

Compare and classify colors ?

FizziQ Junior has been developed by the start-up Trapeze.digital in partnership with the Fondation La main à la pâte. It has been designed for use on tablets by K4-K8 pupils and facilitates the implementation of experimental activities in science and mathematics, based on the Inquiry Based Science Education pedagogy. The app allows students to access the tablet's sensors to carry out experimental measurements and to document their work in an experiment notebook. It is free and without any requirement to register.

This document was originally created in French by la Fondation La main à la pâte as a user guide for FizziQ Junior. It has been translated and amended by Trapeze.digital. Thank you to Pauline Bacle for creating the original document and Ikya Kondapolu for subsequent amendments.

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Warning: as the application is under constant development, some features and/or the appearance of some pages may change. This guide corresponds to version 1.0.108.

Introduction

Themes covered	Colors, shades, hues, primary colors, color synthesis, comparison
Summary and Objectives	Students discuss a way to classify colors and understand the need for an objective criterion. They learn to use a digital tool (FizziQ Junior, a tablet application) to analyze the colors of different objects in the world around them. They characterize them using three primary colors and recreate them using a color synthesizer.
Disciplines involved	Science and technology, visual arts
Duration	1 hour 30 minutes

Getting Started with the Activity

This resource has been designed as an introduction to the FizziQ Junior tool, an application developed by Trapeze.digital in partnership with the La main à la pâte Foundation, and available for free on tablets.

This application offers students the possibility to write an experiment notebook, to organize it into different steps and to add photos, text, drawings... It also allows the use of tools and access to instruments for measuring physical quantities. For more information: <https://www.fizziq.org/fizziqjuniormain>.

Activity : Identifying colors around oneself

General objectives: Understanding the need for a measurable criterion to objectively classify different colors; using the decomposition into three colors (red, green, and blue) to propose a classification of several shades.

Summary	
Disciplines	Sciences and Technology, Visual Arts
Overview and Modalities	The teacher introduces a digital tool to the students that they will use during the session to keep a record of their experiments and take measurements (phase 1). The teacher discusses with the students the subjective nature of color perception and leads them to understand the need for measurement to objectively classify different shades (phase 2). The teacher sets a challenge for the students to find six objects of the color assigned to their group and objectively classify them by color. The students gather the objects and use FizziQ Junior tools to characterize their colors according to a decomposition into three primary colors (phase 3). After validating the identified colors, the students discuss a way to classify them relative to each other (phase 4). At the end of the session, each group presents its choices of objects and colors and the classification criteria used, which can lead to a discussion on how color is perceived and how to characterize it. Finally, the students write a conclusion on the observations made and the concepts covered.
Duration	1 h 30
Materials:	For the entire class: <ul style="list-style-type: none">• objects of different colors scattered throughout the space accessible to students. For student groups: <ul style="list-style-type: none">• a tablet with the FizziQ Junior application;• a photocopy of the student sheet in the appendix (if necessary)
Location	Location: In the classroom or outdoors (playground, for example)
Takeaway Message	
<ul style="list-style-type: none">- There are many colors, but each can be uniquely decomposed into three colors called "primary colors."- Color perception is unique to each individual, but scientific measurement can be used to objectively distinguish nuances.	

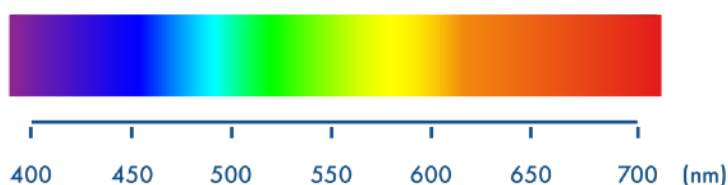
Preparation of the activity

Check that each tablet is charged and that the FizziQ Junior application is installed on it.

- On each tablet, you can also check that the application has the necessary permissions to access the camera, by going to the settings. For Android, in the "Applications" tab, select FizziQ Junior, then check that the camera is in the "Authorized" list. If not, click on "Camera" in the "Not Authorized" list and select "Authorize only if the app is in use".
- To avoid the tablet going into sleep mode too quickly when giving instructions, you can choose a relatively long sleep time (several minutes). You need to strike a balance between a quick sleep time (which prolongs battery life) and the fact that the screen "going off" will be a source of distraction, and sometimes frustration, for students, especially when giving instructions. For Android, you can modify this setting in "Settings" > "Display" > "Sleep".
- Make sure there are enough objects of each color in the chosen location for the activity.

Scientific Note : What is colour?

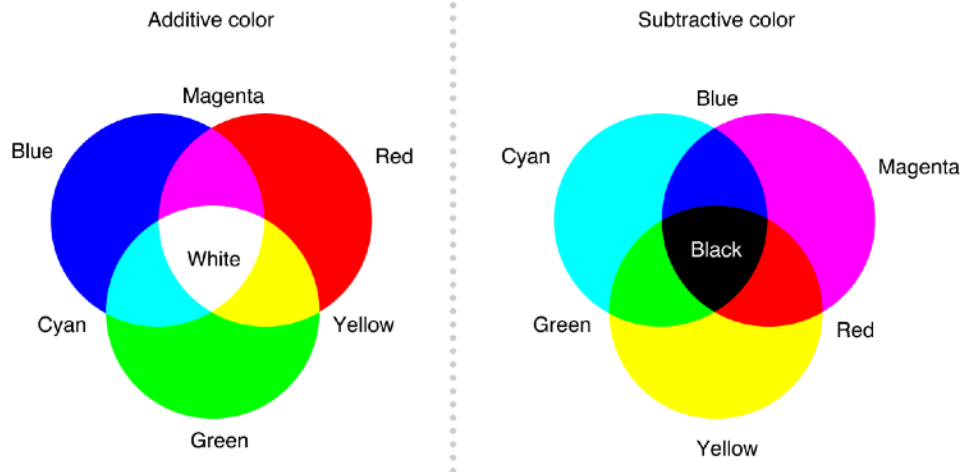
- According to Swiss painter Johannes Itten, "colors are the daughters of light": color is actually the sensation that our brain perceives when light, composed of electromagnetic waves, reaches the retina of our eyes.
- A monochromatic light (etymologically, "of a single color") can be characterized by a physical quantity called "wavelength", expressed in nanometers: our eye is only sensitive to a range of radiations that goes from 400 to 800 nm. A polychromatic light can be characterized by its spectrum, which corresponds to the set of radiations that make it up.



Spectrum of white light (light emitted by the Sun, for example): it is a continuous spectrum that contains an infinite number of radiations.

- When light enters our eye, it transmits information to the brain: color and light intensity. However, color is difficult to objectify. It is the result of a global detection by the eye of a set of radiations: the perceptions of each radiation overlap and the brain interprets the transmitted message as a whole. The light that comes to us from the Sun, for example, gives us a sensation of white, although it is composed of a large number of radiations of different wavelengths corresponding to each color, which are all visible during a rainbow.
- In fact, the brain synthesizes a colored impression from information provided by three types of cells (called "cones") in the retina. Each type is sensitive to a reduced part of all existing colors, but together, the three cones allow us to perceive the entire spectrum of colors visible to the human eye.

- It is possible to produce all colors (by additive or subtractive synthesis) from three suitably chosen colors, that is, chosen so that none of these (primary) colors can be synthesized by combining the other two.
- Two types of syntheses are distinguished, depending on whether we mix "matter" colors or "light" colors:



Pedagogical Note :

- Work on color is part of the larger framework of light and its effects on surfaces or materials that it illuminates. It is based on understanding the relationship between light, matter, and perception. For children, color is generally an intrinsic property of objects, like its shape, for example. They do not conceive - and many adults do not either! - that the color they perceive from an object actually depends on the light that illuminates it and also on their eye.
- This is a theme that allows for easy integration of artistic and scientific education, but also provides an opportunity to work on language with the designation of colors and vocabulary associated with shades

Tentative Agenda

Phase 1 : Introduction and guided familiarization with FizziQ Junior (30 min, optional)

We recommend starting the activity with a session focused solely on discovering and becoming familiar with the FizziQ Junior tool. The teacher explains to the students that they will be using a digital tool throughout the activity. The teacher divides the students into groups of three or four and distributes a tablet to each group. They introduce the FizziQ Junior application and suggest creating an experiment notebook per group directly in the application. To do this, the teacher can guide them

using their own tablet, the guidance in the appendix that can be distributed to students, or by projecting the step-by-step guidance slideshow available on the Foundation's website (see link at the bottom of the page corresponding to this resource).

Pedagogical Note :

The teacher can also project their tablet directly through a computer using an application like Screen Mirroring App (free version with ads), which uses Wifi to display the tablet screen on a web page. Then, project the computer screen using a projector..

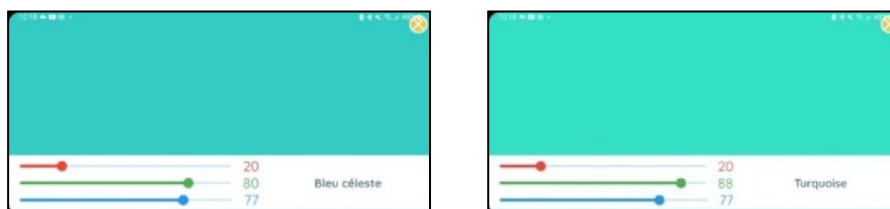
Depending on the class level, for example, if the students are already familiar with using the tablet and/or application, the time devoted to this familiarization can be reduced. However, we recommend keeping at least 15 minutes for the students to re-appropriate the tool and, for example, create and personalize their experiment notebook. This can also be an opportunity for the teacher to give instructions for tablet use: only one student presses the tablet at a time, do not remove the tablet cover, stay in the FizziQ Junior application.

Variation: If preferred, instead of asking students to create a blank notebook, the teacher can use the activity model imagined for this resource using the QR code in the appendix. It will automatically open a notebook with instructions for the students. The teacher can also have prepared their own activity, either by modifying the one proposed in the appendix or by creating a new one. More information is available in the guide on the Foundation's website.

Phase 2 : Role Play (15 min)

The teacher discusses with the students the multiple colors that we perceive in the world around us, lit by natural light (the sun) or artificial light (a lamp).

An adult can distinguish several hundred thousand colors, even if they do not have the vocabulary to name them all. Growing up, we learn to differentiate colors and develop vocabulary to describe them, but this can sometimes be difficult. The teacher can then show the students a color that may seem ambiguous and ask them to describe the color they see: for some, it may be green, for others, blue, some may suggest blue-green, perhaps turquoise.



Two colors that may raise questions among students: are they blue or green? The teacher can use FizziQ Junior on their own tablet to display one of these colors with the "Color synthesizer" (remember to hide the name indicated at the bottom right): see the pedagogical note below for guidance on this functionality.

The students quickly realize that not everyone agrees. The teacher can ask them, "Why isn't the perceived color the same for everyone?"

They can also emphasize the difficulty due to the lack of vocabulary. Indeed, how can you distinguish one light gray from another?

Scientific and Pedagogical Note :

The perception of an object's color involves three elements: the object itself, the light source, and the observer

- By reflecting light, the object changes its spectrum: it absorbs some of the wavelengths of the incident light and reflects others.
- An object's color also depends on the composition of the light illuminating it: the color of an object will not be the same under white light or colored light.
- Finally, color perception depends on the detector (eye + brain or sensor). The perceived color therefore varies depending on the physiological characteristics of each individual (their eye and brain): two people looking at the same object do not necessarily see the same color.

A color name designates a range of colors rather than a specific color, and the names assigned do not correspond to a standard. Within a given range of colors, there are nuances that we try to describe with qualifiers and that serve as common reference points for those who speak the same language.

The richness of color-related terms can vary greatly depending on individual or collective physiological factors (related to adaptation to a particular environment, for example), as well as cultural and historical aspects. For example, the Inuit people, who live in a white world, have multiple names for different shades of white.

It may be interesting to circulate among the students several paint color charts obtained from hardware stores to show that color names can vary from one brand to another, or that some brands do not name the colors, but simply assign them a reference. Students can then question what this reference represents.

The teacher then explains that they will use FizziQ Junior to study the colors around them and try to find a way to classify them objectively. To do this, the teacher presents the different tools they will use:

Using the "Color Spectrum", students will be able to identify the color of an object by pointing the tablet at it: the tool will then give the decomposition of the detected color (see scientific note and pedagogical note below).

The "Color Synthesizer" tool will allow students to recreate the color previously measured by using the values they obtained in red, green, and blue in the color spectrum (see scientific notes and pedagogical note below).


Scientific Note :

Compare and classify colors


- The tablet's camera is equipped with a sensor consisting of a set of filters that, like cones in our eyes, decomposes polychromatic light into the three colors of the RGB system (red, green, blue).
- This spectrum gives a measure of the relative light intensity perceived for each of the three colors, ranging from 0 (corresponding to black) to 100 (corresponding to the color). In other words, this value indicates whether the shade is lighter or darker: it depends on the object's illumination, that is, the amount of light received, thus the intensity of the light source, but also the reflective nature of the observed material.

Note on Usage: Keep in mind that the measurement will fluctuate due to variations in illumination. Also note that the perception of color will not be the same from one tablet to another, as the sensor characteristics may vary

Pedagogical note : How to show the color spectrum with FizziQ Junior ?

1. Open FizziQ Junior and select the "Student" tab on the homepage.
2. Create or open a notebook.
3. Click on  to access the toolbox, then on "Measurements"

4. Select "Color Spectrum"


Aim the camera at an object: the object is visible in the circle and the analyzed color corresponds to the central point. It appears in the background of the viewfinder. The measurement (photo + spectrum) can be saved in the notebook using the button .

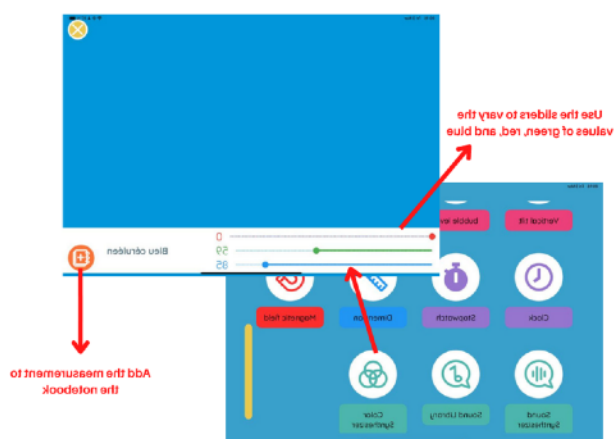
Scientifique note :


- A screen is composed of pixels, each consisting of three lights corresponding to the primary colors for additive synthesis (red, green, and blue): different colors are obtained by activating different combinations of lights on each pixel.
- By varying the intensity of these three colors in the light entering the eye, it is possible to display on the screen, and therefore produce in the brain, impressions of all "colors" or shades. To obtain white, all lights are turned on with equivalent intensities; for black, all lights are turned off.
-

Pedagogical Note : How to display a colour using FizziQ Junior Synthesiser?



- Select "Color Synthesizer" (at the bottom of the list)
- Use the sliders to vary the values of red, green, and blue. The synthesized color can be saved in the notebook using the button 



- Open FizziQ Junior and select the "Student" tab on the home page.
- Create or open a notebook
- Click on  to access the toolbox, then click on "Measurements"

Note : The color names given by the application are based on the list of colors recognized by web browsers. Each of the colors in this list corresponds to specific red, green, and blue values in the RGB system. FizziQ Junior identifies the color in this list that is closest to the measurement to give a name to the targeted color

Pedagogical Note:

- During classroom testing, the activity did not raise any questions about color synthesis from green, blue or red compared to the primary colors of subtractive synthesis, to which students are generally more accustomed. However, if questions arise, it may be useful to distinguish between the "material" color that is paint and the "light" color that is produced by a screen, both having their own mode of synthesis, without going into details (see scientific note at the beginning of this resource).



A student playing with the color synthesizer might, for example, ask why we don't get this yellow by mixing red and green paint

- However, the objective of the session is not to fully address the concepts of color synthesis, but rather to highlight the subjective nature of color determination, with each person perceiving nuances differently, and to find a scientific method for analyzing a color: here, using a quantified decomposition of colors. The synthesis tool then ensures the reproducibility of the measurement: from the decomposition, the initial color is indeed (and systematically) found

Phase 3 : Explore the classroom in search of colors (25 min)

The teacher assigns each group a color from the following: blue, green, purple, orange, yellow, pink, red. Some of these colors generally offer more diversity of shades in the immediate environment of the students and may be preferred for this activity (blue, green, purple, for example, unlike red).

For the rest of the activity, it may be useful to designate roles within the groups, giving responsibilities to each:

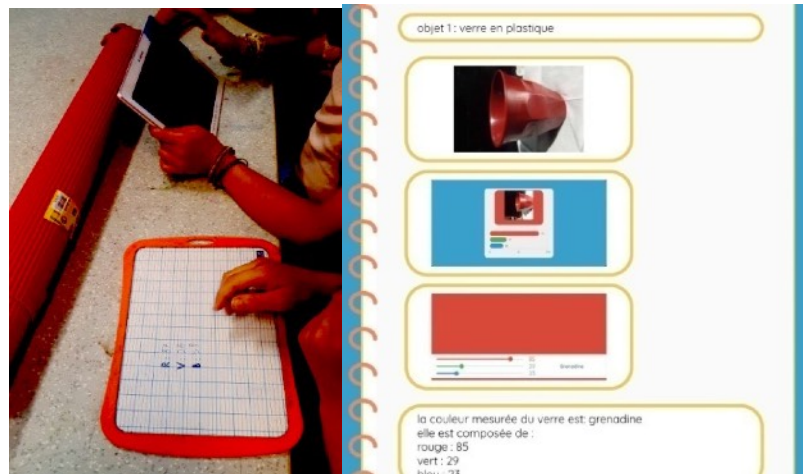
- a collector of objects;
- a color measurement expert using the "Color Spectrum";
- a synthesis expert;
- a writer who will be in charge of "documenting" the measurements, taking pictures of the objects, and writing the group's comments, for example.

The teacher explains the instructions for the activity by writing them on the board or on a sheet distributed to the students, for example. Note that these instructions can also be an integral part of a pre-filled notebook (an activity) that students would download onto their tablet at the beginning of the session using a QR code.

During the session, the students will need to:

1. Find and gather five easily transportable objects on their desk, corresponding to the color of their group.
2. For each object: identify the color (name, characteristics) using the "Color Spectrum," then use the "Color Synthesizer" tool.
3. Keep a record of the observations in the FizziQ Junior notebook: for each object, insert a photo of the object, a measurement, the "identity card" of the color obtained with the synthesis tool, and a written conclusion.

4. Classify the colors of the objects by explaining the criterion(s) they based their decision on.



Examples of measures: On the left, at the Doudeauville school, students are measuring the color of a corrugated paper roll; on the right, a notebook corresponding to the complete process for a plastic glass.

Points to consider :It is important to ensure that the measurement is done in the most reproducible and consistent way possible, particularly by keeping the same light source and illumination.

To do this, you can:

- Identify a specific spot on the desk where the object will be placed for the measurement, for example by marking a rectangle using colored adhesive tape or by sticking a white sheet of paper on which students will place the object to be analyzed;
- Ensure that the students take the measurement from the same spot and at the same distance between the tablet and the analyzed object, while holding the tablet to avoid casting shadows

During this phase, the teacher is encouraged to move among the different groups to validate the observations as they go along and question the students, especially for "borderline" colors (for example, does a turquoise object belong to the blue or green group?). For these objects, the teacher may ask the students whether they should keep or discard the object and explain why based on the measurement. Very quickly, there may be objects that are common to several groups, which will be an opportunity for the students to reflect on an argument to justify their belonging to a color rather than another.



At the Doudeauville school, the teacher chose to have the RGB values for each object noted on a slate as the session progressed. This allowed the students to better understand the values that varied or not

Phase 4 : Discussion on the ranking of different colors (20 min)

Within each group, the teacher will ensure that:

- Once a sufficient number of objects have been selected and colors analyzed, students discuss and agree on a criterion for comparison and ranking accordingly.
- Students organize the different objects on the table one after the other, according to the chosen order, and take a photo of this ranking to include in their notebook. They can add textual comments to explain their approach.

When all groups seem to have converged on a classification method, the teacher takes time in the whole class to discuss the different ranking choices made by students. He asks them to explain how they proceeded and the difficulties they encountered.

- Students note that certain colors appear difficult to classify: Vermilion can be placed in the orange or red family; turquoise in the blue or green family, etc.
- Some students explain that they ranked the colors from lightest to darkest: this is one of the first parameters that children consider. The teacher then ensures that the group used a measure or whether they relied on "their eyes," and, if so, whether they think everyone in the class would agree with such a ranking or whether there might be variations.
- Other students explain that they ranked their colors based on the criterion of intensity (the value given in the spectrum) for a given color, ignoring the other two. This ranking system generally resembles the previous one, but the distribution is made here based on an objective criterion.

At the end of this discussion, it is important that students understand that there is no "right" or "wrong" ranking, nor is there a unique way to compare colors and rank them. However, for this ranking to have scientific significance, it must be based on a measurable value, not just on our senses. An example of ranking would be to sort all colors "based on the amount of red they contain":

the "amount of red" criterion is a value that can be measured and does not depend on our eyes or preferences.



At Doudeauville school, this group of students, in charge of the color green, first began to rank (without relying on measures) the three pencils on the left of the photo from darkest to lightest. They quickly realized two difficulties with the other objects: the green of the felt pen and the corrugated paper roll is also a light green, but is it lighter than that of the colored pencil? The "green" of the stapler is difficult to place because "it's not the same green": the group in charge of blue also thinks it would be better for this object to be with them. This example shows the importance of having a measurement and an objective criterion rather than relying solely on our eyes and feelings.

Conclusion (15 min)

At the end of the session, the teacher can invite students to propose a conclusion to the activity, reviewing the concepts they discovered and what seems important to them. Here is a possible example of written notes to follow this exchange, which students can add to their experiment notebook, directly in FizziQ Junior: "We perceive a multitude of colors, each in a different way. We can describe them with words, but this description is not precise and can vary from person to person. Using a measurement tool, we analyzed the color of several objects illuminated by the light of the Sun. We were able to describe them by breaking them down into three values corresponding to red, green, and blue. This description is precise and allows us to find the color from any tablet, thanks to the synthesizer, and to compare shades objectively."

Further Activities

- It may be interesting to propose, as an extension of this activity, a session where the teacher illuminates objects with colored spotlights: students can then realize that the perceived color of the object changes because color perception depends on incident light.
- The following resource, intended for cycle 1, offers more complete scientific explanations: <https://fondation-lamap.org/sequence-d-activites/les-couleurs-en-maternelle>.

- To go further on color synthesis, you can consult the following resource on the Foundation's website: <https://fondation-lamap.org/sequence-d-activites/composer-des-couleurs-a-partir-de-matiere-ou-de-lumiere>.
- This activity can also lend itself to a lexical work to distinguish colors, in French or in visual arts. Direct denominations, in a single word, are ultimately few (white, black, red, green, yellow, blue, brown, violet, pink, orange, gray...) compared to the extraordinary diversity of shades that we perceive. It may be interesting to discuss with students the various lexical combinations that exist to express this variety: add an adjective (light, dark, deep, dark, bright, pale, bright...) to the color term, combine two color terms to express intermediate colors (blue-green, yellow-orange, yellow-green, red-purple...), modify the ending of a color term (greenish, yellowish, bluish...) or add to the color term a reference referring to a plant, an animal, a mineral, a material or a proper noun (country, city, painter...): navy blue, sky blue, periwinkle blue, sapphire blue, ruby red, emerald green, apple green, poppy red, blood red, lemon yellow, pearl gray, Sevres blue, Chartres blue, Delft blue, Prussian blue, Chinese blue, Bengal rose, Veronese green, Nattier blue, Klein blue...

Credits

Images on page 4: © Éditions Belin, DR

Images on pages 5, 7, 8, 9, 13 and 14: Screenshots from the FizziQ Junior app (Trapeze.digital)

Annexures


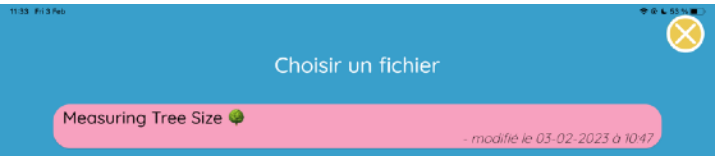
FizziQ Junior Associated Activities (QR Code)

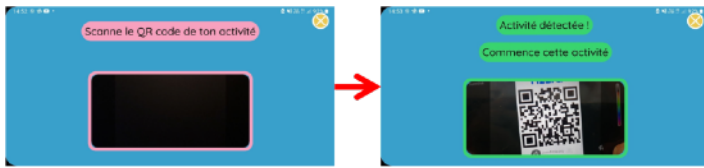


Version without images
No WiFi connection required



Version with images
WiFi connection required

	<ol style="list-style-type: none">1. Open FizziQ Junior and click on the "Student" tab on the home screen.2. In the "Student" menu, select "I am starting an activity". The student has two options.
	<ol style="list-style-type: none">3. Case 1: click on "The activity is in my locker". <p>The list of activities available in the locker appears and the student can select one by clicking on it; the notebook opens.</p>



2. **Case 2: click on "I download an activity".**

The window that opens allows you to scan the QR code of the activity: when the activity is recognized, the message "Activity detected!"

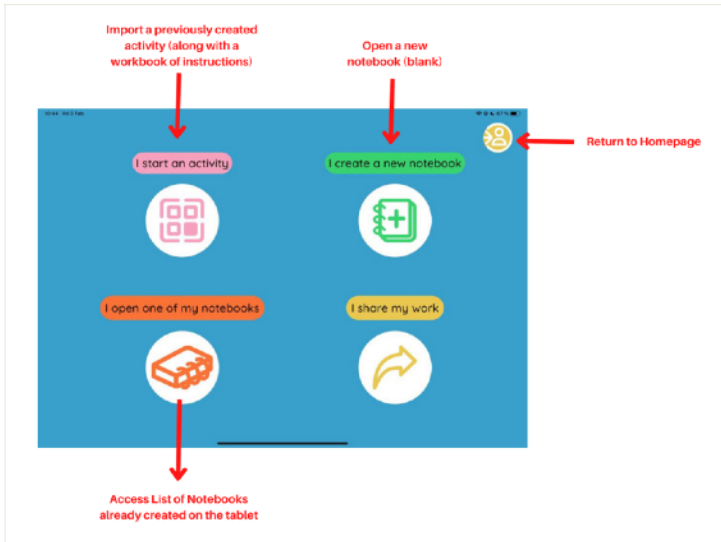
Click on " Start this activity " to open the notebook associated with the activity.

Guidance for Students (if needed)

This step-by-step guidance can be distributed to students to save time if they are stuck, unfamiliar or uncomfortable with the application, and to help them draw conclusions and respond to the challenge.

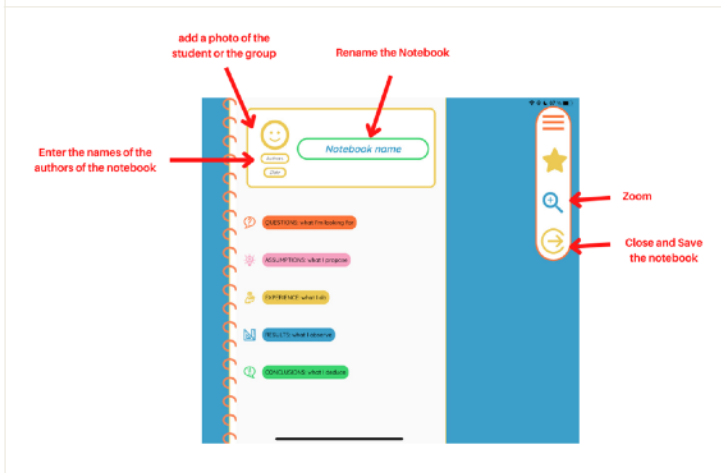


1. Open FizziQ Junior and click on the "Student" tab on the home screen.



In the "Student" menu, select one of the tabs to open :

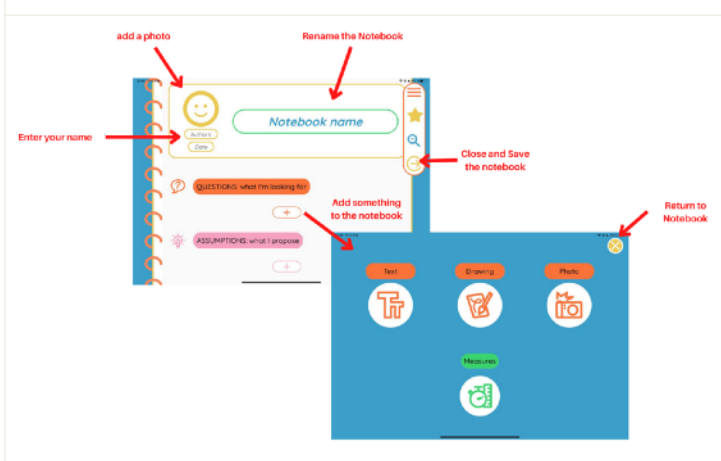
3. a new (blank) notebook;
4. a notebook from the list of notebooks previously created on this tablet;
5. or a notebook prepared by the teacher (i.e. an "Activity", see below)



3. The notebook is open: you can personalize it and fill it with your measurements and observations.


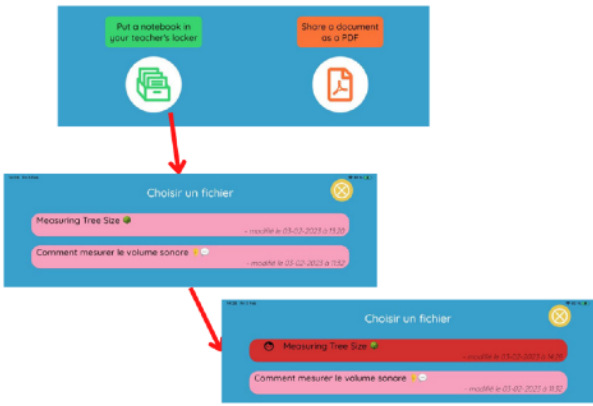




4. You can also delete a notebook from the list of notebooks stored in the tablet by clicking on the notebook and dragging the card towards the left side.



- **Access the list of tools and measuring instruments**
- To add a card to the notebook, click on the button in a given section: the window that appears gives access to the toolbox.
- Please note that the corresponding map will be added to the selected section.

How to Share the Experiment book with the Teacher ?

	<p>1. In the "Student" menu, click on "I share my work". Two options are offered:</p> <ul style="list-style-type: none"> • "Put in your teacher's locker"; • "Create a document to share" (in PDF format).
	<p>2. By clicking on "Put in your teacher's locker", you have access to the list of notebooks saved on the tablet:</p> <ul style="list-style-type: none"> • select the notebook you want to share; • confirm that you want to place it in the "teacher's locker"; • the insert of the notebook that has been placed in the locker turns red (which means "Pending correction", see below).
	<p>3. By clicking on "Create a document to share", you have access to the list of notebooks saved on the tablet: select the notebook you want to export in PDF format.</p> <p>When the PDF file is created, simply press the button  and use the sending method of your choice (Drive, AirDrop, mail, etc.)</p>

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This resource was produced with the support of



Education Resilience in Europe is funded by the Grant Agreement signed on 21 September 2022 with Cisco Education and supported by operational activities by Science 4 Learning agreement No. 010302020. The content of the document is the sole responsibility of the organizer, and it does not represent the opinion of the European Commission (EC), and the EC is not responsible for any use that might be made of information contained.



Date of Publication

February 2023