Experience With Autonomous Robots and Wireless Handheld Internet Devices in a Computer Basics Course

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Abstract

Beginning undergraduate engineering students need computing skills. A course was developed to support the retention of those undergraduates who were lacking in basic computing skills. This paper discusses the results of using novel technologies in an assimilation course. The technologies consisted of autonomous robots that were relatively easy to build and Pocket PCs with an integrated wireless capability in order to access the Internet. The paper includes the background information on the course, technologies, and the applicability. In addition, student experiences with the tools are also covered in the paper.

I. Introduction

The effective use of computer applications is essential for incoming freshman engineering students. However, there are some entering freshman engineering students who lack the computing skills necessary to be productive in the beginning courses. The lack of skills can be attributed to a variety of reasons, such as an impoverished pre-college environment or inattentiveness to the details when the opportunity was made available. Considering the efforts that are spent on recruitment of students, the need exists to provide a support structure to retain these students. In order to succeed in an undergraduate engineering degree program, there is a need for relatively rapid assimilation of computing skills, otherwise the struggle begins as the student attempts to catch up to the expectations.

This paper addresses the issue of student success in terms of a computer basics course designed for those entering freshman with deficient computer skills. The paper begins by briefly discussing the experience with a placement exam, computer skills needed by engineering students, and a computer basics course. There is further discussion on the use of autonomous robots in the computer basics course in order to apply software development skills during the same semester. In addition, the wireless handheld Internet devices are addressed from the standpoint of acquiring computer skills and the applicability to time management and study skills. The paper concludes with a survey and retention data to support the concepts and future research directions. The research reported in this paper was part of a larger project supported by a grant through the State of Arizona Proposition 301 program.

II. Computing Skills of Engineering Students

This research effort was an outgrowth of retention efforts within the Ira A. Fulton School of Engineering at Arizona State University. There were students having difficulty in completing the courses CSE 110 - Principles of Programming with Java and ECE 100 – Introduction to Engineering. There were deficiencies that were identified on the part of those students not doing well in both courses. Specifically, the students having difficulty were primarily lacking in the essential skills needed to either use the computer applications required in the coursework and / or lacking in the ability to develop software. A one unit course, ASE 194 – Computer Basics With a Vision, was initially offered as a means to meet the needs of these students. [1] The first course offering was in the Fall 2001 semester. The class met on a Friday afternoon for fifty minutes once a week during the extent of the semester. With the exception of the meeting time, this course was well received by the students and faculty member.

This first course addressed the essential computer skills expected of an entering Ira A. Fulton School of Engineering student. Students were also introduced to several computer applications in a variety of engineering application domains. Thus, the students were provided with a vision of the use and power of computers to encourage them to remain in the course. For those students who maintain the vision, these applications were intended to assist in their retention until they complete their respective degree programs. Software tools that most incoming university students' use were covered early on during the course, such as email, word processing, spreadsheets, and web searching. In addition, software development basics were covered in order to prepare the students for the first computer science course.

The subsequent offerings of the course expanded on the original concept with an extension to a two unit course. In support of meeting the vision part of the course, autonomous robots that are relatively easy to build were used for group projects in which the students modify the onboard program for robot motion. This course also placed wireless handheld Internet devices in the hands of the students with the aim of improving student performance and retention.

Based on the success that has been achieved in mathematics education, a placement exam was developed for providing advice on whether a student had the skills necessary to pursue the beginning computer science course. The exam was intended to serve in a manner similar to the approach that many Mathematics Departments use to determine whether a student is ready to begin the sequence of Calculus courses. The placement exam results have been useful for providing advice to the students. The placement exam results have been reviewed against the student performance results in both courses. The placement exam has been modified through three offerings with the longer term objective of using the results for required course placement.

There can be some concerns raised about a course such as computer basics with a vision not being part of a degree program and thus impeding the possibility of students completing degree programs within four years. The downward spiral out of a degree can begin with the inappropriate placement of a student in the initial stages of a degree program. This research

effort has focused on trying to minimize the amount of extra coursework necessary to become fully immersed in the degree while at the same time seeking to maximize student retention.

III. Wireless Handheld Internet Devices and Robots

The wireless handheld Internet capability was initiated after a review of an article by Comerford.[2] The Comerford article provided a survey of the handheld technologies with access to the Internet that existed in 2000. However, after Comerford's article appeared and the selection of the device, there was an advance with the integration of a wireless capability into the Pocket PC. The Toshiba Pocket PC e740 was selected as the PDA. The use of these devices includes the necessary computer applications, as well as a built-in wireless capability. This integrated Wi-Fi capability, that met the IEEE Standard 802.11b, gave access to the Internet wherever there was a wireless island on campus. Those devices with a modem capability were not included because of the additional monthly service charges for the Internet connection.

The November / December 2000 issue of IEEE Intelligent Systems was a special issue on Robotics and Education. Three of the articles in the special issue generated interest for including robots as an application in the computer basics course. Sutherland discussed an upper level undergraduate robotics course that she taught at two institutions.[3] Horswill presented a laboratory based course, suited for graduate students, that used research level autonomous robots.[4] Maxwell and Meeden bridged the undergraduate and graduate gap by incorporating robotics research in undergraduate group projects.[5] These articles provided motivation and experience, but there still was a need for transitioning the concepts to a new undergraduate engineering student.

Parallax BOE-BOT Full Kit was selected as the autonomous robot for use in the course. These robots include the Parallax BASIC Stamp 2 microcontroller. These robots have the potential for demonstrating considerable functionality. One advantage of using these robots in this type of course is that the robot construction is quite simple and straightforward with an approximate build time around two hours. The relative ease of hardware construction coincides with the software development. There are sample program segments to help the students get the robots into motion.

In order for the students to use the Pocket PCs and robots, there was a check out form that needed to be completed and signed by each student. Apparently this check out concept is quite common in other academic disciplines, e.g., for music instruments, but not common for engineering students.

IV. Computer Basics With a Vision Course

The course included lectures on software engineering with an overview of software development and maintenance through to the topics of detailed design and implementation. Early on in the course, there was a discussion on the software code of ethics that was developed by the Association for Computing Machinery / IEEE Computer Society Joint Task Force on Software

Engineering Ethics and Professional Practice and subsequently endorsed by both professional societies. Students were assigned a part of one of the principles for in class discussion to demonstrate understanding. The students provided examples of situations that satisfy and fail to satisfy the code of ethics. In order to unify the software engineering code of ethics with the engineering students from non-computing disciplines, the students investigated the code of ethics for a variety of other disciplines. There was also discussion on the similarities and difference between these codes of ethics. The software code of ethics became part of the discussion throughout the remainder of the semester, e.g., in conjunction with algorithm development, robotics, and the Internet.

One fourth of the final grade in the course was based on the results of homework, of which there were five assignments. These homework assignments were designed to encourage independent work in that answers to several of the questions were unique to the individuals. Some of the assignments built on earlier homework results to help maintain integrity in the context of a comprehensive code of conduct.

The homework assignments covered using email, web search engine, text editor, and spreadsheet applications, as well as algorithm development. The web search engine assignment went beyond trivial searching to include multi-level searching in order to obtain the correct result. Time management was the basis for three of the homework assignments. The time management assignment was designed to channel the student towards using the Pocket PCs for scheduling of activities and improving study habits.

One fourth of the final grade in the course was based on an in-class midterm examination. The questions on the midterm examination were based on computer application usage that was similar to the scope of the homework assignments. The midterm answers were developed on a computer and submitted electronically, graded, and the results are returned through email.

One fourth of the final grade in the course was based on an examination that was similar in nature to the midterm examination. In addition, there were group quizzes provided that were included in the final grade determination, but were a means to provide a collaborative environment for working together in class that later became the basis for a group effort robotics assignment.

The last of the final grade in the course was an assignment that was a group effort in robot development. This assignment involved the development of a robot that performs a particular task, such as to spell ASU on an 8.5 inch by 11 inch sheet of paper, to maneuver around an obstacle course, or some equivalent task. The conceptual functionality must be described in one typed double spaced page, which is due within two weeks of the assignment requirements being distributed and subject to modification and final approval.

A written report and robot demonstration were due on the last day of classes. The written report included a cover page with the group name and members followed by the conceptual functionality, software design, and code.

During the last class, each group presented to the rest of the class the report and a demonstration of the robot functionality. Group members were expected to perform at approximately an equal amount of effort, as the group project accounted for 25% of the final grade for the course. The groups that were randomly determined in class and used for group quizzes were the same groups used for the group project.

V. Outcomes

The robot applications have been successful. With the exception of one project, the groups implemented projects that followed a path of motion that was repeatable. There are three categories of these projects that were proposed and developed by the students in the three offerings of the two unit computer basics course. The first category involved writing out a word. The second category was driving through a specified path. The third category made the robot perform a dance step.

Varying success of robot development by the students, as well as variations in the properties of the surfaces on which the robots moved, caused some deviating from the results expected by the students. The one exception project, mentioned earlier, chose a type of project that was different from the typical project that would follow a path. The exception project used the sensor feature available with the kit in order to determine when an obstruction was met and a decision was needed to alter the movement. However, this project had a group member who was a returning student with considerable electrical engineering work experience. This level of experience gave the group some confidence to venture beyond the typical project scope.

The robots were also discussed in the context of the DARPA Grand Challenge, which is an autonomous robot race from a point near Los Angeles to a point near Las Vegas that was scheduled for March 2004. The students reviewed the DARPA Grand Challenge rules and analyzed the capabilities of the course robots to compete in such an event. For example, the power source consisted of AA batteries, which obviously would not last the distance required to travel, so an alternative power source would need to be sought or replacement would need to be brought along on the trip.

The students have provided subsequent feedback that the Parallax BOE-BOT kits prepared them well for developing the robots from scratch in the Introduction to Engineering course that is required of all students in the engineering degree programs. In addition, these robots provided a basis for implementing algorithms in a simple computer programming language. The approach allowed for the students to receive immediate feedback on the output of a program.

As part of the final exams, the students had to develop an Excel spreadsheet that compared computer application usage. The first set of data was the percentage use of the Toshiba Pocket PC for calendar, contacts, e-mail, Internet, notes, tasks, Windows media, and other functions. The second set of data was the percentage of those same activities before receiving the Pocket PC. In addition, the students had to compare the functionality with and without the Pocket PC

by listing two ways in which using the Pocket PC was better than not using the Pocket PC and two ways where not having access to the Pocket PC was better.

The important part of the exam question for the students is the ability to develop the spreadsheet, but the percentages are the relevant part for the researchers. In general, the students demonstrated the most increased percentage use with the calendar and Windows media programs. The e-mail and Internet use is expected to increase as the wireless islands become greater and larger on campus. Also, the notes capability is limited by the ability of a student to perform data entry by poking symbols with a stylus or writing recognition.

There were nineteen students enrolled in the first two offerings of the computer basics with a vision course that used the robots and Pocket PCs. One of the students did not complete the course for medical reasons and subsequently left. There are a variety of factors that influence subsequent course enrollment, such as course availability, advisor recommendations, and outside work activities. The data available was based on student actions within six months to a year after the course.

Three of the remaining eighteen students enrolled in and completed a subsequent course in the Department of Computer Science and Engineering with one student earning a grade of A and two students earning a grade of B. Five of the remaining eighteen students enrolled in and completed a subsequent ECE 100 – Introduction to Engineering course with two students earning a grade of A, one student earning a grade of B, and two students earning a grade of C. There is a survey planned to explain the grades in the subsequent related courses. Also, the survey will complement the end of semester course evaluation to provide information on what can be done to improve the existing computer basics with a vision course.

VI. Summary and Future Plans

This paper described the background that was the basis for the development of a computer basics course that incorporates autonomous robots and wireless Internet devices. The course was built upon an initial offering of a one unit course on computer basics that was successful in retaining students. In comparing the initial offering with the current version of the computer basics course, these new and novel technologies had a positive impact on the students.

The students in each offering of the course have provided recommendations on software features to improve the functionality of the Pocket PCs. One application under development is an Internet based mentoring capability whereby a faculty member could provide specifications to students in a course that could be used to adjust a study schedule on an individual basis.

The computer basics course will be under review for possible inclusion in the Ira A. Fulton School of Engineering curriculum. Those technologies that were used in previous course offerings need to be re-evaluated and if necessary then purchased for the course. Introducing several different types of autonomous robots would provide an opportunity for the students to get more experience with these devices in preparation for the Introduction to Engineering course.

The selection of the robots would then be a more important aspect of the project requirements formulation and analysis.

The Department of Computer Science and Engineering is evaluating the results of three offerings of a placement exam that is used for determining entry into the first computer science course. Preliminary results indicate that the placement exam will be used as a basis for allowing entry into the first computer science course. The introduction of outcomes and assessments for accreditation purposes has been a benefit for course to course transition throughout the degree program. However, the placement exam and the computer basics with a vision course would be the crucial determining factor for getting the student at the right starting point in the degree program.

References

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