Mindstorms Robotics

Lesson 1 (2019)

Introduction to Software and Programming

Goal: To be introduced to Mindstorms robotics, the NXT programming interface, uploading programs to the block, running programs from the block, and a simple introduction to loops.

Lesson Outline
I.   General Introduction
Using the robot preassembled with all of the sensors, demonstrate what the robots can do and briefly discuss the different sensors and how the block sends and receives signals to and from the sensors
II.   Introduction to software environment
Brief discussion about the software interface including different functions
III.   Activity – Creating a simple program
Students will code a simple program to make the robot move in a square
IV.   Activity – Uploading the program to the robot
Students will learn how to upload the program they have created to the block
V.   Activity – Running the program
Students will learn how to run the programs that they have uploaded to their block
VI.   Activity – Using a loop
Students will learn on a basic level what a loop is and how it can be used
VII.   Discussion
Review the results of the lesson and general terminology

Materials
1   Preassembled robot with all 4 sensors attached
10   Mindstorms robots with blocks
10   USB cables
10   figure sheets

I.   General Introduction
Divide the students into 10 groups of 3
Note: Wait to hand out the materials until after the following demonstration

Use the robot that is preassembled with all of the sensors attached to demonstrate what the robots can be programmed to do, and explain what each sensor detects.
     1) Turn on the brick and run the program **Dance**
     2) Demonstrate how each of the sensors works
        • Make noise to make the **sound sensor** make the robot move forward
        • Place your hand in front of the **ultrasonic sensor** to make the robot spin around
        • Push the **bump sensor** to make the robot back up
        • Block the **light sensor** to make the robot make a noise and display a picture

Explain briefly what the following words mean: **the brick, code, program, coding/programming**

      The brick – a name for the block on the robot that holds the programs

      Program – a sequence of instructions that can be interpreted and executed by a computer

      Code – the set of instructions that is contained within the program

      Coding/Programming – creation of a program

II.   Introduction to software/programming environment

Note: Do not hand out the robots or the cables yet

Tell the students that they will be following a set of instructions that will be given to them and to **only** follow these instructions

1) Hand out the Figure Sheet
2) Tell the students to open **NXT 2.1 Programming** by double clicking on the following icon
3) The program should open and it should look like **Figure 1**
4) Instruct the students to press the **orange X (not the red X to close the program)** near the top right of the screen as highlighted in **Figure 1** to make the accessible area larger
5) Instruct the students to start a new program by typing **Square** into the "Start New Program" box as shown in **Figure 2** and the program should then look like **Figure 3**
6) **Figure 4** then shows the controls that the students should become familiar with, so briefly explain what each of the controls do from top to bottom
   - Move (Gears) – This block is used to control the motors on the robot to cause the robot to move **(This is what we will be using mostly)**
   - Record/Play – This block can be used to record an action that the robot makes and play it back **(We will not be using this)**
   - Sound (Speaker) – This block can be used in order to play a sound from the block
   - Display (Screen) – This block can be used to display an image, such as a smiley face, on the block's screen
   - Wait (Hourglass) – This block can be used to wait until a certain condition is met **(This will be very useful)**
   - Loop – This block can be used to repeat a certain set of commands **(We will be learning a little bit more about this today)**
   - Switch – This block can be used to run a certain set of commands until a specific condition is met **(We will use this in future lessons)**
7) **Ask if the students have any questions, if not, we will move on to the first activity**
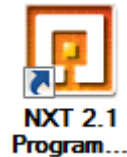
III.   Activity – Creating a simple program

Note: Still do not hand out the robots or cables
LET 1 STUDENT DO ACTIVITY III, 1 DO ACTIVITIES IV AND V, AND 1 DO ACTIVITY VII

Tell the students that they will be making a program to make the robot move in a square

Your Notes:

1) Instruct the students to turn to the second page of the Figure Sheet
2) Instruct the students to click on the move block and place it on the diagram as shown in **Figure 5**
3) Once the block is placed, tell the students to click on the block and a menu will show up at the bottom of the screen as shown in **Figure 6**
4) Explain what each of the selections from **Figure 6** are briefly
    - Port – This determines the ports that the motors are connected to **(B and C should be selected and should not be changed)**
    - Direction – This determines the direction of motion with the up arrow meaning forward (the direction the block faces) and the down arrow meaning backward
    - Steering – This determines which motor turns the robot left and which turns the robot right **(C should be left and B should be right)**
    - Power – This can be increased or decreased to make the robot move faster or slower **(Tell the students to leave this at 75 or some of the following instructions may not work correctly)**
    - Duration – This determines how long a command will be executed
        i. Unlimited – Run the command forever
        ii. Degrees – How many degrees the wheels will rotate **(NOT the number of degrees in a turn, as in 90 degrees will not make the robot turn 90 degrees but rather will make the wheels turn 90 degrees or ¼ of a rotation)**
        iii. Rotations – How many rotations the wheels will rotate
        iv. Seconds – Run a command for a specific amount of time
5) Instruct the students to change the duration to 2 seconds and match all selections to **Figure 6**
6) Instruct the students to then add another move block to the diagram and to change the direction **ALL THE WAY** to the left (or else there will not be a sharp turn) and to change the duration to **190 Degrees** as shown in **Figure 7** (**NOTE:** This number worked for my robot, but some of the motors are calibrated differently, so this number won't always make the robot go in a perfect square)
7) Tell the students to highlight the first two blocks they created and to press the "Copy" button at the top of the page and then to press "Paste" 3 times so that there are 4 sets of the same directions
8) Instruct the students to place these instructions back to back so that it looks like **Figure 8**
9) Congratulate the students because they have just created their first program and ask them if they have any questions before we move on to putting the programs onto their robots

IV. Activity – Uploading the program to the robot

SWITCH TO THE SECOND STUDENT

1) Hand out both the robots and the USB cables to each of the groups
2) Instruct the groups to plug the USB cable into the computer and into the top of the brick
3) Tell the students to press the orange square on the brick in order to turn the robot on so that a program can be uploaded
4) Direct the students attention to the bottom right of the block diagram and tell them to look at **Figure 9** on the next page and explain each of the buttons
    - NXT Window (top left) – displays whether the robot is connected or not and information about the battery life and storage **(We will not use this)**

Your Notes:

- Download and run selected (top right) – will run the highlighted selection of the program **(We will not use this)**
- Download and run (Center) – This will download the program and run it immediately **(We will not use this)**
- Download (Bottom left) – This will download the program onto the brick so that the program can be run from the brick **(This is what we will use)**
- Stop (Bottom Right) – This will stop the currently running program if download and run was selected **(We will not use this)**

5) Tell them to select download (bottom left) and the program will download onto the brick without running
6) Ask the students if they have any questions before moving on to the next activity

V.   Activity – Running the program

1) Instruct the students to unplug their robots from the computer
2) If the robot is already turned on, tell them to select the icon that says "My Files" then to select "Software Files" then to select "Square"
3) Tell them to find a suitable area so that the robot can move in a square about 2 feet by 2 feet and to put the robot down
4) Tell them to select "Square Run"
5) **Note: If the program does not run properly or the robot runs into something, the program can be stopped at any point by picking up the robot and pressing the grey button below the orange button on the brick**

VI.   Activity – Using a loop

SWITCH TO THE THIRD STUDENT

1) Explain to the students that the program that we created simply uses 4 sets of the same commands in a row, and that it would be much more efficient to repeat 1 set of commands 4 times, and this can be achieved by using a loop
2) As explained earlier, a loop allows us to repeat a set of commands as many times as we want
3) Instruct the students to highlight the last 6 blocks on the block diagram and press backspace or delete to remove them, leaving only the original 2 blocks
4) Tell them to click on the loop button and to place it on the block diagram
5) Instruct them to highlight the 2 commands and then click and drag them into the loop to look like **Figure 10**
6) They can then upload and run the program in order to see how the robot will continue to run these two commands as long as the program is not aborted
7) **NOTE: The program will run forever, so tell the students to pick up the robot and hit the grey button below the orange button to stop running the program**
8) Ask them if they have any questions and congratulate them on successfully implementing a loop to make a more efficient program

Your Notes:

VII.   Discussion

A review of the lesson should include the following questions for the kids to answer

- What is the brick?
- What is a program?
- What is code?
- What is done with the NXT software?
- What does the brick do?
- How can we make a program that repeats commands more simple?
- What does a loop do?

Note to VSVS volunteers
Remember to pick up all 10 cables, all 10 robots, and all 10 figure sheets

Please erase the programs that have been downloaded to each of the bricks so that the bricks do not become cluttered with programs

Your Notes:

Mindstorms Robotics

Lesson 2 (2019)

Sensors – Sound and Light Sensors

Goal: To be introduced to the sound and light sensors, interfacing the sensors with the block, and making a program that utilizes the sensors.

Lesson Outline
I.　　**General review and introduction**
Review of previous week's explanation and general overview of lesson goals
II.　　**Activity – Building and attaching the sound and light sensors**
Students will put the sound and light sensors together and attach them to the robot
III.　　**Activity – Creating a Program to utilize the sound sensor**
Students will code a simple program to make the robot spin around after activation of the sound sensor
IV.　　**Activity – Creating a program to utilize the light sensor**
Students will code a simple program to make the robot back away after activation of the light sensor
V.　　**Discussion**
Review the results of the lesson and general terminology
VI.　　**Questions about College**
Ask the students if they have any questions about college

Materials
10　　Mindstorms robots with blocks
10　　USB cables
10　　ziploc bags with sound sensor and parts
10　　ziploc bags with light sensor and parts
10　　sound sensor build sheets
10　　light sensor build sheets
10　　figure sheets

I.　　**General review and introduction**
Divide the students into 10 groups of 3
Note: Wait to hand out the materials until after the review and introduction

A review of the previous lesson should include the following questions for the kids to answer
- What is the brick?
- What is a program?
- What is code?
- What is done with the NXT software?
- What does the brick do?
- How can we make a program that repeats commands more simple?
- What does a loop do?

Briefly explain to the students that we will be doing the following:

Building and attaching the sound and light sensors
Creating a program to utilize the sound sensor
- Spinning around
Creating a program to utilize the light sensor
- Backing away

II.   Activity – Building and attaching the sound sensor and the light sensor
LET 1 STUDENT DO ACTIVITY II, 1 DO ACTIVITIES III, AND 1 DO ACTIVITY IV

Tell the students that they will be following a set of instructions to build both the sound and the light sensor attachments that will be given to them and to follow these instructions

1) Hand out all of the materials
2) Tell the students to follow the instructions to build and attach both sensors to the robot
   - This should probably take about **10 minutes** to do, make sure to walk around and help the students with putting together the sensor attachments
3) Instruct the students to connect the sound and light sensors to the brick with cords and to make sure that they plug the cord into the bottom of the brick in
   - Sound Sensor goes in **SLOT 2**
   - Light sensor goes in **SLOT 3**
4) Make sure that everyone has built and attached their sensors before moving on to the following activity

III.   Activity – Creating a program to utilize the sound sensor
SWITCH TO THE SECOND STUDENT

Tell the students that, in this activity, they will be making a program utilizing the sound sensor to make the robot spin when there is a loud noise

1) Tell the students to open **NXT 2.1 Programming** by double clicking on the following icon
2) Instruct the students to start a new program by typing **Sound Sensor** into the "Start New Program" box
3) Once a new blank program appears, instruct them to place a loop on the block diagram as shown in **Figure 1** by clicking on the loop button highlighted in **Figure 1**
4) Instruct the students to drop a wait function for the sound sensor into the while loop as shown in **Figure 2**
   a. Change the attributes for the sound sensor to ">75"
   b. Match **Figure 3**
5) Tell the students to place a move block on the block diagram as shown in **Figure 4**
   a. Make sure the move block attributes match **Figure 5**
6) **Ask if the students have any questions**
7) Have the students plug their robots into the computer and download the program onto the brick
8) Once the program is properly downloaded, the students can place their robots on the ground, run the program, and clap to activate the sensor
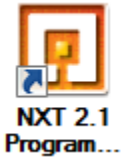
Your Notes:

IV.   Activity – Creating a program to utilize the light sensor
SWITCH TO THE THIRD STUDENT

Tell the students that, in this activity, they will be creating a program utilizing the light sensor to make the robot move backward when the light is blocked.

1) Using the same program, simply change the wait function attributes to "Light Sensor"
   a. Have the students make their program look like **Figure 6**
   b. Make sure the light sensor wait function attributes match **Figure 7**
2) Change the Move block to move straight backwards
   a. Match **Figure 8**
3) **Ask if the students have any questions**
4) Have the students plug their robots into the computer and download the program onto the brick
5) Once the program is properly downloaded, the students can place their robots on the ground, run the program, and block the light to activate the sensor

V.   Discussion

A review of the lesson should include the following questions for the kids to answer

- How does the sound sensor work?
- How does the light sensor work?
- What does a for-loop do?
- How does the wait function work?

VI.   Questions about college

Allow the students now to ask you any questions they want about college
    Try to talk about:
- School
- Schoolwork
- What you're studying
    Try to avoid:
- Don't talk about parties
- Don't talk about alcohol
- Don't talk about anything inappropriate

Note to VSVS volunteers
Remember to pick up all 10 cables, all 10 robots, all 10 ziploc bags with touch sensors, and all 30 figure sheets

Please erase the programs that have been downloaded to each of the bricks so that the bricks do not become cluttered with programs

Your Notes:

Mindstorms Robotics
Lesson 3 (2019)

Sensors – Touch Sensor

Goal: To be introduced to the touch sensor, interfacing the touch sensor with the block, and making a program that utilizes the sensor.

Lesson Outline
I.   **General review and introduction**
Review of previous week's explanation and general overview of lesson goals
II.   **Activity – Building and attaching the touch sensor**
Students will put the touch sensor together and attach it to the robot
III.   **Activity – Creating a Program using the touch sensor and a switch statement**
Students will code a simple program to make the robot back away after activation of the touch sensor
IV.   **Activity – Creating a program to utilize an infinite loop with the touch sensor**
Students will code a program to make the robot run forever and back up and turn around when the touch sensor is activated
V.   **Discussion**
Review the results of the lesson and general terminology

Materials
10   Mindstorms robots with blocks
10   USB cables
10   ziploc bags with touch sensor and parts
10   touch sensor build sheets
10   figure sheets

I.   **General review and introduction**
Divide the students into 10 groups of 3
Note: Wait to hand out the materials until after the review and introduction

A review of the previous lesson should include the following questions for the kids to answer
- How does the sound sensor work?
- How does the light sensor work?
- What does a for-loop do?

Briefly explain to the students that we will be doing the following:
Building and attaching a touch sensor
Creating programs to utilize the touch sensor
- Backing away from a wall
- Backing away from a wall, turning around, and moving again

II.   Activity – Building and attaching the touch sensor
LET 1 STUDENT DO ACTIVITY II, 1 DO ACTIVITIES III, AND 1 DO ACTIVITY IV

Tell the students that they will be following a set of instructions to build the touch sensor attachment that will be given to them and to follow these instructions

1) Hand out all of the materials
2) Tell the students to follow the instructions to build and attach the sensor to the robot
   - This should probably take about **8 minutes** to do, make sure to walk around and help the students with putting together the sensor attachment
3) Instruct the students to connect the touch sensor to the brick with the cord and to make sure that they plug the cord into the bottom of the brick in **SLOT 1**
4) Make sure that everyone has a built and attached sensor before moving on to the following activity

III.   Activity – Creating a program to utilize the touch sensor
SWITCH TO THE SECOND STUDENT

Tell the students that, in this activity, they will be making a program utilizing the touch sensor to make the robot move forward until it runs into a wall at which point it will back away from the wall.

NXT 2.1 Program…

1) Tell the students to open **NXT 2.1 Programming** by double clicking on the following icon
2) Instruct the students to start a new program by typing **Touch Sensor** into the "Start New Program" box
3) Once a new blank program appears, instruct them to place a loop on the block diagram as shown in **Figure 1** by clicking on the loop button highlighted in **Figure 1**
4) Instruct the students to select the loop and at the bottom of the screen change the "Control" to "Sensor"
5) The details of this loop should look like **Figure 2**
   a. Sensor should be on "Touch Sensor"
   b. Port 1 should be selected
   c. Action should have "Pressed" Selected
6) Explain briefly that this for-loop is used to check for when the touch sensor is pressed and whatever is inside of the loop will continue to repeat itself until it is pressed
7) Tell the students to place a move block inside of the loop **Figure 3**, the move block should have the attributes displayed in **Figure 4**
   a. Direction – Backwards
   b. Duration – 0.1 Seconds
   c. Next Action - Coast
8) Explain to the students why the duration is 0.1 seconds
   a. The loop will only check for to see if the condition is met every time the code is finished, so if it checks to see if the touch sensor is pressed every 0.1 seconds instead of a longer time, then it will react more quickly to running into the wall
9) Have the students place another move block on the diagram after the for-loop as shown in **Figure 5**, the move block should have the attributes displayed in **Figure 6**
   a. Nothing should change
10) **Ask if the students have any questions**

Your Notes:

11) Have the students plug their robots into the computer and download the program onto the brick
12) Once the program is properly downloaded, the students can place their robots in front of a wall and run the program to show how the robot reacts to running into the wall

IV.   Activity – Creating a program to utilize an infinite loop with the touch sensor
SWITCH TO THE THIRD STUDENT

Tell the students that, in this activity, they will be creating a program utilizing the touch sensor to make the robot move forward until it runs into a wall. The robot will then back up, turn around and begin to move forward again.

1) Have the students open a new program
      a. File → New
2) Tell the students to place a loop onto the block diagram and then place a switch inside of that loop as shown in **Figure 7**
3) The details of the switch statement should match **Figure 8**
4) Have the students place 3 move blocks inside of the switch statement as shown in **Figure 9**
5) The details of each of move block should match **Figures 10-12** (each move block is labeled 1-3)
6) Explain to the students how the switch statement works and why the infinite loop is necessary
      a. The switch statement will follow a certain command based on the input given
            i. If the button is not depressed then it will move forward
            ii. If the button is depressed then it will back up and turn
      b. The infinite loop is necessary because it will constantly run the switch so that the program is always checking for one of the two states in the switch
7) **Ask if the students have any questions**
8) Have the students plug their robots into the computer and download the program onto the brick
9) Once the program is properly downloaded, the students can place their robots in front of a wall and run the program to show how the robot reacts to running into the wall
10) Make sure to explain to them that they just programmed the robot to do something very useful, and used today in technology
      a. This program can be related to the "Roomba : iRobot" vacuum cleaning system

V.   Discussion

A review of the lesson should include the following questions for the kids to answer

- How can we check the state of the sensor?
- Why do we put the move block to 0.1 seconds instead of just having the robot go for a longer period of time?
- What does a for-loop do?
- How does the switch statement work?
- Why do we need a for-loop around the switch statement?

Note to VSVS volunteers
Remember to pick up all 10 cables, all 10 robots, all 10 ziploc bags with touch sensors, and all 20 figure sheets. **Please erase the programs that have been downloaded to each of the bricks**

Your Notes:

VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE – ROBOTICS
http://studentorgs.vanderbilt.edu/vsvs/

Mindstorms Robotics
Lesson 4 (2019)

Sensors – Ultrasonic Sensor Challenge

Goal: To be introduced to the ultrasonic sensor, interfacing the ultrasonic sensor with the block, and making a program that utilizes the sensor.

Lesson Outline
I.   **General review and introduction**
Review of previous week's explanation and general overview of lesson goals
II.   **Activity – Building and attaching the ultrasonic sensor**
Students will put the ultrasonic sensor together and attach it to the robot
III.   **Activity – Creating a Program using the ultrasonic sensor and a switch statement**
Students will code a simple program to make the robot back away after activation of the ultrasonic sensor
IV.   **Activity – Creating a program to utilize an infinite loop with the ultrasonic sensor**
Students will code a program to make the robot run forever and back up and turn around when the ultrasonic sensor is activated
V.   **Discussion**
Review the results of the lesson and general terminology

Materials
10   Mindstorms robots with blocks
10   USB cables
10   ziploc bags with ultrasonic sensor and parts
10   ultrasonic sensor build sheets
10   figure sheets

I.   **General review and introduction**
Divide the students into 10 groups of 3
Note: Wait to hand out the materials until after the review and introduction

A review of the previous lesson should include the following questions for the kids to answer
- How can we make a program that repeats commands more simple?
- What does a loop do?
- What is a switch statement?
- How does the touch sensor work?
- What were the two programs that we made last time?

Explain to the students that we will be making the same program this week as we did in the last lesson, but instead of using a touch sensor we will be using an ultrasonic sensor.
-       Tell the students that the ultrasonic sensor can be used in a similar way as the touch sensor can be used

Explain what an ultrasonic sensor does and how it works
- The ultrasonic sensor can also be called a distance sensor
- The ultrasonic sensor measures the distance to an object in front of it
- The ultrasonic sensor can both send and receive signals, unlike the touch sensor which just receives signals

(For this next part I would advise drawing a simplified diagram to explain)
- The ultrasonic sensor sends out a high frequency sound wave (a sound wave that we cannot hear)
- The sound wave reflects off the surface in front of the sensor (if there is one) and returns to the sensor
- The ultrasonic sensor receives the signal back and can tell how far away that object is based on the amount of time the signal took to get back to the sensor

Briefly explain to the students that we will be doing the following:

Allowing the students to build and attach an ultrasonic sensor independently

Creating programs to utilize the ultrasonic sensor on their own

> **Note: As in, not step by step instructions like the previous lesson, but each tutor will walk around and help the students while they attempt to make these programs on their own**
> - Backing away from a wall when the sensor is activated
> - Backing away from a wall, turning around, and moving again when the sensor is activated

II.   Activity – Building and attaching the ultrasonic sensor
Allow the students to work on all the activities together

Tell the students that they will be following a set of instructions to build the ultrasonic sensor attachment that will be given to them and to follow these instructions

1) Hand out all of the materials
2) Tell the students to follow the instructions to build and attach the sensor to the robot
   - This should probably take about **8 minutes** to do, make sure to walk around and help the students with putting together the sensor attachment
3) Instruct the students to connect the ultrasonic sensor to the brick with the cord and to make sure that they plug the cord into the bottom of the brick in **SLOT 4**
4) Make sure that everyone has a built and attached sensor before moving on to the following activity

III.   Activity – Creating a program to utilize the ultrasonic sensor
Allow the students to work on this activity together

NOTE: These are the step by step instructions to follow in case the students are having trouble (the same as the previous lesson but with the ultrasonic sensor instead of the touch sensor), but otherwise for this lesson you should allow the students to attempt to create their own solution.
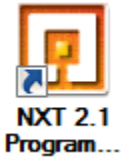
Your Notes:

Tell the students that, in this activity, they will be making a program utilizing the ultrasonic sensor to make the robot move forward until it recognizes that it is 5 inches from the wall at which point it will back away from the wall.

1) Tell the students to open **NXT 2.1 Programming** by double clicking on the following icon
2) Instruct the students to start a new program by typing **Ultrasonic Sensor** into the "Start New Program" box
3) Once a new blank program appears, instruct them to place a loop on the block diagram as shown in **Figure 1** by clicking on the loop button highlighted in **Figure 1**
4) Instruct the students to select the loop and at the bottom of the screen change the "Control" to "Sensor"
5) The details of this loop should look like **Figure 2**
   a. Sensor should be on "Ultrasonic Sensor"
   b. **Port 4** should be selected
   c. Until should have "5" Selected and "Inches" should also be selected
6) Explain briefly that until the ultrasonic sensor is closer than 5 inches to an object, what is inside of the loop will continue to repeat itself until that condition is met
7) Tell the students to place a move block inside of the loop **Figure 3**, the move block should have the attributes displayed in **Figure 4**
   a. Direction – Backwards
   b. Duration – 0.1 Seconds
   c. Next Action - Coast
8) Explain to the students why the duration is 0.1 seconds
   a. The loop will only check for to see if the condition is met every time the code is finished, so if it checks to see if the sensor is closer than 5 inches to the wall every 0.1 seconds instead of a longer time, then it will react more quickly to getting close to the wall
9) Have the students place another move block on the diagram after the for-loop as shown in **Figure 5**, the move block should have the attributes displayed in **Figure 6**
   a. Nothing should change when this block is placed on the diagram
10) **Ask if the students have any questions**
11) Have the students plug their robots into the computer and download the program onto the brick
12) Once the program is properly downloaded, the students can place their robots in front of a wall and run the program to show how the robot reacts to getting close to a wall

IV.   **Activity – Creating a program to utilize an infinite loop with the ultrasonic sensor**
SWITCH TO THE THIRD STUDENT

Tell the students that, in this activity, they will be creating a program utilizing the ultrasonic sensor to make the robot move forward until it approaches a wall. The robot will then back up, turn around and begin to move forward again.

1) Have the students open a new program
   a. File → New
2) Tell the students to place a loop onto the block diagram and then place a switch inside of that loop as shown in **Figure 7**
3) The details of the switch statement should match **Figure 8**
4) Have the students place 3 move blocks inside of the switch statement as shown in **Figure 9**

Your Notes:

5) The details of each of the move blocks should match **Figures 10-12** and each move block is labeled 1-3
6) Explain to the students how the switch statement works and why the infinite loop is necessary
   a. The switch statement will follow a certain command based on the input given
      i. If the sensor is not activated then it will move forward
      ii. If the sensor is activated then it will back up and turn
   b. The infinite loop is necessary because it will constantly run the switch so that the program is always checking for one of the two states in the switch
7) **Ask if the students have any questions**
8) Have the students plug their robots into the computer and download the program onto the brick
9) Once the program is properly downloaded, the students can place their robots in front of a wall and run the program to show how the robot reacts to approaching a wall
10) Make sure to explain to them that they just programmed the robot to do something very useful, and used today in technology
    a. This program can be related to the "Roomba : iRobot" vacuum cleaning system

V.   Discussion

A review of the lesson should include the following questions for the kids to answer

- How can we check the state of the sensor?
- Why do we put the move block to 0.1 seconds instead of just having the robot go for a longer period of time?
- What does a for-loop do?
- How does the switch statement work?
- Why do we need a for-loop around the switch statement?

Note to VSVS volunteers
Remember to pick up all 10 cables, all 10 robots, all 10 ziploc bags with ultrasonic sensors, and all 20 figure sheets

Please erase the programs that have been downloaded to each of the bricks so that the bricks do not become cluttered with programs

Your Notes: