

# MODULE 2.1: THE LEGO BOOST CONSTRUCTIONS

CODESKILLS4ROBOTICS: Promoting Coding & STEM Skills through Robotics: Supporting Primary Schools to Develop Inclusive Digital Strategies for All

IO2: CODESKILLS4ROBOTICS Dual Digital Educational Back Pack for Primary Schools

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# 1. Building and Programming Small Robots

In Module 2, the focus is on the implementation of the four (4) creative scenarios. In these scenarios the pupils will use three (3) of the main constructions of the Lego Boost kit, namely, Vernie, M.T.R.4 and Guitar 4000. First though, they must build them and get familiar with their capabilities.

This process will mainly take place through the application provided by Lego. The Lego Boost app is designed to provide students with step-by-step instructions on both assembly and basic functions for each construction. The consortium has prepared extra material explaining in detail the step-by-step guide capabilities of these robots. This material acts complementary to the app so that students can better understand what they are building with Lego and its capabilities. This part comprises the first chapter of Module 2.

#### 1.1 The Lego Boost Constructions

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In the following links, you can find the documentation (pdf files) we have also prepared with instructions on how to build in a step-by-step process the five (5) main constructions of Lego Boost that you can find in the following links:

- 1. Vernie
- 2. <u>M.T.R.4.</u>
- 3. <u>Guitar4000</u>
- 4. Autobuilder
- 5. Frankie the Cat

The purpose of these pdf files is to replace the Lego Boost App only for the construction (building) of the robots in the case where either the teacher wants to minimize the use of tablets by the students or the Lego Boost App crashes for some reason.

As it has been mentioned before, for the purposes of this project and its four (4) creative scenarios, only the first three (3) constructions will be used (Vernie, M.T.R.4 and Guitar 4000).



### 1.2 Vernie

#### 1.2.1 Vernie's Movement and Communication

Vernie can move his head and move himself around. He can also communicate by using small phrases and questions.



The above program controls Vernie's head movement. The first block controls the speed of the left side movement and the second the speed of the right side movement. The third block, makes Vernie utter a small phrase.





In the second program Vernie moves himself around. You can control the "steps" of the movement and the degrees of the turns. You can also make Vernie swing around himself.

Notice the last two blocks. Is there any difference between them?

There are many ways that can trigger Vernie to act. In the following program, two new ways are demonstrated (Orange Blocks).



The program is activated when we shake Vernies' hand. It makes Vernie say hello, move a "step" and ask a question. Then he waits until the second orange block has been activated. This block uses the sound sensor to determine the level of sound. When the sound reaches the selected level, the block is activated and the rest of the program runs.





#### 1.2.2 Vernie as a Cowboy

#### Shoot the Target



With the blue block, Vernie shoots an arrow.



The second block makes Vernie wait and aim until you clap your hand. The moment he hears the sound, Vernie shoots the arrow.





The above program makes Vernie enter in a duel with you. You need to be prepared and push the button quickly.



With this program, Vernie rotates in a random mode until he shoots.



#### 1.2.3 Vernie as a Police Officer



With the above program, police officer Vernie uses different triggering conditions. The first loop makes Vernie walk around until a sound or an obstacle is detected. Then a subprogram is activated.



With the above program Vernie asks you some questions (cop questions). The interesting thing here is that in the last block of the program cop Vernie is using a random phrase.



#### 1.2.4 Vernie as a Dancer

With this program, Vernie creates a disco atmosphere and starts dancing when he hears music.



You can make Vernie dance as you want. The above program is just an example. There are no rules, but always keep the music playing!!!





#### 1.2.5 Vernie as a Singer



You can record anything you like and Vernie will sing it. On the microphone section block, you will find the record function. Every time you record something, a new voice block is created and you can use it on Vernie.

The green blocks used in the above program make Vernie move his head in random.

There is a huge variety of sounds in the purple and blue block sections. Just be as creative as you can...

Try to run this program and you will understand what we mean by that...











## 1.2.6 Vernie as a DJ



Use sound effects with the above program.





#### 1.2.7 Vernie as an Athlete

#### Vernie is racing

You can control Vernie through your tablet with the following program. Just push the button to accelerate and use the slider for steering.







# Vernie is playing golf

Play some golf with Vernie. This program allows you to control his stick.







#### Vernie is a Boxer

With this program, every time you push the button Vernie will give a punch.







#### 1.2.8 Vernie's Sub-programs



On the blue block section, there are some blocks that contain sub-programs. When you choose those blocks, a blue program window pops up. In this window, you can see the program that is "hidden" inside the block. You can always modify these blocks as you like, by clicking on the blue window.





#### 1.3 M.T.R.4

#### 1.3.1 M.T.R.4 the Lifter



With the above program, we test the lifting arm of the vehicle. The first block detects an object near the sensor. When an object is detected, the next blocks of the program are executed and the object is lifted.



In the turquoise area of the menu, we can find the block, which allows us to operate the vehicle via the tablet. We can use this function in combination with other functions.



In the above example, we can operate the vehicle with the tablet and when it encounters an object, it automatically lifts it.

#### 1.3.2 M.T.R.4 the Destroyer



By making the appropriate modifications you can turn the M.T.R.4. into a destruction machine. With the program shown in the figure above, every time the vehicle detects an object near it, it hits it with the hammer.



You can also use this feature in combination with other functions. For example, the above program makes M.T.R.4 move straight and every time it finds an object in its way, it smashes it.



#### 1.3.3 M.T.R.4 Attack with the Catapult

You can use the vehicle's hammer in numerous ways. For example, you can make a catapult out of Lego pieces and use the hammer to trigger it. You can use the joystick widget to control the vehicle. When M.T.R.4 is in the right position, you can press the button to activate the hammer.







#### 1.3.4 M.T.R.4 Search and Destroy

You can program your robot to search the area around it and destroy whatever objects it finds. With the following programs, our M.T.R.4 does that in two completely different ways.

In the first program, we use a "forever loop" to make M.T.R.4 move around and a sensor-triggering block, which activates the hammer each time an object is detected.



In the second program, we use a different approach in order to make M.T.R.4 search the area around it. By using the turquoise block shown in the image below, we set our vehicle to move straight ahead until it meets a wall, while using the distance sensor to detect objects in front of it. Then it makes a step back, rotates itself for 90 degrees and continues its way.







# 1.3.5 M.T.R.4 Racing

With the following turquoise block, you can take control of M.T.R.4 to race through a track.



Hold down the Button Widget to speed up, let it go to slow down and use the Slider Widget to control the steering.









#### 1.3.6 M.T.R.4 Racing Challenge

You need to make a track suitable for this Challenge. Each contestant will have a specific time to get to a checkpoint. If the M.T.R.4 arrives on time, the timer will be reset to give you time to reach the next checkpoint etc. Every mistake makes you waste time and if you fail to get to the checkpoint on time, the game is over. The following program does just that.

In the first row, the turquoise block starts the timer for a specific number of seconds (we chose 10 seconds but it is actually up to you to decide). In the third group of blocks, we have a triggering mode that requires the detection of the color blue (you can always choose another color) by our color sensor. When that happens, the turquoise block resets the timer to its original value (10 seconds). Therefore, our checkpoints need to be colored blue (for example a blue post it on the ground) in order to reset the timer.



We could make the challenge even more interesting with some adjustments. For example at some point along the way, you can add a target that the vehicle should aim for.

In the following program, we have added a new triggering mode, which shoots the arrow when we clap our hands. It is up to you to add as many more tasks as you want.











# 1.3.7 M.T.R.4 Joystick Configuration

You can configure the joystick widget to control the M.T.R.4 in other ways. In the following program, we added two turquoise blocks. The first block is checking if the joysticks' button is pressed and when the condition is met, M.T.R.4 shoots the arrow. The second one allows us to control the vehicle with the joystick.



You can also use these configurations in the previous challenge (Racing Challenge).







#### 1.3.8 M.T.R.4 Program Trees

In the yellow section of the menu, you will find two blocks with a flag on them. One of them can be used inside a program and the second one is a starting method block. When a program activates the first block, the starting method with the same number is running.

For example, the following program is designed to help you remove any leftover Lego pieces on your play mat. The first group of blocks is activated only once at the start of the program. The M.T.R.4 makes a step forward and then the flag block is activated.

The vehicle rotates itself for random degrees and then it moves for five steps forward. If the sensor detects the color red (the boundaries of the cardboard are painted red) the vehicle stops, makes a step back and the flag start method is activated again. This way, our vehicle always stays within the limits of the cardboard.







#### 1.3.9 M.T.R.4 Record and Playback Sounds

In the purple section of the menu with the microphone image, you will find a block, which allows you to record a sound. After that, a new sound block is generated and that sound can be used.



Here is an example of a program, which makes M.T.R.4 rotate itself while it generates the sound, just like dancing or maybe yelling. There are unlimited opportunities to use this block... Give them a try!





Of course, there are a number of prerecorded sounds for you to use and you can use them with all the starting methods.

In the following program, we make the M.T.R.4 react to the clap of our hands. It makes a step forward and produces a sound in response.







#### 1.3.10 M.T.R.4 Sub-Programs

The grey section of the menu is the section of the sub programs. There, you can create a custom block and use it in your programs.

This kind of blocks are very useful when you want to use a coding block chain often. In that case, you do not need to put together all the blocks repeatedly. You just make this block chain in a custom sub-program block and use it as often as you want. With this method, your coding is much simpler and you avoid repeating yourself, which is one of the fundamental principles of programming.





In this section, you can add a block and customize it. A dark blue background shows that you are in "customizing mode".







When your custom block is ready, you can find it in the grey section of the menu. It



will always be there for you to use it whenever you want in your programs.





#### 1.3.11 M.T.R.4 Time Your Challenges

In the orange section of the menu, you will find the display widget, which shows at the display a number. In the following program, we have used this block in order to show the timer. Pay close attention to the fact that we have to put the block inside a forever loop in order for this command to work.







# 1.4 Guitar 4000

#### 1.4.1 Guitar 4000 Automated Tempo

With these orange blocks, the Guitar plays chords automatically. The notes to be played depend on the position of the controller. Different play modes are available depending on the blue blocks used.

Try all the blocks in order to find the one you like the most!!!





# 1.4.2 Guitar 4000 Triggering Modes









You can use your Guitar as a real one. By using the orange block shown in the pictures above you can trigger the Guitar to play several chords. As in the previous mode, you can use different blue blocks to choose the sound you like.





#### 1.4.3 Guitar 4000 Assigning Different Colors to Different Sounds

Why settle for just normal guitar sounds?

If you take a close look at your guitar you will find that depending on where the slider is situated, there is a color Lego flat piece. You can assign each color a different sound by using the purple blocks. Give it a try and make your guitars' sound unique!!!





# 1.4.4 Guitar 4000 Loops and Effects









You can combine the "forever" loop with the effect blocks located at the purple section of the interface. You can use these effects with the instrument of your choice. You can also choose how the effect will be triggered and adjusted, by simply connecting the purple effect block with one of the little orange blocks, as seen in the figures above.





#### 1.4.5 Guitar 4000 Record

You can also record your own sound and use it with your guitar. In order to do that, you need to select the block located at the dark purple menu, as shown in the figure below.



Selecting this block will activate the application in which you can record and edit a sound.

















When you finally have the sound you want ready, you can save it as a new purple block, which will always be available in the sound menu to use it any way you want.





# 1.4.6 Guitar 4000 Accompanying Musical Instruments







#### 1.4.7 Guitar 4000 Repeat Chords Game

You can rehearse by using the following program. By activating it, your guitar will play three chords, while at the same time the guitars' led (lamp) will show the position of the slider that corresponds to each one. Then you have to repeat the sequence correctly. If you make a mistake you have to repeat the effort until you do it right.



You can also use the following program to create a game in which you must be able to repeat an increasing number of chords.



With the following program, you can make a game that will automatically increase its difficulty. In this program, we use a variable to set the number of chords you need to repeat starting by 3. Then, by using a forever loop, we increase the number of chords



you need to repeat by increasing each time you succeed the value of the variable by one.



