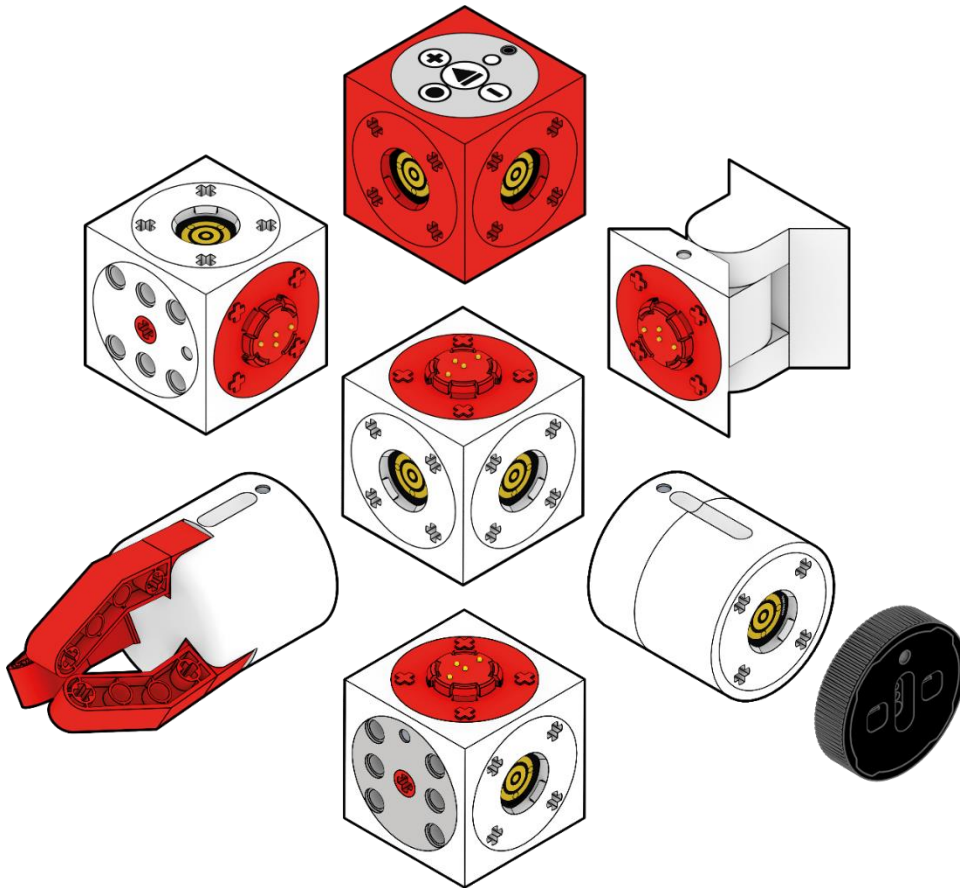




for Windows and macOS



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Preface

Children, young people and adults are able to learn and experiment with the Tinkerbots robotics sets in a playful manner. In the process, the Tinkerbots Education Sets were tailor-made for use in schools, workshops, labs and other educational facilities. Herewith, children and young people are given the opportunity to familiarise themselves with the topics of programming, robotics and sensor technology.

The Tinkerbots Blockly App is a programming environment that was specially developed for the programming of Tinkerbots robots. The intuitive drag-and-drop function can be used to deliver fundamental programming concepts such as loops, variables, conditions, etc. Thus, with the help of different programming blocks, children as of the age of 10 can gain initial experiences with programming. Since it is possible to display the code in the Python Programming Language, the Tinkerbots Blockly App is also perfectly suitable for use in higher school classes. The software runs on Windows and macOS computers.

This document explains the various Tinkerbots modules in the Tinkerbots Education Sets and the Tinkerbots Blockly programming environment. The material is suitable as an introduction for using the Tinkerbots Education Sets and as a small reference text for the modules and the programming environment.

Introduction to the Tinkerbots Education Sets

Tinkerbots Education Sets

Tinkerbots offers two different Tinkerbots Education Sets - the Basic Set and the Expert Set. Each set contains the following components:

	Education Basic Set	Education Expert Set
Powerbrain	1	1
Double Motor	1	1
Motor		2
Pivot	1	2
Twister		1
Grabber		1
Multisensor	1	2
Cube		1
Special Wheels	2	2
Wheels		4
Cubies and accessories	10	95
Brick Adapter	4	8
Power Supply	1	1
Bluetooth Dongle	1	1

Tinkerbots modules

The Powerbrain

The Powerbrain is the core of each Tinkerbots robot and contains both a computer (the brain) and the battery (the source of energy). The Powerbrain is the central module of a Tinkerbots robot, which can control all other modules and is programmable.

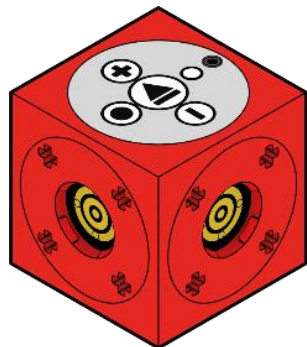


Image 1 The Powerbrain

Other Tinkerbots modules can be attached to the Powerbrain. In doing so, if you or the pupils want to build your own robot, it is not necessary to follow a specific order. You can connect the modules in a long row or connect up to five modules directly to the Powerbrain.

Play button: Switches the Powerbrain on and off. Here you can also start and stop the movement patterns that you learned with the recording button.

Charging socket: Connect the Power Supply here to charge the Powerbrain.

Status LED: The Powerbrain can display different statuses via the colour of the LED.

Green	Powerbrain is turned on and ready to use
Flashing green	Powerbrain performs recording
Flashing yellow	Powerbrain is charging
Yellow	Powerbrain is fully charged
Flashing red	Powerbrain is in recording mode
Blue	Powerbrain is connected to the app
Violet	Powerbrain requires firmware update
Flashing violet	The Powerbrain firmware is being updated

Record button: Press this button when the Powerbrain is turned on and the status LED is green. The LED will then flash red and a short sound will indicate that you can now teach the robot. To do this, move some modules and, for example, conduct a short movement sequence with the Wheels, the Pivot or the Twister. Then press the record button again to end the recording. If you press the play button, the sequence that was just learned is executed. The movement is repeated until you stop it using the play button.



If you switch the Powerbrain on and off again, the learned movement pattern is no longer stored.

Plus and minus button: Accelerate and slow down the execution of the recorded movement sequence.

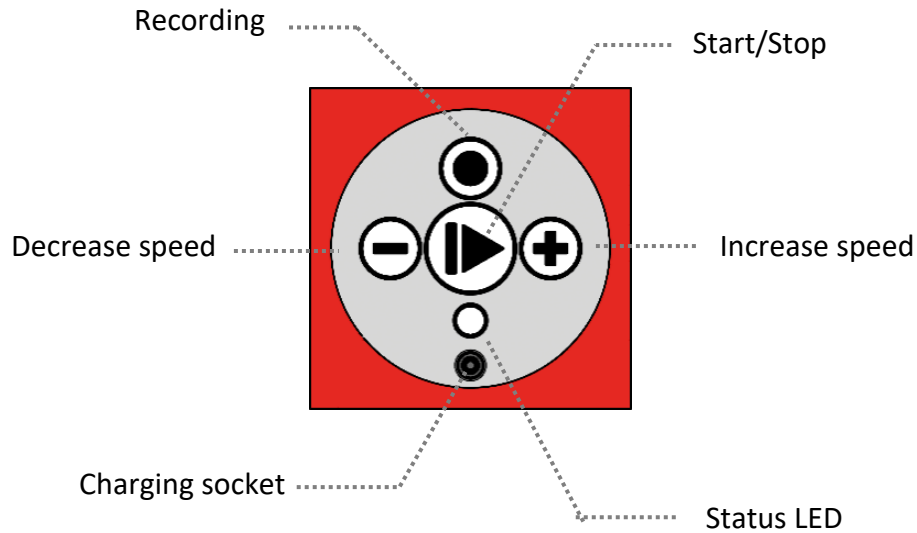


Figure 2 Powerbrain keypad

The Double Motor

The Double Motor is a module with two opposing motors. One motor has a red axle and the other has a blue axle. As is the case for all Tinkerbots modules, the LEDs of the Double Motor light up for a few seconds when they are connected to the Powerbrain. The color plays a role in later programming stages (details for this can be obtained from the *Tour Through Tinkerbots Blockly* section).

The Double Motor can be inserted into a robot in any direction. For example, if the robot carries out a movement incorrectly, you can either adapt the programming or turn the Double Motor.

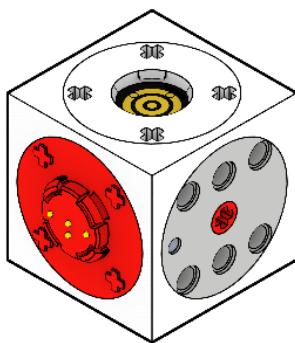


Image 3 The Double Motor

The Motor

The Motor module only has one movable axis in contrast to the Double Motor. To construct a steerable vehicle using the Motor module, it is necessary to additionally use a Pivot or Twister module.

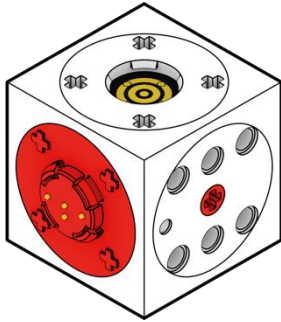


Figure 4 The Motor

The Pivot

The Pivot is a module that can turn by 180°, similar to a hinge. In the programming interface it is possible to specify an exact angle that the Pivot should take up. It can take up an angle of -90° and 90°.

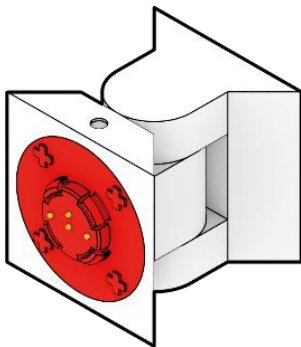


Image 5 The Pivot

The Twister

The Twister module can rotate 180°. Together with the Pivot module, there are so many degrees of freedom in which the robot can move.

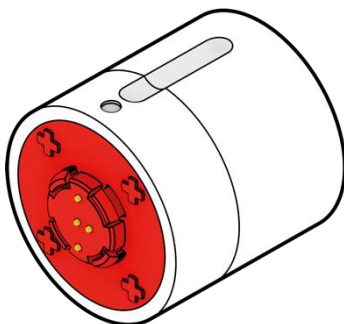


Figure 6 The Twister

The Grabber

The Grabber can grab objects and transport them from one location to another in combination with other modules. It is often useful to combine the Grabber with a Pivot or Twister module.



Figure 7 The Grabber

The Multisensor

The Multisensor module brings together numerous sensors. The sensor unit in the middle of the Multisensor detects light intensity, colors, distance and gestures.

The infrared sensors 1 and 2 detect differences in brightness and can well be used as line following sensors as a result of their positioning.



Image 8 Multisensor



During the detection of objects, it is important to remember that bright objects reflect more light. Therefore, they are detected earlier than dark objects.

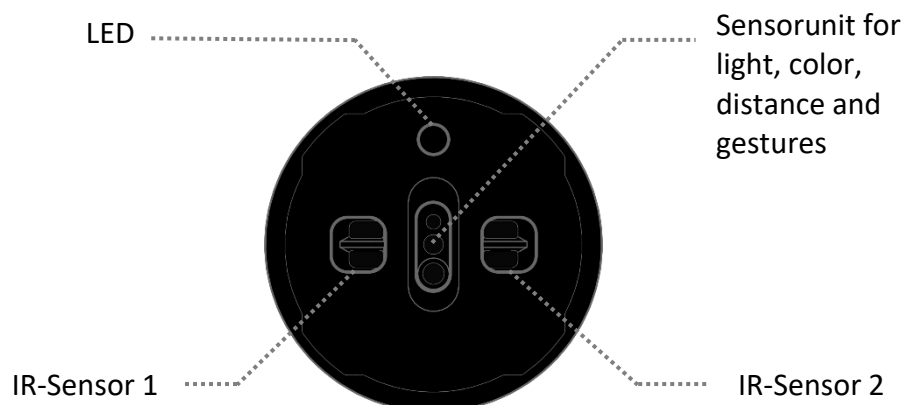


Image 9 Structure of the Multisensor

The Cube

The Cube is a passive module that can transmit control signals to up to six other modules. The module is not programmable but it allows you to implement many creative ideas.

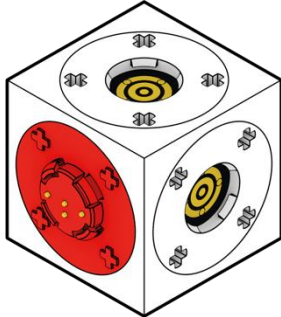


Figure 10 The Cube

The Special Wheels

The Special Wheels are larger than the normal Wheels. They are ideal for all surfaces. The Special Wheels are especially useful if you want to guide the Multisensor close to the ground to build a robot as a line-follower.



Figure 11 The Special Wheels

The Wheels

The Wheels can be used, for example, to construct vehicles that have a very low centre of gravity and are therefore more stable going into turns. The Wheels can also be used as feet for grabbing robots.



Figure 12 The Wheels

Cubies and accessories

The Cubies are a range of passive components that can be used to construct a wide variety of robots. They are available as tetrahedrons, cubes and other shapes, and in different colours. In addition, there are axes and components that are required for constructing robot vehicles.

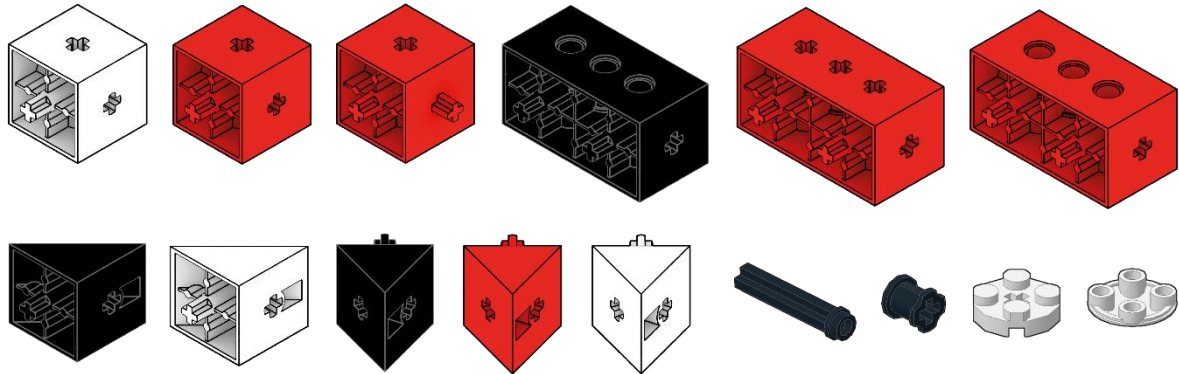


Figure 13 The Cubies

The Brick Adapter

The Brick adapter can be attached to the cube-shaped **Tinkerbots** modules, making them expandable with other components from the set as well as compatible with LEGO®.

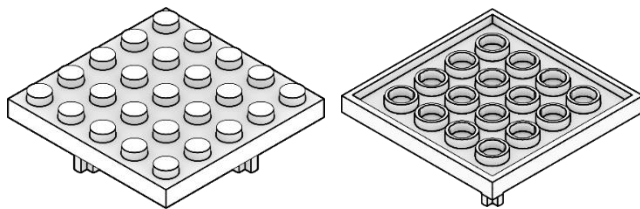


Figure 14 The Brick Adapter

The Separator

To detach the Tinkerbots Cubies from each other or to separate the Brick Adapter from the modules, a self-constructed Separator can be used.

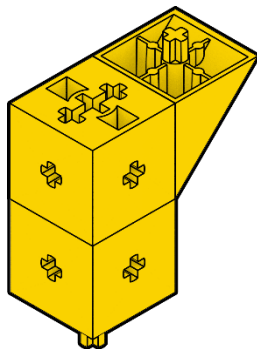


Figure 15 The Separator

Charging the Powerbrain

Use the 9V power supply included in the delivery to charge the Powerbrain for first use. Charge it briefly for 30 – 45 minutes and then it can be used for 90 minutes. During the charging process, the status LED of the Powerbrain will flash yellow.

To increase battery life, the Powerbrain should be regularly charged for several hours until the status LED is continuously yellow.

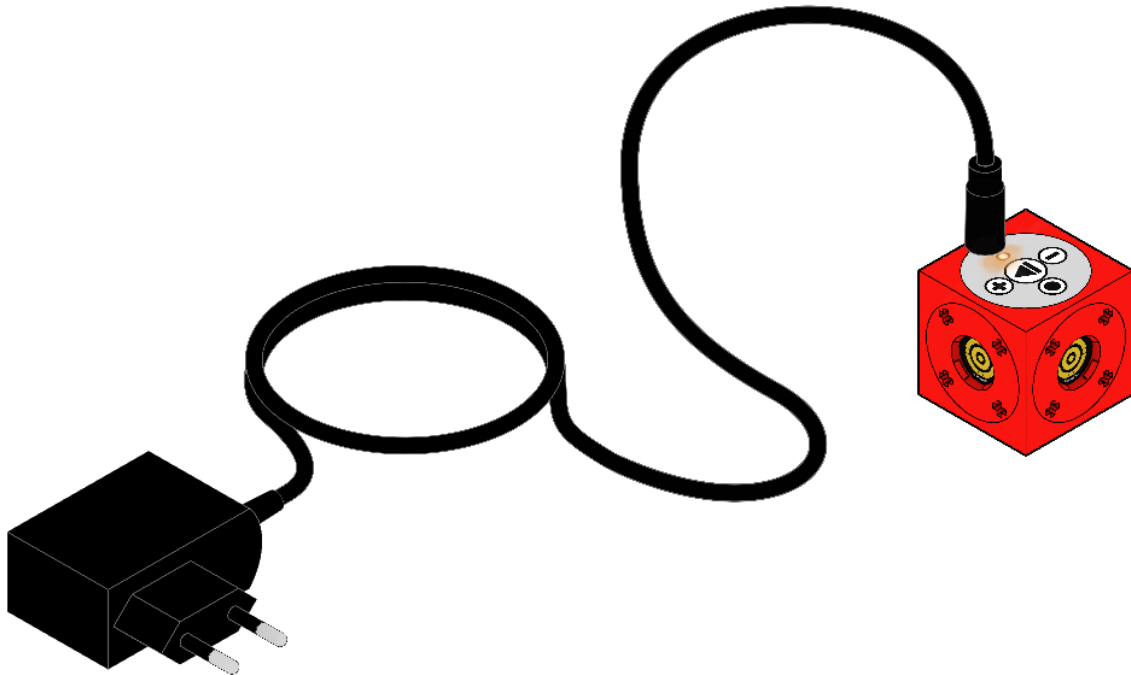


Figure 16 Power supply



If the Powerbrain is not used when switched on (status LED green), it will switch off automatically after approx. 10 minutes.

Introduction to Tinkerbots Blockly

Tinkerbots Blockly is a programming interface which can be used to program the Tinkerbots robots. They contain everything needed to create and execute a program.

The most important building blocks and functions of the programming environment will be explained in the following. It is advisable to familiarise yourself with the programming interface very well prior to using it in class.

System requirements for Windows and macOS

The system requirements for the use of the Tinkerbots Blockly software are a PC with Windows 10 or a Mac with macOS 10.14 or higher.

The Tinkerbots robots require a Bluetooth connection, which you can easily establish for Windows devices using the special Bluetooth dongle provided. MacOS devices do not require the use of the Bluetooth dongle if the system supports Bluetooth Low Energy (BLE).

Plug the Bluetooth dongle into your PC or Mac before installing Tinkerbots Blockly. Download the Tinkerbots Blockly App under www.tinkerbots.de/en/blockly and open the application. Tinkerbots Blockly and the Bluetooth dongle are now fully installed and ready to use.

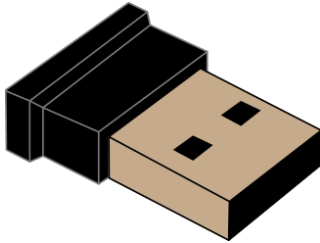


Image 17 Bluetooth Dongle

A tour of Tinkerbots Blockly

The programming interface is divided into different areas. The most important functions are explained in the following and illustrated in the image.

Toolbox: In the column on the left side of the page there is a toolbox with different categories, for example, the single **Tinkerbots** modules. In it you will find different programming blocks that are needed for the creation of a program.

Workspace: The workspace is the space into which the blocks from the toolbox are dragged and dropped and in which the program is written in this manner.

Settings: The settings are located in the top right below the gears symbol. This is where you can adapt the language and carry out further settings.

Save/Open: Above the workspace there is a button to open another project or to save the current project.

View/Undo/Redo: The eye symbol in the right lower corner of the workspace centres the view on the *Start program* block, the arrows next to it allow to undo the last step or to redo the undone one (corresponds to the shortcut Ctrl+Z for undo and Ctrl+Y for redo).

The view can be moved by holding down the left mouse button. With the scroll wheel of the mouse the view can be enlarged and reduced.

Play and Stop: The *Play* button is located in the top right edge of the workspace. This is where the program code can be transferred to the Powerbrain (button shows *Wait*) and executed. If a program is executed, the *Stop* button becomes visible and the program can be stopped by clicking on the button.

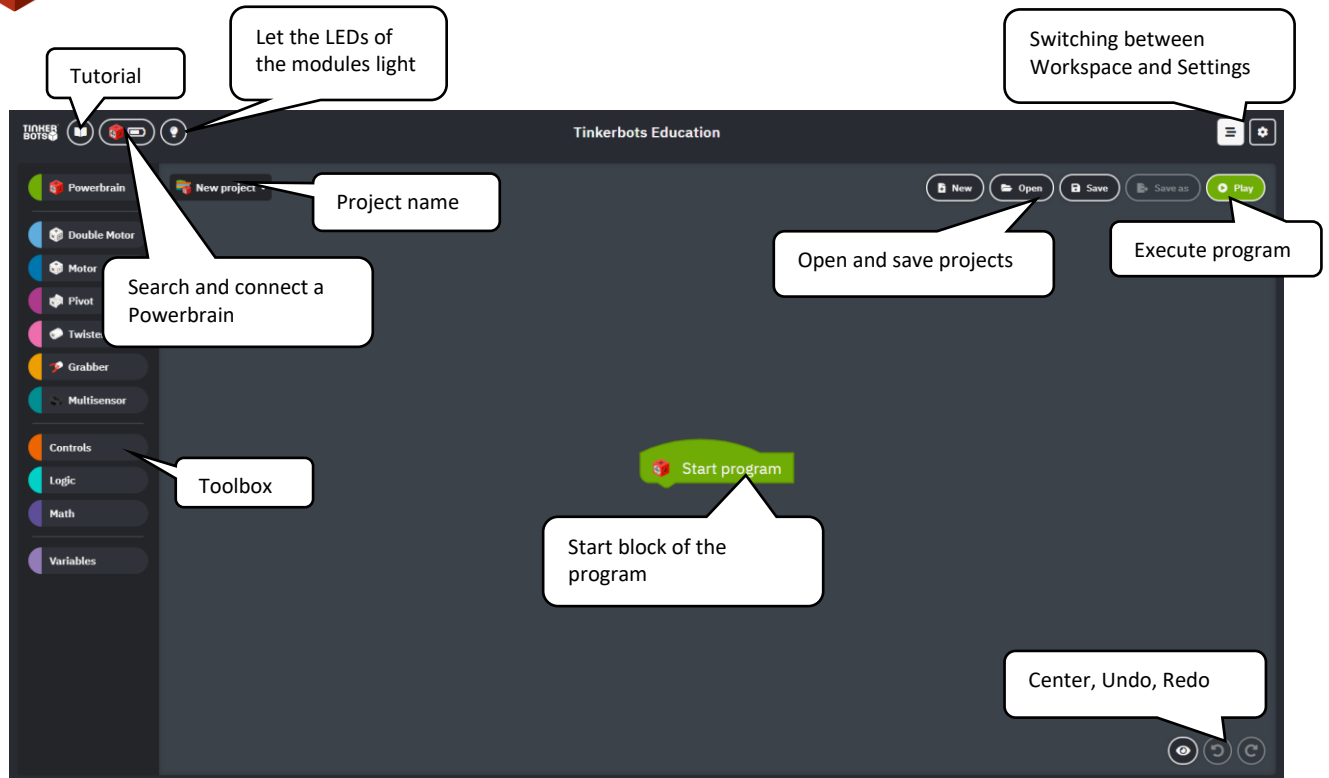


Image 18 Screenshot of the programming interface with notes

Using the Powerbrain with the Tinkerbots Blockly App

First switch on the Powerbrain by pressing the *Play* button in the middle of the Powerbrain. The status LED of the Powerbrain should now be green.

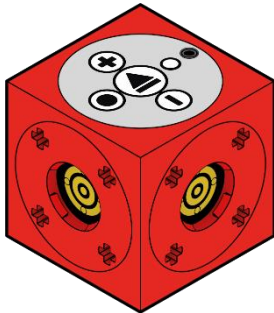


Image 19 Powerbrain with function keys

In order to use the Powerbrain with Tinkerbots Blockly, click on the *Connect* button in the top left of the app. Then a list with all Powerbrains in the environment will be displayed. Now select your Powerbrain and click on *Connect*. The higher up the Powerbrain is positioned in the list, the closer it is to the PC or Bluetooth Dongle. If the Bluetooth connection has been established, the status LED of your Powerbrain will turn blue.

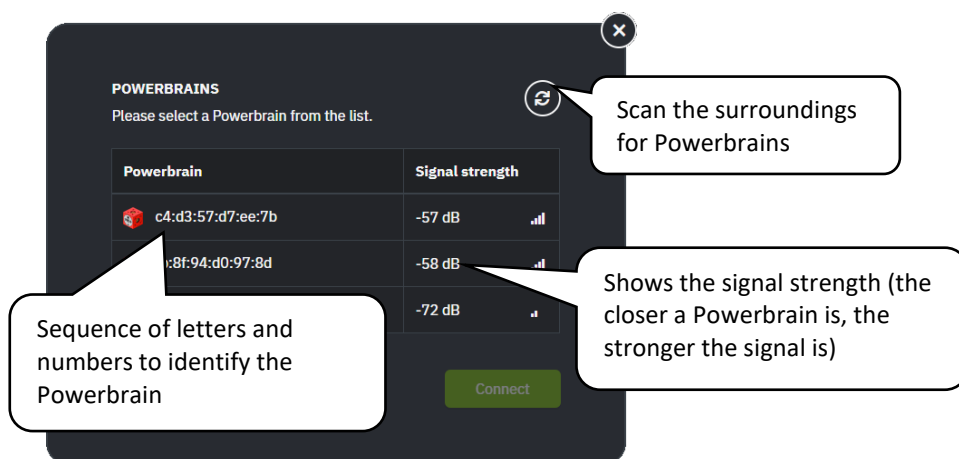


Image 20 Connect the Powerbrain



It is advisable to label the individual Powerbrains with the first digits of the letter and number sequence that appears in the Powerbrain selection list to make it easier for students to find "their" Powerbrains. See sample image.



Image 21 Powerbrain with label

During each connection, the Tinkerbots Blockly App automatically determines whether an update is available for the Powerbrain. If this is the case, a corresponding dialogue will open. In order to start the Powerbrain update, please confirm the dialogue. This process lasts approximately five minutes. Before the lesson, make sure you have searched for updates for the Tinkerbots Blockly App and the Powerbrain so that the programs function optimally. If the update is not to be executed immediately, click on cancel to postpone it to a desired time. It will be displayed again once the app is restarted.

Once the update has been completed, the Powerbrain must be reconnected to the Tinkerbots Blockly App. To do so, repeat the aforementioned steps.

Basic modes of operation in Tinkerbots Blockly

Command blocks

The Tinkerbots Blockly programming interface works with command blocks, which can be combined for a program depending on the task or project. Similar to a puzzle piece, you will find a tab below the block and elements with a suitable blank can be fitted in to it. If two matching blocks are brought together via Drag & Drop, they will connect automatically.

The interface is highlighted in white to show that the elements fit together. Blocks that do not match have a different shape or do not match from a logical perspective. In these cases, the interface is not highlighted in white and the blocks cannot be connected.

The *Start program* command block is shown at the very beginning and cannot be deleted. The block marks the start of each program code.



Each block that is connected to the *Start program* block is carried out once as soon as it is transferred to a Tinkerbots robot. The transfer of a program only takes place if you press the green *Start* button in the top right corner of the workspace. The order of execution is from top to bottom. If the end of the command chain is reached, the program will stop and the Tinkerbots robot will stop its activity.

The elements from the *Controls* category can be used to repeat specific instructions or commands. A program can be carried out permanently, if the *repeat forever* block is selected and inserted in the command chain. This is a so-called (endless) loop.



Commands within the *repeat forever* block are now executed consecutively until the program is ended or the loop is cancelled via the *Stop* button.

Cancel program

The execution of a program can be cancelled at any time by pressing the *Stop* button at the top right in the Tinkerbots Blockly App.



If the mouse cursor hovers above a programming block for a while without moving within the programming interface, an explanation on the function of the respective element will appear.

Manage blocks: A right mouse click on a block opens a context menu with the following functions:

Copy block: The selected block is duplicated

Copy block stack: This and all following blocks are copied

Add comment: Helps to documents your own program

Collapse block: Hides this section

Delete block: Selected block is deleted

Help: Displays an explanation of the selected block

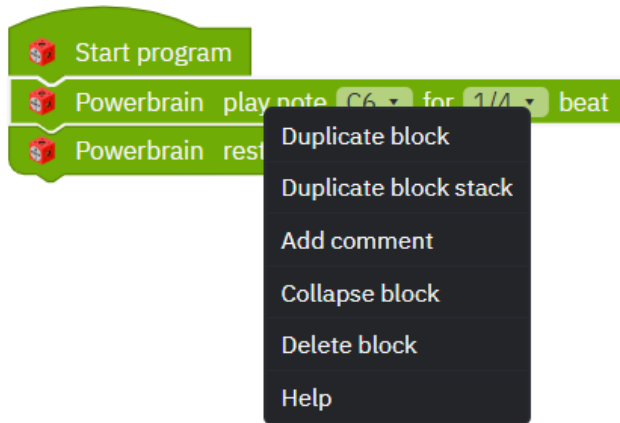


Figure 22 Context menu shown by right-clicking a block

You get access to the following functions by right-clicking on the background:

Clean up blocks: Transparent blocks are aligned properly; the view is centred

Delete blocks: Deletes all blocks in the project

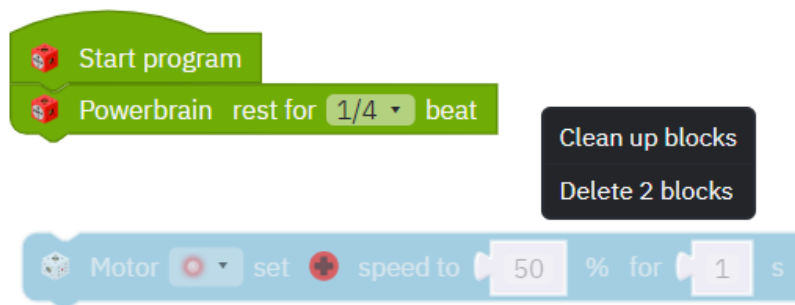


Figure 23 Clean up or delete blocks by right-clicking on the background

Remove block

In order to remove one or several blocks, they can either be pulled to the left on to the toolbox, whereby a recycle bin symbol is displayed. Alternatively, you can also press the Delete or Backspace keys.

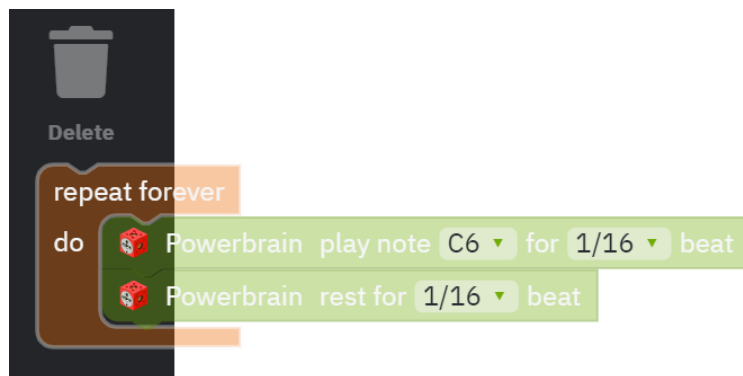


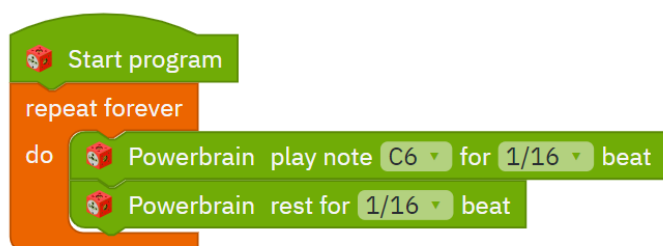
Image 24 Deletion of blocks

Application of basic functions

Test the basic functions prior to your first lesson.

To start with, pull the *repeat forever* loop out of the *Controls* toolbox category into the workspace and connect this to the *Start program* block. Subsequently position the *Play note* command within the *repeat forever* loop from the *Powerbrain* category and *Powerbrain rest for* right below

You have now already written your first program. Now it's time to execute the program code. Click on the green *Start* button in the top right corner of the workspace.



Save the programming code

Save your program via the *Save* button on the left of the *Play* button on the programming interface. A dialog field opens in which you can determine the name and storage location.



Save your program regularly, particularly if you change a larger part. Also be sure to save your program before closing Tinkerbots Blockly. If you give your program a significant name, you will be able to find it quicker from a list.

Display module colors

Once the Powerbrain is connected, another button will appear next to *Connect*. By clicking on the *Show colors* button, the connected modules will display their current color for a few seconds via the installed LEDs. For example, to control a Double Motor, the color of the dot in the dropdown menu of the *Double Motor* block must match the color of the LED on the corresponding module. The colors also serve to distinguish the modules if you have connected several of the same type.

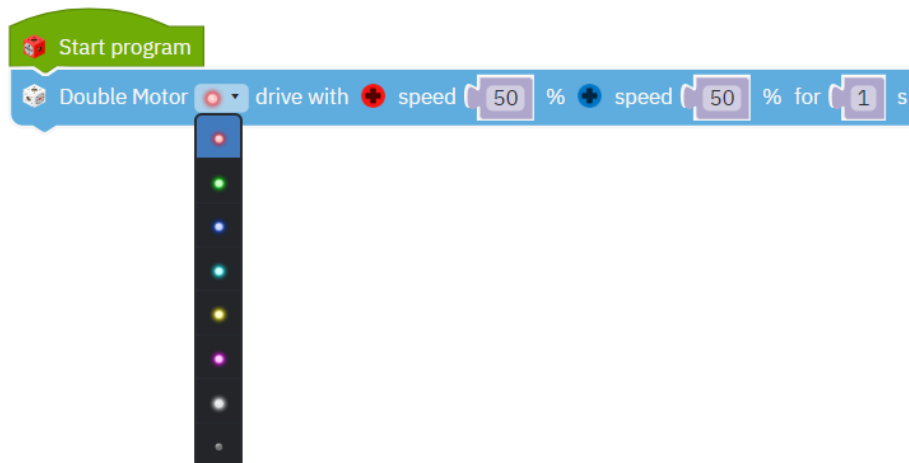


Image 25 Double Motor block with a dropdown menu of the colors - the current color is highlighted blue

Now you can execute the program on the robot by pressing the *Play* button in the top right within the Tinkerbots Blockly App.

Use of Tinkerbots Blockly by several people on once device

Tinkerbots Blockly automatically ensures that the work status of the last session is displayed again when the app is opened.

If several people are using Tinkerbots Blockly on one device, we recommend creating a separate user account on the device (Apple Mac or Microsoft Windows). This ensures that created programs can only be opened by the person that wrote them. If several users work using one user account, it may lead to the problem that other user's files are opened and edited.

Learning levels in Tinkerbots Blockly

Programming can be done at different learning levels in the Tinkerbots Blockly program environment. The learning levels are divided into levels 1-3. Learning level 1 is suitable for beginners learning their first programming steps. The learning levels after that gradually become more challenging. When learning levels 2 and 3 are selected, additional blocks are visible in the toolbox.

Learning level 1 (suitable from 5th grade) is suitable for beginners. The number of categories and blocks is reduced to make it easy to get started. The movement module blocks are sequential, meaning they are only executed one after the other.

Learning level 2 (from 8th grade) is suitable for advanced learners who are already very familiar with level 1. The new categories Functions and Variables are visible, behind which are further commands. Additional command blocks are also visible in the other categories. It is possible to set the speed with a speed parameter for the Pivot and Twister modules.

Learning level 3 (from 10th grade) is suitable for experts who have already dealt with levels 1 and 2. The use of new blocks and categories in learning level 3 requires good abstraction skills and complex thinking from the user. All blocks and categories are available in learning level 3. The category list is now visible. Furthermore, it also introduces the concept of concurrent programming. In the block programming, there are now the same possibilities available for programming the Tinkerbots as in Python. After completing learning level 3, the Blockly code can be displayed in Python code. This level of knowledge enables a good transition from a visual programming language to text-based programming in Python.



More detailed information on concurrency, functions and lists can be found in the respective teaching material.

Teaching material for Tinkerbots Blockly

A variety of teaching material is available for the Tinkerbots Education Sets. The teaching material can be found and downloaded directly on the website www.tinkerbots.de/blockly-tutorial/.

There is basic teaching material for learning levels 1-3. We recommend working through all the basic material to be able to use the further material later.

Troubleshooting: Possible module error statuses

Symptom	Cause	Rectification
Powerbrain will not turn on	The Powerbrain battery is completely discharged	Charge Powerbrain battery (see instructions "Charging the Powerbrain")
Powerbrain triggers a constant sound	Powerbrain collapse	Press the plus and minus buttons of the Powerbrain keyboard for seven seconds to force a shut down
Powerbrain no longer reacts	Powerbrain collapse	Press the plus and minus buttons of the Powerbrain keyboard for seven seconds to force a shut down
Module LED is violet once the Powerbrain has been switched on	Module is in the boot loader mode	Module has to be repaired in the settings in Tinkerbots Blockly by module recovery; for this, activation of the "Advanced Features" is necessary.
Module LED is red once the Powerbrain has been switched on	Module was not recognised by the Powerbrain	Disconnect robot from Powerbrain and then reconnect