"Robots: Fantasy and Reality"- A First-Year Colloquium

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Abstract

At Hiram College, first-year students are introduced to college life through a course called the First-Year Colloquium. Faculty members from all disciplines have complete freedom in determining the topic and activities of the colloquium, although there are some guidelines that must be followed. This paper describes a First-Year Colloquium called "Robots: Fantasy and Reality." This colloquium added Lego Mindstorms robotics to the standard topics of reading and writing, and included reading and writing assignments that fit both the general colloquium guidelines and the topic.

Introduction

At Hiram College, first-year students are introduced to college life through a course called the First-Year Colloquium. Every student takes a colloquium, and they are taught by faculty from all academic areas. The faculty have complete freedom in determining the topic and activities of the colloquium, although there are some guidelines that must be followed. This paper describes a First-Year Colloquium called "Robots: Fantasy and Reality." This colloquium added robots (building and programming) to the standard topics of reading and writing.

The purpose of the colloquium program is to introduce students to college-level reading, writing and critical thinking, using a topic of the faculty member's choice. Therefore, the class included reading assignments that include both science fiction and science fact, and several related writing assignments. In addition, this colloquium had additional goals that the students be introduced to critical aspects of computer science: design, debugging, and documentation.

These additional goals were addressed by requiring students to design and build their own robots. Six Lego Mindstorms kits were donated to the College for this purpose. Each kit included the RCX™ programmable brick, motors, touch and light sensors, and Lego blocks. RoboLab™ programming software was purchased separately. Because the number of robot kits was small, students were also expected to learn to work together effectively as teams.

Several challenges were faced in developing this colloquium. These included: making time for laboratory work in a relatively packed curriculum, making science interesting and exciting to non-scientists, and developing assignments that were both challenging and interesting to students who came from a wide variety of backgrounds and interests.

Student Population

While many other courses that use robots are geared to students majoring in engineering and/or science (Kumar and Meeden, 1998; Beer, Chiel and Drushel, 1999), each First-Year Colloquium at Hiram College includes a mixed group of liberal arts students. The majors of the students in the 1999 Robots: Fantasy and Reality colloquium (as of Fall 2000) are representative of the college as a whole, as can be seen in Table 1. (Two of the original 15 students have left Hiram College, and are not shown in the table). Only two of the students had had prior programming experience, though most had built with Lego blocks before.

Major	# Students
Computer Science	3
Other Science	3
Management	3
Education	1
English	2
Psychology	1

Table 1: 1999 Colloquium Students' Majors

In addressing this diverse group of students, no background knowledge could be assumed, and assignments needed to be carefully presented in a way that would invite *all* of the students to become involved. Unlike a course for majors, there is no curricular motivation for learning the skills of design, debugging, and documentation. Instead, the final challenge (and the teamwork involved) served as the motivator for the students to put in the extra effort required to learn the design principles and programming necessary to make their robots work.

Using the built-in programs that come with the Lego Mindstorms package allowed the programming aspect of the class to be delayed until the groups were well-established and had already had several successes with their robots. This lowered the intimidation factor of the programming language, though some students still were uncomfortable at first.

The RoboLab™ visual programming language (Lego Group, 1998) proved easy to learn, and seemed to be less intimidating than a syntax-driven programming language such as Not Quite C would have been. In fact, two students who were taking the Introduction to Computer Science course at the same time proved to be much more comfortable with RoboLab than they were with the C++ they were learning in computer science. All five teams were able to develop fairly sophisticated programs for their recycling robots over the four-week period that they had for development.

Reading Materials

Three types of reading materials were used in the colloquium: examples of science fiction using robots, factual material on robotics and artificial intelligence, and specific material on building with Lego Mindstorms. Early in the course, when students were working on their fantasy robot papers, the emphasis was on science fiction. The role of robotics and automation in society was explored by reading *I, Robot* (Asimov, 1950) and contrasting the societies in *Caves of Steel* (Asimov, 1954) and *Player Piano* (Vonnegut, 1952). We also joined with a philosophy colloquium to discuss what makes a robot "human", using the *Star Trek: Next Generation* episode "The Offspring"(Echevarria, 1990). The second part of the course focused on robot design and construction using Lego Mindstorms; for this portion of the course, we read Fred Martin's paper (Martin, 1996) and the materials that were included with the Lego Mindstorms set. The final portion of the course was a brief introduction to Artificial Intelligence topics from the point of view of Robotics; for this portion of the course, we used the book *In Our Own Image* (Caudill, 1992).

Assignments

Because the First-year Colloquium is at the heart of Hiram College's Writing Across the Curriculum Program, there are very specific guidelines for oral and written assignments. All colloquia must assign four papers, one of which is a research paper and two oral presentations during the 12-week term. In the Robots: Fantasy and Reality colloquium, most of these assignments centered on two challenges for the students: the fantasy robot that the students would imagine and then research, and the recycling robot that each group of student would build and program using its Lego Mindstorms Kit. The remaining assignments were reading and writing assignments related to the science fiction stories covered in class.

Fantasy Robot Assignments

One of the oral assignments and two of the written assignments were aimed toward having students connect "robot fantasy" with "robot reality". The purpose of the first assignment was to introduce students to the wide range of existing, available robots. Each student was to find an article in the news media that described a robot, follow up on the news article by finding a second source with a more detailed description (scientific journal or commercial site with detailed specifications), and present the information about that robot to the class. Students shared their chosen articles ahead of time to ensure that each presentation would be unique. After these presentations, the class discussed the wide variety of robots that are currently deployed or in the research stages.

These discussions led immediately into the first paper, "Fantasy Robot." For this paper, students were to imagine a robot that does not currently exist, but they wished they could have one right now. They were then to motivate the need for this robot and describe it in detail. Students came up with a wide variety of ideas here and really enjoyed these papers.

The final paper that the students turned in was their research paper, written in the form of a research proposal asking for funds to develop their fantasy robot. The students included the motivation from their first paper, then described the state of the art of robotic technologies that would be relevant to their fantasy robot. Finally, the students wrote a revised description of their fantasy robot taking into account what they had learned from the literature. In addition to the usual objectives of a research paper, this paper allowed students a chance to revise and retarget an existing paper (their Fantasy Robot paper), and introduced them to the scientific proposal as a genre of writing.

Lego Mindstorms Assignments

Another written assignment and the second oral assignment focused on building and programming Lego Mindstorms robots. Students were divided into groups of three for these activities; each group had a standard Lego Mindstorms kit that they kept for the semester. The written assignment was a laboratory journal containing report for all in-class laboratory session and for any outside work that students did while developing their robots, and the oral assignment was a final report on their robot, including a post-mortem of its performance on the challenge task.

Students developed their robot through a set of structured assignments, followed by a group challenge. The assignments were:

- inventory the Lego kits (in class)

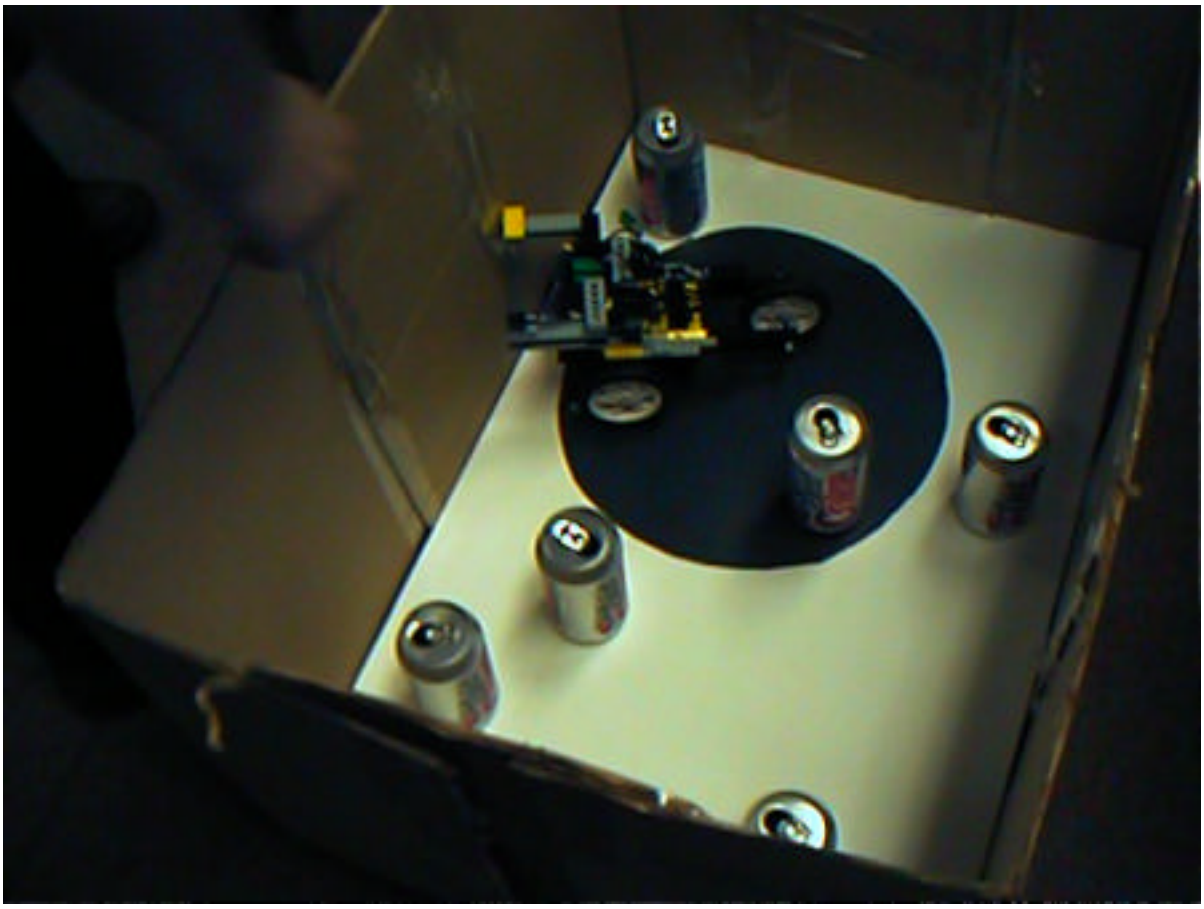

Figure 1: Robot Recycling Challenge

- build both the strongest and the weakest box each group could think of (built outside class, demonstrated and tested to destruction in class)
- experiment with gear ratios and drive trains (in class, included some drag racing)
- build a car with differential steering and program it to follow a square path (in-class introduction to programming)
- program the car to follow a black road on a white background using the light sensor from the kit (two in-class sessions for programming)
- design, build and program a recycling robot (two in-class sessions for development and testing, otherwise the work was done outside of class)

The inventory assignment was both a practicality (to make sure that all kits were complete), and a chance for teams to learn to work together on a relatively simple task. The box-building was a chance for students to remember their Lego construction skills, and also to experiment with bracing techniques from their reading assignment (Martin, 1996).

For the remainder of the labs, students worked on steerable vehicles (using differential drive). At first, students used only the programs built into the RCX ™ brick from their Lego Mindstorms set. We spent half of a class on the theory of gear ratios and then each team built a car and experimented with different drive trains, testing both speed and torque. The hall outside the classroom proved to be a perfect drag strip.

The programming assignments were carried out in a computer lab, using the RoboLab ™ software (Lego Group, 1998). Once the software was introduced, each group programmed their car to follow a square path. These programs were first written without loops, then revised to include counted loops. In the second lab, students experimented with the light sensors, then programmed their cars to follow a black road on a white background, using the poster that came in the Lego Mindstorms set. Again, the hallway outside the lab was used for testing. Once students had their road-following robots working, they were encouraged to work on bumpers and other touch sensors for their recycling robots.

The recycling challenge was carried out on a white poster board with a large black construction paper circle attached to it. The poster board was surrounded on all four sides by cardboard walls. Six upright soda cans (approximately half full of water, with the tops well-taped)

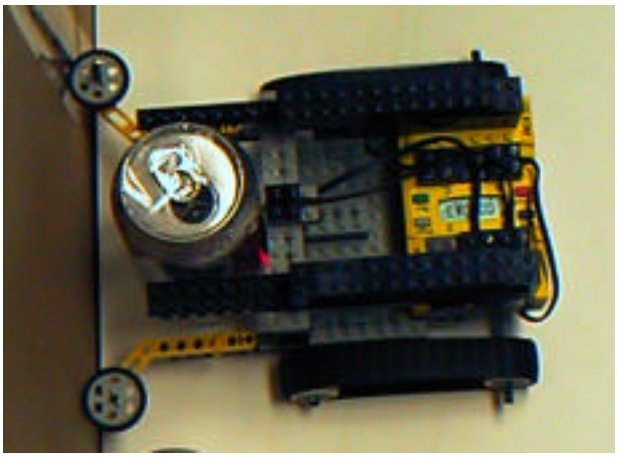

Figure 2: Robot With Can

were scattered on the poster board and the challenge was to move as many as possible to the black area within 10 minutes or until the robot got hung up in a corner. (Unfortunately, at the final test, no robot lasted more than a couple of minutes without getting inextricably stuck). Students were given the dimensions of the poster board and the circle, but the location of the circle was not revealed until the final public showdown. Figure 1 shows the initial configuration of the recycling center. After some experimentation, the size of the field was doubled with a second piece of poster board to allow the robots more room to maneuver. Figure 2 shows a robot that has captured a can, but is up against the wall so that it cannot easily push the can to the black circle.

The students' journals contained a record of all work with the robot kit, from comments on the inventory process through the design and implementation of the recycling robot, including design decisions, results of experimentation, and changes that were made because of these results. The better ones had careful drawings and descriptions of testing, and most also included information about whether and how well the teams were working together.

The oral assignment was a team presentation of their robot's development, their final design and a post-mortem of the robot's performance. These were given on the last day of class, approximately one week after the recycling tests. The presentations served as a fitting finale to the course, with students sharing their accomplishments as well as describing what they had learned from the class.

Evaluation

The evaluations of the course from the students themselves were quite positive. They enjoyed using the robots and they felt that they had learned a great deal. Students also noted that they had not wanted to work in teams, but felt that they had learned from the experience. Students were surprised by the amount of trial and error, and by the amount of time that they had put in to get their recycling robots working. The fantasy robot / research proposal assignment was another clear success. Students were able to combine creativity with solid research to write a very unique paper. The proposals were generally excellent and well thought out. Students seemed to like these papers the best — when choosing papers for their portfolios at the end, most students chose the fantasy robot paper as well as their research paper. Finally, the students' performance in the second course in the First Year Program, a writing-intensive seminar, was quite similar to their performance in the "Robots: Fantasy and Reality" colloquium. Therefore, students' critical reading and writing did not suffer because of the extra time that they spent working with robots.

Overall, the "Robots: Fantasy and Reality" colloquium was a success. It provided the critical reading and writing required of all liberal arts students, while also imparting the development, debugging, and documentation skills required of future computer scientists and engineers.

Acknowledgements

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