Revitalizing Multidisciplinary Electricity Courses: A Comparative Study

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Abstract

All undergraduate students in the Technology Department at Northern Illinois University (NIU) are required to take electricity and electronics fundamentals courses. Rapidly changing technology necessitates the continual review and upgrade of these multidisciplinary courses so that they continue to serve both the student and industry in a relevant way. This paper describes changes needed to revitalize curricula as the results of 1) a self-assessment to ensure that the courses support the department curricula, 2) an investigation of similar programs instituted at other colleges and universities, 3) joint coordination with Rock Valley College (RVC) to streamline courses at both institutions, and 4) a survey with the department's industrial advisory committees. Additionally, various instructional technologies that were specifically designed for teaching in a multimedia environment commonly referred to as "Smart Classrooms" are also presented and described in this paper. Finally, students' surveys regarding the use of PowerPoint presentations, Blackboard or on-line courses, videocassette education product, computer simulation, as well as, lessons learned for future improvements are presented and discussed.

I. Introduction

The Technology Department at NIU offers three undergraduate programs: Electrical Engineering Technology (EET), Manufacturing Engineering Technology (MET), and Industrial Technology (IT). All technology students are required to take Electricity and Electronics Fundamentals (TECH175) and its companion Laboratory (TECH175A) that can be viewed at the department's web page http://www.ceet.niu.edu/depts/tech/academic/classes/class. For some students, this is possibly their only opportunity to learn basic electricity skills before graduation. Due to their multidisciplinary nature, these courses have traditionally been a challenge to teach, and therefore, innovative teaching methods have been employed to accommodate different learning styles. Since the Technology Department has been engaged in a major examination of its educational programs and curricula, the need for such revision has never been greater.

In the past, technology educators have published interesting results, mainly using quantitative research methods[1]. Some studies have used qualitative methods to achieve similar objectives[2]. A more effective approach, however, is to combine both methods for a comprehensive understanding of the underlying issues[3] that necessitate the construction of a meaningful course database that can be used to achieve the desired outcomes. Therefore, a comparative study

among fifteen colleges and universities was conducted in this study to help create a profile of the differences and similarities that exist in such multidisciplinary courses. This was achieved by conducting surveys, interviews, and discussions over a six-month period using different methods, including the use of Internet sites such as etd-l@coe.neu.edu - a nationwide affiliation with technology educators. Contacts were also made with the department's diverse advisory committees, providing inputs on significant issues that affect the quality of the department's programs.

Furthermore, information technologies have become an essential means to promote knowledge, especially at educational institutions[4]. Recent studies have shown that students at all levels are increasingly expecting an educational delivery system that caters to their need[5]. Today, educators are leading schools into uncharted learning environment[6]. Advanced information technologies are now helping create what are called "virtual" classrooms, where students equipped with laptops can attend classes from almost anywhere in the world[7].

Nowadays, modern classrooms are fitted with overhead projectors, video/audio equipment, and a computer usually connected to a campus-wide server[8]. With this arrangement, teachers can download files from their own computers, use PowerPoint or slides for presentations, and display audio/videos educational products. They can also search the Internet and bring live entertainment into the classroom in order to help students in their learning process. In addition, various instructional technologies such as PowerPoint presentations, Blackboard, videocassettes, and computer simulation specifically designed for teaching in a multimedia environment were developed and discussed. Finally, the outcome of a student' survey to measure the effectiveness of these teaching methods and recommendations for future improvements was also presented.

II. Course Revision

Given today's diverse industrial applications, the topics covered in TECH175 were quite restrictive. The concern was not primarily about students being specialists at this level, but rather a need to provide them with a broad base of knowledge. As a result of this study, the course contents, including its lab components, were modified as follows:

Old Catalog Description:
TECH 175. Electricity and Electronics Fundamentals (3): Fundamentals of dc and ac circuits, network laws and theorems, passive circuit components, and digital systems.

New Catalog Description:
TECH 175. Electricity and Electronics Fundamentals (3): Fundamentals of dc and ac circuits, Ohm's Law, Kirchhoff's Laws, power calculations, semiconductors, basic electronic circuits, electric machines, and digital systems.

A 10-questionnaire survey was sent to the 30 members of the department's industrial advisory boards during the summer of 2003. It should be noted that 20 people (67%) had responded to this survey with their responses provided in Table 1.

Table 1. Industrial Survey

Survey questionnaire	Strongly Agree	Agree	Disagree	Strongly Disagree
1) At this introductory level, we believe that covering circuit network analysis and theorems such as Mesh, Nodal, Thevenin, Norton, and Superposition techniques are inadequate.	20%	60%	10%	10%
2) In this course, students should know basic DC and AC circuits such as Ohm's law, Kirchhoff's analysis, and power calculations.	90%	10%	0%	0%
3) To gain industrial skills, students should be introduced to machines and transformers.	30%	70%	0%	0%
4) Basic wiring diagrams and fault protection circuitry such as circuit breakers, fuses, relays, and contactors should be taught at this level.	10%	80%	10%	0%
5) In this course, students should learn to read ladder diagrams and design basic control logic.	20%	80%	0%	0%
6) At this level, semiconductors and explain the basic operation of power supplies, voltage regulators, and amplifiers?	30%	60%	10%	0%
7) In this course, students should learn to construct simple electric circuits and collect data using multimeters and scopes?	50%	40%	0%	10%
8) In your opinion, should students at this level be introduced to integrated circuit (IC)?	30%	70%	0%	0%
9) Should students in this course be taught basic logic gates and digital circuits?	20%	50%	3%	0%
10) Do you believe that students at this level should learn to employ Boolean algebra and Karnaugh Maps to simplify logic expressions?	0%	20%	50%	30%

III. Information Technologies

Four different instructional technologies were developed and include:

A) PowerPoint Presentations

Almost all covered course materials were converted into PowerPoint presentations. The author has spent a great deal of time preparing these presentations, but it was considered time well spent since these files can be reused with minor changes if required, providing more time for future course development and revision. PowerPoint presentations were actually delivered during the first 15-minute of class and mostly covered fundamentals and major points. However, good efforts were directed towards keeping the text to a minimum with lots of illustrations, diagrams, and examples.

B) Blackboard

Blackboard[9] is web-based software used by NIU for on-line information and course offerings. Blackboard may either be used as a course supplement to post information or may completely go on-line. Students were given access to view on-line course information, such as syllabus, periodic announcements, homework assignments, and also practice exams. Additionally, they were able to communicate with each other and e-mail messages. Students were also able to browse the on-line course site and retrieve any information they may want to have.

C) Videocassette Product

Another teaching aid was used in this course and consists of four different sets of videocassettes[10]. These include topics such as DC/AC circuits, electric motors, semiconductor devices, and digital circuits. The objective was to give students another chance to learn the material from a different source and person. It was hoped that students would make the connection so that they could see the whole picture. However, this was not always the case, as will be discussed later.

D) Computer Simulation

Computer simulation was another excellent tool used by the instructor to help students understand complex theories through simulation. For instance, electromagnetic principles were explained by animating a rotating coil inside a magnet. Students were able to predict the polarity of the voltage induced inside the generator as shown in Figure 1. The computer software[11] is textbook tailored and followed the chapters and type of problems used. Students were asked to go through the interactive tutoring materials, provide answers, and randomly select problems from three different levels.

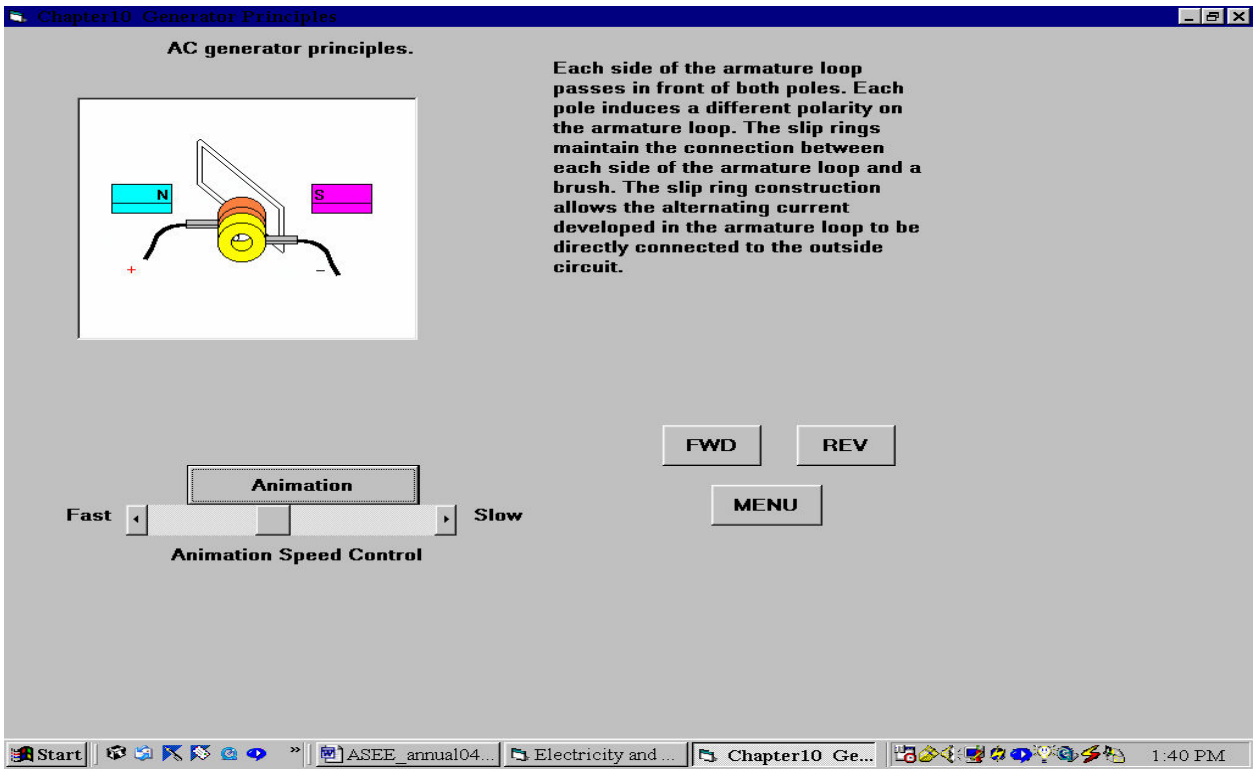

Figure 1. Computer Simulation of a Simple Generator

To measure the effectiveness of these different teaching methods, a student survey was administered towards the end of the semester. All responses are tabulated below with brief interpretations.

1) Please give the following:

a) Your Major------ b) Your GPA------ c) Years in college------

Table 2. Student Population and GPA

Major	Number of Students	Years in college	GPA
IT	15	3	2.67
EET	14	2	2.69
MET	4	2	2.50
Others	4	2	2.97
Total	37	2	2.70

Table 2 shows a typical student population for Tech 175: Four majors were reported: IT (15), EET (14), MET (4), and Others (4). Students were mostly junior level with an average GPA of 2.70.

2) Do you have any previous exposure to information technology as used in this classroom?

Yes--------- No----------

Table 3. Previous Exposure

Major	Yes	No	Yes %
IT	13	2	87
EET	11	3	79
MET	4	0	100
Others	3	1	75
Total	31	6	84

The majority of students (84%) reported in Table 3 to be familiar with the use of information technology. That was quite expected since most classrooms at NIU are equipped with multimedia capabilities.

3) Do you believe that using information technologies is more effective than classical presentation?

a) Definitely----- b) Somewhat---------- c) Not at all

Table 4. Projector Effectiveness

Major	Definitely	Somewhat	Not at all
IT	9	6	0
EET	7	7	0
MET	0	4	0
Others	3	1	0
Total	19	18	0

Again, all students agreed as shown in Table 4 that using information technology is much more effective than traditional presentation.

4) Please rank on a scale of 4 (1-Excellent, 2-Good, 3-Average, 4-Poor) the following information technologies:

a) PowerPoint-------- b) Blackboard------- c) Videos-------- d) Interactive Software

Table 5. Information Technology Ranking

Major	PowerPoint	Blackboard	Videos	Software
IT	1.73	2.13	2.67	1.8
EET	1.64	1.64	2.5	1.93
MET	2	1.75	2.25	1.5
Others	1.25	1.75	3.5	2.5
Total	1.65	1.82	2.73	1.93

1-Excellent, 2-Good, 3-Average, 4-Poor

As shown in Table 5, students have ranked high the usage of PowerPoint, Blackboard, and computer software. However, their appreciation for videocassettes was lower. It is interesting to note that this may have something to do with timing. Videos were always played in this class after the PowerPoint presentation. As a result, students may have been overexposed to the same materials. This interpretation gained ground after students, in another survey, found the same videos to be just great. This time they were played first and before PowerPoint presentations.

5) For what reason do you access Blackboard/Website designated for this course?

a) PowerPoint-------- b) Notice/Update------ c) Practice test--------d) All-------

Table 6. Reasons for Using Blackboard

Major	PowerPoint	Note/Update	Practice Test	All
IT	0	0	5	10
EET	1	0	0	13
MET	0	0	2	2
Others	0	0	2	2
Total	1	0	9	27

The answers to this question in Table 6 were reassuring enough to say that Blackboard is an effective teaching tool and that faculty should take advantage of all of its features, including on-line grades, testing, and instant messaging. However, one should also recognize the fact that not all courses are suited for on-line teaching such as some engineering and technology courses, which require concurrent teamwork and hands-on experience.

6) In your opinion, did information technology make it a better course?

a) Yes, a lot----- b) Somewhat------ c) Not at all

Table 7. Information Technology

Major	Yes	Somewhat	No
IT	12	3	0
EET	9	5	0
MET	3	0	2
Others	1	3	0
Total %	67	29	4

For this question, 67% of the students in Table 7 strongly agreed, 29% somewhat agreed, and only 4% disagreed. This was another indication that students, in general, are in favor of using information technology in the classrooms.

7) What effects does information technology have on your class participation and attendance?

a) Increased-------- b) Decreased-------- c) No influence

Table 8. Class Attendance

Majors	Increased	Decreased	No effects
IT	8	0	7
EET	5	0	9
MET	0	0	4
Others	1	0	3
Total%	38	0	62

Responses given in Table 8 indicated that 62% of the students asked did not consider information technology to be a big factor for attending classes. However, 38% reported positive impact on class attendance. Again, this was a significant result confirming that information technology can actually improve overall class retention and performance.

8) Would you recommend these teaching methods be maintained in future course offerings?
a) Yes--- b) No----- c) No opinion

Table 9. Overall Approval

Major	Yes	No	No opinion
IT	14	0	1
EET	12	0	2
MET	3	0	1
Others	3	0	1
Total %	86	0	14

Table 9 revealed yet another significant result. Nobody suggested in anyway stopping the use of information technology in the classrooms. On the contrary, 86% of the students recommended its continuous use. Nevertheless, students who had no opinion for this question (14%) might have other concerns for which further investigation might be warranted.

IV. Future Improvement

Several lessons were learned that would be applied for future improvement. Although simple analysis was used in this study, one may easily deduct that most students are appreciative of the use of information technology and wanted the techniques to continue, but they can also be critical. Therefore, educators must keep students engaged in the classroom by employing different teaching techniques and diversity. Actually, the best lessons may be derived from reading students' comments and suggestions. These comments, which may seem conflicting at first, can provide valuable insight into what students like and dislike.

V. Conclusions

This paper discussed changes needed to revitalize basic electricity courses in the Technology Department at Northern Illinois University. As a result, a new course description was developed based on information obtained from conducting an industrial survey and also investigation of similar programs at other academic institutions. Additionally, four different information technology techniques were presented to accommodate different learning styles and improve performance in such multidisciplinary basic electricity courses. The outcome of a student' survey to measure the effectiveness of using PowerPoint presentations, Blackboard, videocassettes, and computer simulation, was also presented and discussed.

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Biography

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Youakim Al Kalaani graduated from Cleveland State University with MS and Doctoral degrees in electrical engineering with a concentration in power systems. He is a member of IEEE and ASEE professional organizations and has research interest in electric power generation, renewable energy, unit scheduling, and optimization. He is currently an Assistant Professor in the Technology Department at Northern Illinois University.