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Comparison of the LEGO Mindstorms NXT and EV3 Robotics Education Platforms

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Abstract

The release of the latest LEGO Mindstorms EV3 robotics platform in September 2013 has provided a dilemma for many youth robotics leaders. There is a need to understand the differences in the Mindstorms NXT and EV3 in order to make future robotics purchases. In this article the differences are identified regarding software, hardware, sensors, the brick, and resources. Through situational advice, recommendations are given to study the comparison chart and review finances to make an educated decision about which kit will meet programmatic needs and ensure a successful purchase.

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Introduction

The recent emphasis on Science, Technology, Engineering and Math (STEM) initiatives has led to rapid growth in youth robotics programming (National 4-H Council, 2008; Barker & Ansorge, 2006). However, educators across the country are now faced with the daunting task of keeping abreast of new robotics technologies (Ewers, 2010). The release of the latest LEGO Mindstorms EV3 robotics platform in September 2013 has provided a dilemma for many youth robotics leaders (LEGOa, 2013).

Many 4-H programs have already purchased some Mindstorms NXT kits. The dilemma arises in knowing what course to take for future robotics purchases. Many 4-H volunteers lack confidence in this area and will look to the 4-H educator for advice (Barker, Grandgenett, & Nugent, 2009).

For those who have already purchased the Mindstorms NXT sets, one wonders if they are still going to be useful. Can you do programming with a mix of the old NXT and the new EV3? With limited resources, is it better to buy additional NXT sets or switch to the new EV3? To answer these questions, the authors interviewed experienced robotics coaches and a LEGO® Education sales representative. Figure 1 identifies the historical release years of the platforms; this will help identify which versions you may currently be working with.

Figure 1.

Historical Release Years of the LEGO® MINDSTORMS®

1998 : release of the RCX brick - **RCX** for **R**obotic **C**ommand **eX**plorer

2006 : release of the NXT brick - **NXT** for **NeXT** generation
2009 : release of the NXT 2.0 - an updated version of the original **NXT**
2013 : release of the EV3 system - **EV3** for **Evolution 3**

As with most technology, it is disconcerting to spend scarce resources on a product just to see it become obsolete with the advent of the "next big thing" (Wiggins, 2003). With tightening budgets for out-of-school time programs, educators cannot afford to make a mistake when purchasing STEM equipment. Programs for youth with an academic focus such as robotics have been shown to have the highest cost per participant (Grossman, Lind, Hayes, McMaken, & Gersick, 2009). Generally, there are two reasons that technology consumers hesitate to purchase.

1. The expensive equipment you just bought will soon be upgraded again, or another company will offer a product that will become the industry standard.
2. The cost of the equipment will drop in the future, and you will wish you had waited to purchase.

Fortunately, when purchasing robotics equipment for youth programming, these main two issues are not significant factors. LEGO continues to be the industry leader, the only game in town, so it is unlikely that a new company will move in with a rival product. Because of this, the cost of the Mindstorms will not vary much in the coming years. It is unlikely that you will regret the purchase of the new EV3. Table 1 shows comparison information to assist you in feeling confident about your next purchase in the world of robotics.

Table 1.

Robotics Price Comparison Chart for LEGO MINDSTORMS Education NXT and EV3 Kits

Prices and information as of Nov 25, 2013 from www.LEGOeducation.us and www.LEGO.com	
<p>NXT Base Set</p> <ul style="list-style-type: none"> • No software included • Product ID: W979797 • \$294.95 <p>NXT Software 2.1</p> <ul style="list-style-type: none"> • Disk Provided • Single License <ul style="list-style-type: none"> ◦ Product ID: W900080 	<p>EV3 Core Set</p> <ul style="list-style-type: none"> • No software included • Product ID: W945544 • \$339.95 <p>EV3 Software</p> <ul style="list-style-type: none"> • Online Download • Single License <ul style="list-style-type: none"> ◦ Product ID: W200045

<ul style="list-style-type: none"> ◦ \$79.95 • Site License ◦ Product ID: W991515 ◦ \$339.95 <p>NXT Set with Software</p> <ul style="list-style-type: none"> • Product ID: W991308 • \$371.95 • Building set and Software included 	<ul style="list-style-type: none"> ◦ \$99.95 • Site License ◦ Product ID: W200046 ◦ \$399.95 <p>EV3 Set with Software</p> <ul style="list-style-type: none"> • Product ID: W992123 • \$433.95 • Building set and software included
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Things to Consider

Software

- NXT software comes on a disk; EV3 is a download.
- EV3 software block parameters can be controlled on the block itself, this gives user ability to see all block parameters at the same time.
- EV3 software has features that are familiar to the LEGO WeDo software; this will be a plus for those younger learners who will be transitioning in the future.
- The NXT Brick can be programmed with the EV3 software.
 - Consider purchasing just the software if your budget does not allow for the investment in the whole EV3 package. Students will benefit from learning the new software first, be able to adapt the software with their current NXT builds, all while continuing to stay up to date with the new software, even without the EV3 kits.

Sensors

- Figure 2 shows the NXT sensors include the Ultrasonic, Color, and Touch, which are compatible with EV3 software.
- Figure 3 shows that the EV3 has similar sensors as the NXT, with the addition of a new component, the gyro sensor that allows for easy measurement of the robot's rotation and orientation.

Figure 2.

NXT Sensors



Figure 3.
EV3 Sensors



Hardware

- Rechargeable batteries are not compatible between NXT and EV3, however the charger is compatible with both.
- NXT comes with three medium motors identified in Figure 4.
- EV3 comes with two large motors and one medium identified in Figure 5.
- Ball pivot for spinning.
- Figure 4 and Figure 5 illustrates connections of dedicated ports on the bricks for each sensor and motor provided in each base kit.

Figure 4.

NXT Servo Motor (3 per kit)



Figure 5.

Large (2) and Medium (1) Servo Motor



Brick

- Figure 6, the EV3 brick, is faster and has a stronger processor compared to Figure 7, the NXT brick. However, the EV3 brick takes longer to start up than the NXT; this may be something to consider for those who use these for competitions.
- EV3 can control the EV3 brick using both iOS and Android devices, as opposed to Android only for the NXT.
- EV3 has a micro SD card slot good for loading files and saving data.
- EV3 can also create basic programs directly on the brick.

Figure 6.

EV3 Brick



Figure 7.
NXT Brick



Resources and Support

- www.LEGO.com vs. www.LEGOeducation.us
- LEGO retail and LEGO Education websites.
 - Both offer free technical support for NXT and EV3.
 - Both offer individual purchase of motors and sensors.
 - LEGO Education offers additional resources such as Mindstorms Kit variations, curriculum, software, spare parts, accessories, professional development.
 - On the education website there are many accessories and add-ons to upgrade and expand your builds.
- NXT has more resources currently available for learners than the EV3, including free tutorials and building plans.

Platform Versions

- Be aware when buying Mindstorms there are two versions for NXT and EV3 "home/retail" and "education." The home/retail kits contain different sensors, building parts, and software than the education kits. Before you purchase consider all your needs and compare on the websites.
- The home/retail version can be purchased at many retail stores and online market places, as described in Table 2.
 - Comes with software, interface looks different from education version, but is the same as the education version.
- In Figures 8 and 9 both the NXT and EV3 education versions can only be purchased through www.LEGOeducation.us.
 - "Education" version allows you to buy in bulk if needed.

Figure 8.

LEGO MINDSTORMS Education NXT





Figure 9.

LEGO MINDSTORMS Education EV3



Table 2.

Home/Retail Mindstorms Kits (not the Education Kits)

	
Home/retail version NXT currently on amazon for \$440+ www.LEGO.com no longer sells the NXT 2.0 version, prices may vary due to availability, consider checking out e-bay for people who are upgrading to the EV3.	Home/retail version currently at www.LEGO.com and other retailers \$349.99.

Summary

In summary, if you are buying your first Mindstorms equipment, choose the new EV3 set. The newly released building set will give you the most up-to-date system and will be supported for years to come.

If you already have Mindstorms NXT sets, but you want to purchase additional equipment, this may be a great time to find low-priced NXT sets for sale. The NXT product will be supported by LEGO for several more years, and you can continue to provide robotics instruction using this version.

It may be difficult to teach a group if some youth are using NXT and some have EV3, especially if you have a group that needs step-by-step instruction. However, if the instructor is comfortable with inquiry-based learning, this can be a teachable moment.

So study the tables, review your finances, and then make an educated decision about what product will best suit your needs.

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