VEX IQ & LEGO EV3 Platform Comparison

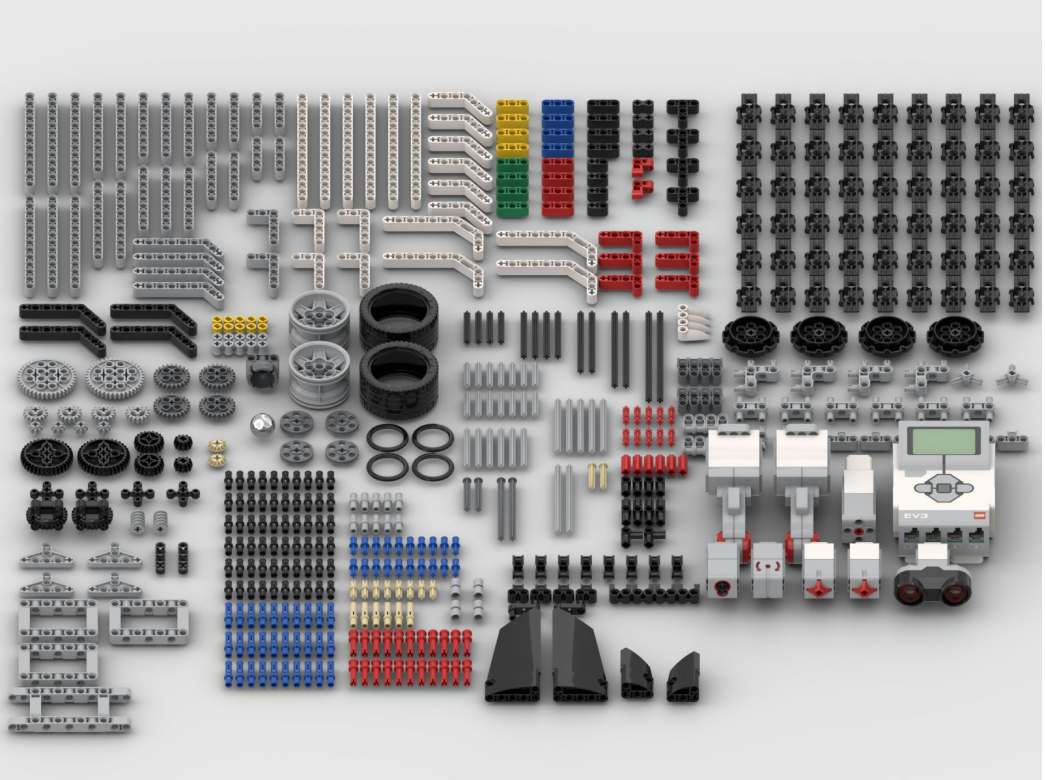
In this section, we aim to provide a general comparison of the VEX IQ and LEGO EV3 platforms, with some specific discussion of why we chose the VEX IQ platform.

Both platforms are designed with similar goals in mind; namely, to be accessible to primary students while still supporting advanced functionality and remaining usable as an introductory robotics platform at the secondary and college levels. This approach lends both platforms to use at the Pico level because they allow participants new to robotics to get off the ground quickly, while leaving plenty of headroom for expansion and advanced functionality.

However, the two platforms take different paths to achieving this goal, and as such there are a number of noteworthy distinctions to be made.

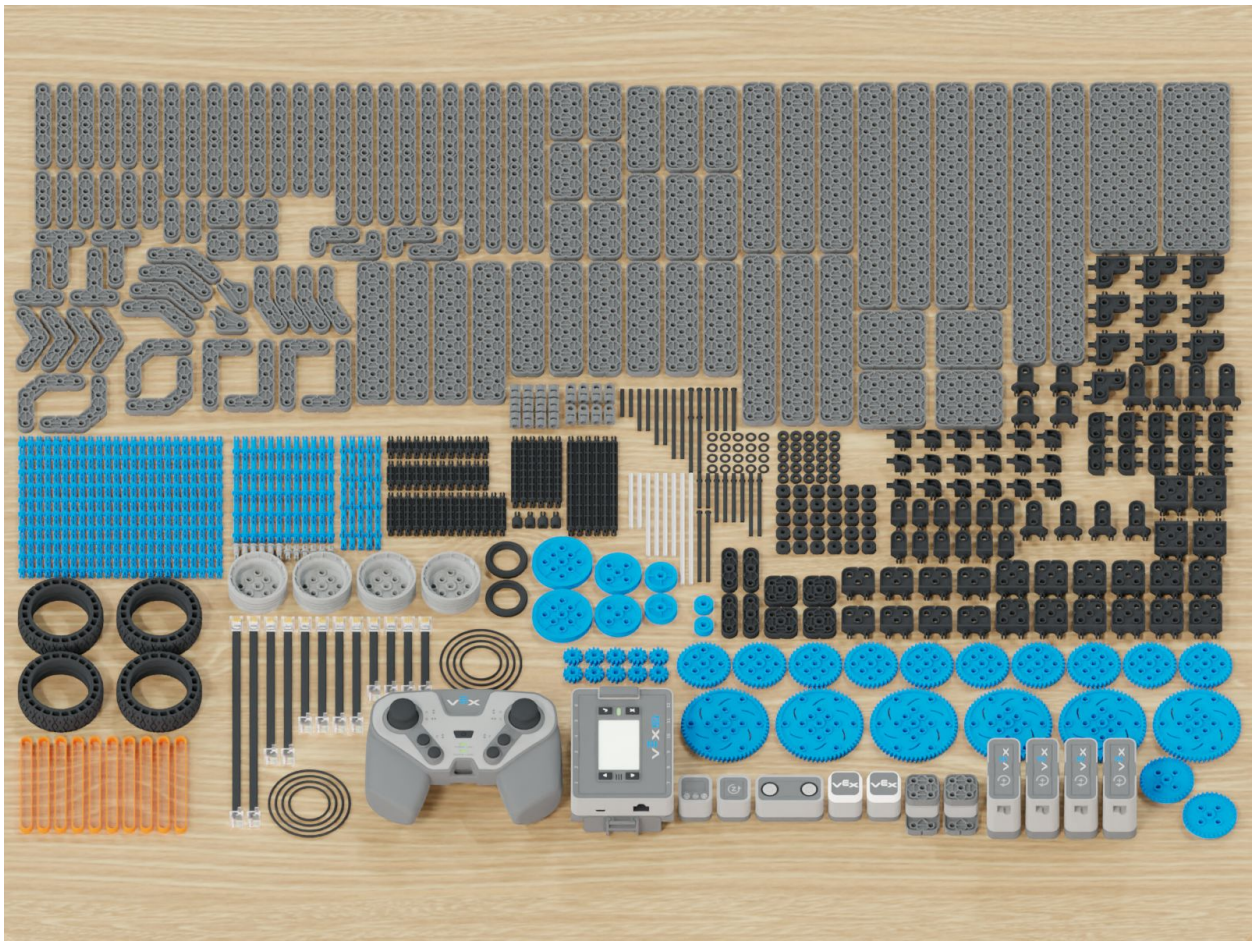
Structural Components

The LEGO® Technic building system is built around the concept of pins and beams, where beams are long thin structural pieces with holes (1xN) into which the pins snap. By attaching many of these beams together using the pins, a larger structure can be made.



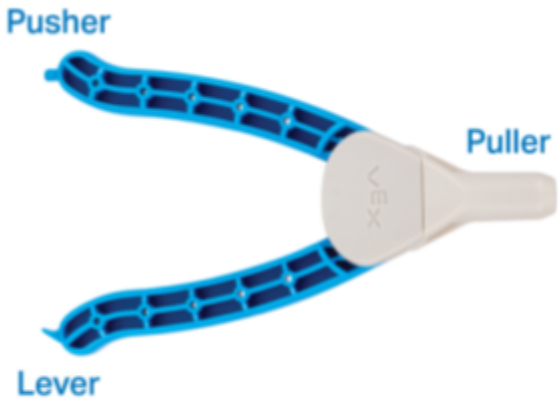
EV3 Core Set (45544)

The VEX IQ system also uses pins and beams. However, the primary structural components of the VEX IQ system are 2xN beams, which allow for much more structure to be built with relatively fewer parts. This can be desirable if you want to build a robot larger than a few inches. The IQ pins also form a much stronger connection than LEGO pins, which can make them a bit more difficult to work with but also results in a stronger structure. Further, the VEX IQ system contains many more corner/joining pieces than LEGO® Technic, making it much easier to build sturdy joints in a wide variety of shapes and geometries.



VEX IQ Super Kit (228-2500)

When building with the VEX IQ system, it is useful to have a tool for removing pins. VEX sells such a tool in their online store at https://www.vexrobotics.com/pin-tool.html (currently $8) but a similar tool can be 3D printed at low cost from a model available here on thingiverse.



VEX IQ Pin Tool (228-4035)

3D-Printed Pin Puller
(image by by goeckerd, CC BY-NC 4.0)

Control Electronics & Programming

The processing power available to the VEX IQ brain falls far short of the Mindstorms EV3 brain. On paper this difference may appear to give the EV3 an advantage, but the IQ brain manages to be more responsive by reducing software overhead. Most notably, the IQ brain turns on in just a few moments whereas the EV3 brain takes a full 30 seconds to power on. The user interface on the IQ brain is also more responsive and, in normal use, the specs are sufficient to match the practical performance of the EV3.

	Mindstorms EV3	**VEX IQ**
Processor	TI Sitara AM1808 (ARM926EJ-S core) @300 MHz	Texas Instruments Tiva ARM Cortex-M4 Processor
Memory	64 MB RAM	32 KB RAM
Storage	16 MB Flash + microSDHC Slot	256 KB Flash
I/O Ports	4x sensor ports 4x motor ports 1x USB A (2.0) 1x MiniUSB (attach to PC) 1x MicroSD	12x combined sensor/motor ports 1x MicroUSB (attach to PC) 1x RJ45 (attach to wired controller)

Remote Operation	Over Bluetooth through a limited first party app or various third party apps. Limited customization.	A reprogrammable gamepad-style wireless controller is included with the kit.
Boot Time	Just over 30 seconds	Roughly 2 seconds
Note	More like a Raspberry Pi	More like an Arduino

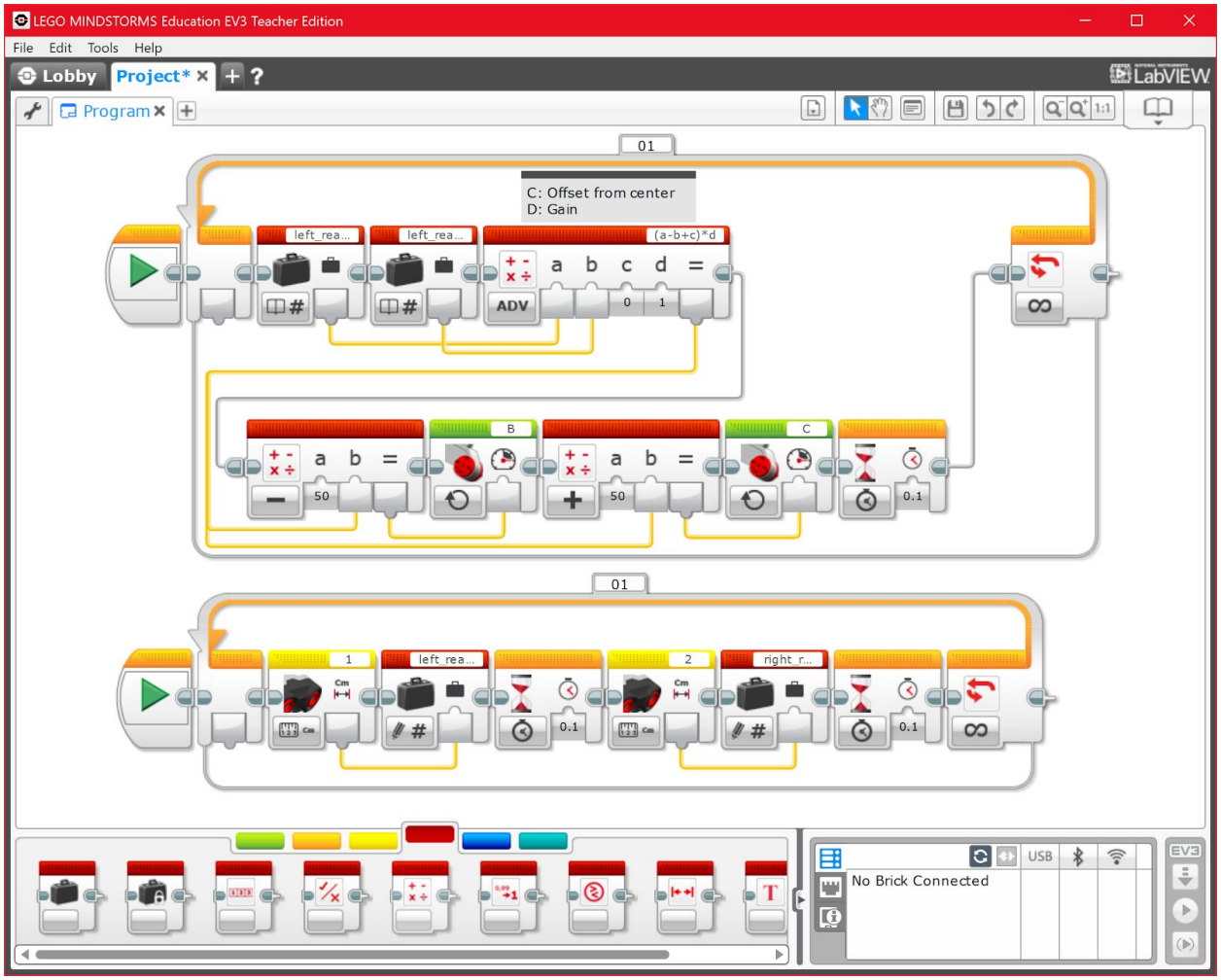
The USB 2.0 port on the side of the EV3 is fully functional and can be used to connect devices such as wireless dongles or USB webcams. Both a camera and a wireless dongle can be attached simultaneously through the use of a USB hub, enabling use cases such as on-board video streaming (as we demonstrate in this video). However, the maximum bandwidth available on a USB2.0 bus is relatively low, so sharing the bus for both the webcam and the subsequent stream splits the bandwidth between them and limits the maximum image quality. On-board processing of the video feed could be a path to explore, but the EV3 lacks video acceleration hardware or comparable CPU power, meaning any real-time video processing would have to be severely limited in scope.

It may be possible that modern machine learning techniques could produce a recognizer model slim enough to run on the EV3 close enough to real time to be useful, however this is beyond the bounds of our expertise. It may be worth further investigation by future teams.

EV3 Programming

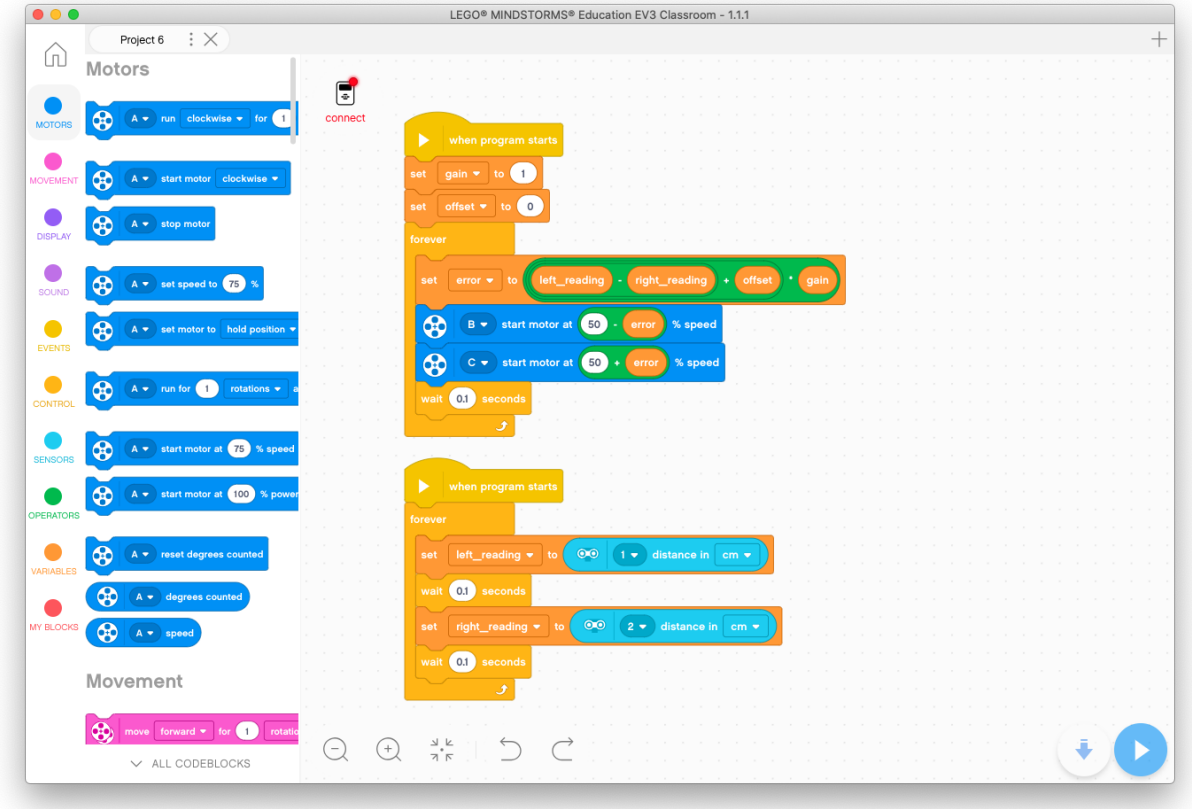
Because the EV3 is linux based, the software development options are very open ended, starting with LEGO's official drag and drop programming suite based on LabView and moving on to the more exotic such as ev3dev where you can program the bot with Python, Java, Go, C++, C, Prolog, or any other Linux compatible programming system. A fairly comprehensive list of the most popular third party EV3 and Mindstorms programming platforms can be found at http://www.legoengineering.com/alternative-programming-languages/.

The official EV3 software can be run from either a computer (macOS, Windows, Chrome OS) or a mobile device (iPad, Android tablet, Amazon Fire). Note, however, that the feature set is significantly reduced on platforms other than macOS or Windows.



Screenshot of last-generation “EV3 Lab” software

At the time of writing, LEGO is in the process of replacing the LabView-based EV3 software (“EV3-G” or “EV3 Lab”) with a new platform based on Scratch 3.0 (“EV3 Classroom”). At the time of writing, EV3 Classroom is only available for macOS and Windows; however, releases for Chrome OS, iPad, and Android tablets are planned for Fall 2020.



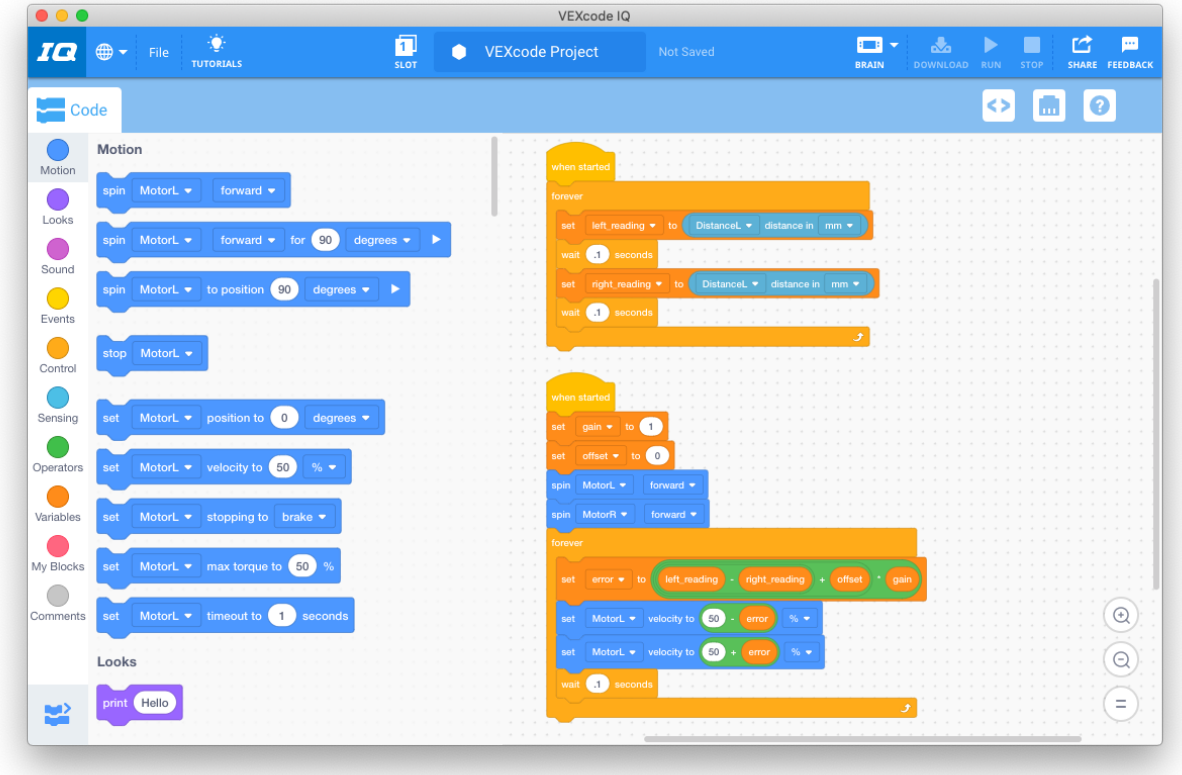
Screenshot of new “EV3 Classroom” software

VEX IQ Programming

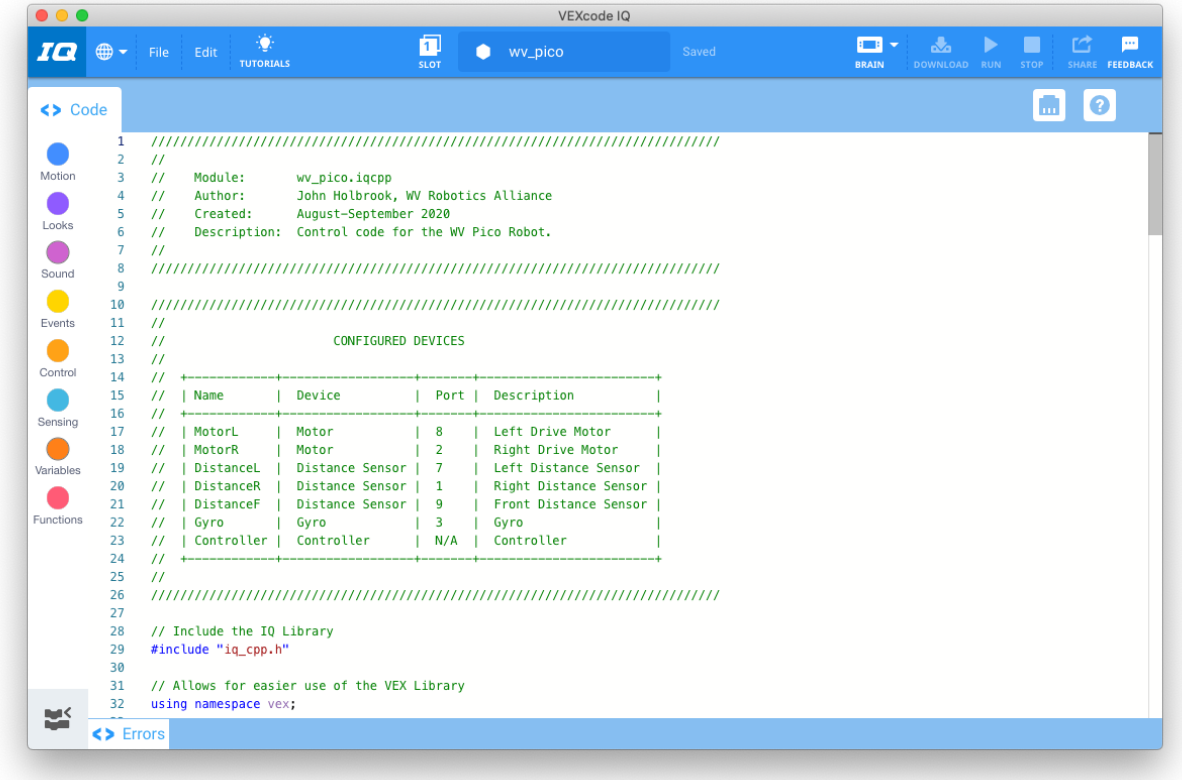
The first-party programming solution for VEX IQ is VEXcode IQ. VEXcode IQ supports programming in Scratch 3.0 and C++, and runs on all the same platforms as EV3-G: macOS, Windows, Chrome OS, iPad, Android tablets, and Amazon Fire tablets. However, unlike EV3-G, the VEXcode IQ Scratch 3.0 language has feature parity across all platforms. Note that programming in C++ is currently only supported on Windows, macOS, and Chrome OS.

Another option for VEX IQ programming is RobotMesh Studio, a browser-based platform that supports programming in Blockly (similar to Scratch), C++, and Python. The cloud-enabled features of RMS could make it a good option for some teams; however, we opted to use VEXcode IQ because it is the official first-party solution and does not require an internet connection on desktop platforms.

Further analysis on the differences between each programming platform can be found in the “Robot Programming” subheading of the “Development Workflow, Resources, and Additional Notes” section at the end of the document.



Screenshot of VEXcode IQ software editing a blocks program



Screenshot of VEXcode IQ software editing a C++ program

In absolute terms, the EV3 platform holds an advantage over the VEX IQ platform in terms of choice of programming languages. But for the purposes of the Artemis challenge at the pico level, the few options available for the IQ platform should be sufficient. On the flipside, the increased count of motor/sensor ports on the IQ platform may prove advantageous for the purposes of the Artemis challenge.

Regardless of platform, the sensors required for basic autonomous navigation will consume many of the ports on the brain. With the EV3's four ports, this would leave little room for creativity in the sensor design for other portions of the robot. Similarly, the fewer number of motor ports on the EV3 practically necessitates a two-motor drive train in order to leave ports available for any additional tasks the robot must perform.

Pricing

The following table summarizes the items necessary to construct our prototype VEX IQ robot:

Part Name	**Part #**	**Qty**	**Price (USD before tax)**
VEX IQ Super Kit	228-2500	1	379.00

Tank Tread & Intake Kit	228-2878	1	27.99
Chain & Sprocket Kit	228-2534	1	22.99
Distance Sensor	228-3011	1	28.99
		Total	**458.97**

In contrast, we estimate that the following purchases would be required to construct an EV3-based robot of roughly equivalent size and capability:

Part Name	**Part #**	**Qty**	**Price (USD before tax)**
EV3 Education Core Set	45544	1	439.90
EV3 Education Expansion Set	45560	1	119.95
Ultrasonic or Infrared Distance Sensor	45504 or 45509	1	34.95
		Total	**594.80**

In general, parts for the EV3 system are available in a relatively small number of large and expensive kits, which may make it necessary to buy a bunch of parts you don't need in order to get a few you want. Individual components can be purchased from third parties on marketplaces such as Bricklink, but parts availability is limited, and some parts can be fairly expensive or hard to find.

In contrast, the VEX IQ system includes a large number of "Add-On Kits" and "Base Packs", most of which are relatively inexpensive ($30 and under) and contain only a certain category of parts. This makes it easy to get only the additional parts you need at a relatively low cost.

Overall, we feel the VEX IQ platform provides better value for money, given the lower cost of the base kit and the increased availability of additional parts à la carte.

Conclusion

Overall, each of the platforms has distinct advantages and disadvantages, both in general and in the particular context of the Artemis Challenge. In particular, the increased computational power and "hackability" of the EV3 platform are appealing for this application. However, we feel that the VEX IQ platform will be a better choice for most teams, due to the larger number of ports on the brain, stronger and more diverse structural components, first-party support for block-based and text-based programming, included controller, and lower overall cost, among other factors.