An Experiment with Electronic Instruction: A Power Systems Course via E-Mail/Internet

Paulo F. Ribeiro and David A. Rogers

INTRODUCTION

Electronic communication has revolutionized the way the business and academic worlds are interacting. E-mail and file transfer via Internet across the globe have been extensively used to exchange written and graphical information in a reliable and efficient way as never before. This paper is about an experiment with electronic mail as the main communication means to teach a power systems course when the instructor was located 1800 miles from the students. The paper describes the procedures adopted to establish a structure for the educational process which could guarantee the achievement of the goals for such a course.

Electronic mail (e-mail) has been met with tremendous enthusiasm by college students, faculty, and administration. But how this new means of communication could effectively impact the educational process was not clear.

This experiment was initiated based on the belief that electronic communication could not only help to enhance the educational process, but also could actually become a fundamental component of the interaction between instructor and students, and among students themselves.

Logistics

The power systems course is part of the curriculum of an undergraduate ABET-accredited general engineering program at Dordt College, Sioux Center, Iowa. The instructor was located 1800 miles away from the students, and only five students were planning to take the course that term. This led to the discussion of establishing a distance-learning approach. The authors, who have been communicating and cooperating via e-mail for a long time, discussed the feasibility and curricular adjustments which would be necessary to implement such an idea. It was decided that with the mature students planning to take the course, things should work. If it didn’t work with this small group of students, it would not work in any other circumstance.

An Electronic Educational Global Village

Electronic mail has expanded the concept of a global village by allowing the educational world to communicate, interact and cooperate in a very efficient way. Initially used by researchers, the Internet system can support instructional activities. Students have the opportunity to exchange ideas and information with anyone in the globe. The "virtual" classroom is becoming a reality in the American educational system.

STRUCTURE OF THE COURSE

Due to the circumstances, a completely different structure and new curricular activities needed to be put in place. Among the several activities established to facilitate the educational process were:

1) an introductory "real lecture" section,
2) weekly meetings of all students to discuss assignments,
3) a rigid schedule of reading and homework assignments,
4) weekly e-mail reports about progress,
5) heavy use of computer simulation,
6) additional "real lectures" in the middle of the semester,
7) utilization of e-mail for research,
8) telephone and fax use during the exchange of information,
9) take-home design final test, given 5 weeks in advance, and, of course,
10) daily or weekly e-mail communication with the instructor, sometimes through on-line interaction.

In order to reproduce as much as possible a "real" class situation in a "virtual" environment, a number of techniques were used. For example, when a student would send a question, the question and answer would be forwarded to all students. Also, when the homework was evaluated, the instructor specifically encouraged...
students to discuss their different analytical solution approaches, graphical illustrations, and mistakes.

PHILOSOPHICAL MOTIVATION

A computer-aided, electronic communication, and graphical environment emphasis, and an interactive approach were used throughout this experimental course.

The two quotations below explain the philosophical motivation for the approach adopted in this course. The first refers to the utilization of computers and the second looks at the dynamics of the interaction among fellow students as an active component of the learning process.

Leibnitz (1671):
*It is unworthy of excellent men to lose hours like slaves in labor of calculations, which could be safely relegated to anyone else if machines were used.*

C.S. Lewis (1958):
*It often happens that two students can solve difficulties in their work for one another better than the master can. When you took the problem to a master, as we all remember, he was very likely to explain what you understood already, to add a great deal of information which you didn’t want, and say nothing at all about the thing that was puzzling you. The fellow-student can help more than the master because he knows less. The difficulty we want him to explain is one he has recently met. The expert met it so long ago that he sees the whole subject, by now, in such a different light that he cannot conceive what is really troubling the student; he sees a dozen other difficulties which ought to be troubling him but aren’t.*

The instructor, then, participates in the process as a facilitator and tutor, and the students and professor share the ownership of the educational enterprise. Thus, it is the belief of the authors that the task of the modern engineering educator seems to have more to do with encouraging curiosity, creativity and responsibility in an open environment than with imposing a tedious, unattractive, textbook approach.

IMPLEMENTATION AND RESULTS

A detailed syllabus was an essential part of the course. An emphasis on computer simulation was given through the use of several simulation tools. The Basic Educational Electric Power System software developed by the University of Manitoba and Manitoba Hydro, professional programs produced by the Electric Power Research Institute (EPRI), and other tools such as Pspice, Mathcad, and EZPower, were extensively used throughout the course.

The course was initiated with actual lectures. The instructor taught for six hours, introducing the students to the structure and mechanics of the course and the basic concepts of power system analysis. Six weeks later the instructor returned to campus for additional lectures. A review of past difficulties and discussions of advanced topics took place. Mandatory weekly student meetings encouraged more interaction. Many times the students would contact the instructor while meeting among themselves. Questions could be answered immediately. A rigid and sequential schedule of homework assignments kept students on track. Heavy utilization of computers was also used as a tool for individual learning. Regular e-mail communication and reports were required from all students.

An emphasis on power quality through lab experiments gave an additional opportunity for the students to have a firsthand experience with the real world, in terms of power system problems. A sample of the projects and lab experiments carried out during the course are listed below.

<table>
<thead>
<tr>
<th>Lab. No.</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1</td>
<td>INTERNET/EPRINET Bulletin Board</td>
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<tr>
<td>3</td>
<td>Energy Conservation</td>
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<td>4</td>
<td>Power Quality Survey</td>
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<td>6</td>
<td>Power Quality Audit</td>
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<td>8</td>
<td>Power Quality Analysis</td>
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<tr>
<td>10</td>
<td>Power Electronics</td>
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**Electronic Interaction**

E-mail exchange of information between student and instructor was the main communication link that made this experiment possible. Weekly and sometimes daily e-mail messages were exchanged to clarify theoretical points, difficulties with homework assignments, and even chat about life in general. Students were required to send at least one weekly report of their progress. Also fax and telephone were used to complement the exchange of information. Sometimes the instructor was traveling but was still able to communicate with the students using a notebook computer. Several e-mail exchanges are shown below.
Sample of e-mail: Student to Instructor

Date: 94-03-10 02:42:28 est
From: jdekoter@dordt.edu
To: PauloR

Prof. Ribeiro
I have been working on the homework and hope to have all of chapters 5 and 6 done and mailed to you by this Friday, the 11 of March. The material is okay and I'm not having many problems understanding it.

Til next time.

Sample of e-mail: Instructor to Students

Subj: Re: weekly report
Date: 94-03-10 12:29:07 est
From: PauloR
To: jdekoter@dordt.edu

Hi Jeff,

Thanks for your weekly report. Rob sent me a note yesterday regarding the use of Spice/EZPower. He wanted to know what typical parameters he should use for cables, transformers, etc. My suggestion was that you guys should actually investigate the influence of different types of parameters on a particular circuit. The reason is that everything depends on the voltage of the circuit, insulation, amount of loads, etc. Please send me a short report by next week. Talk to you later. Cheerio, Paulo.

Final Exams

The final exams were given as an individual take-home/design type test. Students had five weeks to work on designing an industrial distribution system which required running load-flow, short-circuit, and stability studies, and specifying the electrical parameters for transformers, cables, generators, power factor correction capacitors, and loads. Also, system contingencies needed to be investigated. A comprehensive report describing all cases studied and recommendations made was required. Due to the open-ended approach, students proposed different ways to keep the system working under the electrical constraints given.

The results of the tests revealed that the technical understanding of the students exceeded all expectations. The virtual environment, which forces and imposes a sort of omnipresence of the interaction, seems to have contributed to a more effective communication between instructor and students, and among students.

Student Evaluation

All students reacted very positively and enthusiastically to the course. Despite the fact that this was the first time they had this type of course, they unanimously agreed that things had gone well enough for them to learn a not-so-easy subject, power system analysis, at a distance. Indeed, three out of the five students showed a definite interest in pursuing a career in electrical power engineering. By the end of the academic year two of them had secured summer internships with power
utilities. One student kept track of how the time was spent in this course and came up with the following numbers: 30% of the time was spent attending real lectures and in e-mail communication with the instructor; 50% of the time was spent on homework, software application, and lab experiments, and the remaining 20% was spent on group discussion. A typical student evaluation is shown below.

Subj: ENGR 360 Evaluation
Date: 94-07-22 16:29:15 edt
From: rbrtntnd@dordt.edu
To: PauloR

July 22, 1994

Ref: Evaluation of ENGR 360 class

The power systems class was a unique experience. It was nice to try a different approach to learning in class. The teaching method allowed us to pursue our own interests as well as work at our own pace. The demonstrations we were asked to do were very practical, e.g., looking at the current waveform of the computer power supply. The final exam, in which we were asked to analyze a small industrial power system, do motor starting studies and short circuit analyses, and try to improve the system performance, helped us start to piece everything together into a real-life scenario. The organization and planning of the material was good and led to the success of the course. The choice of course software was excellent. When applying for a summer job, my interviewer was impressed that I knew how to use EZPower. They were considering purchasing the program for future use. Dr. Ribeiro was very helpful. If we e-mailed or faxed a question or a problem, we usually received a message, or phone call if the situation warranted, on the same day.

I would have preferred to have Dr. Ribeiro here, but enjoyed the change in regular classroom routine. I definitely benefited from taking the course and am seriously considering pursuing a power system analysis career after graduation.

Rob.

CONCLUSIONS

Remote teaching via e-mail was used to teach a power systems course. The approach seems to have facilitated the task of the instructor and certainly contributed to the success of the course. Above all, this experiment has opened the door for a distance-learning approach which is personal, very interactive, inexpensive, and very efficient. The concept of an electronic educational global village and the virtual classroom is a reality which has been made possible through the electronic mail system. Opportunity for enhanced learning, even at the undergraduate level, can be achieved when a proper course structure is set up and class size is limited. Face-to-face instructor/student contact, however, has to happen at least once, preferably at the beginning of the course. The approach also encourages students to have more ownership of the educational process, to develop communication skills in the information technology environment, and to be more self-disciplined and independent.

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Professor of Electrical Engineering at North Dakota State University, Fargo, ND. Received the BSEE (cum Laude) from the University of Washington in 1961, the MSEE from IIT (Chicago) in 1964, and the Ph.D. (EE) from Washington in 1971. In 1966 he received the M.Div. (cum Laude) from Trinity Evangelical Divinity School (Deerfield, IL). Served as a Second Lieutenant in the U.S. Army Signal Corps in 1961-1962. Conducted research for IIT Research Institute in 1963. Contributed to the development of the doctoral program in microwaves at the Universidade Estadual de Campinas (UNICAMP) - Brazil, from 1972 to 1980. He has contributed papers to IEEE, AGU, and ASEE journals. Received the 1987-88 NDSU College of Engineering and Architecture’s Teaching and Service Award. Dr. Rogers is a registered P.E. in Washington.

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