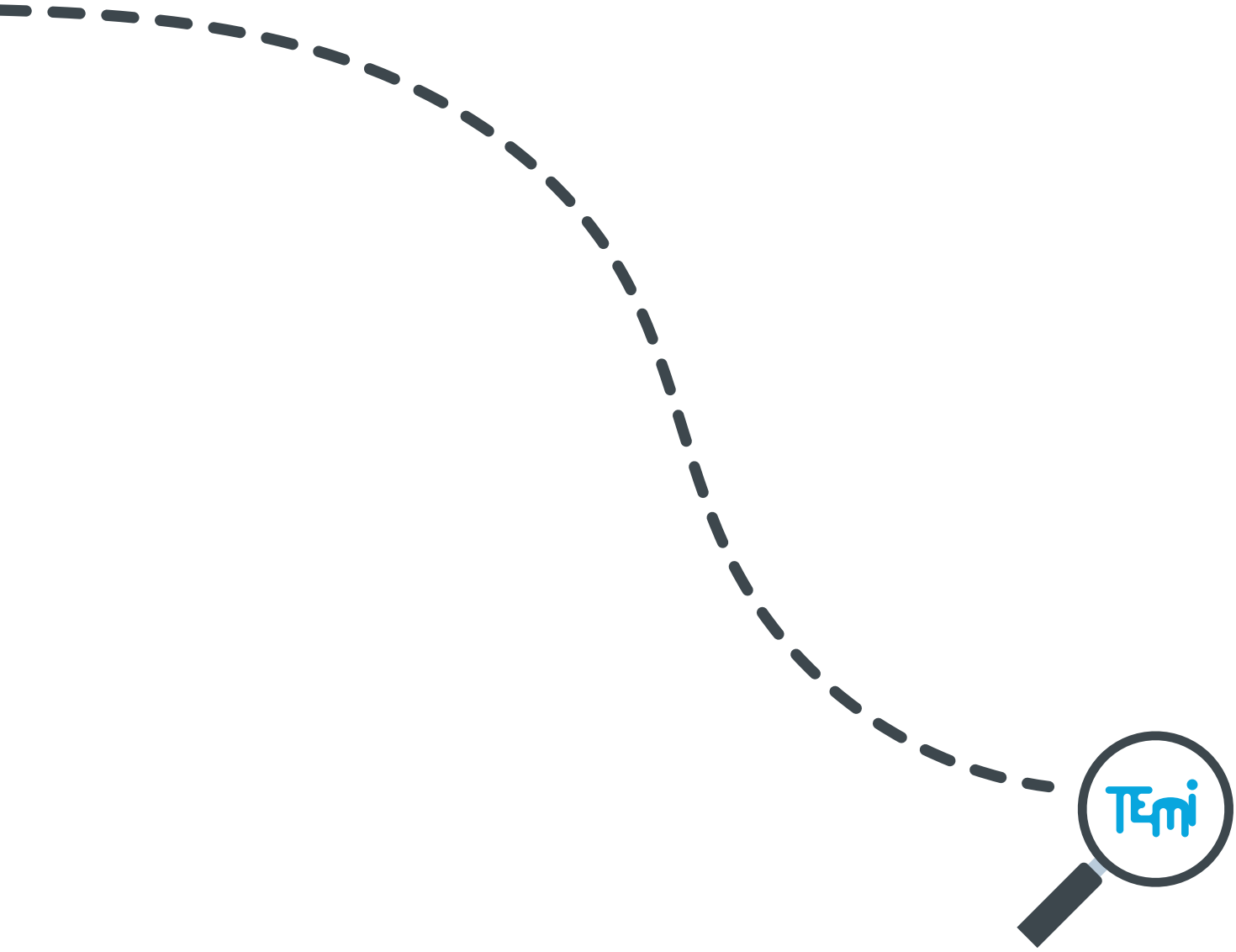
Guess the colour!

CLASSROOM SCIENCE ACTIVITY TO
SUPPORT STUDENT ENQUIRY-BASED LEARNING



This classroom-tested teaching plan uses the four innovations of the TEMI project, as detailed in the Teaching the TEMI Way (TEMI, 2015).

You should read this companion book to get the most from your teaching. The **TEMI** techniques used in this teaching plan are: **1)** productive science mysteries, **2)** the **5E model** for engaged learning, **3)** the use of presentation skills to engage your students, and **4)** the apprenticeship model for learning through gradual release of responsibility. You might also wish to use the hypothesiser lifeline sheet (available on the **TEMI** website) to help your students document their ideas and discoveries as they work.

To know more about **TEMI** and find more resources **www.teachingmysteries.eu**

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teachingmysteries.eu

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Guess the colour!

What's the mystery?

The colour of the objects around us depends on the surface of the object, on the colour of the light that illuminates them, and the system of human perception. If many small pieces of differently coloured cardboard are placed under a nearly monochromatic light, it can become very difficult to distinguish the colours.

DOMAIN(S)

Physics.

SUBDOMAIN KEYWORDS

Additive and subtractive synthesis of colours.

AGE GROUP

12 to **18** years old.

EXPECTED TIME FOR THE MYSTERY

Approximate time for teacher preparation:
Two hour.

Approximate time in classroom:
three or **four** individual **50 min.** lessons.

SAFETY/SUPERVISION

Laser pointers have to be handled with care and never directed towards people's eyes.

Disclaimer: the authors of this teaching material will not be held responsible for any injury or damage to persons or properties that might occur in its use.

PREPARATION AND LIST OF MATERIALS

- Green and red laser pointers
- Diffraction gratings
- Coloured and white cardboards
- Green LED light
- Blue LED light
- Red LED light
- Coloured filters
- Black blankets
- Supports to be covered by the blankets (so that each group will not be disturbed by the lights being used by the other groups).

LEARNING OBJECTIVES

- To become familiar with the additive synthesis of lights and with the subtractive synthesis of the coloured pigments.
- To become familiar with how colours look under different coloured lights.

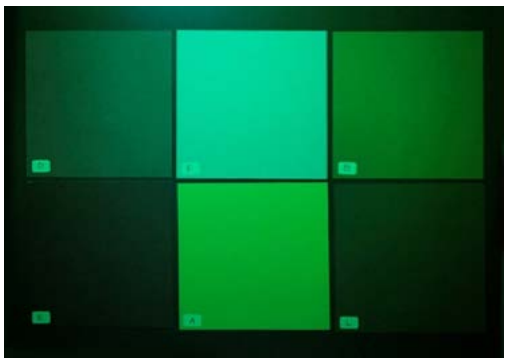
Guidance notes for teachers

THE 5E MODEL

Engage

CAPTURE STUDENTS' ATTENTION

When the game starts, the classroom's main light is off; at a certain point, a monochromatic light is turned on (for example, a green light). A volunteer student is asked to pick up two pieces of cardboard of different colours (the teacher has checked beforehand that these colours are markedly different under the monochromatic light being used): in the example shown in the picture, the colours are cyan and purple. Then the student inserts the pieces of cardboard into two envelopes and closes them. On the top of the two envelopes is written the name of the colour of the cardboard inside. This procedure is repeated with three different monochromatic lights. Under white light, the envelopes are opened and the students observe with surprise the 'true' colours of the pieces of cardboard they have chosen.



Explore

COLLECT DATA FROM EXPERIMENTS

Students start their observations in the darkness (each group should be independent from the others and conduct the experiment while covered with a black blanket): each group has a diffraction grating and many different kinds of lights, from monochromatic ones to incandescent ones. At the beginning of the activity, students become familiar with a monochromatic light (they can use the laser light, for example) and they can see what happens when the light passes through a diffraction grating.

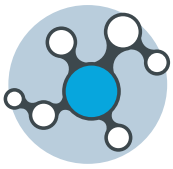
In the second phase, by observing the light used and the colour observed, students should observe which colours are absorbed and which colours are reflected by an object when the object is illuminated with a certain monochromatic light. Deeping their observations, students can use two different monochromatic lights to illuminate their pieces of cardboard. The teacher may help students to choose particular pieces of cardboard to better direct their exploration.

Explain

WHAT'S THE SCIENCE BEHIND THE MYSTERY?

Through observing the light used and the colour, students should recognise which of the colours absorbed are then emitted by the object (the colour of a certain object under a certain light).

It is also possible that different human eyes can see slightly or markedly different colours: this can provoke a reflection on human physiology and its connection with the problem of vision, which is not only a physical problem.



Extend

WHAT OTHER RELATED AREAS CAN BE EXPLORED?

After having mixed the coloured lights (and having therefore experienced additive synthesis), it is possible to repeat the same mixes of colours using acrylics, Ecoline, or coloured inks. This set of experiments will give completely different results from the previous one: this pigment mixing will give an example of subtractive synthesis.

It is also possible to deal with the link between the wavelength of light and colour and the fact that not all the colours we see are present in the spectrum or in the rainbow. This is a very important point that should be emphasised and discussed with the students. A very useful insight can be provided by observing spectral lamps though a diffraction grating.

Evaluate

CHECK THE LEVEL OF STUDENT SCIENTIFIC UNDERSTANDING

A possible way to evaluate students is by giving them problems to be solved from both theoretical and practical points of view. For example, “find a way in which a certain word, written in red on a white cardboard, can disappear” or “can you write a message whose words give two different meanings when illuminated with lights of different colours?” It may also be useful for students to pose questions of this kind by themselves.

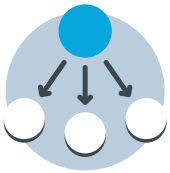
THE 5E MODEL

Showmanship

TIPS ON HOW TO TEACH AND PRESENT THIS MYSTERY

The presentation of the mystery ‘guess the colour!’ is conducted via a game. It is important that the game is performed using a precise theatrical system: students must enter the classroom when the darkness has already been brought about and the three sets of coloured cardboards are placed onto a table. They should be covered with three black pieces of cardboard that will be removed one by one.

The white light of the sun or the artificial light of the room will be turned on only at the end of the game, at which point the students will learn how close their guesses are to the colour of the cardboard inside each envelope.



GRR

TEACHING SKILLS USING GRADUAL RELEASE OF RESPONSIBILITY

Setting up the mystery: perform a game with the class in which students are asked to pick up a certain piece of coloured cardboard from a set of six pieces of cardboard illuminated by a monochromatic light. Under this light, the pieces of cardboard seem to lose their colour.

Demonstrated enquiry (level 0).
Teacher-as-model: you show how to carry out an enquiry process, which students then copy. Explain your hypothesis and tests by ‘talking aloud’. Students record your thinking onto their hypothesiser lifeline sheet. Since this mystery requires many steps to be solved, it is more convenient to use a structured enquiry.

Structured enquiry (level 1).
‘We do it’. Students then use their hypothesiser lifeline sheet to record their own alternative ideas about the nature of white light. They can both combine monochromatic lights to get white light and divide a white light into its component via a

diffraction grating. Students have to record their tests and conclusions regarding their investigation on white lights.

In the second step, students will use again their hypothesiser lifeline sheet to investigate how the colours of the pieces of cardboard change if observed in a particular monochromatic light. They should first experience what happens when mixing inks and then what happens when illuminating coloured cardboards.

Solving the mystery:
Students are led to the explanation by using ideas about the additive synthesis of lights and subsequently about the subtractive synthesis with coloured pigments. At the end of the enquiry learning cycle, they should have a clear understanding of why, for example, the fundamental colours of a printer are magenta, cyan, and lemon yellow rather than red, green, and blue.

Resources

The first video is a 1950s educational documentary about colour. TEMI Youtube Channel:
www.goo.gl/tUDaq5
playlist> this is color

The following video pertains to the additive synthesis of light and the physiology of vision. In addition, it briefly discusses the fact that there is no correspondence one to one between a colour and a wavelength. TEMI Youtube Channel:
www.goo.gl/tUDaq5
playlist> colour mixing

Guess the colour!

STUDENT WORKSHEET

From the game with coloured lights and coloured pieces of cardboard, you have seen that it may be very difficult to correctly pick a certain colour under a monochromatic light. To solve this mystery, it will be necessary to travel into the world of coloured lights.

Engage

WHAT'S INTERESTING?

Task: Work in the darkness if you can.

Explore

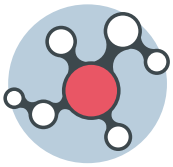
WHAT'S HAPPENING?

Task: Look at the different kind of lights through a diffraction grating, try monochromatic light and light from an incandescent bulb,. What colors do you see in each case?

Explain

WHAT'S CAUSING IT?

Task: Define the color of a cardboard as the color that appears when it is illuminated by a white light. Then, illuminate some colored cardboards with a monochromatic light. Use the red, the green, the blue and the white cardboards first, write down in a table the color of each type of cardboard when it is illuminated by the red, the green and the blue light. Can you find any pattern?



Extend

WHAT'S SIMILAR?

Task: Now, illuminate each cardboard with a couple of different lights at the same time, use all the possible combinations of colors. Write down your observations in a table.

Evaluate

WHAT'S MY UNDERSTANDING?

Task: Work in pairs and make a quiz with ten questions from the topic. Solve your quiz and go through them together afterwards. At the end of the lesson, hand them in to your teacher.