ROBOTS IN THE CLASSROOM … AND THE DORM ROOM*

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ABSTRACT

The purpose of this paper is twofold. First, to argue that despite some disappointing results in using robots in the computer science classroom in the past, we should not yet conclude that robots do not belong there. Second, to present the results of a small pilot study comparing two approaches to teaching an introductory computer science class – one traditional and one which used robots. While the study is not sufficiently controlled to be considered proof of success, initial results are compelling and support the need for further investigation.

1. INTRODUCTION

The notion of introducing robotics into the traditional computer science curriculum is a compelling one. Anyone who has brought a robot into a classroom knows the level of excitement that this tool brings to a classroom full of even the most unenthusiastic students. Robots have the potential to make our current students more engaged in their projects.

Robots also have the potential to attract students to a field they might not otherwise have considered. Many students graduate from high school with no understanding of what the field of computer science is actually about. Classes with robots may help bring some of them into our general education courses and subsequently into our major.

However, several studies have produced both qualitative and quantitative evidence that classes with robot assignments can be frustrating, and even worse, detrimental to student performance.

The purpose of this paper is twofold. First, to argue that despite these disappointing results we should not yet conclude that robots do not belong in the computer science classroom. The greatest source of frustration for students seems to be the lack of access to robots, and with the newest generation of robots that are approaching the price of an (admittedly expensive) text book, there is greater opportunity for students to have their robot alongside their laptop in the dorm room. Second, to present the results of a small pilot study performed at Rowan University in which two introductory programming courses for non-majors were compared, one traditional course and one that used robots to introduce the same concepts. While the study is not sufficiently controlled to be considered proof of success, initial results are compelling and support the need for further study.

2. ROBOTS IN THE CLASSROOM

Robots have been used in a wide variety of computer science classes at the undergraduate level, from introductory courses for non-majors, to advanced electives for majors. [1] [2] [3] [5][6] [7][8] [9]. But they have not always been successful. In an impressive study, Fagin & Merkle evaluated the performance of 938 students taking a core computing course required of all students at the U.S. Air Force Academy. [2] Roughly one-quarter of these students were in special robotics sections of the class in which students used Lego Mindstorms Robots in 4 out of the 6 laboratory exercises. Much to the dismay of the robotics community, test scores were lower in the robotics sections of the course than in the traditional sections, and the use of robots did not affect students' choice of discipline.

Students in the robot sections of this class were limited to assigned lab times to work on their robot projects. Fagin and Merkle concluded that this was the key factor in the poor performance of these students, and suggest the need for a simulator, or the ability to "check out" robots so that students could work on the projects on their own schedules.

In another study, 35 students in a senior-level course were required to share a single Khepera robot for a graphical user interface assignment. [1] While the experience was considered to be successful, students reported that the majority of the problems that they encountered had to do with access to the robot. Many of the students would have preferred to work late at night when the server and robot were not available.

3. ROBOTS IN THE DORM ROOM

One of the newest and cheapest robot platforms designed for education is the IPRE robot which consists of a Parallax Scribbler Robot paired with a plug-in Lancet Fluke board. [4] Programmed in Python, it is designed for introductory computer science students. Initial reports on its use at Georgia Tech and Bryn Mawr indicate that in contrast to Fagin and Merkle's results, that the use of these robots in their classes does no harm. [9]

In the Fall semester of 2008, the author taught three sections of Introductory Programming courses for non-majors, two of the sections were traditional courses taught in Visual Basic, and the third was taught in Python using the IPRE robot base. At a cost of around $150, the IPRE robot is still too expensive to be attractive to non-majors at

Rowan University, but thanks to an award from IPRE, the author was able to purchase enough robots to loan to students for the semester.

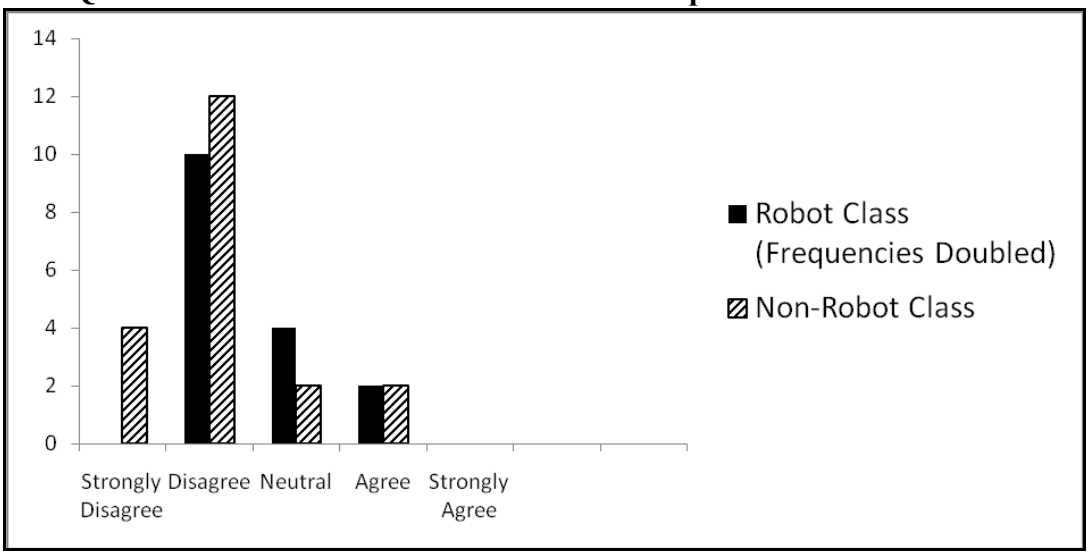
The goal for both versions of these courses is simple: by the end of the semester, students should be comfortable with conditional statements, loops, and functions. The non-robot classes were made up of a variety of majors, primarily math, science, and business, and most of the students were required to take this course as a part of their major. The robot class consisted entirely of students who had yet to declare their major, but who had math SAT scores of at least 560 (560 was chosen because it is the minimum math SAT score required to be admitted to the Computer Science Major).

4. SOME COMPELLING RESULTS

Students in all 3 classes were surveyed at the beginning and the end of the semester. In the non-robot class, 20 out of the 44 students responded to the final survey, in the robot class 9 out of 10 students responded. The graphs that follow are from questions administered at the end of the semester. In the graphs that follow, the robot data frequencies have been doubled for visualization purposes. In other words, 3 students in the robotics class are illustrated as 6 on the graph so that the two classes are easier to compare.

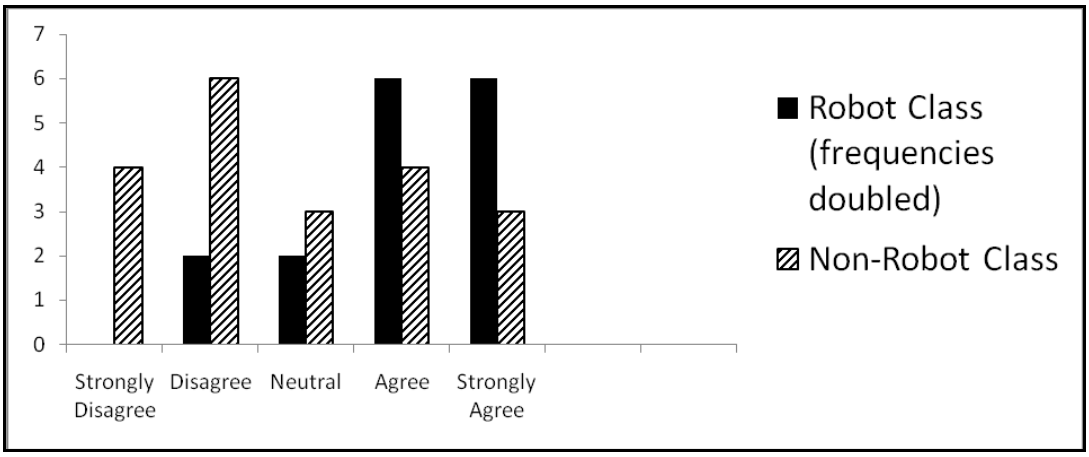
The first graph (Question 1, below) looks at the original students' motivations for taking the classes. Students in both the robotics and non-robotics sections seem, alas, to be equally unmotivated by the desire to learn more about computer science is all about.

Question 1: I took this course to see what computer science is all about



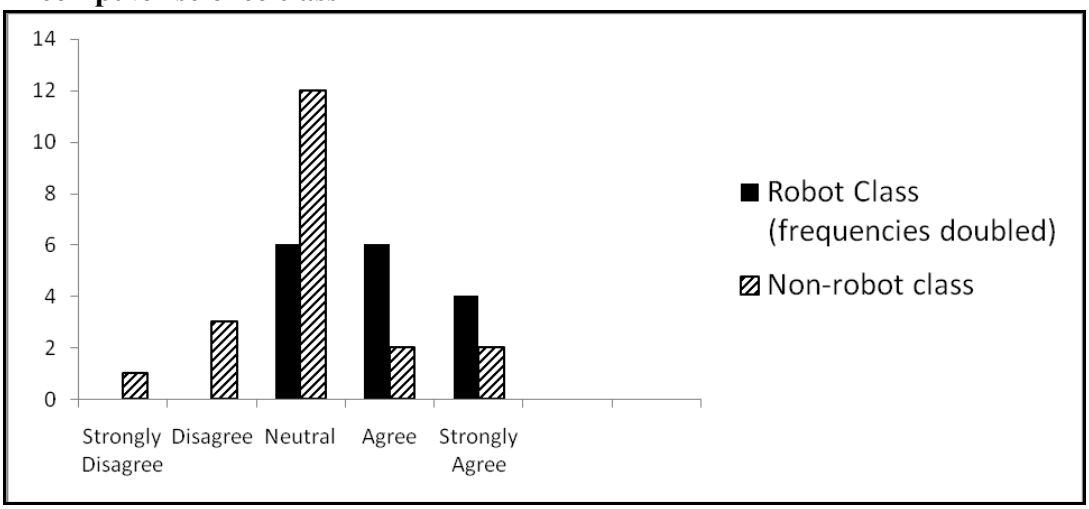
The second graph (Question 2, below) looks at whether students wrote a program during the course of the semester that was not an assignment for the class. Now the results get more interesting. The non-robot class is spread across the graph, with a bit of an emphasis on the strongly disagree/disagree responses. In contrast, the students in the robot classes tended toward agreement, with only 1 out of the 8 students disagreeing, and 6 out of the 8 agreeing/strongly agreeing. Perhaps including robots in the class increased the students' motivation outside of class.

Question 2: During the class, I wrote a program that was not an assignment for this class



The final graph (Question 3, below) addresses the question of whether robots might aid as a recruiting tool for our courses and our major. Students were asked whether their experiences in their class caused them to decide to take another computer science class. Students in the non-robot classes were predominantly neutral. In contrast, students in the robot class were more inclined to agree.

Question 3: My experiences in this class caused me to decide to take another computer science class



5. CONCLUSIONS

While it is important to emphasize that these data are not sufficient to declare that robots should be in the computer science classroom, they are compelling. Students in the robot and non-robot classes seem to have been equally uninterested in computer science when they signed up for the course. But students in the robot course seem more motivated to write programs outside of class that are not required, and to be more interested in taking another computer science class.

Robots are fun and engaging, for teachers as well as students. At a minimum, Summet et. al. have shown that robots can be used and do no harm. Further study is clearly needed, and hopefully the data from my own classes will be mirrored in future statistically significant studies that demonstrate that robots can, in fact, aid in computer science education.

6. REFERENCES

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7. ACKNOWLEDGEMENTS

This work was made possible by an award from the Institute for Personal Robotics in Education.