question	Rating (mean)
1) The pace of this course is consistent with my ability to learn the material.	3.04
2) The instructor is well prepared, and is able to communicate the course material clearly.	3.50
3) The lectures are well organized.	3.63
4) The instructor's grading policies are fair.	2.72
5) You are spending the required amount of time preparing for this class.	3.81
6) You are taking responsibility for this class and keeping yourself up to date with the class material.	3.92
7) The text book and book companion website is helping you learn the course material.	1.71

(Table 3 – Midterm instruction and learning evaluation)

Comparing tables 1 and 3, there is a clear indication that the methods used by the authors in spring 2008 have helped to improve the rate of instruction. Although, the results reflect a fairly small sample of students, the author believes that by continuing working and improving the presented teaching methods more benefits for students and instructors will occur on a continuous basis.

Conclusions

Meeting the challenges presented by teaching electrical engineering to non-EE majors is an ongoing reality. Without a doubt, teaching such a course requires a substantial time investment. Teaching a course covering easy topics doesn't mean a course easy to teach. It does require lots of effort and it does not guarantee good students' course evaluations. While the author feels that the suggestions presented in this paper show promise to a successful non-EE major experience in an EE class and can help improve retention rate, performance, and make the idea of interdisciplinary engineering more appealing to a wider, diverse group of students, each instructor must work within the context of his or her own institutions. Tailoring these teaching approaches to our own institutions is a critical success factor and must be taking into consideration. In addition to incorporating innovative teaching method to engage non-EE majors in electronics classes, we also should strive to align our assessment measures with our goals. Although the author believes that is too early to comprehensively assess the effect of these teaching methods on student learning and retention, assessments data indicates that our preliminary results are encouraging. The teaching methods used have proved to be efficient tools in responding successfully to the challenge of teaching EE classes to non-EE majors.

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