

2006-783: STUDENT ENGAGEMENT THROUGH MATHEMATICAL APPLICATIONS IN ELECTRICAL POWER SYSTEMS

Bruno Osorno, California State University-Northridge

Bruno Osorno has been teaching for over 20 years. He has written over 20 technical papers all related to electrical engineering. His interests are research in engineering education, application of new technologies into the curriculum and computer applications in electric power systems. He received an MSEE from the University of Colorado, Boulder and continued studies towards a PHD degree resulting in ABD. He has a great deal of industrial and consulting experience, more recently he was involved in consulting for NASA-JPL in the analysis of an electrical power system for a new mission. In the past he worked for several years as an electrical design engineer for a world wide chemical company. Currently he is a professor of Electrical and computer Engineering at California State University Northridge and lead faculty member in the Electric Power Systems graduate and undergraduate program.

Student Engagement through Mathematical Applications in Electrical Power Systems

Abstract- : Historically, electrical engineering students have been very proficient in the application of mathematics. At California State University we have experienced, recently, a negative shift of mathematical interest and therefore a lack of progress in the understanding of basic concepts that require a strong mathematical background. This problem stems from the lack of mathematical skills and studying habits. One way to solve this problem is to engage our students into the application of mathematics with simple, yet, powerful problems. An assessment of such engagement occurs every week with a quiz that spans the material covered during the previous week and tests some of the mathematical and engineering skills. This paper attempts to show the results of such assessment and the outcome of a class in which such approach was tasted. During this semester we are testing this technique again in a different course.

Introduction

STUDENT ENGAGEMENT, “SE,” is a technique devised by Celt, “Center for Learning and Teaching,” at California State University Northridge. This technique is one of many approaches to engage students. In this paper we used weekly quizzes all semester long. In addition we had examinations homework and group projects. While this technique is not unique or new, we are using it in combination with its assessment to quantify its effectiveness.

ECE 412 was the course used to test this approach. This course is named Power Electronics and Motor Drives. Because the complexity of the course and the required application of most of the mathematical background the students should have, it was decided to apply a different technique to help them deal with the broad range of material. Quizzes given every week increased the level of learning and commitment towards the course. We were amazed to realize that those students enrolled in this course were not motivated to excel in it. Most of them wanted to get by and “just” pass the course. Also, they found out that the level of mathematical applications was quite involved. Therefore, student engagement “SE” was used and here we are sharing some of the findings. Two sample quizzes are shown in the appendix of this paper.

Engagement

Engagement can be looked at from an extrinsic to an intrinsic level. It was concluded that the “key” to bring students to the classroom in a regular basis was to give quizzes every week. Other approaches were using journals, group problem solving, etc. In ECE 412 it was decided to use quizzes. Figure 1 shows in a graphic form this process.

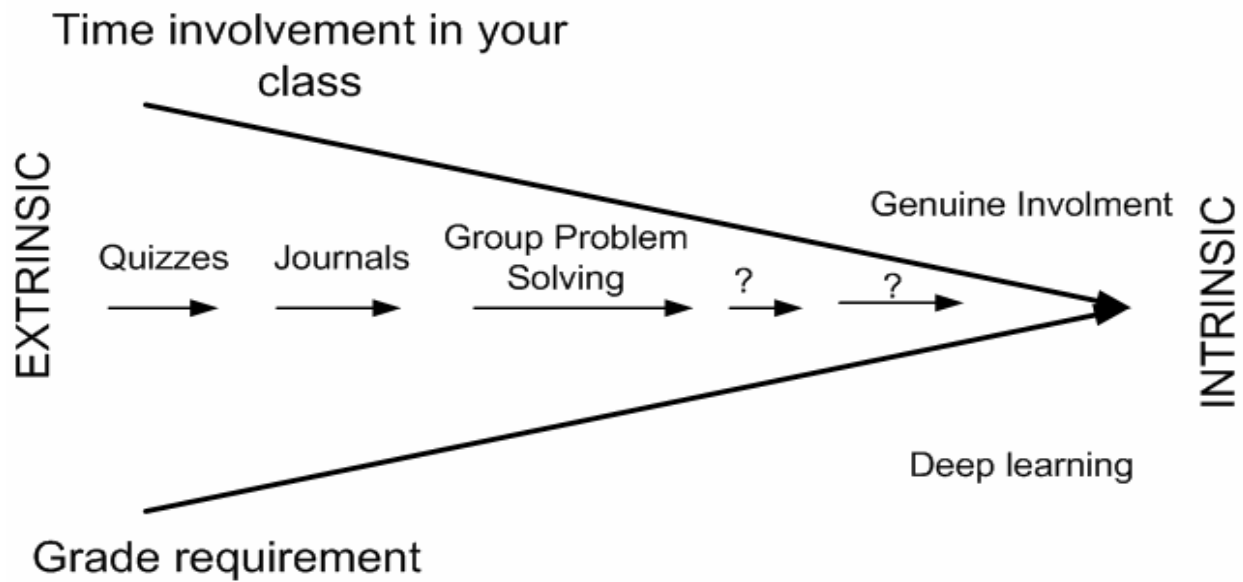
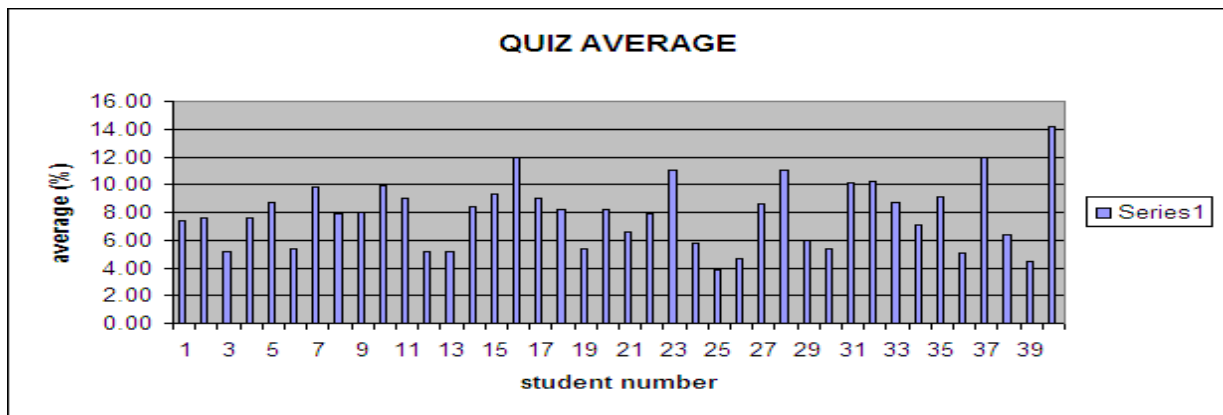


Figure1. Learning flow¹

Time management is a problem that gets enhanced in our commuting campus. The majority of our students work part-time and many full-time in order to survive. Therefore we compete for time and involvement. One way to attract and get students involved is by giving weekly quizzes. These quizzes are straight forward and related to the material covered in class the week before.

Quizzes

Eleven quizzes were given during the semester and the total average was 7.89 in a scale of 10. Figure 2 shows a chart indicating the average quiz grade obtained by each student. Our class size was 41 students at the beginning of the semester, and the class ended with 39 students. The average was 7.89 and the percentage of the grade was 15%. Some samples of the quizzes given are shown in appendix 1, and they were 15 minutes long each.

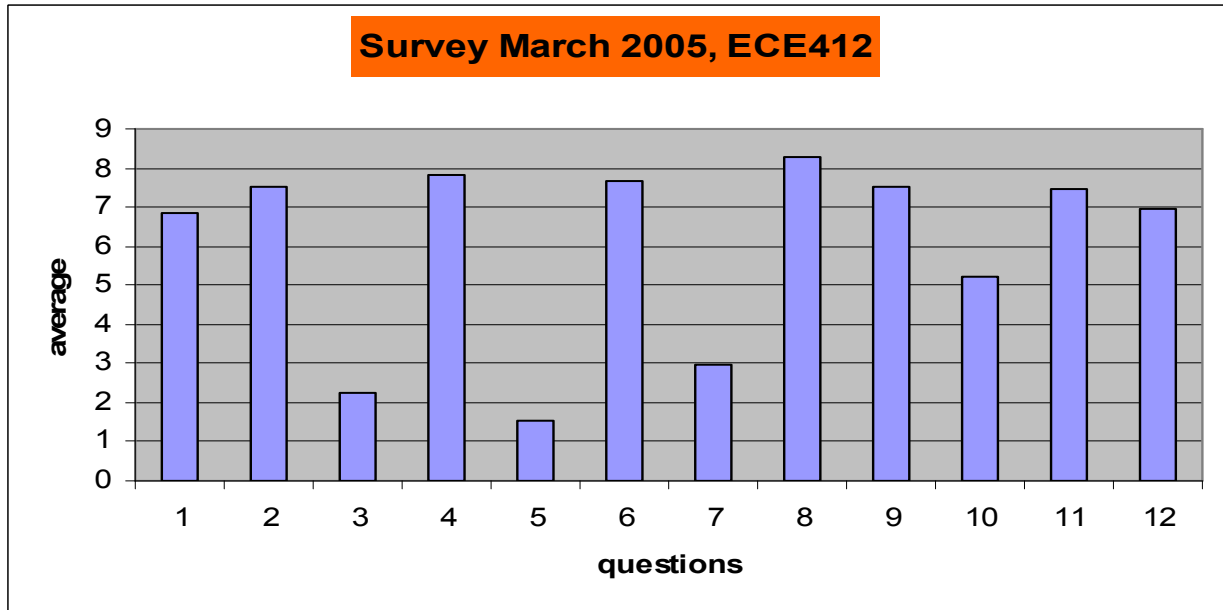


Average=7.89

Figure2. Average of quizzes

Midterm Assessment

During the fifth week of classes a midterm-survey was given to assess the attitude and effect that the quizzes had in the engagement of students. This survey had 10 questions all ranked from 0 to 10. 0 strongly disagree and 10 strongly agree. Figure 3 shows the chart with the results of the survey.



question

- [1] Do you prefer to take a quiz every week?
- [2] Do you feel that you learn more taking a quiz every week?
- [3] Do you feel that you learn less taking a quiz every week?
- [4] Does a quiz every week keep you abreast of the subject?
- [5] Does a quiz every week keep you from learning the subject?
- [6] Do you spent more time studying when you have to take a quiz every week?
- [7] Do you study less when you have to take a quiz every week?
- [8] Would you recommend this course to other students?
- [9] Is the pace of this course adequate?
- [10] Is the textbook adequate?
- [11] Is the homework adequate?
- [12] Has your grade improved by taking a quiz every week?

Figure4. Midterm survey

Questions 4, 6 and 8 obtained the largest averages and this translates into some success in the student engagement that we were trying to accomplish. It seems that keeping up with the material has a strong correlation with the time spending in the classroom and the liking of the subject. It is noticeable from question 1 that there was a reaction against being quizzed every week. The average of this question was about 6.8 indicating a lukewarm attitude.

Academic Skills

It was necessary to perform a second and final survey at the end of the semester. This survey was related to academic skills and the change that students had to make in order to adapt to take a quiz every week. Figure 5 shows a chart indicating the results of the questionnaire. Every question was ranked from 0 (strongly disagree) to 10 (strongly agree).

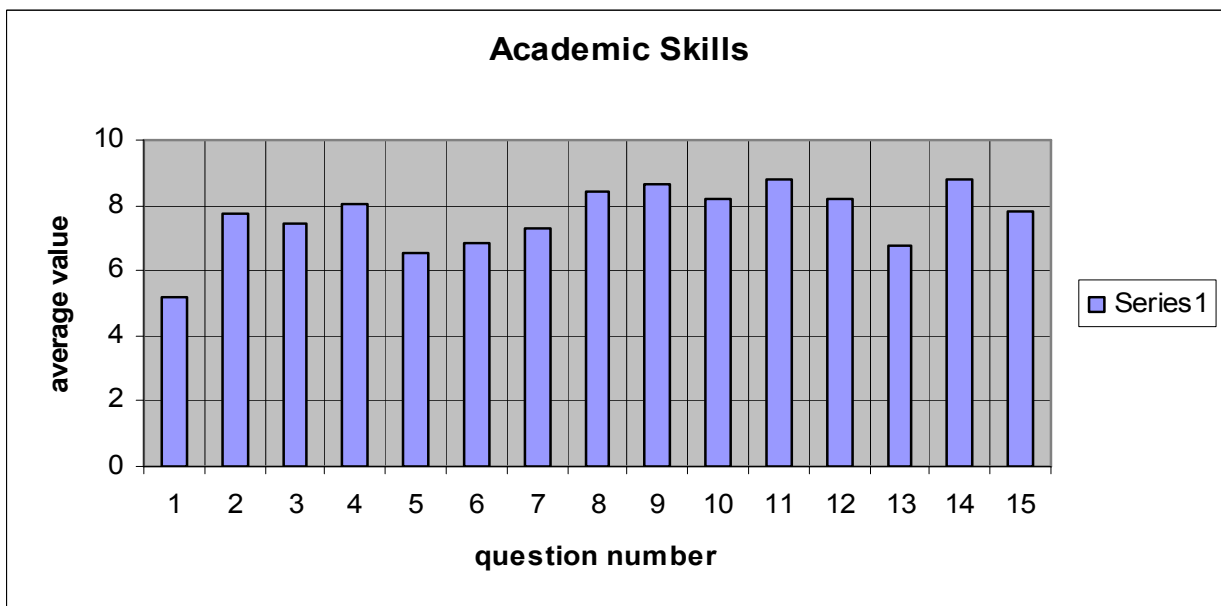


Figure5. Academic skills results

Below we have included the survey given to the students at the end of the semester.

**Survey of Academic Skills²
ECE412 Power Electronics**

Please write a number inside the box for each question. Please use the scale from 0 to 10, where 0 represents a strong disagreement and 10 represents a strong agreement.

1. I interact regularly with my professors both in and out of the classroom.

2. I make effective use of my peers by regularly engaging in group study and collaborative learning
3. I schedule my time, utilizing time management principles
4. I devote an appropriate amount of time and effort to my studies
5. I prepare for each lecture by reviewing my notes and/or reading ahead in the text.
6. I keep up in my classes by having a working knowledge of the material presented in the last meeting before the next class meeting.
7. I am aware of the importance of being immersed in the academic environment of the institution and spend as much time on campus as possible
8. I practice good study skills in areas such as note taking and preparing for and taking tests.
9. I recognized the importance of goal setting and have clear good academic goals.
10. I am effectively managing the various aspects of my personal life, such as interactions with family and friends, personal finances, and outside workload.
11. I am highly motivated through a clear understanding of the rewards graduating in my chosen major will bring to my life.
12. At the university, I know other students in my classes and feel part of an academic learning community.
13. I am aware of and use several campus resources such as the writing center, counseling center, student health center, library, and career center.
14. I feel good about myself and about my situation, and I am confident about my ability to succeed academically.

15. Taking quizzes every week has forced me to reconsider my academic approach to my classes by adjusting and/or including some of the questions 1 through 14 into my every day schedule of activities

16. If you ranked question 15 please, indicated below what questions 1 through 14 have you added or adjusted this semester to help you do better in this course.

1	2	3	4	5	6	7	8	9	10	11	12	13	14

Question 15 is the critical one. *Changes in academic skills due to quizzes every week* was quite dramatic. Of course it would be necessary to correlate this changes with the grades obtained at the end of the semester. About 80% change in academic skills occurred due to quizzes given every week.

Final Grade

The final grade is the ultimate indicator of what effect quizzes had. In the fall semester of 2001 this class was taught without using quizzes every week. Final grades are indicated in figure 6, the average for the final grade using the SE technique was 76.8% which is an improvement from the previous time the class was taught were the average grade was 68.6%.

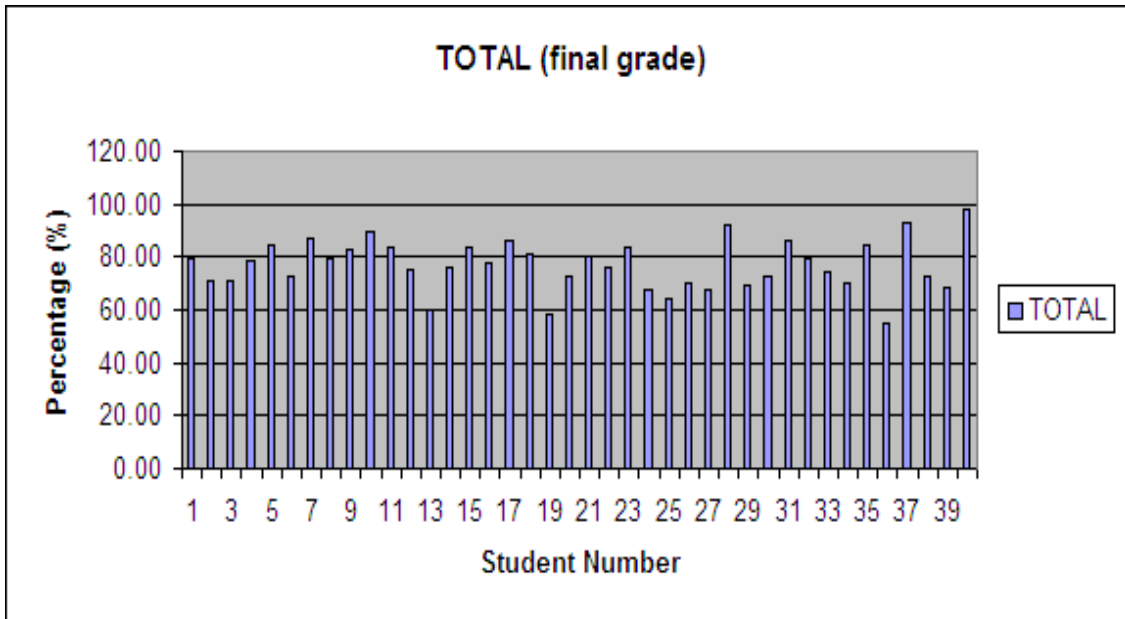


Figure6. Final grade using SE technique, average 76.8%

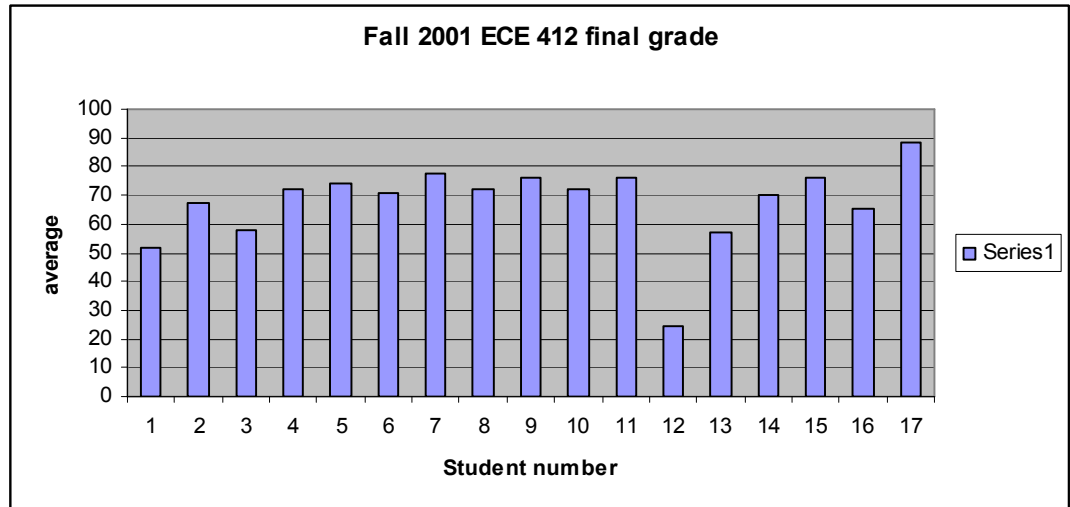


Figure 7. Final grade without using SE technique, average 68%

Conclusions

There is 8.2% difference between results with SE and without. Still, it is a very small change to indicate a complete success. There are many other variables that might have influenced the outcome. For example we could have had a more homogeneous student group in the semester when we applied SE. Another variable could have been the effort shown by the instructor during the SE semester compared to the semester where there was no SE. Changes in homework assignments, textbooks; class notes, etc. could have had an impact. It is my personal impression that the assessment given served as an indicator of making some progress in getting students to apply themselves more towards their studies and at the same time improving their studying skills. I must include an aspect of ABET in this discussion, it is an outcome related to life long learning, It seems that if we teach our students habits about dedication and time management and learning skills, the outcome is completely covered and we have a successful result.

Bibliography

- [1] Cynthia Derochers, "CELT student engagement group," California State University Northridge, Spring semester 2005
- [2] Ray Landis, "Studying Engineering," Presentation and textbook, California State University Northridge. May 2005.
- [3] Bruno Osorno, "Celt student engagement group report," California State University Northridge. May 2005

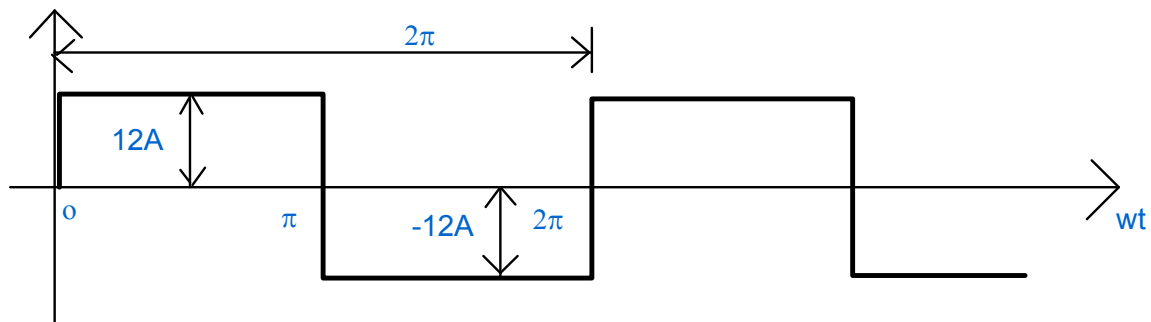
Appendix

QUIZ 5

PROBLEM

Giving the waveform shown below and using table 3-1, determine:

1. I_{avg}
2. I_{RMS} of fundamental
3. Values of the 1st, 2nd, 3rd, 4th and 5th harmonics



QUIZ 6

PROBLEM

A buck converter has the following characteristics:

- $V_d = 15V$
- $V_o = 7V$
- $V_{o_{peak-to-peak}} = 10mV$
- $I_{L_{peak}} = 1A$
- $f = 50KHz$

Find:

1. Duty ratio
2. Filter inductance

