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ABSTRACT

Computer science and other computer related fields are faced with the high velocity of change in technology. Far more important than the knowledge of a particular software package is the liberal education skills that are learned in the process. This paper reviews the laboratory component of a new computer science course offered at Miami University (Ohio) that focuses on developing these skills. The liberal education objectives of the course included thinking critically, understanding contexts, engaging with other learners, and reflecting and acting. Student lab groups experimented with the computer, made hypotheses, and then conducted further, more specific experiments. They did not develop proficiency in any one package, but instead were exposed to the potentials and limitations of many. Overall, the instructors of the course were pleased with the success of the laboratories and the majority of students agreed that the laboratories were successful in achieving the liberal education goals of the course. (AEF)

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Laboratories for a Liberal Education Computer Science Course

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Abstract

This paper reviews the laboratory component of a new computer science service course offered at Miami University. Rather than focusing on computer tool skill building, laboratories are designed to develop liberal education skills such as critical thinking and engaging with other learners. Students do not develop proficiency in any one package, but instead are exposed to the potentials and limitations of many.

Introduction

Academic departments, including Computer Science and Information Systems departments, have long recognized the need to provide service courses to students outside their department. In the case of Computer Science and Information Systems, these courses can generally be classified as skill building or computer literacy.

Both of these kinds of courses usually have a significant lab component in either an open or closed lab format. Laboratories in such courses typically focus on gaining proficiency in a particular package or a set of packages through hands-n activities. Scores of texts (e.g. Pitter, 1992; Duffy, 1991) have been written to support such classes. During laboratories, students either follow the books hands-on tutorial or complete in-class activities designed to help them master the package. An alternate approach to service courses in the computer science area is a lecture style presentation of computer science concepts. This type of course frequently deteriorates into a presentation of terms and their definitions occasionally appended with a "show and tell" demonstration of computer hardware.

The major thesis of this paper is that computer science from a liberal education view can be approached in a very effective way by using laboratories, but with a different purpose than skill-building or term memorization. This paper reviews the laboratory component of such a computer science service course offered at Miami University. Rather than focusing on skill building, labs are designed to develop liberal education skills such as critical thinking and engaging with other learners. Student lab groups experiment with the computer, make hypotheses, and then conduct further experiments of a more specific variety. Students do not develop proficiency in any one package, but instead are exposed to the potentials and limitations of many. All labs are developed with the objective of deepening students' liberal education.

Course Overview

Miami University has long been known for the quality of its liberal arts undergraduate education (Moll, 1985). In keeping with this tradition, Miami began an extensive review and revision of its undergraduate liberal education requirements in the mid-eighties. This effort resulted in the Miami Plan for Liberal Education (Miami Plan, 1989). A set of liberal education foundation courses is one of the major components of the Miami plan. A student must choose foundation courses from each of these five areas: English composition (0 to 6 hours), fine arts and humanities (9 hours), natural science (9 hours) and mathematics formal reasoning and technology (3 hours).

Systems Analysis 151 (Computers, Computer Science, and Society) is a Liberal Education foundation course in the technology area that was first offered at Miami University in the fall of 1992. The primary objective of this course is to develop a perspective on the potential and limitations of computer science and computing technology. Topics covered include: the impact of computing on societies, models of computation, major paradigms for use of a computer, and legal and ethical use of computers. This course also exposes students to programming language and various computer tools (spreadsheets, databases, etc.).

In the words of the Miami Plan "Liberal education involves thinking critically, understanding contexts, engaging with other learners, reflecting and acting, habits that extend liberal learning through a lifetime to benefit both individual and society" (Miami Plan, 1989, p. 10). Each foundation course in the Miami Plan must incorporate these principles. The paragraphs below introduce this course by discussing ways in which it meets these objectives.

Thinking Critically

One of the goals of this course was for students to learn to appreciate the value (and in some cases to overcome fear) of computing technology while being cognizant of potential problems as our society becomes more dependent on such technology. Class meetings were frequently devoted to discussions of the implications of computing technology on our society, and the effect of world view on our understanding and appreciation of computing technology. Examinations contained questions in which students thought critically about these and other issues. Writing assignments (such as a book report) focused on a critical examination rather than a reporting of the material. It is very difficult to think critically about these issues with no knowledge and experience in the use of computers. Therefore, students were exposed to programming and to the use of some common computer software tools.

Understanding Contexts

In this course, we discussed some common world views with an emphasis on understanding ways in which a world view can influence a person's view of computing technology; and the impact that computing technology and its velocity of change has on a person's world view. The students first homework assignment was to write an essay about their world view and how that world view has affected their understanding of technology. We also discussed the primary model in use today: the von Neumann sequential model. It was emphasized that this model affects our problem solutions and algorithms.

Engaging with other learners

Students interacted with one another in both the lecture/discussion and the laboratory portions of the course. In class, discussion was the primary teaching mode when topics of ethics, the societal influence of technology, etc. were the subject. In laboratories, students worked in small groups to accomplish the lab goals.

Reflecting and acting

Students were given opportunities to reflect on what has been learned through out the course, and to use this reflection to make informed decisions. This was one of the primary goals of the laboratory portions of the course. Laboratory assignments were not merely "cook book" descriptions to follow. Thus, student lab groups experimented with the computer, reflected on this experiment, then conducted further experiments of a more specific variety.

Importance of Lab Component

A very important component of this course was the laboratories. Approximately one-third of in-class time was spent in supervised laboratories. The students spent additional time outside of the class completing the labs. For each laboratory, a lab report was required from each group. To assure students were working on the labs and not depending on the other group members to complete labs, individual quizzes were administered at the end of each related set of labs. The lab material was included in only a general way on midterm or final exams.

The objectives of the computer labs in this course were twofold. First, the lab component was used as a vehicle to implement the objectives of a liberal education course (i.e. thinking critically, engaging with other learners). All labs were completed by teams of two to three students. In order to complete the lab, students were required to interact with other students and create a group lab report. Instead of simply following a step by step tutorial, student teams were given a task to accomplish and were required to determine for themselves the steps to accomplish that task. Such an organization forced the student to think critically, reflect, and carefully evaluate alternatives.

The second objective of the labs was to give the students a feel for the potential and limitations of computing technology via hands-on experience. Labs were designed to cover a variety of topics. In particular, depending on the section, the students were exposed to some combinations of the following: spreadsheets, electronic communications, the programming language OpenScript, the package of ToolBook, Lisp functions for turtle graphs, SQL, or a Turing Machine simulator. None of the labs provided the students with a thorough working knowledge of a package or paradigm although all of the labs provided a perspective on the capabilities of a particular package or paradigm.

Sample Labs

As described above the laboratories were developed to help meet the goals of a liberal education. Prior to each lab, the student was give a handout for the lab which consisted of the following sections: laboratory objectives (an itemized list of objectives), background (a description of the package and comments about using the package), laboratory activities (the

tasks to be accomplished in task), post laboratory work (tasks to be completed outside of the in-class lab). Some of the laboratories used the MacIntosh, others the IBM PC, and still others a networked mini or mainframe.

ToolBook/OpenScript

ToolBook is a windows-based application package that was used to introduce students to both software packages and programming. The primary purpose in using ToolBook was to introduce programming concepts in context. Rather than spending several weeks learning a language and then having a student write a very simple program, the intent was to expose the students to a powerful software package and then look at the computer programs behind that package. The labs required that the students look at the script behind various icons. These scripts were computer programs written in the language of OpenScript. A corresponding lecture introduced students to the fundamental programming structures and was used as a basis to compare other programming paradigms.

Xlisp

These labs were an alternate approach to exposing students to a programming paradigm. Xlisp, a public domain version of Lisp, was used with a set of turtle graphics functions to draw some simple stick pictures. This language is especially appropriate in this context because of its simple syntax. The students first modified an existing picture, then created their own. The emphasis was on experiencing the usual programming paradigm that includes the distinction between program development and execution. Some students became sufficiently interested in this process to extend their picture far beyond the lab requirements.

Excel.

Three separate labs introduced the students to spreadsheets via the package of Excel. In the first lab, students learned to enter text, numbers, and formulae, learned how to interpret an existing spreadsheet and learned to use the basic menu system of the Excel package. For the second lab, students made some more complicated modifications to existing spreadsheets, and created and printed a variety of graphs. In the last laboratory, students learned additional built in functions (such as PMT for determining payment from interest rate, amount, and number of periods), and used the spreadsheet to play "what-if" games. Students also created their own spreadsheet using the PMT function to find which bank was offering the best deal on a mortgage when loan points were considered.

Electronic Communication

During a single lab session students learned the basics of electronic mail, learned to understand E-mail addresses, and experienced various services that are available electronically, including bulletin boards, library services, and other information services. Students used a network that had been set up for the Miami community. Via this network they posted messages on a class discussion board, accessed Miami University's electronic library systems and other libraries (e.g. the Library of Congress), and used electronic services to find weather and ski conditions throughout the world. Students were introduced to the internet addressing system and were required to send the lab report to the instructor via electronic mail.

Turing Machines

In this series of three labs, students explored, modified, built, and analyzed Turing Machines. Public domain Macintosh software to simulate Turing Machines (Hannay, 1992) provided an easily used interface. The focus of this lab was on understanding an algorithmic description of a process. First, students explored existing Turing Machines as black boxes by examining inputs and corresponding outputs. Next, they explored the rules of these Turing Machines that produce this functionality, and modified them in some simple ways. Then, they constructed their own Turing Machine to implement a simple string manipulation algorithm. Finally, the lab was tied to a class lecture/discussion of algorithm analysis in which they learned to critically examine the time efficiency of some simple algorithms.

Assessment of Labs

Overall the instructors of the course were pleased with the success of the laboratories although the exercises are still in the initial stages of development. Laboratories are a critical piece to this course and the percent of time spend in labs seemed appropriate and important to the learning process.

Perhaps the most successful laboratory of the course was the electronic communications lab. Students found it very enlighuening to send electronic mail to their instructor, to look up information in off-site libraries, and to check weather conditions in other countries.

One of the problems that was encountered by one of the instructors is the misconception students had about a computer science course. Some students expected and wanted to learn a specific software package in detail. They had come to understand the service courses in computer science or information systems to be skill based and some students found it frustrating to learn that the course in which they were enrolled was not skill based. Also some students were frustrated with

the lack of "cookbook" style laboratories. Although teamwork lessened some of that frustration, some groups wanted more guidance than the labs provided.

In addition to the instructors' evaluation, at the end of the course students were required to complete a final liberal education evaluation. This evaluation contained 72 likert-type questions and several open ended questions. Questions especially relevant to the lab component of the course are listed in Table 1. For presentation purposes, the data for agree and strongly, disagree and strongly disagree are collapsed.

	Agree	Mixed	Disagree
I believe that my critical thinking skills have been enhanced by the laboratories in this course.	42	[illegible]	3
I believe that the laboratories of this course have provided opportunities for me to engage with others in meaningful and effective ways.	52	7	1
I believe that my ability to understand contexts has been enhanced by the laboratories of this course.	36	22	1
I believe that laboratories in this course has provided opportunities to reflect upon my learning and then acted upon what I have learned in an effective way.	43	15	2
The laboratories of this course have helped to give me a better understanding of the potentials and limitations for the use of computer science and computer technology.	47	11	2
Of all the class activities, I learned the most from the laboratories.	40	5	14

Table 1. Student Evaluations

Student evaluations indicate that the majority of students did agree that the laboratories were successful in achieving the liberal education goals of the course. Perhaps most interesting is that 68% of the students felt that of all the class activities, they learned the most from the laboratories.

Summary

Computer science and other computer related fields are faced with the daunting problem brought about by the high velocity of change in computer technology. It is important for students to have the skills necessary to use today's software tools. However, the necessary suite of skills changes rapidly. Far more important than knowledge of a particular software package is the liberal education skills that are learned in the process. Laboratories in computer science service courses can be reoriented to emphasize liberal education skills rather than a software package. The software packages are easily forgotten and quickly out-dated; but skills such as critical thinking, working with others, and reflecting should last a lifetime.

References

Duffy, T. (1991). Four Software Tools: With WordPerfect 5.0/5.1, Lotus 123, and dBase III Plus. Belmont California: Wadsworth Publishing Company.

Hannay, D.G. (1992). *HyperCard* Automat Simulation: Finite State Pushdown and Turing Machines", SIGSCE Bulletin, 24.

Moll, Richard (1985). The public ivys: a guide to America's best public undergraduate colleges and universities. New York. New York: Viking.

Miami Plan for Liberal Education (1989). Miami University, Oxford Ohio.

Pitter, K. (1992). Using IBM Microcomputers: WordPerfect 5.1, Lotus 123 Release 2.2, dBase III Plus and IV Version 1.1. New York: Mitchel McGraw-Hill.