Can Traffic Accidents be eliminated by Robots?

Elementary Science and Technology Grade 7
Teaching- learning Module for Unit Light and Sound

Abstract

This modules leads to a decision making activity related to ways to decrease traffic accidents. Robotics (in this activity, lego mindstorms NXT 2.0) is used where the main science background will be on the reflection of the light at the grade 6 and 7 level. The activity includes the construction of robots which are able to read different wavelengths of light using light sensor. Various sensors will add to constructed Robots (designed as a model car) and experiments are carried out to seek ways to prevent traffic accidents.

Sections Included		
1	Student Activities (for students)	Describes the scenario in more detail and tasks the students should perform
2	Teaching Guide	Suggests a teaching approach
3	Assessment	Gives suggested formative assessment strategies
4	Teacher Notes	Gives expectations of calculations to be carried out by students

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Overall Competencies: The students are expected to:

- Construct a robo-car, controlled by, light sensors for decreasing/increasing the speed of the car according to different- coloured roads and how to present the results in a tabular form/ diagrams.
- Write suitable computer programs using NXT 2.1 programming to control the speed of the car.
- Collaborate as member of a group in designing and carrying out appropriate activities from writing the computer program to solving problems associated with the use of the robot.
- Explain transmitted, absorbed and reflected light, for both white and coloured light and the purity of reflection from different coloured roads.
- Explain wavelength of light in the context of the electromagnetic spectrum and the manner in which light sensors function.
- Decide with justification, whether robots can be viably used to reduce the number of road accidents.

Curriculum Content: Transmission and reflection of Light; Light as part of the electromagnetic spectrum.

Kinds of Activity: Constructing a robo-car using lego mindstorms NXT 2.0; controlling the speed of the robo-car using suitable computer software related to light sensors; undertake additional experiments to determine the effectiveness of speed control the robo-car related to different coloured/material surfaces; undertake a group discussion so as to make a justified group decision on whether realistic (acceptable, cost effective, reliable) ways can be possible using light sensors to decrease the number of traffic accidents.

Anticipated Time: 4 lessons

This unique teaching-learning material is intended to guide the teacher towards promoting students' scientific literacy by recognising learning in 4 domains – intellectual development, the process and nature of science, personal development and social development. Its uniqueness extends to an approach to science lessons which is designed to be popular and relevant. For this the approach is intentionally from society to science to specifically meet student learning needs.

This uniqueness is specifically exhibited by:

1. a motivational, society-related and issue-based title (supported in the student guide by a motivational, socio-scientific, real life scenario);
2. forming a bridge from the scenario to the scientific learning to be undertaken;
3. student-centred emphasis on scientific problem solving, encompassing the learning of a range of educational and scientific goals;
4. utilising the new science by including in socio-scientific decision making to relate the science acquired to societal needs for responsible citizenship

Can Traffic Accidents be eliminated by using Robots?

Name:

STUDENT HANDOUT 1

Surname:

Class:

The Scenario

Road accidents cause many deaths in Turkey. There are many reasons for it. The most important reason is the drivers' inattentiveness when they are driving, especially in the late hours. Most Turkish drivers do not follow the traffic signs related to speed limitation and with increased cars on the roads, many traffic accidents have occurred in the past 10 years. According to the Security Department of Turkey, 4236 people died in 2008; 4324 people in 2009 and 4045 people in 2010 as a direct result of traffic accidents. Are you happy with these results?

Would you be interested in exploring ideas about ways traffic accidents can be reduced (and maybe eliminated)? Let us build robot cars and explore how science and technology might be able to play a role using light sensors.

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Your Tasks

Within the whole class:

1. Discuss the meaning of a light sensor and brainstorm ways a light sensor can decrease the number of traffic accidents.
2. Present information considered relevant from student group searches on the internet about the properties of light.

In groups:

1. Search the internet for information on the property of light, both white light and coloured light.
2. Construct a robo-car using lego mindstorms NXT 2.0 (following instructions?)
3. Integrate a light sensor to the robo-car (follow instructions or devise their own way?)
4. Use different coloured paperboard to make a road for testing the speed of the robo-car (straight or bending)?
5. Writing a computer program following a worksheet giving instructions (structured or guided or open guidance ?) for the light sensor using NXT 2.1 programming (which does what tasks – information given as structured/guided/open?) and upload it to the robo-car.
6. Test your cars' speed (open inquiry - no instructions? who decides the criteria for the numbers tests to be performed?) when it passes along different colored roads.
7. Check the reliability of outcomes on the different colour roads if road surface differs (smooth, rough, waxed, etc – who decides on the different possibilities?) or sloped (who decides on the actual slopes used?).
8. Discuss and test other factors that could influence the reliability of the light sensor to work. (Possibilities here could be (a) wavelengths too close (b) reflectivity too low)

As a class:

1. Presentation of each group's outcomes (how? – (a)from filming, (b)using power point slides, (c)oral report but data written on the blackboard accumulated across all groups), discussion and comparison of each group's outcomes (purpose of this ? –most effective program?)
2. Reach final conclusion on:
   How it might be possible to decrease/increase the speed of cars?
3. Discuss the feasibility of integrating the light sensors to all of the cars?
   Economically? Reliability in all conditions?

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4. Discuss the feasibility of colouring the traffic roads to limit the speed of the cars? Road maintenance issues?

STUDENT HANDOUT 2

The following steps/ questions are to help you to complete your project successfully:

1. What is light?
2. How is light reflected?
3. What is a light sensor?
4. How does a light sensor work?
5. How does a light sensor detects objects of different colours?
6. How does a light sensor send detected data from different coloured objects?
7. Which coloured objects absorb the light best?

Your task is to prepare a presentation using web or sources provided by your teacher and present them in classroom.

STUDENT HANDOUT 3

1. Please try to understand the working principle of light sensors using NXT 2.0. You will find some technical details of light sensor presented in figure 1.

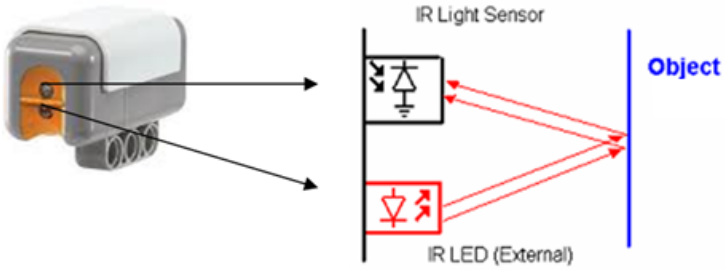

Figure 1. The technical details of a light sensor

2. Please find the percentages of reflected light using light sensor and fill in the table below.

Colour of carton	Percentage of reflection
Red	
Yellow	
Blue	
Green	
White	
Black	

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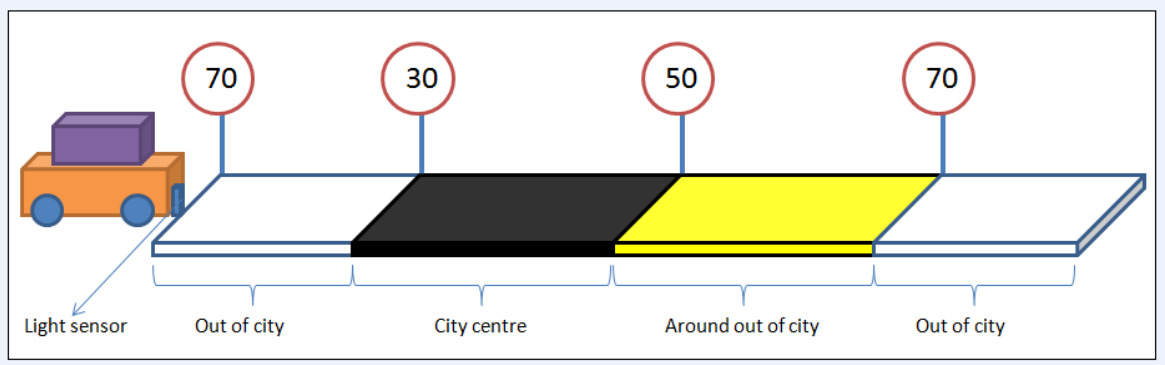
3. Please decide two colours which are absorbed by light sensors in most and in less.

STUDENT HANDOUT 4

1. Please make a robo-car using Lego Mindstorms NXT and blocks. Attached you can find an example to construct a robo-car.
2. When you complete your robo-car, please integrate the light sensor to the car.
3. Please upload the NXT program to your robo-car using USB cable.
4. Please test your robo-car on the roads which is coloured in two different colours.



(It is just an example, you can change the colours whatever you want)

Please note that your robo-car must decrease the speed when it passes the black road and increase the speed when it passes the yellow road. In order to do it, you have to change the power of two engines of the NXT.

You can find the construction steps for robotic-car: **Appendix 1**

5. Write an appropriate program using NXT 2.1 programming.
The Instruction Steps for Programming the robotic car: **Appendix 2**

STUDENT HANDOUT 5

Now it is time to::

1. Discuss the feasibility of colouring the traffic roads to limit the speed of the cars? Road maintenance issues?
2. Discuss the possibility of integrating the light sensors to all of the cars? Do you think that it is economic?

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TEACHING GUIDE

The activity relates to:

- Exploring the reflection of light on the different surfaces.
- Understanding the absorption of the light on the different surfaces.
- Understanding the function of light sensor.
- Introducing the concept of light.

Lesson Learning Outcomes

Lesson 1
At the end of this lesson, students are expected to be able to:

- Be familiar with NXT 2.0 programme
- Construct the robot kits for robo-car

Lesson 2
At the end of this lesson, students are expected to be able to:

- Understand the working principles of light sensor
- Integrate the light sensor to the robo-car
- Prepare different coloured paperboard to make a road for testing the robo-car

Lesson 3
At the end of this lesson, students are expected to be able to:

- Notice that light is absorbed by the object at the end of the interaction between object and light
- Know that why different coloured paperboards are used for testing the speed of robo-car
- Explore the light is absorbed more with dark colour

Lesson 4
At the end of this lesson, students are expected to be able to:

- Understand the reflection of light
- Understand the absorption of light
- Determine the colours which absorbed much light

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Suggested Teaching Strategy

1. Lesson begins with the socio-scientific issue which occurs in the scenario.
2. Teacher explains the role of robotics and light sensor for solving the problem in the scenario and gives information about this.
3. Students who are divided into groups (maximum 5 students) construct a robotic car by using robotic kits and integrate light sensor to the robotic car.
4. Students write a suitable computer programme by using NXT 2.1. They upload them to the robotic car.
5. Results are discussed in the classroom by students.

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ASSESSMENT

This guide to assessment strategies is put forward from different perspectives. In part 1 the assessment is based on the skill to be developed in the student. Part 2 is based on the assessment strategies to use in each lesson and illustrates the assessment which a teacher may use for formative assessment like observation.

Part 1 Assessment based on Skills

Skills	Degrees				
	Low (1)	Acceptable (2)	Mean (3)	Good (4)	Perfect (5)
Social Values					
Able to distribute the tasks within the group					
Able to perform teamwork					
Able to contribute to the discussion in a meaningful way					
Personal Skills					
Willing to perform the project					
Able to think critical					
Able to be creative					
Able to present the subject in an interesting way					
Able to have self-confidence during the presentation					
Willing to present the subject to the class					
Able to indicate opinion when asked					
Using Science Method					
Able to apply different sources to gather information					
Able to make the observations carefully					
Able to determine the purpose of the project					
Able to make an appropriate working plan for the project					

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Able to analyze data collected					
Able to make inferences					

Part 2 Assessment based on lesson

	Dimension	Criteria for evaluation	Mark/grade given
Lesson 1	Make Arrangements	Searches for answers to the questions given in Student Handout 1 and discuss with group members	
		Prepares to use Lego Mindstorms NXT 2.0	
Lesson 2	Construct robo-car	Presents the answers of questions given in Student Handout 1	
		Carries out simple experiments with NXT programme	
		Uses appropriate blocks for constructing a robo-car	
		Integrates the light sensor to the robo-car	
Lesson 3	Testing robo-car	Determines the percentage of reflected light for each colour given in Student Handout 2	
		Makes appropriate instructions and uploads them to the robo-car by using NXT programme	
		Tests the robo-car on different coloured 'roads'	
Lesson 4	Make conclusions	Draws appropriate conclusions related to the robo-car	
		Gives opinions about decreasing the number of traffic accidents by using robots	

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TEACHER NOTES

For the Lego Mindstorms NXT 2.0

- The students should have background information about Lego Mindstorms NXT 2.0 and its working principle to work with them.
- It will take one hour class time to teach your students about Lego Mindstorms if they do not have such background.
- The detailed information can be found on the Lego Mindstorms NXT 2.0 web page: www.mindstorms.lego.com

For the Science and Technology Curriculum

- It is useful to show different equipment which has a light sensor.
- It is also useful to show traffic accident videos and some statics about traffic accidents.
- It is useful to show some about light (especially reflection of light).

Light

Light is made of billions of tiny particles called photons. These photons travel from one place to another in waves. Visible light is the subset of photons that move at a wavelength that we can see. Among the different photons that are in visible light, the ones that have the longest wavelength look red to us, and the ones that have the shortest wavelength look blue to us. All colours come from different wavelengths of light.

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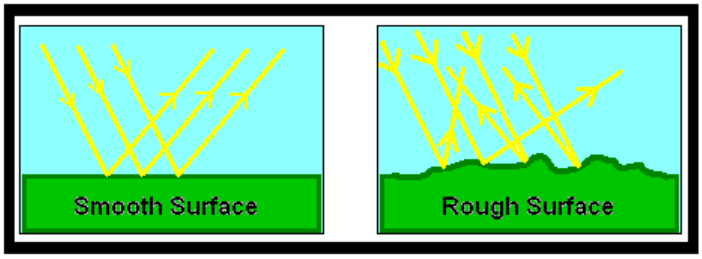
Reflection of Light

Reflection occurs when light bounces off objects. How much reflection depends upon how even the surface is. If the surface is rough, the light scatters. If the surface is smooth and flat, the light will bounce off it at equal angles. That is why a flat mirror reflects a good likeness of the object being reflected.

Look at the diagrams below. Notice the angles at which the light (shown as rays) strikes the surfaces.



Light Sensor Block

This sensor detects ambient (surrounding) light. Using data wires, it can send out the current light value and a logic signal (true/false) based on whether the current light value falls above or below a trigger point.

A trigger point is the specific value in a range of numbers where a change in condition occurs. For example, you might program your robot to move forward only when the light level rises above 60%. The trigger point would be 60.

Specify the trigger point by using the slider or by typing a number into the input box. To specify the range (above or below the trigger point) that will generate the “true” signal, use the radio buttons or the pull-down menu. The “true” portion of the range will be in colour; the “false” portion will be gray.

The default setting for the light sensor block is for light levels above 50% to generate a “true” signal. The radio button to the right of the range is selected and the slider is set at 50. To switch the “true” portions of the range (setting values below 50% as “true”), you would select the left radio button.

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The feedback box in the configuration panel shows the current light value. (To receive feedback, make sure that the light sensor is connected to the chosen port and that communication has been established with the NXT.)

You must drag at least one output data wire from this block's data hub to another block for any information to be sent. (See the Data Hub section below for more information.)

Tip: How do I set the Trigger Point for a Light Sensor?

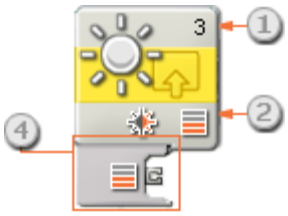
If you want a flashlight pointed at your robot to generate the "true" signal, try pointing a flashlight at your robot a few times and watching the light values displayed in the feedback box. If the flashlight generates light levels of around 80%, you might set the trigger value at 70. That way, bright light above 70% (like from the flashlight) will generate a "true" signal. Weaker light will be ignored.

The trigger point can also be set dynamically with an input data wire.

Detecting the Light Sensor's own Reflected Light

If you check the "Generate Light" checkbox, the light sensor will turn on its own small light source and detect this light if it is reflected back to it. This function is especially useful in difficult lighting conditions like very bright rooms. The function also allows the light sensor to serve as a short-distance range finder. With "Generate Light" turned on, a light sensor approaching a reflective object will detect higher reflected light levels. Therefore, it is possible to use the sensor to avoid running into obstacles.

Display Settings



1. The number shows which of your NXT's ports are connected to the light sensor. You can change this number in the configuration panel if you need to.
2. This icon indicates at what level the trigger point is set. The more coloured bars displayed, the higher the trigger point.
3. This icon is displayed if "Generate Light" is turned on.

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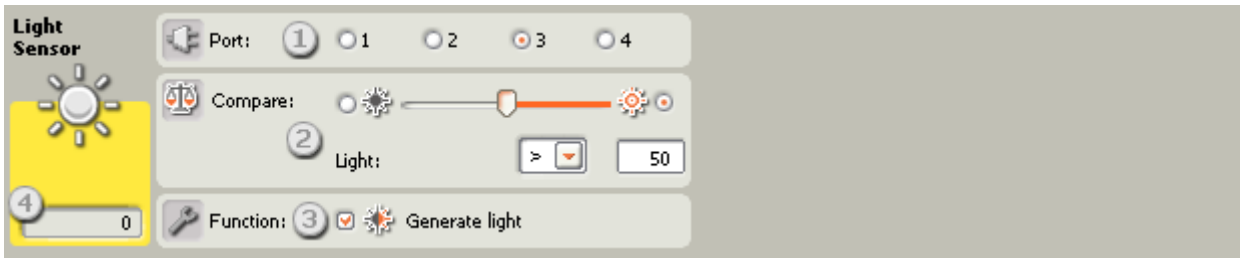
4. The block's data hub will open automatically when the block is placed in the work area. At least one data wire must be dragged from the block's output plug to another block's data hub. (See the Data Hub section below for more information.)

Configuring the Light Sensor Block



1. Choose the port where your light sensor is plugged in. By default, the block will be set to port 3 for a light sensor. You can change this selection if you need to.
2. Use the slider to set the trigger value or type a value directly into the input box. Select the radio button to the right of the slider if you want the block to be triggered by light levels higher than the trigger value; select the left radio button to trigger the block with light levels lower than the trigger value. You can also use the pull-down menu to set the "true" portion of the slider.
3. If you check the "Generate Light" checkbox, the light sensor will turn on its own small light source and detect this light if it is reflected back to it.
4. The feedback box displays the current light reading (0-100%). You can use it to try out different trigger values.

Configuring the Light Sensor block's Data Hub

You can control the Light Sensor block dynamically by connecting data wires (from other blocks' data hubs) to the Light Sensor block's data hub.

Open a block's data hub by clicking the tab at the lower left edge of the block after it has been placed on the work area.

Data wires carrying input information to a block are connected to the plugs on the left side of its data hub. Data wires carrying output information are connected to the plugs on the right side.

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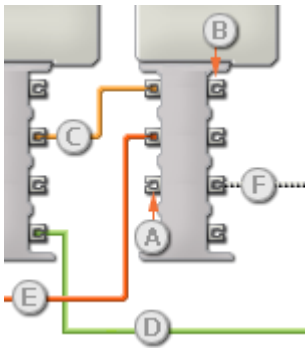

[A] Input plug
[B] Output plug
[C] Number data wire (yellow)
[D] Logic data wire (green)
[E] Text data wire (orange)
[F] Broken data wire (gray)

Passing data from the input plug to the output plug

If an input plug has a corresponding output plug (see A above), the input data will pass through from the input plug to the output plug without being changed. In this case, you can only use the output plug if the input plug is connected to an input data wire; connecting an output data wire to such an output plug without a connected input data wire will cause the output data wire to be "broken" (and coloured gray).

Data wires carry specific types of data

Each data wire carries a specific type of data between blocks. For example, if a data wire is dragged from a logic plug on a block's data hub, it can only be connected to a logic plug on another block's data hub. The chart below shows what kind of data each plug can accept or send out.

Data wire colours

Data wires are identified with specific colours: wires carrying number data are coloured yellow, wires carrying logic data are coloured green, and wires carrying text data are coloured orange.

"Broken" data wires

If you try to connect a data wire to a plug of the wrong data type, the data wire will be broken (and coloured gray). You will not be able to download your program if a data wire is broken.

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If you click a broken wire you can read why it is broken in the small help window in the lower right corner of the work area.

Data must be within the possible range of the plug

If an input data wire transmits a value outside the possible range of the plug it is connected to, the block will either ignore the value or change it to a value within its range. For plugs that allow just a few input values (example: just 0, 1, or 2), the plug will ignore the input if a value arrives outside its range.

For plugs that accept larger input ranges (example: 0 – 100), the plug will force any input outside its range to fit. For example, if a Move block's Power plug receives an input value of 150, the block will change the input value to 100 (i.e., a number within the Power plug's range).

This chart shows the different characteristics of the plugs on the Light Sensor block's data hub:

	Plug	Data Type	Possible Range	What the Values Mean	This Plug is Ignored When...
	Port	Number	1 - 4	1 = Port 1, 2 = Port 2, 3 = Port 3, 4 = Port 4	
	Trigger Point	Number	0 - 100	Value to compare against	
	Greater / Less	Logic	True/False	Logic used in comparison. True = Greater, False = Less	
	Generate Light	Logic	True/False	Determines if the sensor's own LED is on or not	
	Yes / No	Logic	True/False	Result of comparison	
	Intensity	Number	0 - 100	Scaled value read from sensor.	
	Raw Value	Number	0 - 1024	Raw (unscaled) value read from sensor	

Colours and Light absorption

Dark colours do not exactly absorb more heat, but they do convert a higher percentage of light into heat. If you notice when heading out in the sun with a dark

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coloured shirt it gets hot, where a lighter coloured shirt would not get nearly as hot. This is due to the amount of light being absorbed by the colour. The lighter the colour, the smaller the range of visible light being absorbed and converted into heat.

White objects reflect all visible light, where black objects absorb all visible light. This is also why we call both dark coloured objects and poorly lit objects dark.

While colour is a factor of light absorption, it is not the only factor. You will find that some dark objects remain cooler in direct sunlight then other lighter objects. This is due to the fact that there are other factors at play, maybe one material is a poorer insulator; possibly there is a shine to darker object, leading more light to be reflected as a result. But if all but the colour is the same, you will find that darker colours do become hotter when exposed to light.

References

http://www.historyforkids.org/scienceforkids/physics/light/
http://wiki.answers.com/Q/Why_does_a_dark_colour_absorb_more_heat_than_white
http://users.sch.gr/gkevasi/nxt/light_sensor_block.htm
http://www.myschoolhouse.com/courses/O/1/36.asp

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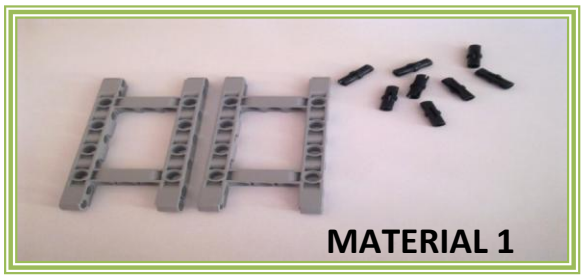
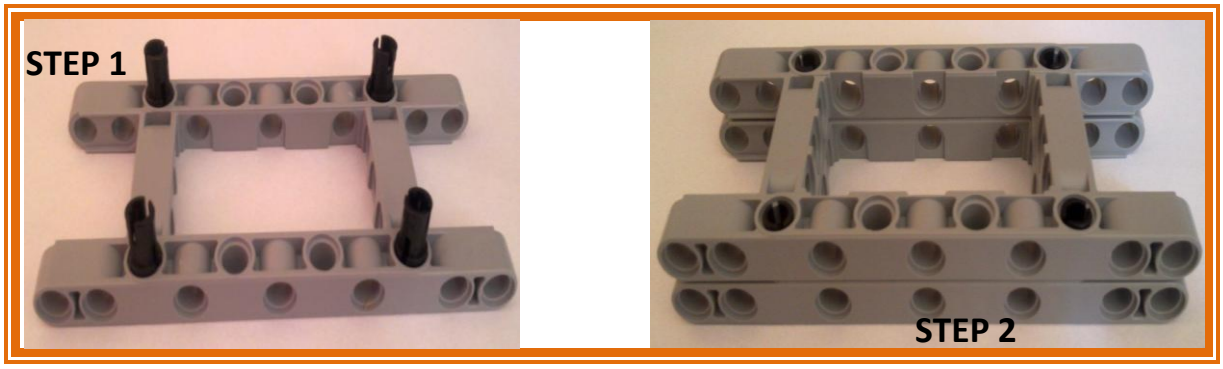
APPENDIX 1:

CONSTRUCTING A ROBOTIC-CAR WİTH COLOR SENSOR





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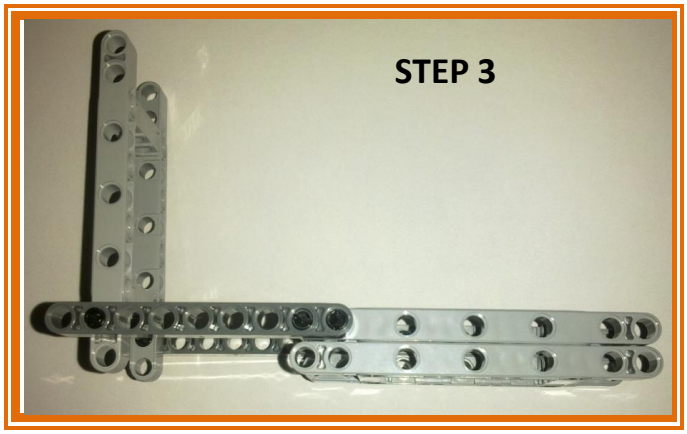

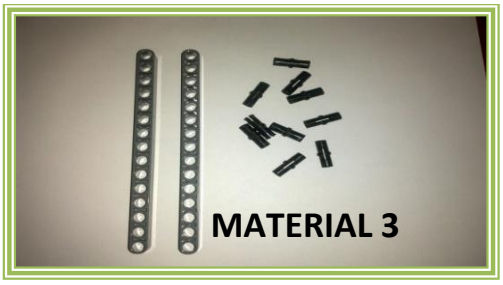

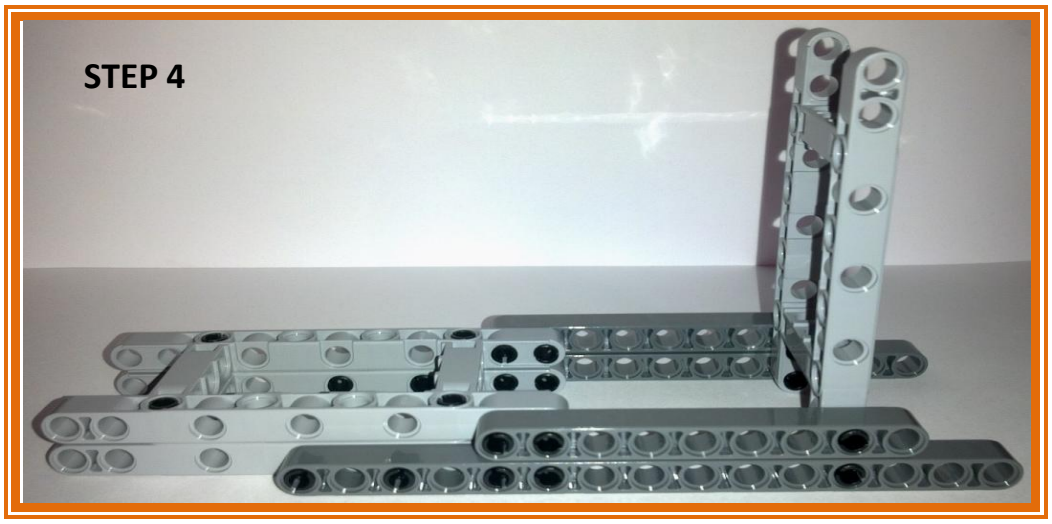

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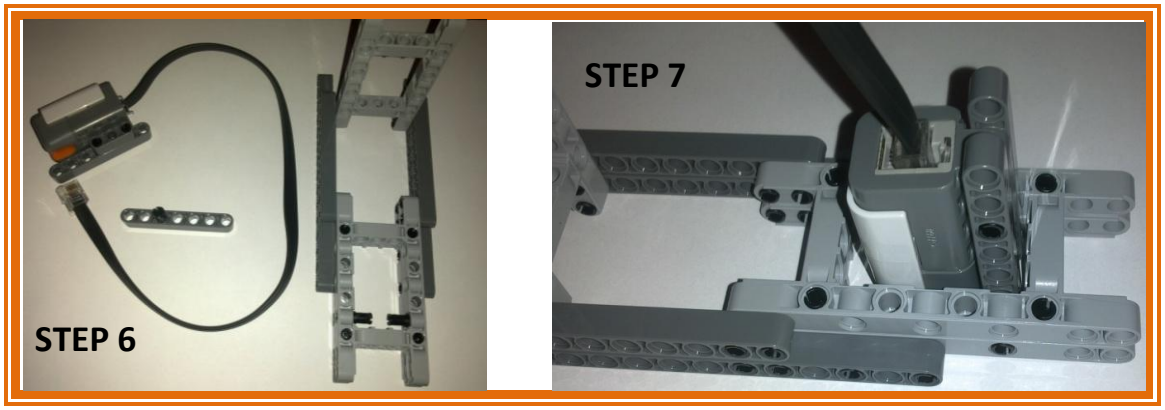

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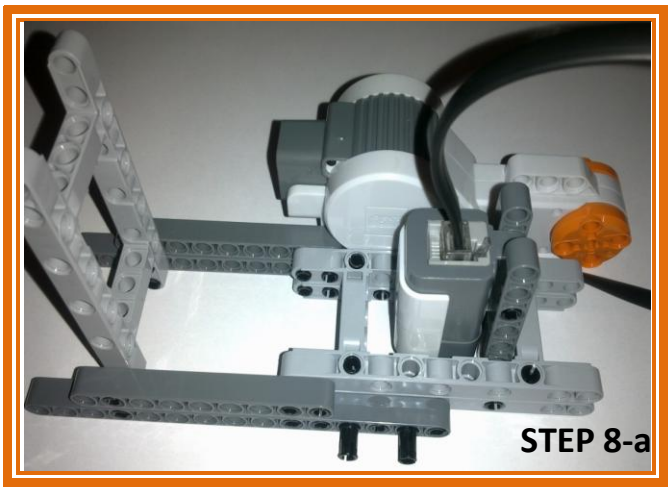

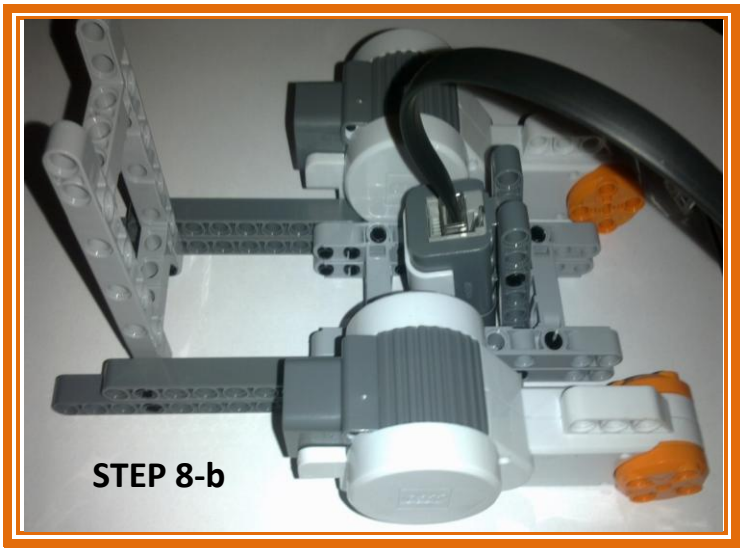

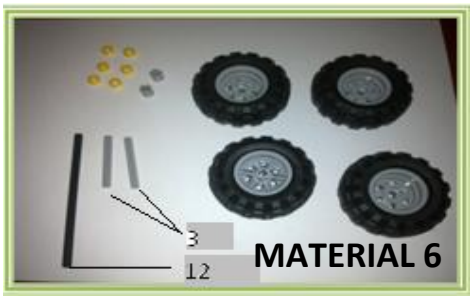

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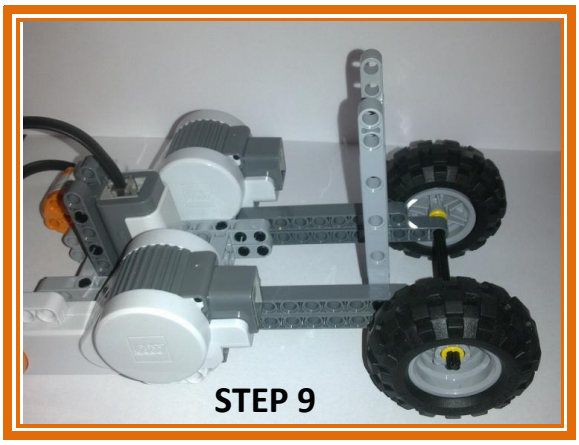

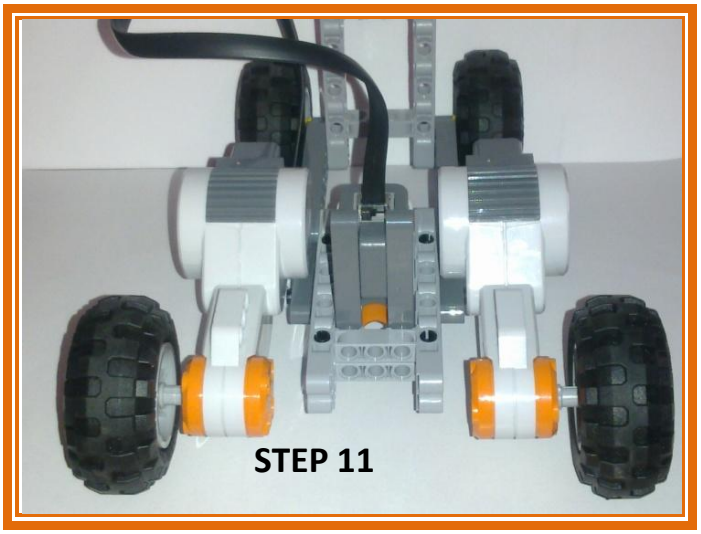

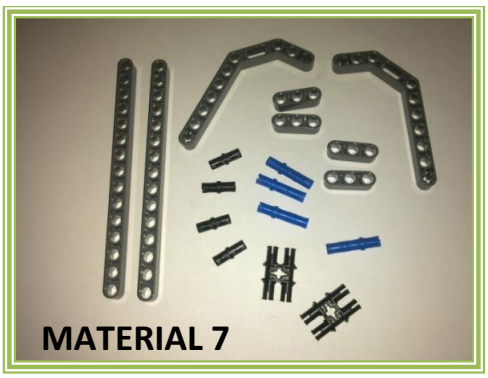

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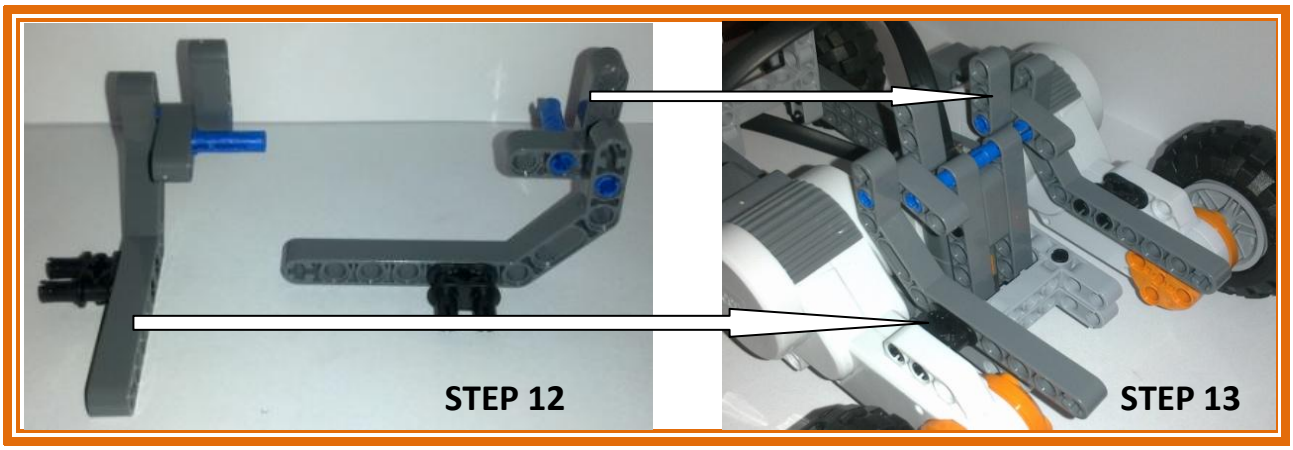

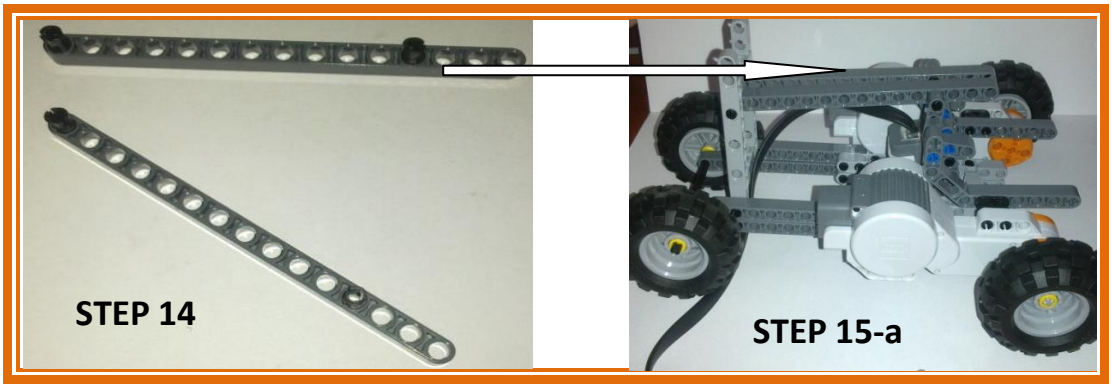

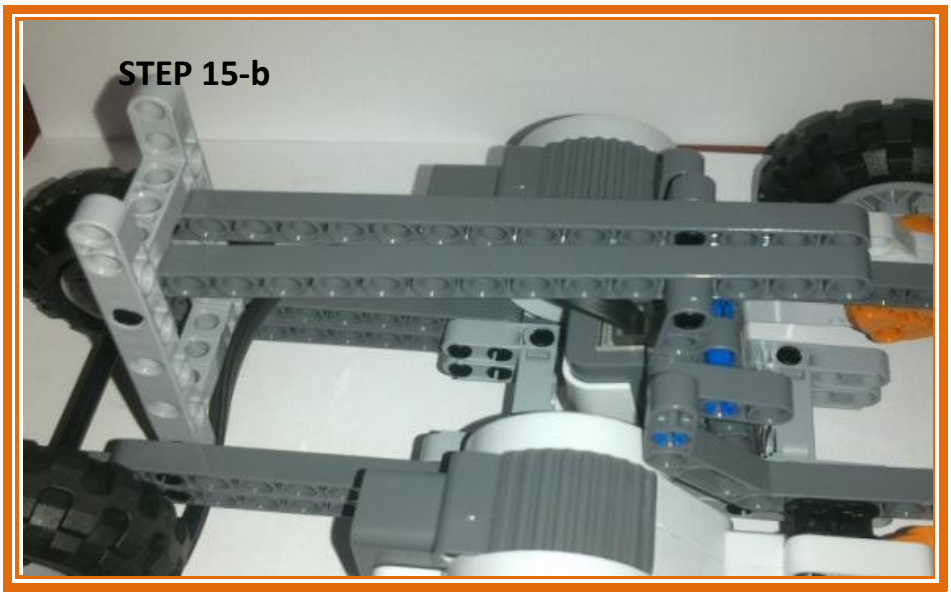

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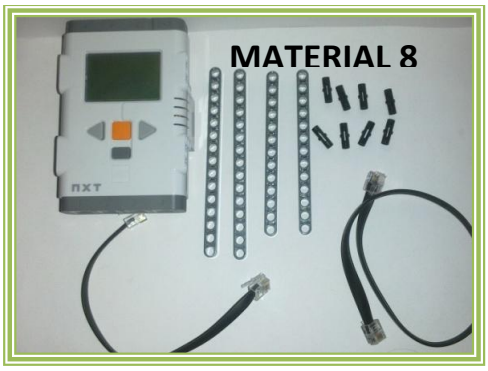

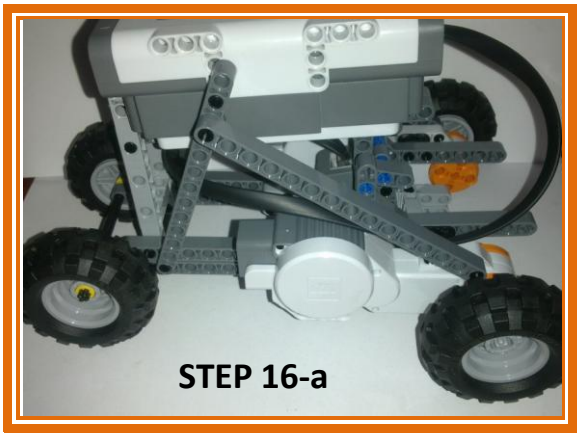

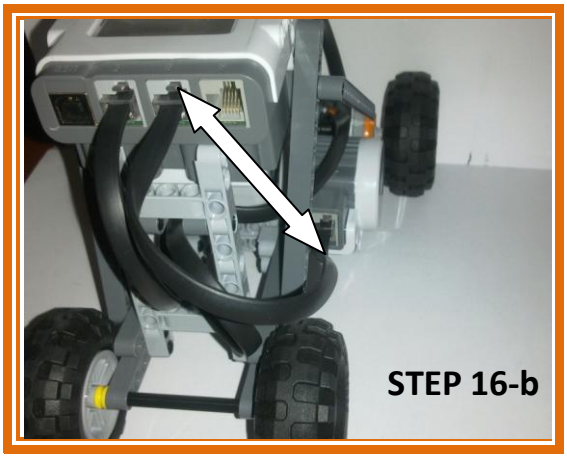

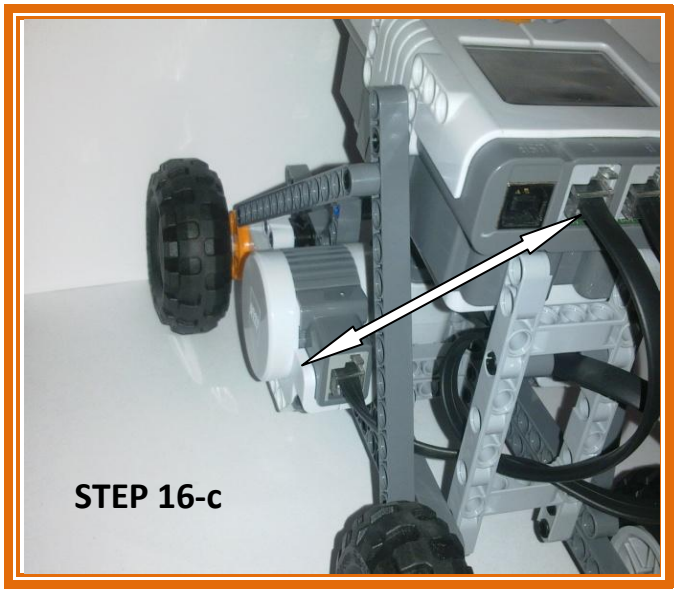

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APPENDIX 2: Programming Robotic car

Move: Allows robot's movement

Record/Play: Records sound and plays it

Sound: Allows robots make different sounds

Display: Allows to monitorize writing on robot's screen

Wait: Allows robot stop for a while

Loop: Allows to replay action.

Switch: Allows robot to select one of two actions

Programming Steps

1. Click the "Move" button and add the icon on your programming table. Then following:
   - Choose B and C ports for engines
   - Choose "forward" in "directions" part
   - Set the engine power to 75 in "power" part
   - Change the selection as "unlimited" in duration part

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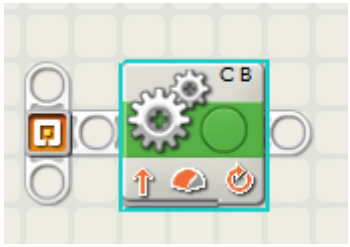
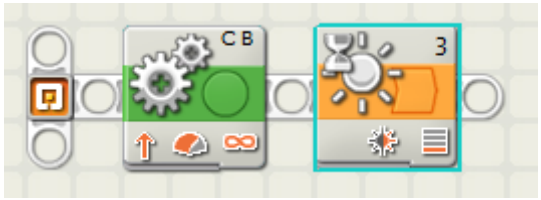


2. Choose light sensor in “wait” part of the left menu. Then the following:
   - Choose “sensor” in “control” part
   - Set the sensor as “light sensor” in “sensor” part
   - Choose “port 1” for light sensor
   - Set the light option as <30 in “until” part
   - Choose “generate light” in “function” part



3. Click the “Move” button and add the icon on your programming table. Then following:
   - Choose B and C ports for engines
   - Choose “forward” in “directions” part
   - Set the engine power to 25 in “power” part
   - Change the selection as “5 seconds” in duration part
   - Choose “brake” in “next action” part

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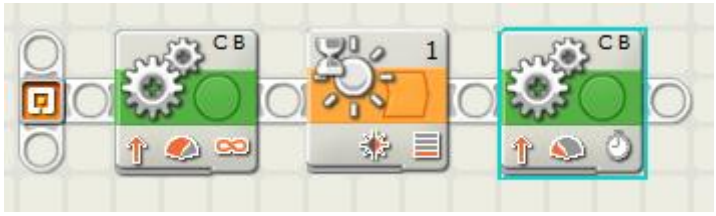

4. Choose light sensor in “wait” part of the left menu. Then the following:
   - Choose “sensor” in “control” part
   - Set the sensor as “light sensor” in “sensor” part
   - Choose “port 1” for light sensor
   - Set the light option as >30 in “until” part
   - Choose “generate light” in “function” part

5. Click the “Move” button and add the icon on your programming table. Then following:
   - Choose B and C ports for engines
   - Choose “forward” in “directions” part
   - Set the engine power to 75 in “power” part
   - Change the selection as “10 seconds” in duration part
   - Choose “brake” in “next action” part

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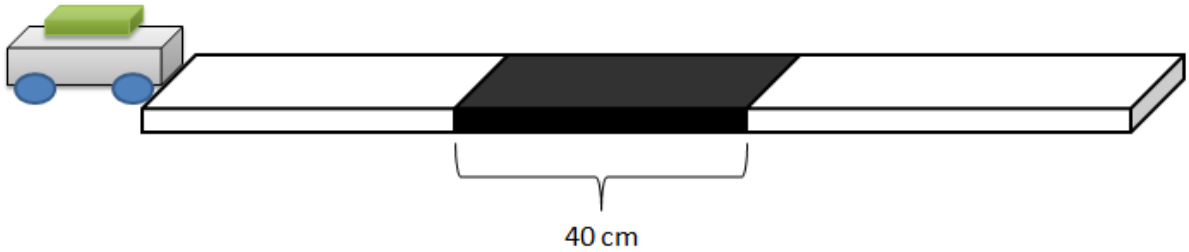
6. Then connect your NXT to computer and click “Download” button and program will be uploaded to your NXT.

7. Stick your white and black paperboards on the floor. The white ones can be as long as you want but black one should be 40 cm.



8. Put the robot on the road and push “Run” button on NXT.

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