Workshops with Little Equipment and One Computer - Tips and Hints
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Tips & Hints

Introduction:

Putting on a robotics workshop can be a great experience or . . . . . it can be a nightmare. During my time with Botball, I have had the opportunity to set up and run many different robotics workshops, some for Botball participants in both middle and high school and others for younger students just interested in science and robots. Some of the workshops were that 'great experience', but others failed to live up to expectations. What makes the difference?

For the past two years, I have designed and run robotics classes for 5th - 7th grade students participating in a summer camp program with the San Bernardino Unified School District. The main purpose of the class is to provide an introduction to robotics and basic programming. The students come from many different schools and spend several weeks participating in the camp program. The robotics class lasts for three days, 3 hours per day.

There are many factors that contribute to a good robotics workshop. In the ideal workshop every student would have the opportunity to design, build, and program a robot. But I don't live in that ideal world. The reality is that there are many obstacles to overcome and subsequent problems to solve in order to have a successful workshop. Here are some tips and hints that I have learned through my experience that may help you develop and put on great robotic workshops for your students even with limited equipment and few computers, or in my case, just one. Here are some basic areas that pose problems and simple solutions that are easily implemented.

Equipment:

None of the schools where my workshops were located have any robotics equipment. The San Bernardino Community College District (SBCCD) who sponsors the workshops, purchased Botball Introductory and Intermediate Kits for the classes. These are great kits which include the Link, motors and servos, sensors, the metal chassis, the camera, and enough LEGO to build a small demobot-like robot complete with interesting and useful effectors. Perfect for a workshop. Of course, we all know what the major problem is in respect to equipment - not enough. The first year for the program we had 10 kits with CBC2 controllers. This year we exchanged the CBCs for LINK controllers and added 3 more kits to the arsenal. Many of the schools have computer labs and technology but in the summer program due to logistics we do not have access to these.

Class Size:

Not having enough equipment isn't a problem if you have a small class size. With the equipment I had, the perfect class size would be about 20 - 24 students. That would give a ratio of one robot per two students. The students would have the opportunity to work together and still have plenty of individual tasks to accomplish. At several of the schools though there were 30+ students.

Scheduling:

The classes were 3 hours each, for 3 days. The first year we were able to schedule the classes one per day and the 3 days in succession at three different schools. This year, the schedule was 2 classes per day, one in the morning and one in the afternoon at five different school campuses. To complicate the matter, the 3 days were also not in succession; so one school might have a Day One of the class on Monday morning, Day Two the following Friday afternoon, and Day Three during the next week. Also the morning class was not as long as the afternoon class due to the lunch schedule and time needed to pack everything up and travel to the other site.

Programming:

To get the most out of an introduction to robotics class basic programming code should be included in the instruction, but with only one computer this is a difficult task. Many of the schools also had the white boards covered with paper and posters for the summer camp program so very little room was available to even write.

Logistics:

The biggest concern in this matter was the packing, unpacking, and transportation of the equipment. Having half-built robots at several different school sites was also problematic, as was how to handle any structures built by students since LEGO, motors, sensors, and servos were limited. We ended up deciding that students couldn’t build the robot from scratch.

Solutions: The key is simplicity, flexibility and organization.

I can’t stress enough the need to keep everything simple and to be as flexible as possible while endeavoring to keep the workshop interesting and beneficial to the students. Most of the problem areas, equipment, class size, scheduling, programming and logistics, are interconnected and finding solutions to one impacts the rest. Organization helps keep you sane, in control, and limits the amount of time you spend picking up LEGO from the floor; a task I do not enjoy.

Make the Most of What You Have

If you have limited equipment as I did, make the most of what you have. With the equipment available 13 robots could be constructed in my workshop. One tip would be to keep at least one robot unbuilt for extra parts if (or more realistically, *when*) something breaks. We had several motors go down, along with 2 sensors, and a servo. Not having replacement parts is quite difficult to handle in the middle of a class. The Botball Introductory Kits come with 2 motors and one servo and the Intermediate Kits have 2 motors and 2 servos.

Use a simple robot design.

The demobot basic robot works well for this kind of workshop. Because we needed to move from class to class and reuse the same equipment, I decided to pre-build the basic robot. Attaching the wheels to motors and building the skid are both time consuming projects so we came with them already in place. But the students weren't left out of the building process altogether. Their tasks included designing and building arms, claws, and sensors holders. Another advantage to this was the ability for every student to build an arm or claw and interchange them with their partner's on the same robot. The LEGO that came with the Botball kits was quite sufficient for this. Just remember to keep the project simple. It worked quite well and gave everyone the opportunity to experience the design process.

Plan Activities for a Single Class Period

Each of the activities that we did could be accomplished in a single class lesson. In each class the students designed and built a particular piece, used it to accomplish their task, and then disassembled it and sorted all the pieces back into respective containers. Here again simplicity is the key. Plan each day of the class as a separate activity that builds upon the instruction from the preceding class. Have several activities using the constructed piece so when the fast students finish there is something else to challenge them Here are the activities for each of our 3 days.

Day One: Introduction to robots

Use different robotic toys to discuss questions like "What is a robot?" "What makes a robot autonomous?" "How are effectors and sensors used in robotics?"

I bring a group of robotic toys to show the kids. (Picture 8) They include a snake, a singing hat, wind up vibrating creatures, Hex Bugs, humanoid robots, omniwheels, Wally from the movie, a panda bear, and Elmo. The favorite one is by far the Elmo doll which sings, talks, and moves. But it is most popular because we have two of them just alike except that one has been 'skinned' as the kids like to call it. You can see all of the inside working parts. We also have 'skinned' versions of the snake and panda bear. We spend about an hour discussing and playing with the robots. We also demonstrate a Create and its ability to sense the edge of the table. (Picture 9)

The rest of the time is devoted to covering basic building skills. Many of the students have never used LEGO or at least not Technic LEGO. Activities range from building a tower that cannot be knocked over by blowing on it to designing a long LEGO piece that does not move and won't break when driven against the wall. The intent of these activities is to demonstrate how to build with LEGO pieces and teach students how to figure out a solution to a problem. I usually don't give many hints but allow sharing ideas with the others. I also cover the appropriate use of the screwdrivers (tools not weapons) and how to attach nuts and bolts (righty tighty and lefty loosey). You would be surprised how many middle school students can't use a screwdriver.

Day Two - Design and Build

The activities on day two consist of building an arm and attaching it to the servo which they mount in the front of the robot. (Picture 2) To make it interesting the activities are planned around several game scenarios. The first is called Kick the Ball. The task is to build an arm at least 1 foot long and swing it to hit a ball as far as possible. I used a foot measurement because the schools conveniently had 12 inch tiles on the floor for measuring. The arm is attached to the servo with the servo horn which is screwed onto a short LEGO liftarm. These are already prepared for the students because in previous workshops keeping track of the small screws proved quite a monumental task. We also do not secure the horn onto the servo with the screw. This allows easy removal and positioning. This is important because they will all be using a program already written with positions for the servos. Following instructions is also highlighted in this task because they need the servo to be aligned correctly for the set_servo_position commands to work properly.

After building their arms, we spend time testing them out by moving the servo with the sensor screen on the LINK. Many students will immediately see the need to redesign and build the arm again. We have several size balls to hit, the small foam balls and large soft balls from the Botball kits, so each student has to plan their arm accordingly. I also set small ping pong balls on top of short pvc pipes and challenge the students to knock it off without knocking over the pvc which is quite a difficult task. How to move the motors was also considered here and the students practiced moving the robots forward, backward, left, and right with the motors and sensor screen on the LINK. In preparation for going over the programming for this activity we discussed the numbers that they were using to move the robot and operate the servo.

After building and testing we go over the program highlighting each line and discussing the logic behind the code. I usually include a short part on binary and how computers work. Then the students have time to run their robots and try out their designs. Be sure to include the instruction that the only ones permitted to throw the balls are robots, not humans. Once successful in this activity the students were allowed to set their arms and joust with another team. This activity was very popular. Give yourself time to dismantle the attachments and the metal servo holders (which we put in the white LINK charger boxes from the kits) and sort the LEGO back into organized bins. (Small cardboard boxes which cost around 50 cents at Walmart work great.) We used packing tape on the lids and seams of all the boxes to give them strength and keep the small pieces from escaping. Small containers of some sort for each team to keep LEGO in is very helpful. (Picture 4) Some classes could clean it all up in 10 minutes and others needed more time.

Day Three - Sensors

The game scenario for this day was 'Grab Botguy.' The students built a claw on the front of their robot designed to grab Botguy and return him to their team. (Picture 5) The claw had one moving finger operated with one servo and a stationary side built onto the chassis. The long sensor was installed in an appropriate place to sense Botguy and close the claw. They had to design the sensor holder and figure out how to build the claw to effectively grab Botguy. (Picture 7) We showed the students how to preset the servo to the correct position using the LINK screen and then attach the finger piece. This allowed the program to operate correctly. Students tested their claws and were happy with successful results. (Picture 1) Then we reviewed the program code.

Simple Program Code Using a Sensor

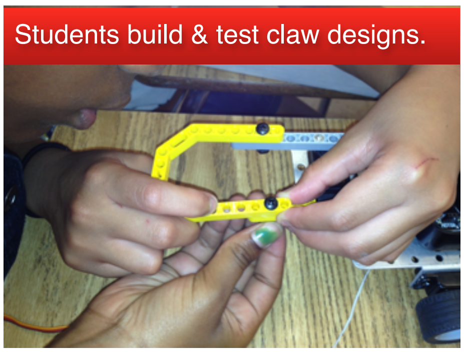
```
int main()
{
        enable_servos();
        set_servo_position(0,700); // open claw
        msleep(100);
        printf("Driving Forward\n");
        while(digital(15) == 0) //forward til sensor is activated
        {
                motor(0,100);
                motor(2,100);
        }
        ao();
        set_servo_position(0,2000); //close claw to grab Botguy
        msleep(2000);
        printf("Driving back\n");
        motor(0,-100);
        motor(2,-100);
        msleep(5000);
        ao();
        printf("All Done\n");
        return 0;
}
```

Once their robot could successfully get Botguy using the program they were allowed to play with other teams to see which robot could win by getting there first and bringing Botguy back to their team. (Picture 6) This was a really fun activity for the students and they were quite excited to play.

The biggest problem running the programs was the LINK controllers losing the code. Matthew at KIPR was very helpful with this matter. We never exactly figured out what was going on but came up with solutions to handle the issue. We preloaded the program onto the link and also had copies on flash drives to reinstall when necessary. The other big problem with programming was the students not aligning the servos correctly so the set_servo_position commands did not move the claw correctly. I used my computer to change the numbers in the set_servo_position commands and the motor commands to move the robots particular distances. Matthew suggested using USB keyboards and letting the students input parameters for the commands. We didn't have them for these workshops, but next time I will try it out letting the students do more programming for themselves.

At the end of Day Three we had a discussion on what they enjoyed the most, what they feel they learned, and robotics in general. The feed back was very positive and even with the limited equipment and difficult scheduling all the students seemed to enjoy the class very much. I will admit that at the end of it all, I was very tired but satisfied that we had succeeded in giving the students a great introduction to robotics.
So give your own robotic workshop and let me know how it went.

(Picture 1)



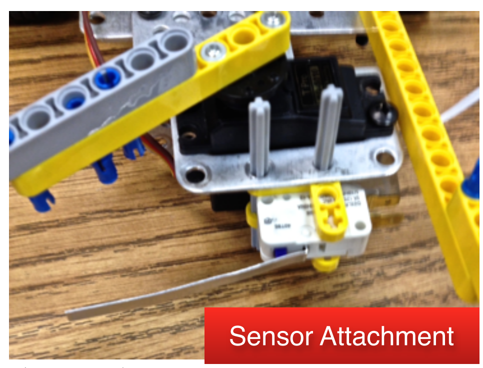
(Picture 2)

(Picture 3)

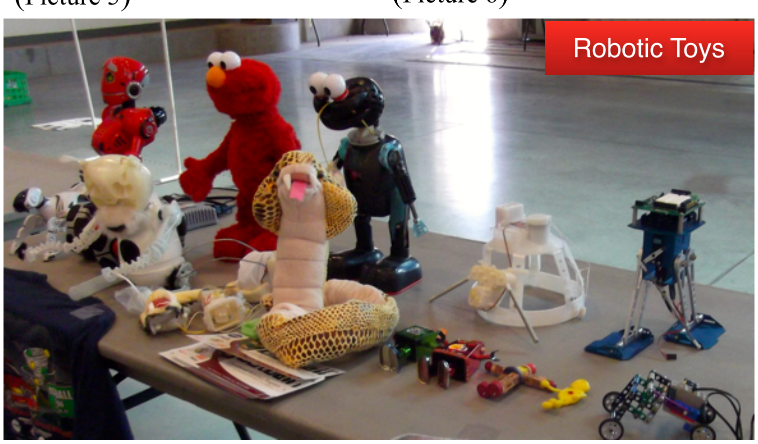
(Picture 4)

(Picture 5)

(Picture 6)



(Picture 7)



(Picture 8)

(Picture 9)