LEGO Mindstorms Robotics

This class introduces students to the NXT and EV3 robots and helps to prepare students for *FIRST* Lego League. Emphasis is placed on building different attachments for the robot as well as programming them. The class begins with an intro to programming with the online Lightbot game and goes through building the basic robot, introducing all the different sensors, and demonstrating how to build good attachments. By the end of the class, students are able to build and program a robot to complete a chosen mission.

Suggested Materials

- Masking Tape
- Black Electrical Tape
- Colored Sharpies or Markers
- 2 FLL mats, 8 robot kits, and Legos
- Pencils
- Laptop Cart with EV3 and NXT software
- Projector
- Personal Laptop
- Nametags
- Ziploc Bags
- NXT Building Instructions:
    - https://education.lego.com/en-us/lesi/support/product-support/mindstorms-education-nxt/nxt-base-set-9797/building-instructions
    - https://goo.gl/q38ofV
- EV3 Building Instructions
    - robotsquare.com/wp-content/uploads/2013/10/45544_educator.pdf
    - https://goo.gl/d4RrGy

Suggested Daily Schedule

Two week classes, with one and a half hour sessions Monday to Friday

	Session 1 (Beginner - NXT)	*Session 2 (Advanced - EV3)*
Day 1: Monday	Introduction Light-bot	Introduction Light-bot Kids choose groups Build robot base
Day 2: Tuesday	New groups Build robot base Intro to EV3 software	Finish robot base Intro to EV3 software Maze challenge
Day 3: Wednesday	Maze challenge build touch sensor touch sensor intro/try-me	Touch sensor Ultrasonic sensor "Four Walls" challenge
Day 4: Thursday	Touch Sensor Ultrasonic Sensor "Four Walls" Challenge build light sensor light sensor intro/try-me	Light/Color sensors Explain Loops game Worktime
Day 5: Friday	Light sensor Color sensor Attachment tips and tricks	Worktime Loops competition (Last 30 minutes)
Day 6: Monday	Explain Loops game Worktime	Mission packet (complete missions at own pace)
Day 7: Tuesday	Worktime Loops competition (Last 45 minutes)	Work on missions
Day 8: Wednesday	Pick one mission to do and begin to work on it	Work on missions
Day 9: Thursday	Work on mission	Work on missions
Day 10: Friday	Exhibition Day!	Exhibition Day!

Activity Plans

Introduction-based activities

1. Welcome, introductions, and icebreaker activity
    a. **Option 1** (minimal-no extra materials/prep needed)
    I never: Everyone sits in a circle of chairs with one person in the middle. The person in the middle introduces himself/herself and says something he/she's never done. Ex: "I'm Tianxin and I've never been on an FLL team." Then, everyone who *has* done that, and the person in the middle, gets up and finds a new seat in the circle. The person in the end without a seat starts the next round.
    b. **Option 2** (prep needed)
    Hand out a bag of Legos to each student. Give them 30 seconds to become familiar with what they have. Then have them walk around the room to find a partner to build something cool with. At the end of 10 minutes, go around the room and have each pair introduce themselves and their model. Then have the volunteers introduce themselves (name, grade, what they like to build with Legos).
2. Pass out the student survey and explain the questions. The survey can be used to construct groups.

Intro to Programming: Lightbot

1. Go over computer guidelines (rules and such for using the computers)
2. Introduce Lightbot and explain how the game is similar to NXT/EV3 programming
3. Allow students to explore the game
    a. LIGHT-BOT (EASY VERSION): http://light-bot.com/hocflash.html
    b. LIGHT-BOT (ORIGINAL, HARDER VERSION): http://www.willamette.edu/~fruehr/141/light-bot.html

Building the Basic Robot Base

1. Pass out instructions or use an online version
    a. NXT Building Instructions: https://education.lego.com/en-us/lesi/support/product-support/mindstorms-education-nxt/nxt-base-set-9797/building-instructions
    or https://goo.gl/q38ofV
    b. EV3 Building Instructions: robotsquare.com/wp-content/uploads/2013/10/45544_educator.pdf
    or https://goo.gl/d4RrGy

2. Pass out the basic robot kits and set up the additional Lego pieces somewhere for the kids to use

Tip: If you do not have all the pieces you need, come up with some workarounds and have students raise their hands when they reach that step so you can explain to them individually what to do

Maze Challenges with Dead Reckoning

1. Preparation: Using masking tape, create a few mazes (1-2 more than the number of groups) in an open space
2. After groups have completed building the basic robot, go over basic programming
3. Have groups each pick a maze to work on and program their robot to go through it without any sensors (dead reckoning)

Touch Sensor Training

1. Preparation: Bring small 2x4's and arrange them into rectangles
2. Go over how to attach it and program the NXT software for it.
    a. For the attachment, you can just follow the basic building instructions provided in the booklet
3. As a large group, create a program that allows the robot to drive until it touches a wall, then stop.
4. Explain to students the **Four Walls Challenge**: Set up four 2x4 walls in the shape of a rectangle. The students will program the robot to touch all four walls exactly once using the touch sensor.
5. Allow groups to work on their own to create a program that will complete the challenge

Ultrasonic Sensor Training

1. Preparation: Bring in manila folders to form the "walls"
2. Explain to students the what an ultrasonic sensor is
3. Show students how to attach it to robot and program it with NXT software.
    a. For the attachment, you can just follow the basic building instructions provided in the booklet
4. As a large group, show how to create a program that allows the robot to drive until it is some distance from a wall and have it stop.
5. Have students work to complete a modified **Four Walls Challenge:** use manila folders instead of 2x4's and have the robot stop a specific distance from the "wall"

Light Sensor Training

1. Preparation: Use black electrical tape to make lines, circles, and other paths for each group's robot to follow
2. Demonstrate to groups how to attach it and program the NXT with it.
    a. For the attachment, you can just follow the basic building instructions provided in the booklet
3. As a large group, create a program that allows the robot to drive forward and then stop at a line.
4. Have each group work on their own to try and have their robot follow a black line, circle, and other paths

Lunar Loops Competition

1. Preparation: Create 10 - 20 loops of different colors. Loops design can look similar to the image on the right.
2. Introduce the color sensor and demonstrate how it works.
3. Explain to students the game and have them work in their groups to try and create working attachments for the game.
4. **Lunar Loops**: 10-15 Loops of different color are set up along a line in a random order. Students program their robots to knock over some colors. Points are assigned to different loop colors, some positive and some negative.

Missions

1. Set up 3 balls at different locations and task students with "kicking" the balls into a goal.
2. Something that involves the bots responding to an object whose location is not already known - perhaps the bot needs to get in the way of a moving object? Or maybe they just need to figure out a way to scan for an object and then retrieve it.
3. Robots will travel through a wooden maze and detect various marks on the walls. Then report back to base with the number.
4. Robots travel through a random wooden maze using ultrasonic sensor. Must be able to complete two random mazes with the same program to "pass."
5. Robot will travel through a path, indicated by tapes with different colors (different tapes leads to different locations) and somewhere in the path should be a ball (1 ball/path). Robots should pick up all the balls, and bring them back to the base.

6. Robots spin a dial until the right color is showing on top.
7. Possibly use mission models from past FLL challenges that integrate sensors.

Students should be given independence when working on the missions. Volunteers should be periodically walking around and checking in with each group to make sure they are all on task and to answer any questions or help with any problems they might have. One mission will be chosen by each group to present on Exhibition Day.

Exhibition Day

1. Have students prepare a short presentation beforehand.
2. Invite parents and friends to see the students demonstrate their robots completing a mission and give their presentation!

Other Notes

- The boxes of Lego pieces along the back wall should be organized by type of piece if possible. Make posters that you can put up to help find them.
- Have hand sanitizer for the kids before and after each class.
- Be flexible with the groups. Maybe allow the kids to switch around while learning the sensors (at that point all the robots are the same), and pick a permanent group by the time you start the loops challenge.
- Have the 1st class create presentations to give during exhibition day.
- Keep the lids on the boxes of sorted Legos and have the kids place the pieces they're returning on top of the lids - at the end of the day the volunteers can check that all pieces were returned to the correct box before putting them back inside.