Integrating a Real Life Engineering Case Study into the Syllabus of an Undergraduate Network Programming using HTML and Java course

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Abstract

The booming Information Technology (IT) business has pushed universities to create IT academic programs (minor or major). The Computer Science and Software Engineering Department of Auburn University have been among the first ones to create an Information Technology Minor. The COMP2000 Network Programming with HTML and Java course has become an important component of this minor. We introduced a multimedia case study, Chick-fil-A, in this course as part of a lab assignment during Spring 2003. We describe the elements of the course, how the case study was included in the class, and evaluation results. The results show that the introduction of the multimedia case study in computer science courses is worthwhile and beneficial.

Introduction

IT successfully merges computing with high-speed communications links carrying data, sound and video. Examples of IT include personal computers, but also new forms of telephones, television and various handheld devices. IT is no longer a luxury, but rather a commodity. "Say goodbye to the personal computing era," writes technology journalist Kevin Manery. "Just on the horizon is the era that comes next – the personal information era."(see Sawyer and Williams 2001)

As a result of the outstanding progress achieved in today's IT, students' demand for IT courses have considerably increased. At Auburn University we take students' needs very seriously. Computer Science and Software Engineering Department (CSSE) now offers an Information Technology Minor that provides students with basic skills necessary to administer computer and Internet technology. These skills include the ability to do web site development, Applet and JApplet development and maintenance, Java programming, Java Script and XML scripting, system and network administration.

An important component of this academic program is a three-hour credit course focused on Network Programming with HTML and Java. This is a 2000 level course, requiring as prerequisites one of the following two courses: COMP1000, Introduction to Computer Applications or ENGR1110, Introduction to Engineering. The COMP2000 course was based on a multimedia syllabi, suitable textbooks, lecture notes, lab assignments, course tutorials, self-paced web site, properly setting the software configuration of the computers and local network in the course laboratory, and preparing the lecture classroom with Internet connection and computer projector.

Challenges in Offering COMP2000 Course

1. A large variety of students' academic majors

COMP2000, as an elective course for non-computer science and engineering students, has attracted students with a very large variety of academic majors starting with Liberal Arts major students, continuing with Business major students and ending with Electrical Engineering students

2. Students' computer backgrounds

This course requires as perquisites one of the following computer courses: COMP1000, Introduction to Computer Application or ENGR1110, Introduction to Engineering. Some students have taken more than one computer course and have already had some experience in using and programming computers or developing web pages. There are also students with a less than average computer background who are, however, very motivated in learning HTML and Java.

3. Students' goals

All students are obviously interested in learning HTML and Java, but have different goals regarding how they will use this type of knowledge. Their interests were:

- Becoming more comfortable with the Internet and WWW
- Being able to build and maintain own web site
- Being able to build and maintain a web site for the company they will work for
- Becoming a professional Web Master or a professional Java programmer

4. Students' inclination toward a self-paced course

Based on their computer backgrounds and goals, some students are interested in working on the lab assignments at home using the self-paced course web site content. Other students, based on the results received from the course survey, need a lot of help (see Marghitu and Hübscher, 2000). They would actually like even the lecture to be hands-on so they can do on a computer everything that the lecturer is doing.

Solutions to the Challenges

1. Developing the multimedia syllabi

The traditional syllabus for a college course has been handed to the students on the first day of class printed on paper. Updates or corrections to the syllabus were available only as announcements from the instructor that had to be noted by the students. A student absent from class on the day such an announcement is made must rely on asking fellow students for the information. For this class, the syllabus is not just a paper handout (see Marghitu, Lin and Ma, 2001), but is also available on the course web site. Updates to the syllabus, including lab assignments and assignment due dates, WebCT practice tests, lecture notes and practice materials are available on the web site, making the latest class information available to the students instantly. Moreover, the web site, and, therefore, the syllabus, is available to the students any time, day or night, without the need to contact the instructor or classmates for the information. The website is available at www.eng.auburn.edu/daniela/comp2000/comp2000.htm.

2. Choosing the right textbooks

The right textbooks for this type of course should be very up to date, easy to read and understand, offers examples, practice work for students, web student companion with learning and testing resources that can be integrated into the course's self-paced web site. We believe that the two textbooks we have chosen meet these requirements.

HTML Introductory Second Edition Authors: Elizabeth Eisner Reding, Sasha Vodnik Course Technology Publishing Co.
Java Programming, Second Edition Author: Joyce Farrell Course Technology Publishing Co.

3. Developing lectures using a multimedia classroom

The development of this course's lectures has been done using Microsoft PowerPoint, Word Pad, Microsoft FrontPage, Netscape and Internet Explorer Browser, Java software, JGrasp and a Gateway SOLO Laptop Computer. The course lecturer uses a fully equipped multimedia classroom.

4. Developing very detailed, self-explanatory hands-on lab assignments

The lab assignments have been designed to be self-explanatory. They include tutorial of the software used and instructions about specific settings of the course lab computers and network. They also include instructions on how to download and install software (Java software, and JGrasp for example).

5. Developing a user friendly, self-paced web site

While the class's self-paced web site < http://www.eng.auburn.edu/users/daniela/comp2000/COMP2000.htm> is available any time, day or night, the instructor is not. For this reason, the class web site must be very clear and easy to navigate for the students. The availability of the web site also means that the students can and are encouraged to work at their own pace.

6. Working with the Network Engineering team in setting the course lab

The lecturer was involved in the software configuration of the course laboratory in order to assure the proper installation of all required software application and was aware of some default settings which will need to be presented in the lab assignments.

7. Developing and administering a class survey in order to find out information about students' computer backgrounds, needs and goals:

In order to better understand students' needs and goals, a course survey has been designed and administered. It has provided very useful information for the lecturer and lab instructor.

8. Integrating in the first Lab assignment a real-life Engineering Case Study: "Operating Systems Choice for Point-of-Sale Terminals at Chick-fil-A"

During Spring 2003, we integrated, in the first lab assignment, a real-life engineering case study: "Operating Systems Choice for Point-of-Sale Terminals at Chick-fil-A" (see Raju and Sankar, 2001). This case study is targeting undergraduate and graduate courses in MIS, IT and Computer Information Systems programs. It provides valuable knowledge that students could use in courses such as COMP2000: operating systems, telecommunications. It provides students an opportunity to participate in decision-making scenarios involving technical and non-technical issues. The objective is to celebrate IT by showing how the decision of the IT personnel and managers can influence the growth of the economy.

By integrating this case study in the first lab assignment of the course we were hoping to:

a) offer students a chance to review and reinforce some prior knowledge of operating systems, computer hardware and software architecture, computer hardware and software functionality and computer software applications (Figure 1), and

b) help students develop their ability to use techniques, skills and modern IT tools necessary in business

Process of Including the Case Study in COMP2000

The case study was assigned as part of one of the lab assignments. The students were provided the CD-ROM of the case study and they were asked to take an IT quiz including questions from the material covered in the case study.

Two questionnaires were used to evaluate student feedback on the case study. Evaluation I consisted of 24 bipolar descriptors. In other words, an item on the evaluation form would represent the concept of clarity on a 5-point continuum from unclear to clear or the case study's relevance on a continuum from irrelevant to relevant. The respondents would click the radio button next to the number on the scale, from 1 to 5 that most

closely corresponded to their attitude toward that element of the case study.

The respondents continued to follow this process through all 24 bipolar descriptors. Because the 24 questions yielded substantial reliabilities, in previous studies, for four clear concepts or constructs, the analysis for Evaluation I was organized by the following four case-study descriptors: (a) interesting and exciting, (b) important and valuable, (c) instructionally helpful, and (d) relevant and useful.

Evaluation II asked the respondents to indicate the extent of their agreement with 16 evaluatory statements on a 5-point Likert scale. Some sample items include statements such as, "I improved my ability to evaluate critically design and ethical alternatives" or "I learned new concepts." The response scale progressed from a rating of 1 which represented the least positive or least favorable response of strongly disagree to a rating of 5 which represented the most positive or favorable response of strongly agree. In addition, in Evaluation II a qualitative element was added to the evaluation process. The form ended with two open-ended questions, which asked the students to provide written responses concerning the strengths and weaknesses of the Chick-fil-A Case Study, as well as suggestions for improvement.

Results of Quiz on IT

The IT Quiz was formed by 22 questions from the content covered in the case study. The average grade of the quiz was 87%, the lowest grade was 64% and the highest grade was 93%. That indicates that students had fully taken advantage of the technical and academic value of the case study that was included in this course.

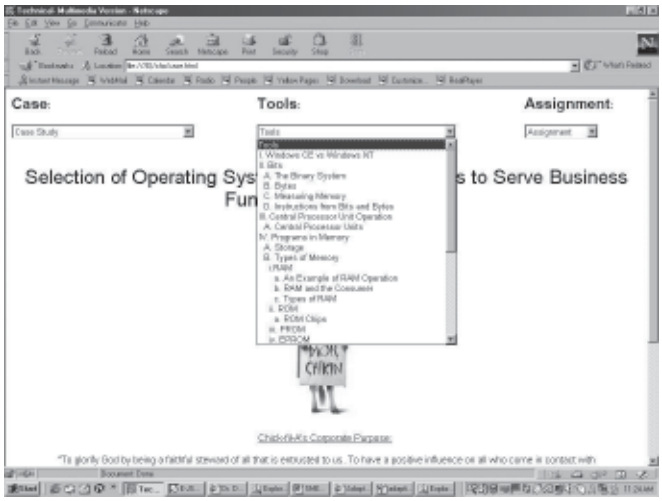

Figure 1. Case Study Learning and Reinforcement Tools

Results of Administering Perceptual Questionnaires

Questions asking for the perception of the students on the use of the case study were analyzed. Since there were a total of 42 questionnaire items, it was important to identify whether some of the items could be combined together to represent a particular construct. Based on past literature (Hingorani et al, 1998; Goodhue and Thompson, 1995), eight constructs were identified that included the 42 questionnaire items. Cronbach Alpha values were computed for these constructs. These values range from 0 to 1 and a value close to 1 indicates that the items coalesced together well enough to represent the construct. There are several opinions on acceptable levels of Cronbach alphas. For example, Nunnaly proposes an alpha of 0.80 and higher, whereas Treacy suggests a value of 0.7 or higher. The mapping of the constructs and the questionnaire items are shown in Table 1 and Table 2.

The Cronbach indices of reliability for the constructs were as follows: (a) interesting and exciting (alpha = .60), (b) important and valuable (alpha = .78), (c) instructionally helpful (alpha = .77), (d) relevant and useful (alpha = .84), (e) perceived skill development (alpha = .74), (f) self-reported learning (alpha = .83), (g) intrinsic learning and motivation (alpha = .71), and (h) communication skills (alpha = 1.0). The high value of the alphas assures us that the items under the constructs could be averaged to measure the constructs. Seven of the eight constructs had acceptable alpha values.

Constructs	Items
Interesting and Exciting	Exciting, Interesting, Lively, Colorful, Emotional, Personal, Warm, Extraordinary
Important and Valuable	Successful at bringing real-life problems to the session, Challenging, Helpful in learning difficult concepts, Helpful in transferring theory to practice, Helpful in providing a sense of accomplishment
Instructionally Helpful	Clear, Easy to comprehend, Straightforward, Well organized, Sensitive, Humanizing
Relevant and useful	Useful, Important, Meaningful, Relevant, Close

Table 1: Mapping of Constructs and Questionnaire Items for Evaluation I

Constructs	Items
Perceived Skill Development	Identify, Integrate, Evaluate, Express, Interrelate, Solve
Self-Reported Learning	Improved understanding, Learned new concepts, Identify central issues, Found connection between concepts and case, Identified various alternatives to the problem
Intrinsic Learning and Motivation	Discussed outside class, Did additional reading, Did thinking for myself
Communication Skills	Improved oral communication skills, Improved written communication skills

Table 2: Mapping of Constructs and Questionnaire Items for Evaluation II

Scaled values for the constructs were computed by averaging the responses across the items identified as best representing the constructs.

The means for the constructs considered in Evaluation I and those who had a Cronbach Alpha above 0.70 are reported in Table 3, and the means for the constructs from Evaluation II are given in Table 4. These means represent the students' reactions to the Chick-fil-A Case Study.

Given that the scores fall on a 5-point continuum with a score of 5 representing the highest possible response and a score of 3 representing the midpoint, the means are on the positive side of the continuum for all eight constructs, indicating that the students had a positive reaction to the Chick-fil-A Case Study.

Table 3 shows that the students perceived the case study to be important and valuable, instructionally helpful, and relevant and useful. Some of the comments by the students reinforce this result:

- I got the most out of the video clips. I was very impressed with the research done on this study and found it very interesting
- It was easy to use. It covered the problem very well
- Good comparisons, excellent compilation of information
- Straight-forward, easy to follow
- Everyone can identify with Chick-fil-A. It was good to see how technology was applied to solve a business problem and the methodology used to achieve the desired end state
- Well-organized and mapped out
- The thorough explanations and unambiguous definitions for commonly used terms were strengths.

Table 4 shows that the students perceived limited improvement in perceived skill development, self-reported learning, intrinsic learning, and communication skills. Although the means were above 3, they were not very far away from 3 indicating that the students did not see much improvement in these areas. Some of their comments reinforce this result:

- The strengths of the study are that they try to see the problems at hand in many different views and try to come up with the best solution for everything
- The reading was very dull and the "pages" of the study didn't keep my attention
- Boring for people that have some knowledge of these types of systems
- Would have liked to see a more in-depth comparison with benchmarks of particular device options
- Multimedia was not applicable in most cases, but gave the case study "identities"
- It seemed to me that other options were not even considered because of a dominant business expectation of how the problem would be solved

This result might have happened since the case study was included in a lab session along with two other assignments. In addition, no lecture time was used to explain the case study, analyze the operating system options, and integrate the case study with the instructional materials used in the class. Given the limited amount of time provided to the case study, it is interesting to see that the students perceived that it was important, valuable, instructionally helpful, relevant, and useful.

Given the results, there are plans to further incorporate the case study in future lectures. For example, the students could be asked to design a HTML page summarizing the problem presented in the case study to add a video of the student summarizing the problem to the HTML page, to add a table comparing the different alternatives, and to create a webpage using frames to describe the analysis performed on the case study, thereby providing a real-world link to the theories cov-

Important and Valuable (N=14)	Instructionally Helpful (N=14)	Relevant and Useful (N=14)
3.7	3.8	3.8

Table 3: Means for Constructs in Evaluation I

Perceived Skill Development (N=13)	Self-Reported Learning (N=12)	Intrinsic Learning and Motivation (N=12)	Communication Skills (N=12)
3.3	3.3	3.1	3.1

Table 4: Means for Constructs in Evaluation II

ered in the first four lectures in this course. Once the case study is integrated in such a manner in the course, the results of the evaluation might change.

Conclusions

At the time of this writing the COMP2000 has been administered eight times. Students' class evaluations have been extremely encouraging and we have started to introduce a multimedia case study to this class. We observe the following:

1. Students are very much interested in the "hands-on", interactive and dynamic type of lecture we have developed. Some of them have expressed their interest in bringing their own laptop computers in class so they can work more effectively with the lecturer.

2. The self-paced course web site allows students to better prepare in advance for the lectures and lab, to work at their own pace on the lab assignments at home or on campus. Due to a weak computer background, some students need to attend the scheduled lab sessions for more one on one work session with the lab instructor.

3. Extra course exercises (not for extra credit) for our more advanced students who would like to explore more of the subject matter as well as for students who need more practice were successfully offered via the course adaptive learning web page. In this way we try to keep a balance between the goals of students who have vastly different computer backgrounds and professional course related goals.

4. Even though the case study was introduced to a limited extent in this class, the data from the various aspects of the course evaluation indicates that the case study method of instruction, which incorporated varying aspects of technology, is a worthwhile and beneficial method of instruction for teaching a CSSE course. The case study method of instruction appeared to combine theory with practice as well as encourage the use of higher-order thinking skills within the students—the two primary objectives of this particular case study.

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Acknowledgements

We thank Randy Bradley for helping us analyze the questionnaires. The funding for developing this paper was based partially upon work supported by the National Science Foundation under Grant Numbers: 0001454, and 0089036. Any opinions, findings, and conclusions or recommendations expressed in this web site are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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