

High School Robotics Course: The #1 Student View  
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### **High School Robotics Course: The #1 Student View**

This year, at Edwardsville High School (EHS), located in Edwardsville Illinois, students were given the opportunity to participate in an Introduction to Robotics class. Nineteen students signed up for this class, including me, and we have been able to learn about and create our own robots. Through this class, I have gained much experience and a new appreciation of team work and documentation. My classmates have also gained much by taking this class. However, there are a few things in this class that I would change.

My latest experience with robotics has come from the Introduction to Robotics class. This has been my favorite class as a high school senior. Not only because I love robots and I have access to advanced equipment, but because I also love to help other students learn about robots. The Introduction to Robotics course was taught by Mr. Hagin, who is also the Computer Team sponsor and I am a Teacher's Assistant for him in the Introduction to Robotics class.

At the beginning of the course, my classmates knew very little of what a robot is and how to create one. For this reason the first week of class was devoted to defining what makes up a robot. This is also when the class was divided into seven groups of two. The class was also lectured as to why it is important to be a team when creating a robot. Lego supplies and electronic parts were given out the second week of class. To get the class building, they were supplied with all the parts necessary to create the demobot from the 2007 Botball workshop. The Botball 2007 demobot is a good choice for newcomers to the robotic world. The demobot is not very structurally sound, which encouraged my classmates to modify or even rebuild their own bots. Also, the demobot introduced the students to a way of mounting the black box motors using Lego pieces. The demobot is also a good choice because it can be built in phases. One phase could be the chassis of the demobot. Another could be the addition of the arm to the demobot. Yet another phase is the addition of the color camera to the demobot. One thing that the entire class noticed is that the demobot is structurally unstable. For this reason, some teams changed the design of the demobot to be more stable. Through this process, the class learned about structural support and how to make a robot stable.

After each group had made a suitable bot, we were ready to begin programming. This was the most difficult part of the class for about half the students. A programming class was not a prerequisite for the Intro. to Robotics class, so about half the class did not have any experience programming anything before this class. The students with programming experience were grouped with students without programming experience in an attempt to spread the knowledge around. The hardest thing about programming is learning the logic of the program. When I say logic, I really mean the ability for someone to know or visualize what the program is going to do. I noticed that many teams said that their bot is "messaging up". More often than not, this was a simple logic error in their program, such as a sleep function in the wrong place.

Another difficult aspect of the programming section of the course is the memorization and implementation of the programming language's functions and syntax. In Intro. to Robotics we used the programming language Interactive C, or just IC. Many students could not create their own program because they did not know any of the functions they would have to use. Not only that, but most students did not know the syntax of the IC language, such as needing a semi-

colon after every line. To solve this problem the TAs of the class made template programs for the class to use. These programs were sometimes incomplete or only accomplished the minimum requirements to complete the tasks. The teams would then have to review and test the program to find what they needed to change. For example, myself, the other TA, or Mr. Hagin would type up a program that would complete the task. We would then erase a few key line such as the `enable_servo` command and some motor commands and tell the students that something is missing. The students then attempted to fix the problem.

I believe the best way to teach this course is to give template programs that are not complete or that fall just under the minimum requirements so the students must complete or fix the program to complete the task. This ensures that the student knows how to read a program and understand it to the point where the student can change or add on to the program to make it work. I also think that giving live demos of bots that complete the task as well as an explanation of how the robot works is a good method of teaching this class. Slide show excerpts taken from the 2007 Botball workshop were also an excellent tool and resource when lecturing on how sensors and motors are implemented in the program and on the robot.

The Introduction to Robotics class had several different sections spread throughout the course. The first section was on what defines a robot. The second section of this class was to introduce movement functions and basic structure in robots. During the second section of this class, the first project was assigned. The first project was to start your robot behind a black line, move forward past the black line and then move back over the black line. Through this project the class learned the basics of programming syntax and logic flow. The third section of the course was light and tophat sensing. Obviously, the class was taught about light sensors, tophat sensors (IR digital sensors) and their applications. The project for this section was to add at least one light sensor to the demobot and program it to follow a black line. The fourth section was about systems engineering. This is a very valuable section in engineering because it helps to categorize and prioritize goals that the robot needs to obtain. This section also serves to better understand the functions the robot needs to have thus what one needs to tell the robot to do. The fifth section was about Back-EMF motor commands. The sixth section was on color camera commands. The seventh section was the final exam, one side of this year's Botball game board.

Other than the projects spread throughout the semester, we had no real gage on what the students learned. The only other source of information regarding the students level of understanding was the one quiz we had towards the beginning of the year. This quiz was a code snippet taken from a line following program using two light sensors. To get an A, you had to describe what the robot would do line by line. To get a good understanding of the level the students were at, I think more quizzes like these should have been handed out. I also think that the students should hand in their programs and that they should be graded on the comments made by the programmer.

The most useful topics covered in this class were the sensors, systems engineering and the Back-EMF commands. This is because using these three sections, the students can accomplish any one of the tasks assigned to them. There could have been other sections as well, but there is not enough time in a semester to get to all the different topics of robotics. One of the missed sections was encoding. The reason why encoding was not included was because the black box motors and servos have built in encoders. However, every bot does not necessarily use black box motors and servos, which means that there is no way for students to figure how long a motor must turn or how far a bot has gone other than by testing multiple times. Another skipped section which could have been helpful is separate processes. Using separate processes

can be very complicated and confusing, but it can also be very powerful and helpful. It has various applications such as running two bots with one XBC or even controlling two parts of one bot differently.

One of the motor command sections could be substituted for another section. I think that the basic motor commands are not very valuable as the Back-EMF commands, but they are easier to wrap your head around. Having two ways to do the same thing and teaching both ways is inefficient. We could be spending that time learning how to encode or run separate processes.

I believe that the XBC and IC are the best choices for teaching robotics at a high school level. The XBC is a very powerful processor and it has many built in features that can be used easily. One feature is the GBA screen. By using this screen, a student can interact with the XBC very quickly and effectively. Using an XBC also embraces out of the box thinking because the motors do not have an easy way to attach the motors and sensors. The only bad part about the XBC is that it is relatively expensive compared to less powerful microprocessors, and that it is rather fragile and delicate. IC is a good choice when teaching the programming aspect because of its flexibility, built in manual and it uses standard programming syntax which gets students ready for the real world of programming. The down side of IC is that it does not have built in assignments and checkpoints that other software, such as Lego Mindstorms, does. Another useful tool that we used in class was the C-based educator and the Robotics Educator. These educational programs can be found online and they include detailed description of IC syntax, commands and sensors.

Overall, I think this course was at too high of a difficulty level. I think that even though my classmates accomplished most of their goals and got relatively far in terms of robotics, they could have gotten more if this was either a year long class, or covered less material. I also think that there should be a full fledge Robotics class since this is Intro. to Robotics. To make the class easier, I think that the color camera and Back-EMF could be dropped from Intro. to Robotics and placed into the higher level Robotics course. Separate processes and encoding could also be put into this class, as well as arrays.

Introduction to Robotics is a very good class. It has taught me the importance of team work and documentation and it has taught my fellow classmates a lot in the field of robotic engineering. There were a few problems with this class. I felt many students lacked the programming aspect of the course and that this could be improved by assigning more programming quizzes throughout the semester. I also think that this class was a high level course. In following classes, I suggest lowering the difficulty of this class by dropping a few of the subjects. I also believe that there should be a Robotics class after Introduction to Robotics. This would allow more growth and learning about robotics at the high school level.