



# The Cabrillo Robonauts

Harbor High School Outreach Program  
Cabrillo Community College  
Santa Cruz California  
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Reviewed By Michael Matera

The purpose the Cabrillo Robotics outreach program was to introduce high school students to teamwork, in a robotics and computer science focused environment, using the 5-week model given by NASA and UNM. We wanted to inspire students into considering a career in a STEM field, particularly computer science and engineering.

Though most of the people involved in last year's outreach program have graduated, this was Cabrillo's second Swarmathon outreach and we used what we learned last year to make this year's outreach a more informative and funner experience for both the high school students, as well as the Cabrillo team members

Initially, we wanted to do outreaches at two different schools, Watsonville High School and Harbor High School, but due to time constraints, as well as factors such as conflicting schedules we were only able to do outreach at one school.

During our first Swarmathon outreach in 2016, we worked with a man named Stephen Buchter, a teacher in charge of the robotics club at Watsonville High School. Although it was a great experience, we chose Harbor High School, as it had more students who were interested.

Earlier in the year I met a man named George Narlesky, a computer science and math teacher who was enthusiastic about starting an outreach with his school, as well as being flexible and understanding towards our time schedule as college students.



Our outreach program followed the 5 week High School competition module provided by NASA.

We were also given the opportunity to participate in an event called the Fourth Grade Experience, an all day long event held by the Santa Cruz County School District that brought all the fourth graders in Santa Cruz county together on the Cabrillo College campus for a day. The goal of the event is to inspire children to attend college and give them a glimpse into what their futures may hold.

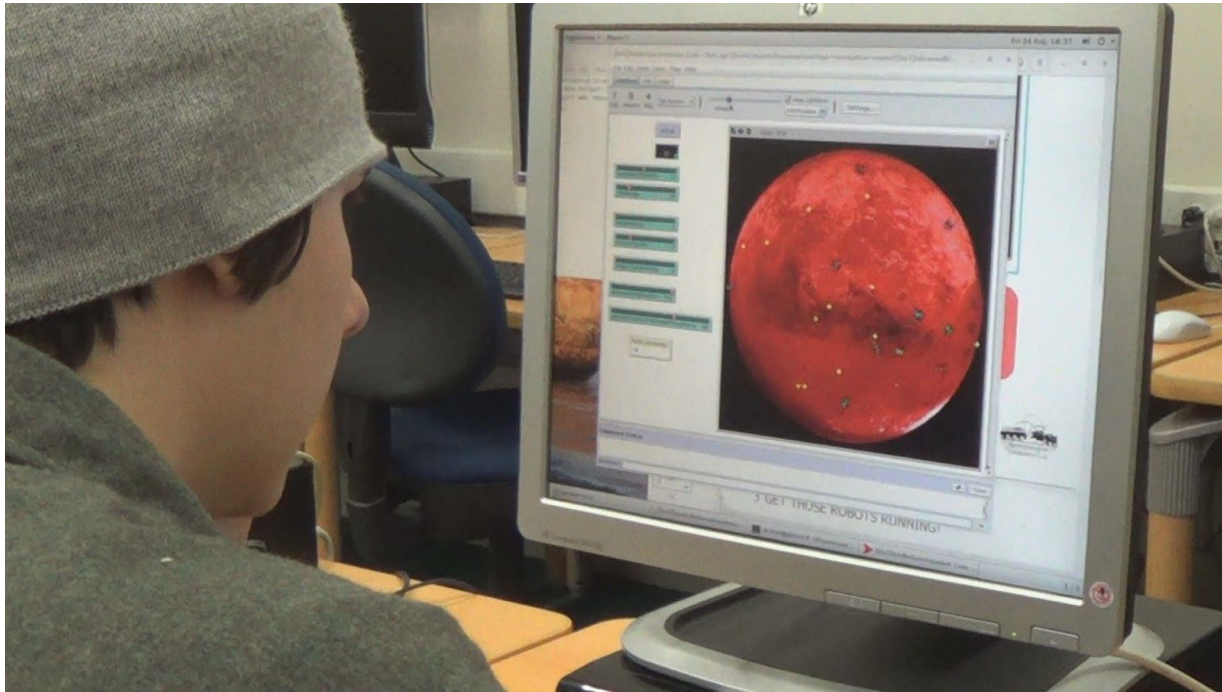
Though separate from our Outreach program, we used the Fourth Grade Experience as an opportunity to tell children about the Swarmathon, and hopefully inspire them to pursue a career in science and technology. The Swarmathon consists of three different themes that appealed to children: space, robots, and biomimicry. Over 600 4th grade children were able to watch our 15 minute presentations made throughout the day about the Swarmathon competition.

During our first Swarmathon module, we met the students at Harbor High School, and we gave them a brief introduction on the Swarmathon competition. Setting up the computers at the school took longer than we had expected; they were running a Debian-based distribution of Linux in their computer lab that had compatibility issues with the Java Development Kit that was required to run NetLogo. We were able to get some help from the High School's network admin and which allowed us to distribute NetLogo and all the project files needed onto all the computers.

All of the kids had previously taken a coding class, but none had ever used NetLogo before. This allowed us to skip most of the programming basics and move right into the first module of the Swarmathon outreach program. We gave the students a quick introduction to the coding and interface basics and setup in NetLogo and we were able to have the students work their way through the PDF instructions provided. We gave a quick introduction to the coding and interface setup in Netlogo and let the kids start working their way through the pdf of the instructions. Soon they had loaded the Mars map and spawned their rovers and rocks. They enjoyed the visual interaction from the project but had some difficulty getting used to the Netlogo syntax. Most of the students made it through this first module in our first meeting. Some of the students didn't quite finish and took the materials home to finish it up.

The second meeting period we decided to introduce the students to our rovers. We brought along Lovelace (one of our rovers) and our wifi network equipment, and we showed them how the rovers were able to communicate with each other. The kids had a number of questions, so we gave them demonstrations to answer. We performed these demonstrations by running the rover in autonomous and manual mode, and utilizing the visual interface. The students were really interested in the hardware that allowed the rovers to partake in such complex activities. At this time, our code base had a few major bugs in it, and the students found infinite enjoyment seeing our rover struggle to pick up blocks, get lost, and collide with obstacles. After this we went inside and gave an introduction to the second module, where we discussed the ideas of biomimicry and insect swarming behavior. This led to our topic of using pheromones to communicate. Once the students understood the underlying ideas, we started the module. Besides a few short hiccups with syntax, the coding went smoothly. Most of the students finished this module in time to do some tweaking and test out different settings.

During the third week, we discussed breadth first search and depth first search. We showed a few examples how these algorithms can be used to solve a maze. With a loose understanding of depth first search, the students went to work on the code. This module proved to be more difficult for the students to grasp than in previous sessions and took longer to complete. They were surprised to see how ineffective the algorithm was when there were few rocks left. We explained there are more effective programs, but they are often more complex in nature. They immediately were jumping to ideas of how to fix the current code and how to effectively change their behaviors.



For the fourth week, we tried something different. We rallied the Harbor High students in the library to play a game called Mama Squirrel, Baby Squirrel. In this game, players break off into teams of two, with each team choosing a Mama Squirrel and a Baby Squirrel. The goal is for the Mama Squirrels to lead their Baby Squirrels to the food, and then to bring the Baby Squirrels back home with the food. This time, the library's encyclopedia volumes were our food.

The Baby Squirrel is blindfolded and moves around on all fours, if it's safe to play that way. Communication is one-way, with Mama Squirrel giving basic movement instructions to Baby Squirrel in a coded language. Each team has its own code that teammates decide upon together beforehand. Mama Squirrel has to think like a remote vehicle operator, using the codewords to tell Baby Squirrel to rotate left and right, walk, and pick up and drop off food.

One example of coded language — Cabrillo Student-Robonaut Ben and Harbor High Math Teacher George came up with a system that would appeal to any squirrel mathematician. To turn (yaw), Mama Squirrel would call "Chatter," which is squirrel for "rotate," followed by an angle in units of  $\pi$  radians. For example — "Chatter: pi over three" translates to, "turn  $60^\circ$  to the left."



We played four rounds, and it was a complete success. The Harbor High students had a blast, and we all got an opportunity to think like rovers, navigating by way of remotely transmitted instructions. George said he'd like to try this again with his next group of programming students at Harbor. In future, a variation of this game could require Mama Squirrel to give sequences of instructions for Baby Squirrel to execute all at once.

With the deadline for our code coming up, our final week at Harbor High School was rather straight-forward compared to the other outreach modules. All other weeks of instruction were building up for this moment: the high school competition portion of the Swarmathon. Step by step, we went through the rules and instructions for the final module. There were some difficulties, but we were available to help the students when they were stuck.



Though the number of students varied week to week, our first outreach workshop had about ten students with five of our team members running the program. We averaged about eight students every week thereafter and four to five students who would run the modules.

After the last outreach module George Narlesky, the teacher from Harbor High School, mentioned that he was working on making our outreach program a class for their spring semester in the following year. Not only would this be good for our Swarmathon team to build a relationship with a specific school for the following years to come, it would effectively make it so that more students are able to participate in our program.



One of the challenges we will have to overcome in next year's competition is, as an afterschool program set during the middle of the semester, the students have prior obligations and responsibilities set upon them. We believe this is a big reason why both of our outreach programs hosted around ten students at any time.

Another challenge we had was keeping the students challenged and interested enough during the program. Although Netlogo is great for teaching students unfamiliar with programming and as an introduction, many of the students that participated in this year's outreach program were familiar and had prior experience with programming languages such as Java, Python, and C++.

This led to a couple of students either finishing their part of the modules ahead of everyone else, or becoming bored if they were unchallenged. The 'Baby Squirrel Mama Squirrel' game was an unplanned game that was a pretty big success; the students had a lot of fun, were involved in teamwork, and most importantly learned an important aspect in programming. Next year's outreach will have at least one or two similar games during each week.

## The Cabrillo Robonauts

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