A Critical Analysis of an Introductory Computer Course for Constructors

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The course Microcomputer Applications in Construction (CON 251) was originally developed to teach computer literacy to undergraduate students. Basic computer skills were taught, which included certain functions in spreadsheets, word processors, and databases. Beginning in the Fall of 1995, a section on multimedia application development was added. Based on the experience gained through teaching CON 251, as well as on the results of surveys of industry needs and student opinions, a new syllabus was devised for the course. The methodology used to create the new syllabus, results of the research, and recommendations for continuous monitoring of the course and adaptation to change are presented in this paper

Key Words Computer Education, Multimedia, Computing in Construction, Undergraduate Education.

Introduction

The course Microcomputer Applications in Construction (CON 251) was originally developed to teach computer literacy to undergraduate students. Basic computer skills were taught, which included certain functions in spreadsheets, word processors, and databases. The competency of the students entering this course has increased during the years due to modifications of the perquisite engineering core class, Introduction to Engineering (ECE 100), wider spread of ownership of personal computers among the incoming students, and increases in preparation in grades K-12.

During the 1994 academic year, the skill level of students at the beginning of the class was checked through a series of interviews and a survey that asked the students to self-select their competency level in a number of software applications. This evaluation indicated that the student entering CON 251 in 1994 was relatively capable in word processing and spreadsheets but not as capable in database management and graphics (Walsh and Breña, 1996). Newer ways of information storage and manipulation, such as multimedia or hypertext, were found to be practically beyond the limits of construction students.

Beginning in the fall semester of 1995 the CON 251 course was changed to incorporate the use of World Wide Web (www) and multimedia programming (Walsh and Breña, 1996). This change was undertaken to maintain a cutting edge position in the course and to expose students to many advanced topics in order to reduce computer anxiety. Additionally, the instructors believed that in the relatively near future construction companies would be requiring an even more advanced knowledge of computer applications from their new employees. It is anticipated

that the use of multimedia and intranets as a means of information management will increase (Aminmansour, 1994).

After three semesters of teaching according to the modified syllabus, an analysis was performed to evaluate the performance of the course (how well it serves the students and the construction industry). A broader analysis was also performed to establish the optimal balance between the different components of the course. This paper presents the methodology applied for the analysis and the results obtained.

Background

One of the major changes to CON 251 in the fall of 1995 was the introduction of a final project. The project consisted of the development of a multimedia application that would illustrate a construction-related topic. This project was to be developed in teams of three to four students. The time spent by each of the teams prior to their presentation varied significantly, from a couple of days up to several weeks.

The presentations proved to be very interesting. Some teams made their presentations unidirectional, just as they would create a slide show with presentation software. Other teams made their presentations similar to the World Wide Web with hypertext links. One team linked its presentation to an external spreadsheet, where the main part of the application was located. Another team linked their application to a spreadsheet that created a database, keeping records of the users.

After the course was concluded in the fall of 1996, each team was asked, "What did your team get out of the creation of this application?" The following list shows a summary of the responses.

- Students gained self-confidence in using many computer applications.
- The teams found that developing a multimedia application was well within their grasp.
- The teams visualized a future step in construction computer technology.
- The teams saw multimedia as a high-tech method for teaching and learning. Several felt that the major benefit would be to educators.
- Several teams indicated that construction companies might be interested in using multimedia to educate employees who are not familiar with field operations or to us in place of traditional seminars.
- The main benefits of the multimedia package occur when it is linked to external programs. Multimedia by itself is not as useful as other programs such as spreadsheets.
- The programmer of any application has to learn to keep the user in mind. A lot of teamwork is needed to develop these applications. When developing a new application it is necessary to keep complete documentation of all the steps as it is "easy to get lost" in the middle of the application.
- Students learned to appreciate user-friendly programs.

Although the answers were interesting and proved again that there is some use in every learning experience, the most important question generated was for the instructor: "What should an introductory computer course for constructors include?"

Methodology

A literature review was conducted to answer the above question and to learn from the experience of other universities. At the same time, a survey was conducted among the CON 251 students and representatives of construction companies. The purpose of the survey was to perceive the current expectations from the graduating students and to assess the expected computer application skills in 10 to 15 years. Once this information was compiled, recommendations for a revised syllabus were made, based on an analysis of the available time and required effort.

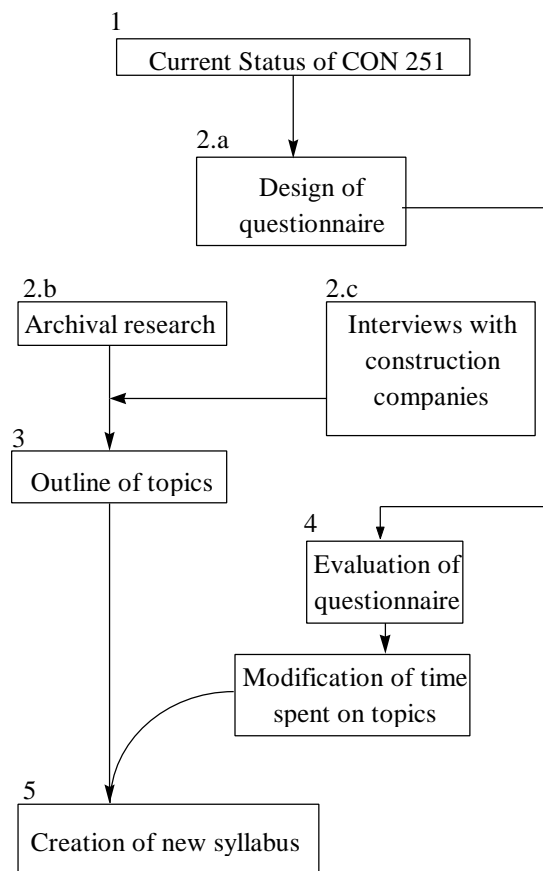Figure 1 outlines the process that was followed to accomplish the objectives of this research.

Figure 1: Analytical framework for assessment of CON 251.

The individual steps included:

1. The initial status of the course. A description of the topics taught currently in the course and the time spent on each one of them is shown in Table 2.
2. The second step was divided into three different parts:

    a. The development of a questionnaire to evaluate the perceived effectiveness of the course in particular topics and the students' perception of the importance of those topics.

    b. Archival research to evaluate the degree to which some other universities are incorporating multimedia.

3. Interviews with representatives from construction companies to determine the computer tools they expect their future employees to know.
4. The creation of an outline that combines industry expectation and curricula from other universities.
5. Student questionnaires were evaluated. Depending on the apparent effectiveness of each topic and the results of step 3, the time spent on each topic was modified.
6. A proposed syllabus was created to be taught in the course CON 251. The syllabus was based on 28 classes (75 minutes/class) during a semester.

The remainder of this paper describes the major steps and results of the research.

Student Opinion

The modified course CON 251 was delivered during three consecutive semesters to approximately thirty-five students and had a very ambitious syllabus covering the following areas (in chronological order):

1. **Microcomputers and Information**: terminology, hardware, software.
2. **Internet**: surfing, searching, style, HTML.
3. **Presentation software**: advanced techniques, presentation style, and timing.
4. **Word processing**: advanced features, office automation.
5. **Multimedia applications** (team project): editing of photographic images, recording of sounds, multimedia programming. Students were asked to develop a multimedia application that described a construction-related topic. Each team selected a topic approved by the professor.
6. **Spreadsheets** (individual and team assignments): creating a macro-driven spreadsheet. Advanced topics were built around the crane selection problem presented by Paulson (1995).
7. **Databases**: creation of relational databases, queries, input forms and reports, choosing between databases and spreadsheets.

At the end of the fall of 1996 an extensive questionnaire was administered to the students to measure the knowledge gained in all the areas taught during the course. The questionnaire was designed to allow the researchers to evaluate if the time spent in the different areas was appropriate. 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. The participation of the students was voluntary and anonymous. Of the thirty-five students in the course, 18 answered the questionnaire.

Table 1

Sections Of CON251 Performance Evaluation Questionnaire

Internet Surfing	Web page creation
Microsoft PowerPoint	Basic skills
	Slide layout
	Effects and animation
	Printing
Microsoft Word	Basic skills
	Formatting
	Page setup
	Graphics
	Indexes and tables
	Edition and revision
Microsoft Excel	Basic skills
	Cells and ranges
	Functions
	Databases
	Charts
	Macros and dialog boxes
Multimedia	Basic skills
	Programming
Microsoft Access	Tables
	Forms
	Queries
	Reports

For each concept or skill, the students were given three options regarding their knowledge:

1. Concept was known before entering the course.
2. Concept was learned during the course.
3. The concept is unknown and the student did not learn it during the course.

The results for each subject were counted. When the results indicated that more than 50% of the students already knew a concept that was taught in the course, we concluded that it was of general knowledge and the time spent in teaching that concept could be reallocated. The following topics fell into this category:

1. The general use of the Internet (Surfing). More than 50% of the students believed themselves highly competent in all skills except assessing the value of a Web page.
2. The basic skills of Microsoft PowerPoint except how to add sound to a slide.
3. In Microsoft Word, the basic skills of formatting, page setup, graphics, editing, and revisions. The use of graphics and images was less clear.
4. In Microsoft Excel, the basic skills, including the use of cells and ranges. The use of functions and charts was less clear.

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

1. Assessing the value of a Web page. The concepts also related to the creation of a Web page, except for the part that related to Java scripts.
2. Microsoft PowerPoint slide layout, effects, and animation.
3. Microsoft Excel functions, macros, and dialog boxes.
4. Multimedia programming skills and component (sound, images, etc.) input.
5. Microsoft Access, essentially all skills.

When the results indicated that more than 50% of the students did not know the concept before and 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 concepts were included in this category:

1. The use of Java for the Internet.
2. The use of indexes and tables in Microsoft Word
3. Some concepts in Microsoft Access.

The final part of the questionnaire gave the students the opportunity to evaluate the importance of the course content by ranking each concept and each subject area on a scale of 1-5 (least important to most important). This evaluation gave us a way to consider the students' perspective on the importance of course topics. Figure 2 shows the results of the subject area evaluations.

Literature Review

A limited program of identifying multimedia educational experiences in use in engineering and construction programs was conducted to obtain a flavor of available programs. A number of examples of multimedia used in education were found. Echeverry (1996) has developed multimedia applications covering several building methods topics. Aminmansour (1996) has developed applications for teaching structural steel design. Dymond (1996) describes a course that includes the development of multimedia applications in environmental engineering. Furthermore, there is rising evidence of the use of multimedia in industry as well (for example Abudayyeh, 1996; Wang, 1996).
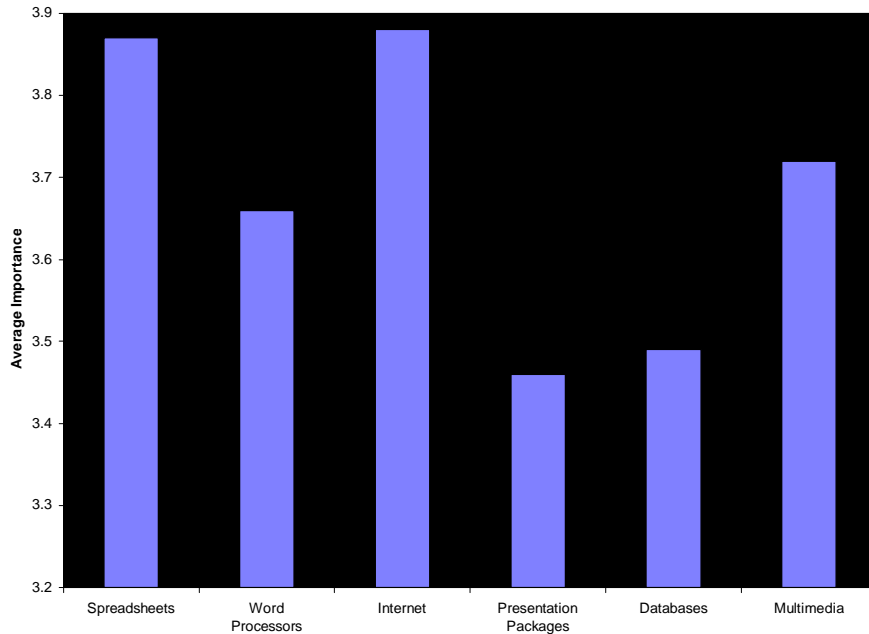
Figure 2: Perceived Importance of Topics by Construction Students

Industry Opinions

After identifying skill areas important to students, we conducted interviews with representatives from several construction companies to evaluate the current usage of computer technology and expectations of graduating students. The representatives were selected by the management of the respective companies and were the persons responsible for the development of "computing policy."

Seven companies of different sizes and involved with different types of construction were selected for interviews. Because of the small number of companies interviewed, special care was taken when drawing the final conclusions. The trends that were clearly common among the interviewed companies were further analyzed and accepted only if a clear value was perceived for CON 251. The names of the companies, by their request, are confidential.

Company A did not rely heavily on computers for information transfer. They are comfortable using common systems such as the fax, telephone, and film-based photographs. The representative of this company stated, "We are in the process of incorporating e-mail in our offices and we don't see a near future of using computers to transmit all of our information. I think that if computers would offer a higher resolution to show images, multimedia would be a valuable tool for us." This company does use spreadsheets and word processors. They also use a package that allows them to combine contract documents such as specifications, change orders, project schedule, estimates, and any other documents that are relevant for a project.

Company B thought that teaching the development of multimedia applications would be appreciated in the industry. New employees need to know how to use spreadsheets, word

processors, estimating software, and scheduling software. The company has recently bought one digital camera for their office in Arizona so that they can evaluate the potential advantages of this technology. Their comments included, "We expect the use of multimedia in the future; however, we don't know when this might occur within our company. We are not looking for a graduate who knows how develop a computer application. If we needed to develop an application, we might subcontract it from a company that specializes in that field."

Company C does not use multimedia at this time. However, they think that in the near future (2 to 3 years) most of their information is going to be managed through computer systems. "We use e-mail to transfer many files from the office to the field and vice versa. We also have to use video cameras sometimes to understand how a certain process is being realized in the field." This company would prefer graduates who know how to use digital cameras, can create reports using those images, and who are, in general, competent in the use of computer applications, including spreadsheets and word processors.

Company D does not use multimedia and does not think that they will be using it in the future. They expect graduates to have knowledge in the use of spreadsheets. The company uses e-mail to send messages from the field to the office. The company does not consider the knowledge of programming multimedia applications to be an asset for new employees.

Company E does not hire construction graduates to create multimedia applications. However, they do consider a student's computer proficiency to be a valuable asset. They have e-mail at every job site at which they can install it. Computer emphasis is on spreadsheets, which are in daily use. This company has its own department of research and development and they have been studying multimedia applications created by other companies. They think that multimedia applications are very helpful for learning certain processes. They have a digital library for which they in the process of incorporating these tools for their employees.

Company F does not use multimedia applications. They do not like to spend a lot of time trying to figure how to insert an image into a word document. The company uses e-mail to send messages; however, extensive information is sent through messenger services. Spreadsheets and word processors are in daily use.

Company G does not seem to be advanced in the use of technology. The information received on the day of the interview (December 3, 1996) was that they were in the process of switching their operating system to Windows 95. They use e-mail to send messages and the most common computer tools that they use are spreadsheets. The company does not consider the knowledge of multimedia programming to be an asset for their new employees.

All the companies were asked to rate the importance of several classes of programs, again on a scale of 1 to 5 (from the least important to the most important. The question was, "How important is it for students to learn the following packages: 1.Spreadsheets, 2. Word processors, 3.Databases, 4.Presentation packages, 5.Multimedia, 6.Internet?" The average results and the student evaluations are shown on Figure 3. The agreement between the two groups is striking, excepting multimedia applications (with which the students are much more familiar).
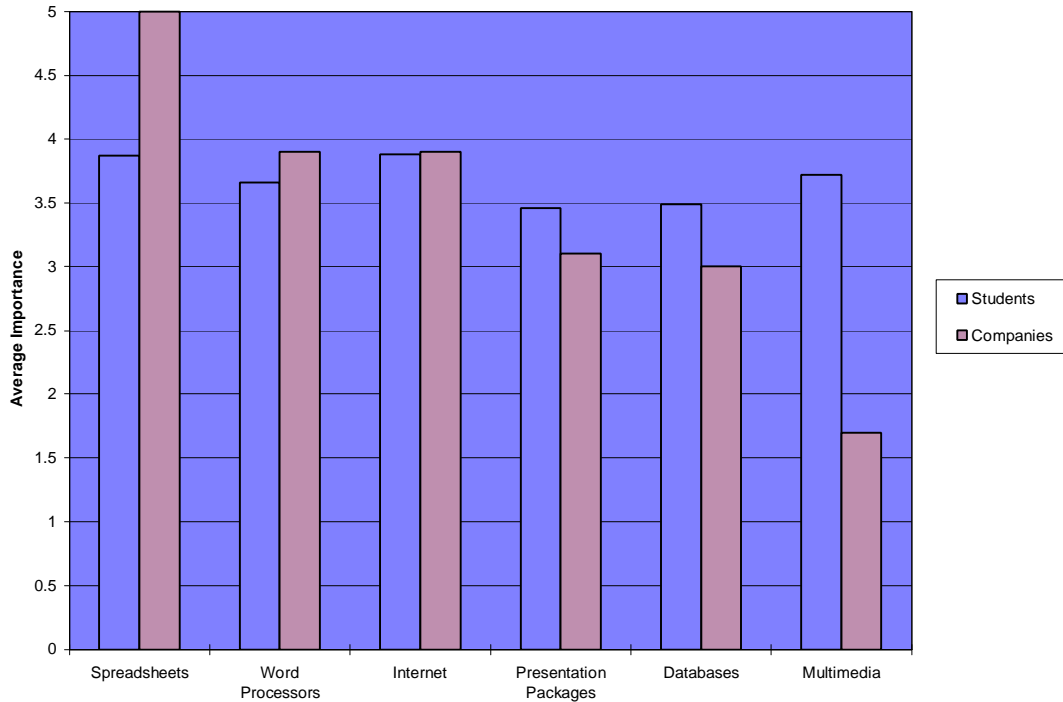
Figure 3: Perceived Importance of Topics by Construction Companies Compared to Construction Students

Proposed Applications

From the results obtained in the interviews with the construction companies and the archival research, as well as forecasts made by the members of the research team, the following applications were proposed for CON 251:

1. Spreadsheets
2. Word processors
3. Presentation packages
4. Databases
5. Use of the Internet (e-mail, and the World Wide Web)

Multimedia use and development will continue to be incorporated into the course, but in a greatly modified version. Even though the construction companies interviewed expressed the viewpoint that multimedia development skills are not needed, we have observed during three semesters that learning some multimedia increases self-confidence and computer literacy dramatically. Therefore, for the next several semesters we will include input and capture of multimedia as part of the class. The students will then learn how to include these components into the application areas listed above. A detailed analysis of the proposed syllabus follows.

Proposed Syllabus

From the effectiveness of the teaching delivery inferred from the student responses, industry evaluations of the importance of each topic, and the experience of the instructors, we developed a revised breakdown of class time per topic. The breakdown is presented in Table 2, along with a summary of the syllabus used in the last three semesters.

Table 2

Proposed Syllabus Changes Based on This Study

Topic	Number of Classes Last Three Semesters	Proposed Number of Classes
Computers	2	1
World Wide Web and HTML	3	3
Presentations	2	2
Word Processors	2	1
Multimedia	10	7
Spreadsheets	5	7
Databases	4	7
TOTAL	**28**	**28**

The first class must continue to be an **introduction to computers**. Students must learn how to evaluate different systems and be capable of deciding which system is the most appropriate for specific needs.

The coverage of **multimedia** will change drastically, with seven lectures instead of ten. The focus will change from programming to acquiring the components, including images, video, and sound. The first class will show students how to acquire still images via scanning, digital photography, and video snapshots, as well as criteria for selecting a resolution. The second class will cover editing the images. The third class will cover capturing movies with a video card and an application for creating animation. In the fourth class students will learn how to record sound using CDs, the microphone, or an external device. An additional three lectures will be spent on application development. These lectures will be distributed over the semester as an all-class project to design an application that will teach a specific construction topic previously chosen. Although the instructor will program the application, all the components required to complete the application will be provided by the students in the class. The students will view the application several times during its creation. This project will be less time-intensive than projects of previous semesters.

Three lectures will be used for the **Internet**. One lecture will explore the World Wide Web and search engines. The second lecture will demonstrate how to use e-mail (including attached files). The instructor should also encourage students to use e-mail for almost all communication outside the computer lab. The creation of a home page will be introduced.. The third meeting will be a workshop in which each student will create his/her personal home page and publish it in the university's server. This personal assignment has been an effective learning tool.

Two classes will be spent on **presentation software**. The first class will include a brief introduction to PowerPoint, since the students generally are familiar with this program. It will

also include the use of the slide master and the general organization of a slide layout. The second class will focus on effects and animation, along with use of speaker notes and presentation rehearsal.

The coverage of **word processors** was found to require a complete overhaul. Students are very familiar with this application. One class only will introduce advanced concepts such as the use of styles, inserting images, and creating a table of contents or indexes.

Spreadsheets will be expanded from five lectures to seven. A team project similar to the one that was used in the previous semesters will be assigned. The first class will be a general overview of such concepts as inputting data, cells and ranges, and simple functions. The second class will cover creating use lookup functions and conditional functions. The third class will teach creating and editing charts. Macros and dialog boxes will be covered in the fourth lecture. The next two classes will be workshops in which student teams can work on their projects. The final class will cover using the database functions of a spreadsheet. This class will also serve as a transition between spreadsheets and relational databases.

Databases will be the final topic of this course, with coverage expanding from four classes to seven. The first class will be an introduction of relational databases. The second class will teach how to create tables. The third class will cover single- and multiple-table queries. Forms and data input will be covered in the fourth class. The fifth class will cover creating and printing useful reports. The two remaining classes will be workshops in which students will work on another team project, the creation of a database for a construction company. For example, a database may be created to track materials delivered to several sites, the personnel involved in delivery, as well as data from the projects to which the materials are delivered.

Conclusions and Recommendations

The limited interviews clearly reveal that construction companies are not looking for graduates who are proficient in developing multimedia applications. Furthermore, as currently taught, multimedia programming consumes an unduly large amount of student time. As a result, we have recommended modifications to the treatment of multimedia in the course. Databases and spreadsheets will be taught in more depth, as those applications appear to be the primary computer tools that students will use during their professional experience.

Obviously, construction companies need time to incorporate new software technologies. Their lack of doing so up to now may be because of the capital or training costs, resistance to change, the current level of construction activity, or simply because of fear. We believe that companies will persist in not having the latest software technology, and that graduates will usually have more knowledge in the use of computers than the company that hires them.

Furthermore, even though multimedia was not highly ranked by the companies we interviewed, students gained computer confidence after being exposed to multimedia. It was a useful application that showed students that they are capable of doing anything they want with a

computer. It encouraged them to explore several applications and learn new things. The final products were engaging and exciting to the students.

Computer technologies (including hardware and software) change dramatically and rapidly. Through the evaluation of the course we have developed a process for maintaining currency and applicability of CON 251. We believe that change must become an integral part of the class and recommend that at the beginning of each semester the questionnaire developed for this research be administered to the students to evaluate their entrance competency. Further, the process of investigating industry needs, peer institution offerings, and delivery effectiveness must be periodically repeated.

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