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PEDAGOGICAL SHIFT: AN INNOVATED COURSE OF COMPUTER LANGUAGES

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Abstract

In the digital economy era, business information systems students need to know multiple computer programming languages in order to meet the requirements of computer literacy. This paper outlines the pedagogy of an innovated course of multiple computer languages for business students in the major of information systems. It discusses the rationale of why the proposed pedagogy is different from and better than traditional ones. Technically, the course consists of two modules. The Teaching Module covers major computer languages in business computing, including COBOL, C++, HTML, JavaScript, Java, and Visual Basic. In the Project Module, students working in teams conduct four projects.

Keywords: IS education, pedagogy, multiple computer programming languages

Introduction

There have been dramatic changes in information technology during the last decade. Most notable is the advancement of computer literacy of millions of information systems (IS) professionals in business and management as a result of the proliferation of electronic commerce. The changes have considerable implications for institutes of higher education whose responsibility is to train the next generation of business IS professionals. In our view, business IS students must acquire fundamental theories of IS as well as essential practical skills in computer applications. They must also develop the life-long learning ability for information technology during their business education. Recently, there is a considerable need for redesigning business IS education curriculum (IS'2000, 2000). Academic institutions are required to pay increasing attention to courses of practical IS skills based on long-term strategic considerations. This paper is to report how this challenge was met by designing the contents of an innovated course of multiple computer programming languages for business IS students.

The Innovated Course of Computer Programming Languages

The course described in this paper is entitled "Programming and Problem Solving," and is designed for sophomore students in the major of business information systems. It is taught over one semester, normally 14 weeks. In its design, this course consists of two distinct modules. The Teaching Module provides an overview of representative computer programming languages in business computing. The Project Module is course projects.

The teaching of a comprehensive computer programming course is complicated by the extensive nature of the subject. The selection of computer languages for the course is crucial in order for it to be valuable educational experience. The fact is that, in the modern computer age, the development of IS still heavily relies on applications of third generation computer languages regardless the advance in fourth generation computer languages and a variety of software packages. Interestingly, this is truer in Web-based applications development. To meet the challenge of the ever-changing computer technology, business IS students must be computer-literate in terms of understanding major programming languages. On the other hand, they cannot afford to learn multiple computer languages on the one-language-one-course basis. The key solution to this problem is to make a pedagogical paradigm shift and develop an innovated course.

The principle we used for designing the components for the course is the skill demands from the job market. There have been many surveys about hard skills required for IS jobs. According to Papp's survey (Papp 1998) for the New England region, the skills in demand as found in the classified IS job advertisements are 16.0% COBOL, 13.4% C++, 10.8% Visual Basic, 9.3% C, 5.0% Java, and 3.0% HTML, which comprise the total of 57.5% general design and development skills. Taking this into account, six major computer programming languages were selected for this course. They are COBOL, C++, HTML, JavaScript, Java, and Visual Basic.

Due to time constraints, it is impossible for students to learn all these computer languages in great details. Nevertheless, students in this course are expected to have a bird's-eye view of computer programming languages as well as to develop practical skills of programming. The objective of this course is that students will understand the characteristics of traditional data file processing in legacy information systems, the philosophies of structured programming and object-oriented programming, the means of Web page development for the Internet, and the concept of human-computer interface design and decision support systems. The central methodology applied to teaching is case study. Specifically, we use typical business computing examples of these computer languages to teach students.

Motivation of the Pedagogy Design

Currently, many undergraduate programs of IS majors offer courses of computer languages. However, the design of these courses is traditionally based on one-language-one-course. During the past years, we have identified opportunities to develop the innovated course of multiple computer languages for business IS students, and have found the new design of such an innovated course have many advantages, as discussed below.

The Needs for Learning Multiple Computer Languages

Due to historical and technical reasons, there have been many computer languages in the information age, and each computer language serves its particular purpose. The needs for learning multiple computer languages can be perceived from a variety of views. From the perspective of basic job skill requirements for IS students, COBOL is still important to learn since many legacy systems are COBOL-based. However, modern Internet-based computing heavily relies on HTML, JavaScript, and Java. Furthermore, from the viewpoint of learning the IS tools for management information systems and decision support systems, Visual Basic is more important than other languages. On the other hand, from the standpoint of computer languages themselves, C and C++ are fundamental in the software industry, and are the typical sister languages of the two different programming paradigms: function-oriented and object-oriented. Given that fact that almost every textbook of information systems analysis and design includes material on object-oriented approach, IS students must know what object-oriented really means.

There is little doubt that knowledge of various computer languages can contribute to the learning and further career development for IS students. Then, the question is how we can teach them in a feasible way.

The Feasibility of Teaching Multiple Computer Languages

It is impossible for us to teach multiple languages by using the traditional one-language-one-course approach. To compact material of multiple languages into a single course, we must identify what concepts are essential for business IS students, and how these concepts can be delivered. After we reviewing the IS'97 model curriculum (IS'2000 2000), we determined that the following concepts are essential for IS students.

- Data processing (file systems);
- Simple data types and string manipulation;
- If-then control structure;
- Loop;
- Function calling and function orientation;
- Object orientation and message sending;
- Web page development;
- Client-server computing;
- Graphical user-computer interface development; and
- Various environments for computer languages.

We consider many concepts included in traditional language textbooks, such as arrays, pointers, sophisticated data types and structures, to be less important for IS undergraduate students and not be emphasized in the innovated course. To better teach these essential concepts of languages, we must change the traditional teaching approach that begins with syntax by adopting the case study approach that begins with a typical example with the key concepts to learn. Despite the variety of syntax in the different languages, languages share many common key concepts, such as if-then control, loop, and function-calling/message-sending. Once a key concept is introduced in one language, it should be understandable for students in another language.

The Pedagogical Shift Adds More Value to Student Learning

This innovated course is fast-paced, and encourages self-learning on the students' part. Given the fact that the nature of this course is practice-oriented, multiple projects with small scale are the required components of the course. The central point of the pedagogical shift from one-language-one-course to multiple-languages-one-course is to add more value to student learning by giving students discipline in self-learning and applying their newly learned knowledge to the real world. According to our observations, students might feel stressful in any programming course, but never felt bored in this course. Next, we describe the course design in more detail.

Teaching Module

For a long time, it has been difficult to find a single integrated textbook that meets our needs. In order to give students a comprehensive guideline for their studies, a manuscript of lecture note was developed for this course during the past years. This manuscript has been revised many times, and has recently published as a textbook (Wang and Wang 2000) that can be downloaded from the Internet.

The Teaching Module is divided into four units based on the categories of business computing problem solving, each of which is followed by a written test. The features of the course competency, relevant paradigms, and business applications are presented below.

Unit 1: Data Processing and COBOL

File processing is an essential type of business data processing. Three basic file organizations (i.e., sequential, random, and indexed) are the basis for the file processing. COBOL-based file processing is the backbone of legacy information systems. In this unit, the techniques involved in file processing, such as hashing function, pointer, and index table, are discussed. Because these techniques are not applied directly in COBOL programming, emphasis is placed on the comparison of the three file organizations in terms of their advantages and disadvantages in various circumstances of data processing.

Since COBOL is still a commonly used computer language in the business community, and it is the first computer language for most business IS students to learn, about 29% class time is devoted for COBOL. Instead of emphasizing the syntax, we present four typical COBOL programs related to payroll processing. These four typical programs give students an undivided prototype of business data processing functions: creating a master file, creating a transaction file, manipulating these data files, and maintaining the data files. The computing environment for this unit is COBOL on the Alpha mainframe computer. Students use PowerTerm, a terminal emulator for Windows, to edit and run COBOL programs.

Unit 2: Object-Oriented Approach and C++

In order to meet the challenge of object-oriented methods in the computer world based on long-term considerations, we recognize that general knowledge of C++ will be an asset for IS students. The focus of this unit is placed on the difference between the traditionally structured approach and the object-oriented approach. C++ is an extension of C. In this unit, students actually learn both C and C++ languages. Students compare the structured approach and object-oriented approach by learning two different themes in C and C++ programming. In the functional theme of C, students learn the structure of elementary function modules and the connections between the function modules through function calling. The principle of programming in this theme is functional decomposition. In the object-oriented theme of C++, students learn the concept and structure of classes, the characteristics of inheritance, and message sending in object-oriented programming, which are unique to the functional approach. We use 24% class time for this unit. The computing environment for this unit is Visual C++ of Microsoft Visual Studio 6.0.

Unit 3: Web Pages, HTML, JavaScript, and Java

As future IS professionals, business IS students have to develop skills of computer applications in the Internet environment. These skills are acquired only when students are able to understand client-server computing through learning HTML, JavaScript, and Java applets. In this unit, students are required to learn the significant features and components of the integration of HTML, JavaScript, and Java applets using 26% of the entire class time. These components include essential tags of HTML, the structure of simple Web pages with JavaScript, Web pages with Java applets, and typical Java applets for animation with audio presentations. The course also presents the stand alone Java programming technique (AWT-based and non-AWT-based) as an optional part. The emphasis of this optional part is placed on a comparison of Java and C++ and their similarity. In teaching this unit, typical examples of Web pages with cookie and FORM checking, and multimedia Web page supported by Java applets are presented. The computing environment for this unit is Netscape or Microsoft Internet Explorer and Visual J++ of Microsoft Visual Studio 6.0.

Unit 4: Graphical User Interface and Visual Basic

In this stage of the course, students have developed basic skills in business data processing and computing on the Internet. This unit provides another important aspect of business computing: graphical user interfaces (GUI) and decision support systems (DSS). Visual Basic is one of the popular programming languages for the development of GUI. Students learn the major tools of developing GUI by mastering control elements including form, command button, label, text, combo menu, and program module. In the programming part, the concepts of do-loop, if statement, arithmetic operations, print and format functions are re-explained in the Visual Basic syntax by an example of on-line invoicing system. To develop their self-learning ability, students are required to use on-line help to learn Visual Basic build-in functions (such as NPV calculation for finance). The computing environment for this unit is Visual Basic 6.0 of Microsoft Visual Studio 6.0.

Examinations

After each of the four units, students are required to write a test. Students are presented with uncompleted computer programs with numerous blanks. Students are supposed to complete the programs, write the expected execution results of the programs, and explain the purposes of these programs. The designs of the tests strongly suggest that the global aspects of applications, including context and outcomes, are more important than the local aspects (syntax) to learn for business IS students.

Project Module

The Project Module of the course concentrates much more on “action learning”, and requires students to conduct their quasi-real-world projects. In this module, students work in teams, typically, of three people. Each group applies computer programming languages discussed in the Teaching Module for their four projects. We expect that, upon the completion of this course, students are able to write programs in these computer languages to solve simple problems related to business IS.

Project Configuration

After each unit presented in the Teaching Module, students form project teams to share common expectations of learning. Three stages can be outlined for each project in the Project Module. In the first stage, students choose project topics based on their general understanding of the computer languages and their basic knowledge of business information system. In the second stage, intensive programming activities are under way for each group’s project. In the final stage, the product of a project is formalized in a project report. Although the components of reports are significantly different from project to project, the report structure adopted in this course is almost the same, a so-called “sandwich” style. The first part of the report describes the background of the business problem to be solved. The second part provides a technical description of the project and presents source code, module diagrams, and exemplars of program execution results. The third part is a user manual.

Project Requirements

Because the natures of computer programming languages are very different from one to another, there is no uniform requirement for the four projects. Nevertheless, we set criteria for each project. For file processing and COBOL, the basic requirements are:

- Structured programs for creating master files and transaction files, and manipulating these files to generate designed print reports.
- Structured diagrams for the programs.

For C++, the basic requirements are:

- Object-oriented programs with two or more classes for data manipulations.
- Object-oriented diagrams for the programs.

For HTML, JavaScript, and Java, the basic requirement is:

- Code of HTML, JavaScript, and Java applets for Web page presentations, FORM data captures, multimedia including images and animation.

For Visual Basic, the basic requirements are:

- Two or more windows of GUI with various control elements, and print report generation.
- Program modules.

Findings and Conclusion

This innovated course has been offered for three years in the College of Business at University of Massachusetts Dartmouth as a required BIS major course. According to the course evaluations, overall 84% of the students were satisfied with this course. 85% of the students considered that the material covered in this course was interesting and useful. 92% of the students favored the two-module approach to this type of course. Nevertheless, 8% students felt that the course workload is too high. According to our observations on the test results and projects, students who are eligible to take this course have no difficulty in learning the techniques outlined in this paper and conduct projects. After the course, some students have shown their ability to participate in the development of more formal projects. Overall, the results indicate that the course discussed in this paper is a valuable component of the curriculum for business students with the major in IS. We believe that a single course of multiple computer languages for business IS students is not only useful, but also feasible.

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