

## How to Use EV3Lessons

By Sanjay and Arvind Seshan



**BEGINNER PROGRAMMING LESSON**

# SITE OVERVIEW

- EV3Lessons.com provides the building blocks for successfully learning to program the LEGO MINDSTORMS EV3
- We also provide extensive resources for robotics teams such as planning tools, Quick Guides, Coach's Corner and Team Building Activities
- Anyone is welcome to use and modify these lessons for educational (non-profit) purposes
  - However, you must give credit to EV3Lessons for the materials and provide a link back to us if you post materials online
  - If you use EV3Lessons materials in any robotics competition (e.g. FIRST, WRO), you must cite your sources in your contest materials.
  - If you make extensive use of our materials, please consider making a donation to the site to support our work

# LESSON DESCRIPTION

<http://ev3lessons.com/lessons.html>

- **Beginner**: These lessons will teach you to move and turn the robot, use the sensors, and use loops and switches.
- **Intermediate**: These lessons introduce more advanced programming techniques such as My Blocks, variables, parallel beams, calibration and math/logic blocks.
- **Advanced**: These lessons assume that you are comfortable using all the blocks in the EV3 environment. The advanced lessons teach you to more sophisticated programs such as menu systems, proportional line followers, squaring on lines and stall detection techniques.
- **Beyond**: These lessons are for students who have completed all our other lessons and interested in learning about third-party sensors and using the EV3 with other platforms such as the Raspberry Pi.
- Beginner Lessons are designed to be done in order. Intermediate and Advanced Lessons may be done out of order. Lessons usually mention specific pre-requisites when needed.
- If you print the lessons out, make sure to return to the site often to check the date on the bottom of the page to make sure you have the latest version of the lesson.
- To be notified of updates, sign up for our mailing list on the Contacts page.

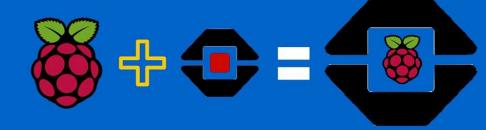
# CORE PROGRAMMING LESSONS

| Beginner   | Intermediate   | Advanced  |
|--|--|---|
|  <ul style="list-style-type: none"><li>• How to Use the EV3Lessons</li><li>• Build a Base Robot</li><li>• Introduction to Brick/Software</li><li>• Moving Straight</li><li>• Port View</li><li>• Pseudocode</li><li>• Basic Turning</li><li>• Displaying Text and Graphics</li><li>• Custom Images &amp; Sounds</li><li>• Intro to Touch Sensor</li><li>• Intro to Color Sensor</li><li>• Loops</li><li>• Switches</li><li>• Importing Additional LEGO Blocks</li><li>• Sound Block</li><li>• Intro to Sound Sensor</li><li>• Intro to Ultrasonic Sensor</li><li>• Basic Line Follower</li><li>• Moving an Object</li><li>• Final Challenge</li></ul> |  <ul style="list-style-type: none"><li>• Basic Ultrasonic Wall Follower</li><li>• Brick Buttons as Sensors</li><li>• Data Wires</li><li>• My Blocks with Inputs and Outputs</li><li>• Moving with My Blocks</li><li>• Turning with My Blocks</li><li>• Color Line Follower with My Blocks</li><li>• Infrared Sensor</li><li>• Debugging Techniques</li><li>• Move Blocks</li><li>• Reliability Techniques</li><li>• Color Sensor Calibration</li><li>• Variables</li><li>• Logic Operations and Decision Making</li><li>• Intro to Parallel Beams</li></ul> |  <ul style="list-style-type: none"><li>• Parallel Beams Synchronization</li><li>• Arrays</li><li>• Intro to Proportional Control</li><li>• Proportional Line Follower</li><li>• Proportional 2 Color Line Follower</li><li>• Proportional Ultrasonic Wall</li><li>• Proportional Control with the Sound Sensor</li><li>• Follower</li><li>• Ramping Up</li><li>• Intro to Gyro Sensor</li><li>• Gyro Sensor Turns</li><li>• Gyro Move Straight and Wall Follow</li><li>• Squaring on Lines</li><li>• Stall Detection</li><li>• Menu System</li><li>• Data Logging</li><li>• Bluetooth</li><li>• Random Block</li></ul> |

# BONUS LESSONS

## Beyond

- Importing Third-Party Blocks
- PixyCam for MINDSTORMS: Introduction
- PixyCam for MINDSTORMS: Color Identifier
- PixyCam for MINDSTORMS: Using Color Codes
- Mindsensors PSP-Nx Controller: Introduction
- Mindsensors PSP-Nx Controller: Simon Game
- EV3 Raspberry Pi Communicator
- Controlling Lights with an EV3
- Introduction to ev3dev
- Raspberry Pi and ev3dev Communicator
- Controlling Lights using ev3dev and Raspberry Pi
- NXT Light Sensors in EV3

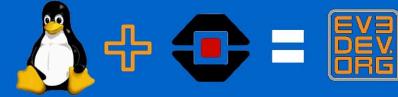


The logo features a red Raspberry Pi logo on the left, followed by a yellow plus sign, a black hexagonal icon containing a red square, and an equals sign, all set against a blue background. Below the graphic, the text "RPi & EV3" is displayed in white.

RPi & EV3

New Lesson Series





The logo features a white Tux the Penguin logo on the left, followed by a yellow plus sign, a black hexagonal icon containing a red square, and an equals sign, all set against a blue background. Below the graphic, the text "Linux & EV3" is displayed in white.

Linux & EV3

New Lesson Series



# **LESSON STRUCTURE**

- 1. Each lesson starts with a list of objectives and ends with a challenge**
- 2. In most lessons, we provide hints in the form of Pseudocode. Students who need a hint should look at the Pseudocode.**
- 3. We provide a challenge solution as well, but want students to complete the challenge on their own before checking the solution**
- 4. A discussion guide is included after the challenge that will help understand the main objectives**
- 5. Some lessons have companion worksheets for students. More will be added over time.**

# QUICK GUIDES

| Hardware  | Programming   | Documentation & Strategy  |
|---|---|---|
| <ul style="list-style-type: none"> <li>Cable Management 1</li> <li>Cable Management 2</li> <li>FLL Robot Build Guide</li> <li>Shielding Techniques</li> <li>Using Gears with the EV3</li> <li>Passive Attachments</li> <li>Carabiner LEGO Digital Designer File</li> <li>One Way Gate LEGO Digital Designer File</li> </ul> | <ul style="list-style-type: none"> <li>One Minute Line Follower</li> <li>Using Sensors: Move Until</li> <li>Improving Robot Reliability</li> <li>Color Sensor: Shielding and Calibration</li> <li>My Blocks</li> <li>Myths &amp; Truths About the Gyro</li> <li>Truth About Turns: Pivot Turns</li> </ul> | <ul style="list-style-type: none"> <li>Using Comments to Improve Code</li> <li>Engineering Notebook</li> <li>LEGO CAD &amp; Robot Build Instructions</li> <li>Robot Game Strategy</li> <li>Mission Planning Worksheet</li> <li>Learning FLL Runs</li> </ul> |

| EV3 Platform  | Misc.   |
|---|---|
| <ul style="list-style-type: none"> <li>Edu vs. Home Edition Software</li> <li>EV3 and NXT Compatibility</li> <li>Updating Software/Firmware Home Edition</li> <li>Updating Software/Firmware Edu Edition</li> </ul> | <ul style="list-style-type: none"> <li>LEGO Organization Systems</li> <li>Roles and Responsibilities</li> <li>Tournament Checklist</li> <li>Ten Off-Season Ideas</li> <li>FLL: Getting Started Guide</li> </ul> |

<http://ev3lessons.com/guides.html>



**MYTHS & TRUTHS  
ABOUT THE GYRO**

By Droids Robotics, 2015

*"We used to fear the gyro but we did your @EV3Lessons today at practice and now we love it!" - FLL Team*

There are numerous myths about the Gyro sensor that we would like to discuss. These myths make teams afraid of trying out the sensor.

The gyro sensor is an extremely useful sensor, but does take a bit of work to use correctly. That is why we have the Gyro lessons in **Advanced** on EV3Lessons.com:

|   |   |
|---|---|
| <b>MYTH</b>   | <b>TRUTH</b>  |
| The gyro is unreliable for turns.   | The biggest problem with the gyro is drift and lag. Both can be fixed.  |
| You cannot use software to correct for the gyro's drift. All you can do is unplug and replace the sensor. | There are software solutions you can try. There are several examples of solutions on <a href="#">EV3Lessons.com</a> .                                       |
| Placement matters: The gyro needs to be low to the ground and at the center of the robot.                 | See images below.   |
| Using two gyros will cancel out the drift.  | • If the application is for a Gyro Boy or another type of robot that is balancing or has a twisting motion, other installs will work too.                   |
| The gyro measures angles.   | • Unfortunately, this does not work.  |
| The gyro cannot be used in FLL reliably.  | The gyro measures angular velocity (rate) and computes angle from this.   |
| It takes 30secs or more to correct for drift.   | The gyro can be successfully used in FLL if you correct for lag and drift.  |
| Gyro accuracy is an issue.  | • Gyro drift takes as little as 0.1 seconds and at most 3 seconds and is easily done during table set up time in FLL.                                       |
|   | • While the gyro might be a couple of degrees off, other techniques (odometry) can produce similar or worse errors. Build a robot to tolerate these errors. |

Gyro Sensor mounting guide for an FLL robot

1: Angular installs  
2: Sideways installs  
3: Straight up or down  
4: Tilted  
5: Upside down, but parallel to ground

# SKILLS CHALLENGES

## Challenges

**FIX MY CODE**  
Skills Challenge  
By EV3Lessons

**LINE FOLLOWING**  
Skills Challenge  
By EV3Lessons

**"ON" MODE**  
Skills Challenge  
By EV3Lessons

**Materials:**  
Sample code with errors (such as the one on the left)  
Pick the sensors or blocks that the students should be familiar with already.

**Materials:**  
White floor/paper and black electrical tape  
or  
EV3Lessons.com training mats  
or  
Any FLL mat with lines to follow

**Materials:**  
Sample code on the left.  
EV3 for the students to test their code.

### Fix my Code Series

These challenges test a student's ability to read and understand code written by others. The goal is to identify errors and fix them. We will add challenges for each sensor

[Challenge 4: Touch Sensor: Fix My Code](#)

[Challenge 2: Fix My Code](#)

### Line Following

These challenges are to practice writing line followers and find ways to improve them.

[Challenge 1: Line Following](#)

### Other Skill Challenges

These are other challenges that we have not categorized yet.

[Challenge 3: On Mode](#)

<http://ev3lessons.com/challenges.html>

# **RESOURCES: COACH'S CORNER**

# Coach's Corner

## Maximize Learning, Minimize Cloning

By Asha Seshan  
Not the Droids You Are Looking For  
(Pennsylvania, USA)



In this article, I will discuss how to maximize learning and minimize cloning in your team: the good and bad opinions are out there, events, and more.

Research has shown that the first place to start with any topic. It is important to distribute the information to the individuals involved.

But what about the rest of the team? How can we ensure that everyone is learning and growing?

## Coaching: What Can You Offer

By Carrie Koepke  
The Final Elements and Fantastic LEGO Ladies (Missouri, USA)



When a neighborhood FLL team formed in 2014, my daughter was excited to join. My son watched The Fantastic LEGO Ladies embrace their first season, tugging my sleeve about next year. In 2015, The Final Elements was formed. They followed in the Ladies' footsteps, able to attend the Razorback Invitational in their Rookie year. Both teams are excited to see what the Animal Allies season will bring. I coach The Final Elements and offer occasional support to The Fantastic LEGO Ladies.

It was intimidating to step into an FLL coach role. The closest I have come to an engineering degree was editing my friends' and husband's papers in college. My expertise is in English and Biology. Nonetheless, I am about to walk into year two of coaching my son's FLL team, The Final Elements. Last year was a bit of a shock to the system, but even more shocking was how many coaches I kept meeting who had zero experience. As we chatted about the perplexing oddity, it became clear that our background didn't matter. We arrived with the desire to help these kids reach their goals and our own unique abilities to nurture their dreams.

"We know our Coaches and Mentors don't have all the answers; we learn together." Thank goodness for this Core Value! Walking into our first meeting, the boys and the majority of the other parents (with a variety of engineering backgrounds) already knew more than me. I still have a lot to learn. I have discovered is that this allows the team to take ownership of their knowledge. They carefully explain their robot design and programming work to me, developing their understanding as they do so. They also take my inquiries well. When I ask why they do something, or if it can be done more efficiently, or if it should be done at all, they know I am asking because I don't know. It is an opportunity to take a step back and solidify their thoughts or take a new approach.

**Know your strengths and weaknesses.** I have coached before . . . in a completely different field. For years I coached children's gymnastics. Those years taught me to be aware of team dynamics, as well as how to focus on one individual while maintaining a connection with others.

# RESOURCES: CORE VALUES ACTIVITIES

## NEWSPAPER TOWER Core Values Activity

By Sanjay and Arvind Seshan



**Objectives:**

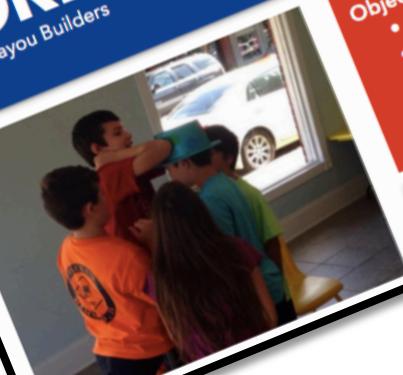
- Coming up with creative solutions to a problem (there are many ways to solve this challenge)
- Pick a challenge

**Before you begin:**

- 2 full sheets of newspaper

## HATS OFF! CORE VALUES ACTIVITY

By The Bayou Builders



**Objectives:**

- Exercise creativity
- Work together
- List ideas
- Share ideas

**Notes for the Coach/Team**

## ACT IT OUT Core Values Activity

By Sanjay and Arvind Seshan



## RECYCLED ART CORE VALUES ACTIVITY

By The Bayou Builders



**Objectives:**

- Working together to develop an action plan
- Choosing from a large set of items in a short amount of time
- Exercise creative thinking
- Explaining the decision making process utilized

**Notes for the Coach/Team**

recycled. Packaging works

# RESOURCES: PLANNING & SCORING TOOLS



**Wheel Converter: Automatic Distance to Degrees**

This tool can be used to easily convert your wheel/tire size information into useful data to be used by your First Lego League team.

**STEP 1: Enter Wheel Dimensions**

Input your wheel diameter in millimeters \*-OR-\* You can click one of the tires commonly used by FLL teams below.

**Large Motorcycle Wheel - 94.2x20**

**EV3 basic tire - 56x28**

**Motorcycle tire - 81.6x15**

**Balloon tire - 56x26**

**Small tire - 43.2x22**

**STEP 2: Enter Distance Robot Needs to Move**

Input the distance you would like the robot to move in either inches or centimeters:

inches  centimeters

Will be updated for Animal Allies

Also available on Apple App Store and Google Play

# CREDITS

**Author: Sanjay and Arvind Seshan**

**More lessons are available at [www.ev3lessons.com](http://www.ev3lessons.com)**



This work is licensed under a [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.](#)