Introductory Computer Applications for AEC Freshmen

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Abstract

Computer applications have already become very important for the success of the Architecture-Engineering-Construction (AEC) industry. It is clear that few professions can be successful without excellent knowledge of computer applications in today's life. An Introduction to Computer Applications (CNST 3000) course was originally developed at Southern Polytechnic to teach basic computer literacy to undergraduate construction students. Basic computer skills such as word processors, spreadsheets, power point and some database skills were taught in previous years. With the recent computer revolution and the change of requirements of the construction industry, the course content was revisited. Web Page development, internet/intranet, use of Palm Pilot, scanner, and editing of photographic images were introduced recently. Based on the experience gained through teaching this class and results of student and industry opinions, a new syllabus with a number of classes was developed. The study suggests to monitor the course continuously and to modify the course contents and time, from the feedback of the students and the building industry.

Key Words: Undergraduate Education, Computer Application, Construction, Multimedia.

Introduction

The computer is best viewed as a tool, which can be used for successful construction project management (Paulson, 1995). The level of cutting-edge computer technology is changing everyday. Information transfer via multimedia tools has increased significantly in construction in the areas of presentations, training and reference (Aminmansour, 1994). Even computer applications have expanded rapidly in estimating, scheduling and project management. Use of the Internet, Intranet and Extranet is now a direct part of the construction management process (Neil, 1996). Computer Integrated Construction (CIC) became popular to integrate the management, planning, design, construction and operation of constructed facilities (Sanvido and Mediiros, 1990). Jung and Gibson 1999 identified fourteen construction business functions that may be integrated using CIC (Jung and Gibson, 1999). A literature review of identifying multimedia educational experiences and computer applications in engineering and construction
programs was conducted to obtain a sampling of available programs (Kenneth and Brenda, 1996). Dymond (1996) describes a course that includes the development of multimedia applications in environmental engineering. Aminmansour (1996) has developed applications for teaching structural steel design.

Increase of computer use is particularly true for all professions such as architects, engineers and contractors who are very much involved in the building industry. Based on the importance of the computer applications for the AEC professionals, computer applications in construction (CNST 3000) was originally developed to teach computer literacy to undergraduate sophomore students in Construction at Southern Polytechnic State University (SPSU). Basic computer skills were supposed to be taught, which included certain functions in spreadsheets, database tools and word processors. The educational tools were skill-based and primarily centered on the use of computers as an end, with exit competencies consisting of the ability to perform certain functions judged as important by the instructor.

**Background**

The competency of the students entering the course has increased during the years due to a wider spread of ownership of personal computers among the incoming students, and increased preparation in K-12 schools (Kenneth et al. 1996, Michael, 2001). For these reasons, the focus of the class has recently been altered, to provide an appreciation of the use of computers as an information management and transfer tool to support the operations of a construction project or a construction company.

![Number of Computers over the Years](image)

**Fig 1. Installed Computers in Grades K-12 in the U.S.**

The skill level of students at the beginning of the class were checked through a series of interviews and surveys that asked the students to self-select their competency level in a number of software applications. The evaluation indicated that the students entering CNST 3000 in 1998 was relatively capable in word processing and spreadsheets but not as capable in database
management and graphics. Changes in the course were therefore needed to prevent boredom and perceived irrelevance based on the entry competence (Snyder et al. 1995).

After two semesters of teaching this class according to the modified schedule, a critical review was performed to evaluate the performance of the course in respect to student understanding and service to the construction industry. A broader analysis was also conducted to establish the optimal balance among the different components of the course.

**Course Overview**

The changes made in the course include a dramatic reduction of the time previously spent on skill-based training in spreadsheet and word processing software, to allow the incorporation of multimedia elements and the Internet into the classroom. A summary of the course syllabus containing a complete list of the subjects covered along with the number of classes is presented in Table 1. For the first delivery of the course in the Fall of 1998, the course was scheduled for a one-hour -and- 50 minutes class period two days a week. The course is conducted in a computer laboratory, with single use computers for each individual student.

In every lecture, construction-specific applications of the particular software are discussed in the class. The various skills required are demonstrated only incidentally to the final project, and it is stressed that the student needs to become proficient with the Help utilities and to engage in self directing learning to go beyond that the level of skill taught in class. This implies that the Help utilities are always demonstrated; it becomes rapidly apparent that they all work about the same way. In the beginning of the course, emphasis was placed on the specifics of the processes, but as time went on, the emphasis shifted to the beginning and end of development. The process elements in between were steadily, more and more often, left up to the students.
Table 1. Summary of Course Syllabus

<table>
<thead>
<tr>
<th>Topics</th>
<th># of Classes</th>
<th>Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Basics</td>
<td>3</td>
<td>Computer Terminology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Computer Selections</td>
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<td></td>
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<td>Evaluations</td>
</tr>
<tr>
<td>Microsoft Word</td>
<td>3</td>
<td>Basic skills</td>
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<tr>
<td></td>
<td></td>
<td>Formatting</td>
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<td></td>
<td></td>
<td>Page setup</td>
</tr>
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<td></td>
<td></td>
<td>Graphics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indexes and tables</td>
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<tr>
<td></td>
<td></td>
<td>Edition and revision</td>
</tr>
<tr>
<td>Microsoft Excel</td>
<td>5</td>
<td>Basic skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cells and ranges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Functions</td>
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<td></td>
<td></td>
<td>Databases</td>
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<td></td>
<td></td>
<td>Charts</td>
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<td></td>
<td></td>
<td>Macros</td>
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<tr>
<td>Microsoft PowerPoint</td>
<td>4</td>
<td>Basic skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Slide layout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effects and animation</td>
</tr>
<tr>
<td>Internet</td>
<td>3</td>
<td>Surfing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Home page format, layout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Home page creation</td>
</tr>
<tr>
<td>Microsoft Access</td>
<td>4</td>
<td>Tables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forms</td>
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<tr>
<td></td>
<td></td>
<td>Queries</td>
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<td></td>
<td></td>
<td>Reports</td>
</tr>
<tr>
<td>Multimedia</td>
<td>6</td>
<td>Basic skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applications</td>
</tr>
</tbody>
</table>

**Approach**

The class relied heavily upon collaborative learning techniques as part of the delivery method. Clearly, from the ambitious schedule of materials covered in the class presented in Table 1, methods for improving delivery efficiency were essential to the success of the course. Computer learning is heavily interest-based; thus, different students of a working team will tend to learn different things. Further, each student in the group will have a different set of entrance competencies with the various software products. Both of these forces tend to create an atmosphere in the groups in which the students teach each other, which raises the delivery efficiency. Most assignments are collaborative in nature, although a few individual assignments were completed as well. Projects completed early in the semester are competency based, focusing on skill developments in specific software applications. As the course proceeded, the assignments and projects become more result-based. The projects developed also became steadily more public, from the multimedia projects, which will be used to generate teaching tools for use in other classes to the home page materials which will be used on the Internet.
The most unusual portions of the curriculum for this class are the Internet and multimedia portions. In the Internet portion, resources on the Internet geared to contractors are identified to students, both as a means of developing information sources and as a means of experiencing the global nature of the industry. Students also learn about the simple multimedia tools to prepare the home page through the use of hypertext markup language (HTML) and/or front page. The students are thus able to learn how to obtain, use, and present information from the Internet. The powerful features of multimedia as an education, training and marketing tools are also presented. A number of multimedia authoring packages are considered, with comparisons made based on comfort of use, cost, PC platform availability, and flexibility. The goal of this educational process is the switch from use of multimedia to creation of multimedia, a demonstrated means of improving information transfer abilities. The requirements for both compelling presentation style and accurate information are stressed.

**World Wide Web**

A very common error is to think about the web and the Internet as synonymous. The web is a collection of protocols and standards used to access information available on the Internet. The Internet is the physical medium that is used to transport the data. Because common protocols and standards are available to provide data from worldwide sources into a computer regardless of platform, and in a variety of media, the Web represents a powerful vehicle for information exchange. Remote project control (Schriener, 1995) and materials data are already available on the web, and the potential uses in construction expand every day.

Curriculum for the World Wide Web portion of the class followed an experience-then-develop approach. That is, the students learned first to use the resource and then to author it. Specifically, this part of the course was divided in two areas 1) show the students how to use the World Wide Web, and discuss its properties and 2) help the students to develop home pages for the World Wide Web.

Netscape is used as a viewer for the first part of the World Wide Web curriculum. At first we focus on how the web works, examining the features of Netscape, as well as the concept of hypertext links. In these early encounters, the students are asked to direct movements around the Web, choosing hypertext links to follow by acclamation. Materials of simple general interest, not related to construction, are used to stimulate students to understand the mechanics of the Web.

To continue with this level of appreciation, students are encouraged to simply hunt around on the Web and look for something of interest, and to bring back an address and a short description of a Web page. To improve the efficiency of information access, an important step in developing competence is to become familiar with means of searching for a specific topic through one of the search engines available. Depending on the search engine, the information collected may contain only the name and address of the homepage, or it may also include information about the contents of a page; the words in a text-based document; or information about multimedia files. Several of the search engines are used in the class, but are now used specifically as related to construction. Again, while asking for student direction for topic areas, a number of construction-related resources are identified and accessed.
The limitations of the search engines available on the Web are stressed. The big problem is that the search engines are based on indexes created by humans. Unless a home page title or URL address contains a word that fits the search profile, or the creator of the page or document has indexed it with that word, it is possible to miss resources that may be important. Finally, it is absolutely critical that students understand that anyone, anywhere, can put whatever they want on the web. Therefore more than normal effort must be expended to verify information obtained. With a complete understanding of these issues, one can effectively search for information on the Web.

Once the search engines are used to identify some construction-related Web pages, a few construction topics are reviewed. Some of the construction related Web pages such as CONSTRUCWARE provides actual job site management and coordination support through links to the schedule of a project, photographs of job progress, and safety information. Meeting announcements are posted on the system, and the site also has an E-mail capability that allows communication about current issues at the job site between the contractor, subcontractor and the architect. Some portions of the web sites are not available because of passwords to maintain the confidentiality of certain issues within the project. The students found this application very interesting, particularly the photographic images of the job site as a real world example.

Student Feedback

After the course was concluded in the Fall of 1998, each team was asked, "What did your team learn out of the class?" The following is a summary of the responses:

- Students gained valuable information regarding computer Hardware and Software
- They became more confident in using computers in their work
- They can identify the software which will suit their professional needs
- They became confident in using and developing multimedia applications
- They found that the main benefits of multimedia occur when it is linked to external programs. However, it may not be useful like stand-alone programs such as Excel.
- Students learned to appreciate user-friendly programs

Although the answers were interesting and thought provoking, the most important question was asked for the information of instructor - "What should an introductory course for construction include?"

The course had a syllabus covering extensive areas of software applications:
1. **Microcomputers and Information**: terminology, hardware, and software
2. **Word processing**: advanced features, office automation, indexes and tables including preparation of student resume
3. **Spreadsheets** (individual and team assignments): advanced topic such as cash flow determinations, including a micro-driven spreadsheet.
4. **Presentation software**: advanced techniques, presentation style, and timing.
5. **Databases**: creation of relational databases, queries, input forms and reports; analyzing and choosing between databases and spreadsheets
6. **Internet**: surfing, searching, style, format. Create your own homepage.
7. **Multimedia applications**: editing of photographic images, recording of sounds, multimedia programming.

At the end of Fall 1998 and summer 1999, an extensive questionnaire was administered to students to measure the knowledge gained in all the areas taught during the course. The questionnaire was designed to evaluate the appropriateness of time allocation for each area of content. It was divided into several sections for each of the topics, as shown in Table 1. Each section was further divided into detailed questions regarding specific skills. Out of 47 students, 34 answered the questionnaire.

For each concept or skill, the students were asked regarding their knowledge:
1. Skill was acquired before entering the course
2. Skill was acquired during the course
3. Skill was not acquired during the course

When the results indicated that more than 50% of the students already knew the topic that was taught in the class, we felt that time spent in teaching that skill could be reallocated. The following topics fell into this category:

1. About 60% of the respondents felt about Microsoft Word that they had the basic skills of formatting, page set up, graphics, editing and revisions. The use of graphics, tables and images were less clear.
2. In Microsoft Excel, About 54% were confident about the basics of Excel except functions, charts and databases.
3. 58% of respondents felt that they understood power point presentations except the addition of sound.
4. The general use of the Internet (surfing). More than 70% of the students believed that they are highly competent in this area except assessing the value of a home page and creation of their own home page.

When the results indicated that more than 50% of the students learned the concept or skills during the course, we concluded that the time spent for that concept was appropriate and it should be taught employing the same method used during the semester. This category included the following topics:

1. Microsoft Excel functions, macros, program documentation and data organization
2. Microsoft PowerPoint slide layout, effects, and animation
3. Microsoft forms, queries, reports and data management
4. Assessing the value of Web Pages except active service provider (ASP) and Java scripts
5. Multimedia programming skills, such as images

When the results indicated that more than 50% of the students did not know the concept before, nor did they learn the concept during the course, we concluded that the concept required more time and should be approached on a more basic level. The following skills are included in this category:
1. The use of indexes and tables in MS word
2. Basics of relational database and data base management in MS access and excel
3. The use of Java scripts

The questionnaire also gave the students an opportunity to evaluate the importance of the course content by ranking each topic on a scale of 1 to 5 (1 for "least important" and 5 for "most important"). This information gave us the students' perspective on the importance of course topics. Figure 3 shows the results of students' importance rankings:

**Fig. 3. Importance of Topics**

**Importance of Topics by Students**

From the students' feedback, industry communications and instructor experiences, we developed a revised breakdown of class time per topic. The breakdown is presented in Table 2. In the *Introduction to Computers* section, students learn the terminology of computer hardware, software, how to evaluate different systems and be capable of deciding which system is the most appropriate for the specific needs.

Students are very familiar with *word processors*. One class is dedicated to the use of styles, inserting images, tables and indexes. Another class is for writing the students' own resume using MS word.

*Spreadsheets* will be covered in nine classes instead of five classes for the students' interest and industry needs. The important topics for this section are data input, cells and ranges, detail use of mathematical and statistical functions, look up and conditional functions, editing and creating...
charts, and macros. In these classes, data organization and management will be emphasized. A team and an individual project are given regarding construction cash flow analysis.

Table 2: Revised Course Syllabus

<table>
<thead>
<tr>
<th>Topic</th>
<th>Number of Classes in the Previous Semesters</th>
<th>Proposed Number of Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intro. to Computers</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Word Processors</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Presentations</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Databases</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Internet</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Multimedia</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>29</td>
</tr>
</tbody>
</table>

For the presentation software, three classes will be covered using PowerPoint. In this section, use of slide master and the general organization of a slide layout will be discussed. In the second class, effects and animation, along with use of speaker notes and rehearsal will be discussed. In the third class, students need to present a construction topic by using PowerPoint.

Databases will cover introduction of relational databases, how to create tables and forms, single and multiple table queries, creating and printing of reports. In this section a team project is given to develop a database of subcontractors (about 100) using form. The information should include Name, Address, Tel/Fax no, Contact, Specialty, Volume of work for last three years for the General Contractor (GC) and so on. Students will be asked to generate several reports from the developed data by using queries.

In the Internet section, the students will explore the world wide web, different search engines and use of e-mails. The creation of a personal homepage will be introduced. Students need to create and publish their own home page in this section.

In the multimedia section, the focus will be images, videos and sound. This section will show how to acquire still images via scanning, digital photography, video snapshots and selection of resolution. Use of Palm Pilot is also discussed in this section.

Conclusions

Computers and their applications are changing dramatically with the innovations of existing and new computer technologies. Continuous monitoring and evaluations of the course outcome and applications should be very important for the teaching of this class. Students' computer background is also important because it is changing due to early exposures of computers in the middle and high schools. We believe that continuously updating the contents must become integral part of the class and recommend that at the beginning of each semester students' competency should be evaluated. In addition, evaluation of student's needs, other institution
offerings and delivery effectiveness should be carried-out. In that way, students will usually have more knowledge regarding the application of computers than the companies that will hire them.

Bibliography


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