Travis Burroughs' Robotics Guide for Teachers

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There are 3 categories of robots commonly found in the educational robotics market;

- robots designed to teach coding
- robots designed to teaching coding and mechatronic engineering
- robots designed to teach coding and electronics engineering

Deciding what robotics platform works best for your school's particular goals can be a challenging task. Educators need to consider many variables when making decisions - student age and ability, depth of robotic education, future educational paths within the school, long term digital technology plan and teacher workload. In this article we will break down some of the different educational robots and explain where and how they can fit into a school's curriculum

Code only robots

Teaching students how to code is growing in popularity around the world and it is easy to see why. Manual jobs are slowly being lost to automated processes and our education systems are trying to keep up with the changes. Teaching coding is a great way to make students understand how those automated processes work. The larger benefit of learning to code is teaching students logical computational thinking. Computational thinking skills help students derive logical algorithms that can help them in their day to day life as well as help them understand how technology works. If a school is seeking a robotics solution to teach STEM these may not be the robots you are looking for. They do a great job teaching the technology component and touch on maths, but they are far from a complete STEM platform. Code-only robots are a great addition to already jammed packed curriculums and they allow students to apply their software programming knowledge and skills to a piece of independent hardware.

Sphero

Year Level: 3 - 7
Class Set: 12 robots
Base Cost: $150
Teaching Hours: 6 - 10

Sphero is a very simple and durable robot that is a great addition to primary and early secondary classrooms. It can be programmed using a scratch like or C interface. The robots are limited to simple behaviours and have no sensing capability past impact. The durability of these robots allow students to learn computational thinking in some unique and engaging ways. Students can build jumps and obstacle courses that they can program the robots to navigate. During the last Olympics my school had year 5 students design Olympic games and then programed the Spheros to compete. These robots are very suitable if you are looking at a 4 - 8 hour robotics unit or for something that can be easily moved between classes. The robots cost $150 and there are many companies that will lease class sets out on a weekly bases.

M-bot

Year Level: 3 - 7
Class Set: 24 robots
Base Cost: $140
Teaching Hours: 10 - 20

The M-bot is a great little robot with a wide range of sensors and it can be programmed using both a logical block based application and in C-code using the Arudino IDE. The M-Bot is by far the most versatile code-only robot on this list. The lowest priced M-bot costs $140 AUD.

The M-bot is a great coding platform that can be used across years 4-10 depending on the curriculum areas that need to be covered. Despite the versatility of the M-bot it is not suitable for a full semester robotics program, but it would make an excellent addition to a digital technologies course.

Bee-bot/blue-bot

Year Level: 1 - 4
Class Set: 12 robots
Base Cost: $130
Teaching Hours: 4 - 8

Excellent resources for early primary students. Students can program these robots without any computer interface just by pushing buttons on the back of the robot. Students learn basic computational skills without the need to understand a defined programming structure. The advanced Blue-bot version allows students to use an i-os device or an Android device to program basic movements. The robots are tough and hold up to the abuse of students.

The simplicity of their programming limits the amount of time that can be devoted. For the $130 AUD price tag 1 or 2 of them are a good addition to a primary makerspace or classroom as an early introduction to robotics.

Edison V2

Year Level: 5 - 10
Class Set: 24 robots
Base Cost: $ 60
Teaching Hours: 10 - 20

This costs $60 and is an excellent robot for introducing students to sensors and programing. The robot has a verity of different built in sensors that allow the robot to detect sound, light, IR signals and lines. Students can use a flowchart based programming application similar to Lego-EV3's environment to program the robot. Similar to the Lego EV3 programming environment the Edison teaches students computational thinking but not proper program structure.

If you are interested in working in a proper programming language there are some unofficial applications that allow the robot to be programmed with python. This robot is ideal for teaching students computational thinking in years 4 – 6, although the Edison is still a relatively new platform.

Dash and Dot

Year Level: 3 - 7
Class Set: 12 robots
Base Cost: $300
Teaching Hours: 6 - 10

Dash and Dot robots are another excellent product to introduce to young primary students. The Dash version has distance sensing capability as well as a built in accelerometer that can be used to sense its motion and surroundings. The Dot version only utilizes an accelerometer for collecting data and is very similar to a Sphero in design. Both of these robots can be driven using an i-pad or programmed using a scratch like interface. The build quality of both the Dash and the Dot robots is okay, but nowhere near as indestructible as the sphero. They cost around $300 with an additional $100 AUD for the curriculum.

Coding and Mechatronic Engineering

Mechatronics is the combination of multiple engineering principles to create truly integrated systems. The robots that fall under this category are great solutions for teaching STEM. With a well-rounded curriculum they incorporate principles of physics, a wide range of technology, engineering principles and practices, and applied mathematics. All of these platforms also have extra-curricular competitions that can help students with engagement and taking control of their own learning.

Lego EV3

Year Level: 4 - 8
Class Set: 12 robots
Base Cost: $500
Teaching Hours: 20 - 40

The Lego platform is a very high quality platform targeted at primary and lower secondary students. It has the ability to utilize information form up to 4 sensors to control up to 4 motors in various configurations. The basic kit comes with several different sensors, 2 “strong” motors and 1 “regular” motor, as well as a standard assortment of Lego pieces. Lego provides instructions for several robots, but most do require an expansion kit. The software used by Lego is a preparatory flow chart based program. It teaches students about computational thinking. Students who have worked with Scratch or any other blocked based programming platforms may be unfamiliar with Lego’s logic and programing flow, but thankfully if you have Lego EV3 and are struggling with its programming environment, RoboMatter has released a version of their Robot-C programming application that works with the EV3. Robot-C for Lego makes the platform a lot more usable and provides a logic that students can link to Scratch or any other C based language.

The robot can be controlled manually over Bluetooth for student controlled operations. Lego as well as many educators have put together some really great curriculums for teaching with EV3. In Australia students can use the Lego EV3 platform to compete in the First Robotics Competition or RoboCup.

VEX IQ & EDR

Year Level: (IQ 5 - 8) (EDR 7-Uni)
Class Set: 6 robots
Base Cost: (IQ $550) (EDR $850)
Teaching Hours: 200+

The VEX IQ robotics kits are targeted at students in years 5 - 8. The platform is very robust and has a lot of student design capability. The basic kit comes with a large variety of sensors, similar to those that come with the Lego EV3 as well as 4 high strength motor. The robot brain has 12 open IO ports which allow it to use data from up to 12 sources or to drive up to 12 motors. The kit also comes with a large verity of plastic parts, gears, pulleys and wheels that can be used for robotic design. The VEX IQ platform does not suffer from the same design limitations that the EV3 robots have, making it an ideal platform for teaching robotic design. The VEX IQ also comes with a fully programmable remote control that students can use to drive their robot when it is not in autonomous mode. There is also a Bluetooth module that can be added to allow programming and controlling from an I-Pad application.

The VEX IQ robots are available in Australia for $550 AUD with no extra costs for software or curriculum. VEX EDR is the only robotics platform targeted at students from year 7 to University in Australia. The robots are very similar to their IQ counterparts, but are bigger and made from metal and industrial plastics. The EDR system also allows for cutting and manipulation of components. There are a few options as far as kit go, the basic dual control starter kit comes with a variety of sensors building materials and 4 motors for $900 AUD. The Super kit comes with an array of sensors, way more building materials and 7 motors for $1800 AUD. VEX also has a large number of extra parts and electronics that can be purchased. Like the IQ the VEX EDR also comes with a programmable remote control that uses an independent Wi-Fi network to communicate with the robot. For added functionality a second remote can be tethered to the first one, giving the opportunity for a second driver.

There 5 different means of programming the VEX IQ robots and 4 for the EDR. Firstly the Scratch like ModKit allows students to drag and drop coding blocks to program the robot. ModKit can then be used to program the robot via Bluetooth or a micro USB tether. ModKit does not work with the more complicated VEX EDR platform. Robot-C Graphical is another drag and drop based programming environment that allows students to produce graphical C-codes for robots. RoboMater as produced some amazing curriculum that goes along with the Robot-C Graphical interface. Robot-C's traditional programming application allows the program to write code in proper C-code. Easy-C is another flowchart based programming application that is very quick for students to use. Easy-C has a $100 price tag associated with it and like all flowchart based programming environments it gives up educational value for ease of use. The last programming method is RoboMesh, a Python based programming application that really allows students to produce unique coding solutions.

VEX IQ and EDR have a unique competition structure with multiple events throughout the year. The VEX tournaments allow students to drive robots and test autonomous programming. During the year each event plays the same game, therefore students gain a lot of formative feed at based on their achievements. Students take that feedback and use it to re-start the robot design process as they prepare for the next competition.

Contact DATTA Vic at pl@datta.vic.edu.au for information on VEX teacher professional learning opportunities, as well as for tournament dates and registrations.

Coding and Electrical Engineering

This category focuses on robots that are ideal for teaching STEM with a focus on electronics engineering. Unlike the code-only category, there is no limit on what can be done with Electrical Engineering robots. The limitations that most teachers will face is time and student engagement. Robots can be a simple as a 2 motors and simple sensors to as complex as a fully working Ironman suit.

Arduino

Year Level: 7 - 12
Class Set: 24 robots
Base Cost: $3 - $60
Teaching Hours: 100+

I have been working with Arduino and running Arduino professional development since 2008. I love the platform and it comes in many forms depending on the needs of your students. I have had students use the small Arduino Digispark to build simple light displays all the way up to using Arduino Megas to drive 3D printers and Arduino Duo to run large competitive robots. The robots are programmed using the Arduino IDE, which is pretty much just a C-Code compiler. There are some scratch based programming environments in development that bring Arduino down to a primary level.

There is a massive online community that is centred around Arduino, and as a result students will be able to find resources and support almost instantly from around the world.

There are also many Arduino enthusiasts out there who have put together very diverse and engaging curriculums. If you have not had a chance to play with an Arduino, I would suggest purchasing one and seeing if you can make it blink. The most common board the official Arduino Uno is available for around $30 and replicas can be purchased from e-bay or Ali-express for less than $3.

There are 2 downfalls that you will find with the Arduino. The first is driver issues; there always seems to be issues getting drivers to work on over restricted school computers. This has improved in recent years, but I still have to get the IT department to sit with me every time I bring a new Arduino product into the school. The second issue is student engagement; some students do find the wiring and programming the Arduino difficult. This puts a little more pressure on the teacher to keep students engaged and feeling confident in their work.

Arduino Kits

Year Level: 7 - 10
Class Set: 24 robots
Base Cost: $30 - $300
Teaching Hours: 100+

There are tons of Arduino kits on the market and they all have different levels of merit. The biggest benefit of the Arduino platform is that it allows students to use design thinking to produce interesting and unique projects. Using kits takes that design thinking capability away from projects, but they do give educators an easy introduction in how to teach with the platform. If you are new to Arduino it is worth getting a cheap kit to experiment with before diving into Arduino.

Check out http://www.datta.vic.edu.au/content/suppliers-who-support-datta-vic for a list of suppliers. Check out our annual conference programs for some great, hands-on sessions for teachers on working with Arduino.

Build your own Bot (Arduino)

Year Level: 7 - 10
Class Set: 24 robots
Base Cost: $25
Teaching Hours: 100+

I have spent many years working with students building any number of Arduino robots, as a result I have been able to establish which commonly sourced parts work best. I have developed a "kit" robot to teach coding and electronics to my IT and Systems Engineering students. The benefit of this robot is that it shows students how a wide range of Arduino compatible sensors and parts work. Once students have mastered the simple robot they can design and build their own robots based off of the components on the "kit" robot. If students want to add additional features to their creations there are a wide range of other sensors in the classroom that they can utilize. Students can also use low cost 3D printers to build the mechanical components of their robots. My build instructions, .stl files and curriculum is all available for free on my blog. (http://theprojectinventory.blogspot.com.au/2017/07/cheap-arduino-robot-with-everything-you.html)

Picaxe

Year Level: 7 - 10
Class Set: 24 robots
Base Cost: $20
Teaching Hours: 100+

Picaxe is another microcontroller like the Arduino that is commonly used in schools around Australia. Capability-wise it works in the same way with kits or build your own options. From a price point the Picaxe is slightly cheaper, allowing for more take home robotics projects.

Contact DATTA Vic at pl@datta.vic.edu.au for information on Picaxe teacher professional learning opportunities. We run 2 all-day workshops, suitable for all abilities each year, as well as hands-on sessions on Picaxe at our annual conferences

Raspberry Pi

Year Level: 7 - 12
Class Set: 24 robots
Base Cost: $100
Teaching Hours: 100+

Raspberry Pi is a standalone computer that can be embedded in any number of projects. As far as robotics goes it can be used to build simple stand-alone robots or in can be used in conjunction with an Arduino to build incredibly complicated systems. From a coding perspective anything is possible, the pie can run simple scratch programs and complicated Python programs all at the same time. There is a massive online community similar to the Arduino that teachers and students can go to for support and resources. If you are looking at just getting started with robotics, Raspberry Pi is not your best option. The learning curve is very steep and unless you have a coding background it would be a struggle to pick up robotics and Raspberry Pi skills all at once. For me Incorporating Raspberry Pi into my robotics program has been a long process, and it is still only utilized when a student's project could really benefit by its computing power.