All Things LEGO at Indiana University, Bloomington

http://www.indiana.edu/~legobots/

A Brief History

August, 1998
Mindstorms Robotics Invention System released.

November, 1998
Prototype kit is purchased by CS Department.

December, 1998
Curriculum addition to A110 utilizing the kits proposed; additional kits ordered for Spring 1999 semester.

Spring, 1999
A110 TecTrac run as a prototype addition to the curriulum. 15 students participate in the Little LEGO 500; fun had by all. **LEGOScheme** written during finals week.

Summer, 1999
Learning with LEGO Robots, an intensive 3-week seminar using Mindstorms offered in the School of Education at IUB.

Fall, 1999
A110 TecTrac run again, doubles in size, enrolling 1.5 women for every man. Also, **WebWorms**, an independent study taken on by two non-CS undergraduates.

Spring, 2000
A290: Introduction to LEGO Robotics to be offered provisionally in the CS department at IUB.

The Fall 1999 semester is double the size of the Spring 1999 semester, and fully 2/3rds of the enrollment is comprised of self-selected women interested in working with the Mindstorms kits.

When given the option, one group of women in both the morning and afternoon labs chose to work as a women only team. We feel that there are great opportunities for research in gender roles and technology in the liberal arts setting using the Mindstorms kits as learning levers and motivators.

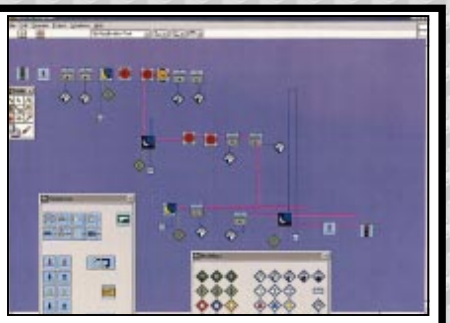
The 'Little LEGO 500' was neither approved nor endorsed by the LEGO Group, but it was a lot of fun for the students nevertheless. Many grad students in the CS department at IUB wondered why they didn't get to play with the LEGOs...

From the Abstract to the Concrete

We have enjoyed great success in using ROBOLAB from Tufts University/LEGO Dacta/National Instruments in conjunction with the LEGO Mindstorms Robotics Invention System. The Director-based programming environment that comes standard with the kit proves to be too limiting, and doesn't provide enough challenge to the students as we attempt to explore programming and building robots with the Mindstorms kit.

There are a number of powerful aspects to using the ROBOLAB environment. First, there is minimal syntax to get in the way of programming the RCX, making what has traditionally been a very mathematical field (programming) more accessible to all students with good thinking and problem solving skills, as opposed to just those with strong mathematical skills. Second, the programming environment is essentially a flowcharting tool, and any errors students make are on the level of their logic, as opposed to the syntactic level. Third, and perhaps the most compelling reason to use ROBOLAB, is that it provides a *shared visual representation of their program*, which can easily be discussed with students, and that visual representation of a *logical, abstract process is made concrete when they download and run the program on the RCX.*

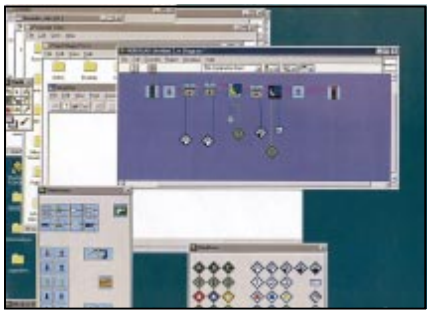
This shared visual environment provides students the opportunity to approach programming in a distinctly non-mathematical way by focusing on problem solving and critical thinking. Hours are no longer lost searching for some obscure syntax error. "But I only know how to program in LanguageX" is something that these students do not say, as we are teaching them how to think about programming and solve problems like a programmer, independent of the syntactic issues so commonly encountered by novices. Fortunately, there is still room for logical errors (and therefore learning), which are the kinds of errors we want novice programmers to be concentrating on.



Before and After: While working on a line follower (where the direction of curvature is known), one team of students dove straight in to building and programming. While it is wonderful that the environments we are working in (LEGO and ROBOLAB) support this behavior, planning ahead and thinking through the problem is still an important part of the process.

Above: The team of students attempted to muddle their way through the problem as best as they could, adding pieces in incrementally, downloading, testing, and repeating the cycle until they were stuck. Despite the fact that they are, essentially, programming in a flowchart, they still can make logical errors that will bring the entire team to a halt.

Below: The team was asked to go the whiteboard and work through the problem in plain English (pseudocode, if you will). When they had finished writing out three statements, they said "Oh! And we loop back here!" The problem was not nearly as complex as they had been making it, and proceeded to start over and write the simplified program shown below.



A110 TecTrac: Problem Solving and Teamwork

Background

A110: Introduction to Computing enrolls approximately 1,000 non-CS majors each semester at Indiana University. The curriculum provides opportunities for creativity and teamwork while focusing on mastery of basic word processing, spreadsheet, and HTML authoring skills.

The A110 TecTrac is a special lab sequence within the course. Students work together on a volunteer basis for three hours a week, completing a series of increasingly difficult challenges using technologies that might otherwise be inaccessible to them. The Spring 1999 semester saw the introduction of the LEGO Labs, utilizing the LEGO Mindstorms kits, enrolling 15 students. This semester, 32 students are enrolled in the A110 TecTrac.

What's it About?

These labs focus on teaching problem solving skills in team centered environments. The LEGO Labs are especially popular, due partially because the Mindstorms kit is LEGO, a popular childhood toy for many students, and because it represents an opportunity to explore computers in an environment very different from the classroom setting that the bulk of the A110 curriculum is set in. Our conditions for enrollment in the labs are quite simple: students must be willing to commit to a weekly 3 hour lab, be willing to have fun, and be willing to play with LEGO the way they were intended to be played with - on the floor!

The Students

The students who enroll in these laboratories tend to be very interested in learning and exploring the material at hand. They are looking for new challenges that are not available to them in a traditional course setting. Regardless of their reasons, they come from all areas of the university, with a very diverse set of interests and backgrounds.

The Labs

The LEGO Labs are built on a three-tiered model, where the first 3 weeks are spent in exploration of the kit and software (ROBOLAB by Tufts University/ LEGO Dacta/National Labs). Students are given straight-forward challenges, and given time and freedom to simply play with the kit. What is critical at this point is that the students achieve success early and often. In the second tier, we present a sequence of increasingly difficult challenges (both with respect to building and programming), where the students need to both apply knowledge gained previously, and develop new skills to achieve their goal. Thought problems leading into each lab are drawn from many fields of study to set the stage for the challenges they will face in attempting to build and program LEGO robots.

The last portion of each semester in the LEGO labs involves a culminating challenge, where all of the inter-team relationships that developed through the semester are tossed aside, as the students attempt to demonstrate their superiority and ingenuity in some challenge agreed upon by all. The Spring 1999 semester saw the "Little LEGO 500," where students built robots capable of navigating a simple oval raceway in each of two lanes, and then in a grand free-for-all. What this semester will bring is yet to be seen. There is already talk of challenges requiring robots that communicate with each other to achieve some goal, thus requiring inter-team cooperation. Whatever it turns out to be, it should be fun!

http://www.indiana.edu/~legobots/tectrac/index.html