
AC 2011-2657: STUDENT FEEDBACK TOWARDS MEDIA BASED INSTRUCTION: IMPROVING STUDENT RETENTION IN INTRODUCTORY ELECTRONICS & NETWORK ANALYSIS COURSE

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Student Feedback towards Media Based Instruction: Improving Student Retention in Introductory Electronics & Network Analysis course

Abstract - This paper discusses an educational effort to improve student retention in introductory electronics and network analysis course offered at a university in northeastern United States. It uses a new media-based tutorial and mini project intended to engage students in their studies. The paper, also seeks to study the effects of technology mode of instruction that complements conventional mode of instruction. This development, as well as lessons learned in the first three years of technology mode of instruction in introductory engineering courses (namely Electronics and Network Analysis) is evaluated numerically. A concluding section is offered that discusses the benefit of balancing conventional mode of instruction with technology mode of instruction.

INTRODUCTION

This paper examines the outcome of a survey and the feedback concluded by students that supported their outlook toward a media-based tutorial used in the instruction of Electronics and Network Analysis. The paper also presents an educational effort to improve student retention by engaging them in their studies. The assessment of this paper is in agreement with other comparable studies done on media-based instruction and student engagement. For example, Chen et al.¹ found that enhancing student engagement is an important step to increase student retention, accomplishment and outcomes. Cohen et al.² also found that students learned more from media based instruction compared to traditional modes of instruction. Likewise, Powell et al.³ explored this topic further and found that media based instruction was significant in raising the GPAs of the students.

To foster an environment whereby student engagement is enhanced a midterm project was assigned where the class was randomly divided by the professor into several groups of three to four students per group. The project was to design a “night lamp”, that is a circuit that turns an (light-emitting diode) LED light on when the room gets dark. A list of components for a possible circuit to accomplish this project was also given. Each group had to design and build the night lamp, write a report, and give a five minute power point presentation. The mini project was very successful since students collaborated and were engaged in the entire learning process.

The survey responses indicate that students, self-rated skilled computer users, found technology-driven and technology-based instruction to be beneficial to their learning process. However, their responses were mixed on the ease of learning the material. Furthermore, students still found traditional methods to be valuable while technology-based instruction made it more intuitive and enjoyable. Technology-based instruction resulted in a 100% passing rate from approximately 60% in previous semesters. These numbers exclude students who had performed poorly and had already dropped the course after midterm grades were due.

COURSE CONTENTS AND OBJECTIVES

I. Electronics

The Electronics course deals with an introduction to electrical circuits involving active components such as integrated circuits, diodes, transistors, and their applications. The course starts with a basic introduction to circuit theory. This includes a quick review of current and voltage divider rule, source transformation, Thevenin's and Norton's theorems, transfer function, and circuit models for amplifiers. The course covers an introduction to the physical operation of electronic semiconductor devices such as the diode, the field-effect transistor, and the bipolar junction transistor. Device models are developed to aid in circuit analysis and design. Biasing, large-signal and small-signal analysis and the principles used in the design of electronic circuits are included in the course. The course also offers a laboratory component that introduces students to simulation/modeling CAD tools such as PSpice and Mathematica's toolbox Analog Insydes for the design and analysis of electronic circuits. By the middle of the semester students are assigned into groups to complete a midterm project where they build, test, and present their work. Several mini-projects are assigned throughout the semester. The prerequisite for this course is Circuit Analysis. The assessment for the course is as follows: 20% Laboratory, 10% Home Work, 10% Quizzes/Presentation, 30% Midterm Exam, 30% Final Exam. The majority of the students are from the electrical engineering program since this is a core required course for their curriculum. The course is a four-credit hour course (three hours lecture and one three-hour laboratory per week). A pilot study was conducted for this course. The students will have gained the following skills by the completion of the course:

1. Ability to summarize the terminal characteristics of operational amplifiers, and design/analyze fundamental circuits based on operational amplifiers.⁵⁻⁸
2. Ability to illustrate the operation principle and characteristic of diodes, and design/analyze fundamental circuits based on diodes.⁵⁻⁸
3. Ability to summarize the operation principle and characteristics of BJTs, and design/analyze fundamental amplifiers based on BJTs.⁵⁻⁸
4. Ability to summarize the operation principle and characteristics of MOSFETs, and design/analyze fundamental amplifiers (including differential pair) based on MOSFETs.⁵⁻⁸
5. Ability to construct fundamental circuits based on operational amplifiers, diodes, BJTs, and MOSFETs experimentally (lab skills).
6. Use simulation/modeling CAD tools such as PSpice and Mathematica's toolbox Analog Insydes to design and analyze simple electronic circuits.

II. Network Analysis

The Network Analysis course deals with the process of finding the voltages across and the currents through every element in a group of interconnected elements. The course starts with an introduction to elementary rules, theorems, and laws relevant to AC circuits. This includes an introduction to differential equation modeling and analysis of linear circuits with sinusoidal inputs (power, phasors, impedances, and admittances). The second half of the course continues with the whole works of circuit analysis in the frequency domain (Bode plots, frequency response, Laplace transforms, and Fourier analysis). The course also includes a laboratory component that introduces students to simulation/modeling CAD tools such as PSpice, Matlab, and Mathematica's tool box Analog Insydes for optimizing design parameters and verifying

design performance. The prerequisites for this course are Circuit Analysis and Differential Equations. The assessment for the course is as follows: 20% Laboratory, 10% Home Work, 10% Quizzes, 15% Midterm Exam I, 15% Midterm Exam II, 30% Final Exam. The majority of the students are from the electrical engineering program since this is a core required course for their curriculum. The course is a three-credit hour course (two hours lecture and one two-hour laboratory per week). A pilot study was conducted for this course. The students will have gained the following skills by the completion of the course:

1. Analyze linear circuits excited by steady state sinusoidal sources and compute phaser and instantaneous voltages and currents and complex and time-average power. Single and polyphase circuits.⁹⁻¹²
2. Derive transfer functions (variable-frequency response) from circuits containing independent sources, dependent sources, resistors, capacitors, inductors, operational amplifiers, transformers, and mutual inductance elements.⁹⁻¹²
3. Analyze the step response of linear circuits using Laplace transform theory.⁹⁻¹²
4. Derive two-port parameters from circuits containing resistive and impedance elements.⁹⁻¹²
5. Use simulation/modeling CAD tools such as PSpice, Matlab, and Mathematica's toolbox Analog Insydes for optimizing design parameters and verify design performance.

Both course objectives are in agreement with ABET Criterion 3 outcome and assessment for accrediting engineering programs.¹³ The laboratory section for both courses involves building and testing simple electronic circuits and making measurements in the laboratory using basic laboratory equipment, CAD tools, and working in a group. The two courses were taught in a similar fashion with the exception that Network Analysis had Matlab as an extra CAD tool. The software was introduced by weekly tutorials complemented with labs and or assignments that were based on the tutorials.

EVALUATION PROCESS AND INFORMATION COLLECTING

In the next sections of the paper the results and feedback of a study that was completed by the students will be described. These studies were based on their attitude towards media based modules that were used to smooth the progress of teaching Electronics and Network Analysis course. The modules also offer an interactive virtual laboratory setting by which they can get instant feedback to what-if questions.

STUDENT POPULATION

Twenty-nine students at a university in northeastern United States participated in the study. Twelve of these students were enrolled in Electronics and seventeen were in enrolled in Network Analysis. With more non-traditional students than comparable programs, students varied in age from 20 to 32 years with an average student age of about 23 years of age. All students in Electronics were male and juniors with all but one majoring in Electrical Engineering. There were a handful of older student in this course. In Network Analysis, the students were mostly male with a mix of juniors and seniors, most majoring in Electrical Engineering. Students in both classes ranked themselves concerning computer skills based on a 10-point scale, 10 being the highest. All students rated themselves with scores of at least 7 with an average rating of 8.

MEDIA BASED MODULES FOR TEACHING ELECTRONICS AND NETWORK ANALYSIS

An original media based module was produced to smooth the progress of teaching engineering fundamentals and PSpice for Electronics and Network Analysis course. The students registered for the course had access to the media based modules that was available on a network drive. To gain access to the tutorials, the students had to use a campus computer to log onto their accounts. The modules start by giving a step by step simulated demonstration to help grasp the fundamental procedures of using PSpice analysis of a simple circuit, DC, AC, and Transient analysis. It also includes demonstrations of applications using techniques such as Laplace Transform and Fourier Series.

The module illustrates all the required setups, file saving, operating the program, and viewing the results through text editor and screenshots. Every major step is shown in full detail. Students can set their own pace and time and hence, are in no rush to complete the modules.

ASSESSMENT METHOD

The module was housed on a network drive in a specified folder and the students were directed to log onto their campus account and download it to a working directory. Most of the students had no previous knowledge or experience with PSpice at the time of the execution of this media based module. They were able to understand, follow, and complete the module in a short amount of time and with relative ease. In the next scheduled laboratory meeting they used PSpice to run a simulation to analyze and complete the assigned laboratory experiment that was designed for that day.

The primary assessment purpose for this study was to evaluate students' outlook towards media based modules.¹⁴ In order to accomplish this task, a survey comprising of 12 questions was given to students enrolled in Electronics and Network Analysis at the end of the laboratory meeting. The complete survey used in this study included one question on self assessment of computer skills (10-point scale, 10 being best) and 12 additional questions concerning media based instruction using a five-point Likert scale (1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree). Furthermore, background information made up of the students major, year in college, age, and gender was gathered. On the back of the questionnaire, students were asked to write feedback regarding the use of media based tutorials.

STATISTICAL OUTCOMES AND INQUIRY

Table 1 presents the statistical outcomes from the 29 participants regarding the 12 media-based instruction questions. Almost all average scores for both classes are above the neutral rating of 3.0. This demonstrates that the students as a whole have positive outlooks towards media-based instruction since they either strongly agree or agree to all declarations.

Table 1. Summary of Questionnaire Reactions

Question	Mean for Electronics	Mean for Network Analysis
Q1. I am highly conversant with using a wide array of computing applications such as MS Office.	4.17 (0.72)	4.24 (0.75)
Q2. I feel technology driven instruction techniques facilitate ease of learning CAD tools such as PSpice.	3.75 (0.75)	3.82 (0.81)
Q3. I would prefer to use technology based instruction techniques while learning to use PSpice when I practice by myself.	4.00 (0.95)	3.71 (1.05)
Q4. Technology driven instruction plays a paramount role in making learning enjoyable.	3.75 (0.87)	3.71 (0.85)
Q5. I think learning CAD tools such as PSpice will be beneficial to my prospects.	4.08 (0.90)	4.18 (0.81)
Q6. I feel technology related instructional materials are easy to understand.	3.00 (1.13)	2.71 (0.99)
Q7. Technology based instruction techniques are more helpful than textbooks in the learning process.	3.67 (1.15)	3.47 (0.72)
Q8. Technology based instruction techniques are intriguing and help me concentrate on the subject matter better than other techniques.	3.58 (1.24)	3.35 (1.00)
Q9. Traditional methods do a mediocre job when dealing with learning CAD tools such as PSpice.	2.83 (0.58)	2.88 (1.06)
Q10. I can learn in an unhurried manner and pace myself using technology based instruction techniques.	3.92 (1.00)	3.76 (0.90)
Q11. Technology based instruction techniques get me more involved in the subject matter.	3.58 (1.08)	3.65 (1.00)
Q12. I was encouraged to experiment and learn more due to technology based instruction.	3.67 (1.23)	3.59 (1.23)
<i>Class Size (N)</i>	<i>12</i>	<i>17</i>

Note: Standard deviations in parentheses next to means.

Perhaps due to the ambiguous wording in the question, Question 9 is the only question that has below a 3.0 from both courses. Students neither agree nor disagree that traditional methods are mediocre. Question 6 received a rating of 3.0 for Electronics and below 3.0 for Network Analysis. While response patterns, in general, are similar across courses, we analyze the detailed responses for each course.

Figure 1 and Figure 2 show the detailed responses of the students by course. Although there were insufficient data points to offer reliable outcomes, the figures serve to express similarities and differences in the outlooks of students. The 5-point Likert scale was consolidated into 3 responses of agree, disagree and neutral.

As indicated in Figure 1, Electronics students agreed on all statements with the exception of Questions 6 and 9. On the ease of comprehending the technology-related instructional material, the class was split equally between the responses. A quarter of the students disagreed with the statement that traditional methods do a mediocre job when dealing with learning CAD tools such as PSpice. This response, in conjunction with 60% of the students agreeing that technology-based instruction techniques are more helpful (Question 7) suggest that technology-based methods ought to complement traditional methods, instead of substituting for them.

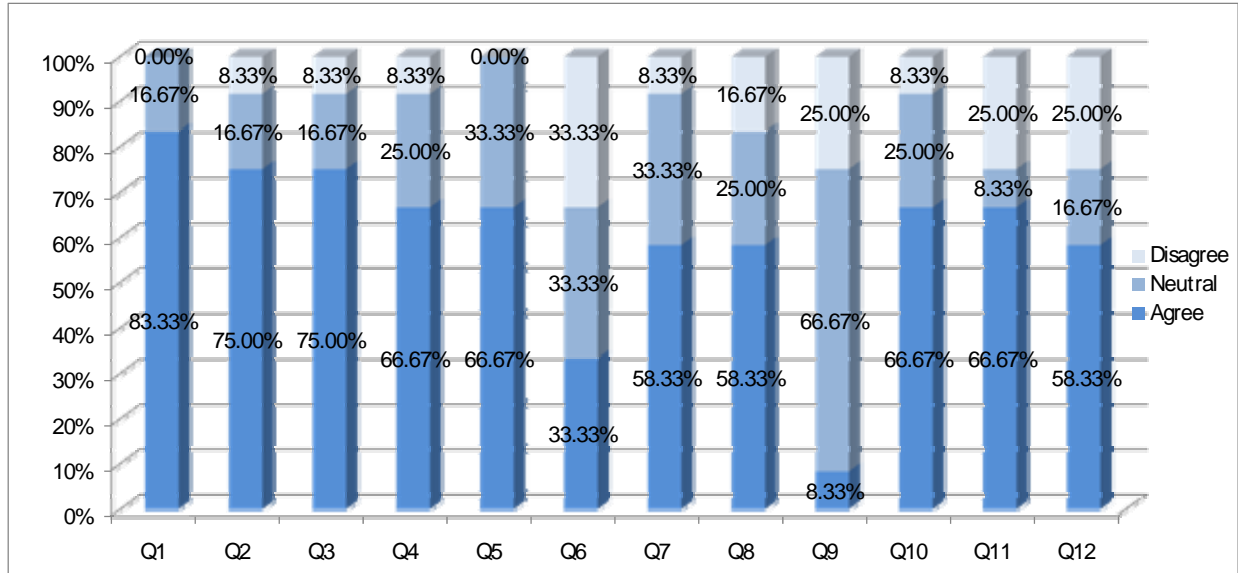


Figure 1: Detailed Student Responses for Electronics Students

As indicated in Figure 2, while responses of the Network Analysis were similar to those of Electronics students, there were some differences. This class was less homogeneous (split equally with juniors and seniors) than the former class, with a smaller proportion indicating their computer skills are high (Question 1). As a result, only 70% found technology-driven instruction techniques to facilitate ease of learning CAD tools and only 65% preferred to use technology-based instruction techniques while learning to use PSpice. Furthermore, the proportion agreeing to the ease of understanding technology-related instructional material (Question 6) was much smaller. In this particular class, there were several impatient students who were unwilling to spend the time outside of class learning the tutorials for the software. As a consequence, it is not surprising that fewer fractions responded positively to the benefit of pacing themselves to learning the material (Question 10) and being more involved (Question 11). Unfortunately, the responses may not be entirely uncorrelated with background characteristics (age and maturity level) of the students. Nonetheless, we were able to compare the survey results for Electronics and Network Analysis students.

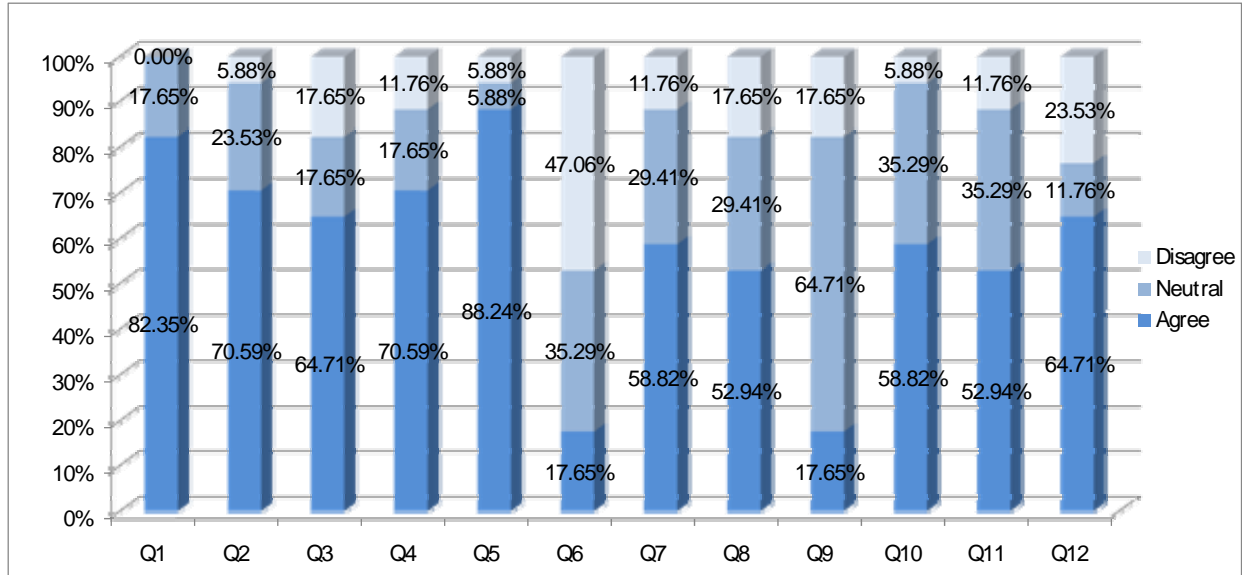


Figure 2: Detailed Student Responses for Network Analysis Students

STUDENT FEEDBACK

The following are actual reactions by students that provide further insights into the use of media-based instruction.

I. Electronics

- I enjoyed learning to use new programs that help in understanding ideas that we learned by hand in class. Not only are they a useful skill to know for the professional world, but they also provide a unique learning experience in the classroom.
- Doing lab on our own schedule was very beneficial for my schedule, allowing me to do them during the week when it was best for me.
- The tutorials received over the time of this course were beneficial to learning the language and style of the programs required for course assignments.
- I enjoyed using all the different computer programs.
- I really like the fact that we weren't rushed or timed to do the labs. It's really helpful.
- The PSpice tutorials and labs made it easy to learn how to use PSpice.

II. Network Analysis

- PSpice was beneficial to my understanding of electrical circuits and design.
- It was nice to have the tutorials to guide me in learning programs I have not used before. It was a lot easier to understand, compared to searching the internet.
- I enjoyed learning how to use new software to complement standard textbook learning.
- I do believe that these programs are highly useful to the learning process for engineering majors.
- Many of the tools used in this class were beneficial in my opinion since they are used in the industry. I feel that I've gained extra sets of skills that I can use in the future.
- PSpice is a really good tool. Thanks for exposing it to us.

The students, in general, had positive comments about their learning experience. From the teaching perspective, the use of technology-based instruction resulted in a 100% retention of the students. In prior semesters when such tools were not used, the passing rate was only about 60%. The students unanimously agree that the lack of a tight deadline and being able to work on their own pace and time improved their class performance.

CONCLUSION

In summary, this paper offered the outcomes of a survey taken in order to evaluate the usefulness of technology based teaching techniques in electronics and network analysis course at a university in northeastern United States. It measured the effectiveness of media based instruction in undergraduate Electronics and Network Analysis courses for electrical engineering majors at a university in northeastern United States. These results suggest that students preferred incorporating technology based instruction techniques to complement conventional instruction techniques to smooth the progress of learning engineering fundamentals in an accelerated mode. Moreover, engaging students in their studies by assigning mini projects has the effect of improving student retention and quality.

It is the intention of the authors to repeat this experiment over the next several years and to share the new outcomes with the education community in the future through suitable publications.

REFERENCES

- [1] Chen, H. L., Lattuca, L. R., and Hamilton, E. R., "Conceptualizing engagement: Contributions of faculty to Student Engagement in Engineering," *Journal of Engineering Education*, vol. 97, no. 3, pp. 339-353, July 2008.
- [2] Cohen, P., Ebeling, B., and Kulik, H., "A meta-analysis of outcomes studies of visual-based instruction," *Educational Communications and Technology Journal*, vol. 29, no. 1, pp.26-36, March, 1981.
- [3] Powell, J. V., Aeby Jr., V. G., and Carpenter-Aeby, T., "A comparison of student outcomes with and without teacher facilitated computer-based instruction," *Computers and Education*, vol. 40, no. 2, pp. 183-191, February, 2003.
- [4] Nagel, L. W., "SPICE2: A Computer Program to Simulate Semiconductor Circuits." Tech. Rep. UCB/ERL M520, University of California, Berkeley, 1975
- [5] Sedra, A. S. and Smith, K. C., *Microelectronic Circuits*, 6th ed., Oxford University Press, 2010.
- [6] Hambley, A. R., *Electronics*, 2nd ed., Prentice-Hall, Upper Saddle River, NJ, 2000.
- [7] Razavi, *Fundamentals of Microelectronics*, Wiley, 1st ed., 2008.
- [8] Horowitz, F. and Hill, W., *The Art of Electronics*, 2nd ed., Cambridge University Press, NY, 1989.
- [9] Nilsson, J. W. and Riedel, S., *Electric Circuits*, 9th ed., Prentice Hall, 2011.
- [10] Alexander, C. K and Sadiku, M. N. O., *Fundamentals of Electric Circuits*, 4th ed., McGraw-Hill, 2009.
- [11] Dorf, R. C. and Svoboda, J. A., *Introduction to Electric Circuits*, 6th ed., John Wiley & Sons, 2010.
- [12] Stanley, W. D., *Network Analysis with Applications*, 4th ed., Prentice Hall, 2003.
- [13] ABET, "Criteria for Accrediting Engineering Programs", ABET, Inc., 2011.
- [14] Thomassian, J.-C., Kumazawa, R., and Kinnicutt, P., "A Study of Freshmen Student's Outlook to Media Based Tutorials of Matlab/Java in Computing for Engineers," ASEE Proceedings, 2007 ASEE Annual Conference and Exposition, June 2007.