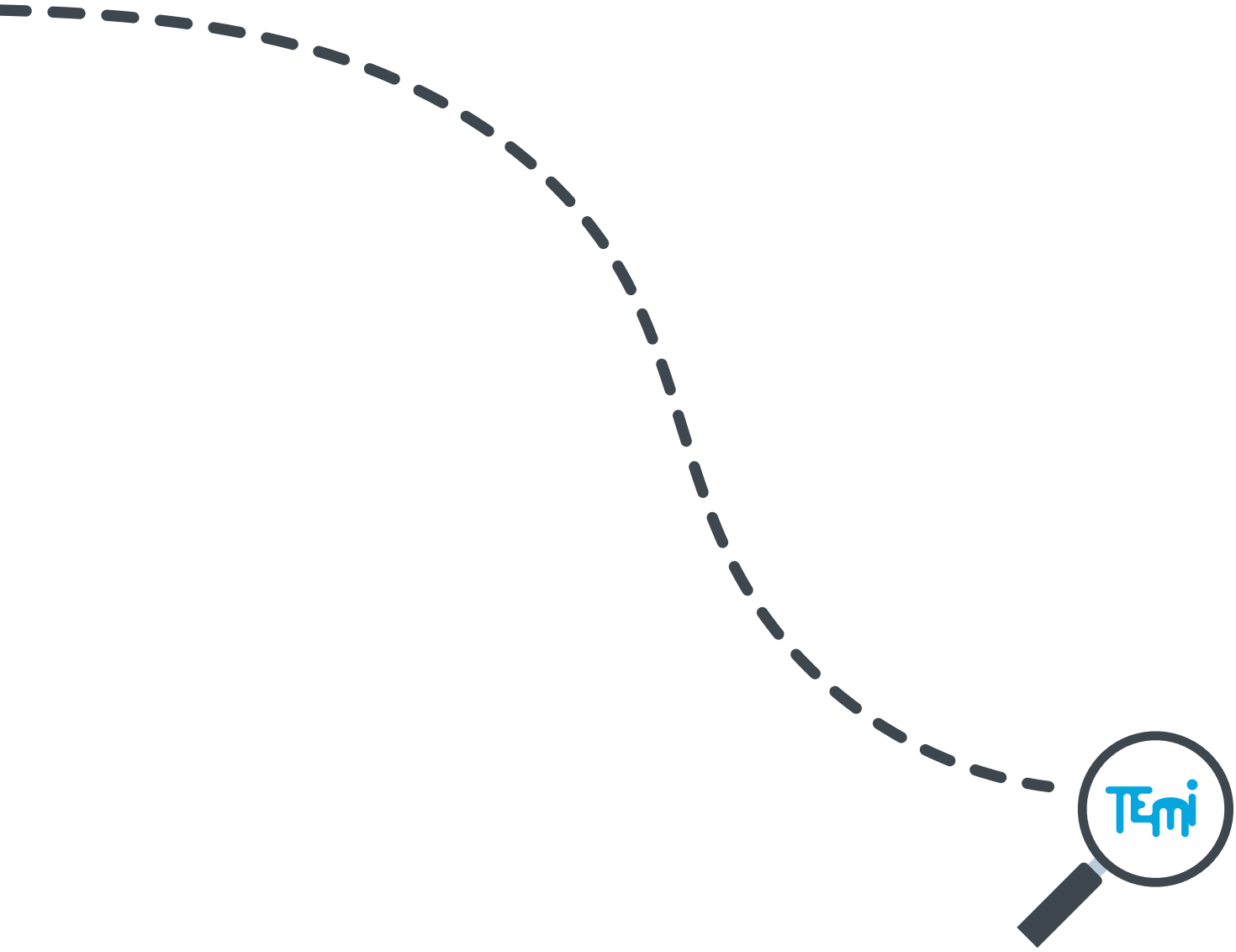
The mystery of the disappearing laboratory report

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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The mystery of the disappearing laboratory report

What's the mystery?

This mystery deals with a laboratory report in which the written results suddenly vanished. The students need to find out how the writing vanished, how to recover the vanished data, and what the secret of the pen is.

DOMAIN(S)

Chemistry.

SUBDOMAIN KEYWORDS

Energy (exothermic and endothermic reactions), chemical equilibrium, thermodynamics.

AGE GROUP

16 to **17** years old.

EXPECTED TIME FOR THE MYSTERY

Approximate time for teacher preparation:
One hour to prepare the lab reports (writing them and warming them up to make the ink disappear).

Approximate time in classroom:
Up to **six periods of 45 min** each: one period to engage and explore, one to explain, three for open enquiry, and one to present the enquiry in class.

SAFETY/SUPERVISION

None. If there is use of liquid nitrogen, the safety regulations related to its use are necessary.

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

- A pilot friXion ball erasable ink pen for each group of three to four students.
- A lab report with missing/erased data.
- Different equipment to heat and cool the paper (such as a kettle, hair dryer, or liquid nitrogen).

LEARNING OBJECTIVES

Exposing students to reversible chemical reactions. Experimenting with the conditions that influence such reactions.

Guidance notes for teachers

Engage

CAPTURE STUDENTS' ATTENTION

The teacher tells a story about how she/he left students' lab reports in a hot place (such as in a car in summer or in front of a fire place); the next day, when the teacher looked at the reports, most of the data had disappeared. Alternatively, the teacher can hand out greeting cards (for the new school year, for a holiday, etc.) in which half of the text is missing.

Explore

COLLECT DATA FROM EXPERIMENTS

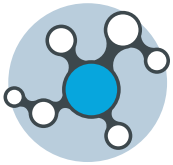
Students can try to make the ink reappear. They can suggest and try their own ways of making the ink reappear. Students often suggest actions such as heating or cooling the paper to different temperatures, exposing the paper to different levels of pH, or exposing the paper to light at different intensities.

Explain

WHAT'S THE SCIENCE BEHIND THE MYSTERY?

The ink is made of a thermochromic pigment, which is sensitive to temperature changes. As the ink is exposed to high temperatures, it changes from coloured to colourless. This property is exploited to make erasable ink: when ink is applied on paper rubbed with a special plastic (on the cap of the pen), the heat caused by the friction makes the ink disappear.

However, this is a reversible reaction and the colour can be made to reappear upon cooling.



Extend

WHAT OTHER RELATED AREAS CAN BE EXPLORED?

Students can design their own enquiry-based experiments based on their knowledge of thermodynamics, energy and Le Chatellier's principle to explore the thermochromic properties of the ink. This enquiry is open ended: the questions should come from the students.

Sample questions could be: "at what temperature does the ink disappear?", "at what temperature does the ink reappear?", "can the process be made non-reversible (e.g. by overheating the ink)", and "if the pen is heated, can it be used to write invisible scripts?"

Evaluate

CHECK THE LEVEL OF STUDENT SCIENTIFIC UNDERSTANDING

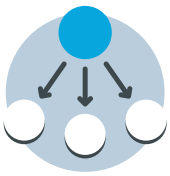
Students are assessed via two methods. They should prepare a formal written lab report and an oral presentation of the lab report in class. The written and oral lab reports assess skills like making observations, asking questions, designing experiments, writing scientific explanations, and proposing hypotheses. The oral presentation further allows for discussion and for presenters to improve their lab reports.

Showmanship

TIPS ON HOW TO TEACH AND PRESENT THIS MYSTERY

The engaging story has to be relevant to the teacher and the scenario in class. It can relate to a recent lab report, an upcoming holiday, etc.

As an additional exercise, students may draw a picture that 'uses' the phenomenon of the disappearing/reappearing ink to express an idea and show it. This could be a good way to encourage students to use some showmanship in the presentation.



GRR

TEACHING SKILLS USING GRADUAL RELEASE OF RESPONSIBILITY

The activity begins with the presentation of the mystery. In the first stage (explore), students conduct a structured enquiry (level 1) in order to understand the phenomenon and solve the mystery.

In the extend stage, students conduct an open-ended enquiry (level 2). Here, with the help of the teacher, they learn to ask research questions, design an experiment, carry out the experiment, process the data, and reach conclusions based on the data.

Resources

More on the phenomenon can be found at the following website:

www.tmchallcrest.com/chromazone/Thermochromism.htm

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STUDENT WORKSHEET

Yesterday we had great results at the lab! We explored different kinds of reactions, measured the temperature vs time for all of them and organized the data in beautiful tables. We thought about every detail! Titles, units, observations-everything was there!! We were so tired and proud, that we decided that we deserve a break on the beach in this hot summer day. When we came back and opened our notebook, we were shocked to see that our data was gone! The outline of the table was there, but the data was gone!

Engage

WHAT'S INTERESTING?

Task 1: Suggest relevant observations or questions that need to be considered in order to resolve the mystery of the missing data and to write 'the story of the table'.

Task 2: Suggest how to make the missing data in the lab report you received reappear.

Explore

WHAT'S HAPPENING?

Task 1: Ask for materials and equipment to try and make the ink reappear. Explore the behaviour of the ink.

Task 2: Describe what you did and what happened.

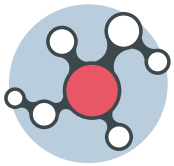
Explain

WHAT'S CAUSING IT?

Task 1: Hypothesise about how the ink works.

Task 2: Give a reasonable explanation for your hypothesis based on the concepts related to energy transfer in chemical reactions.

Task 3: Brainstorm with the class and explain how the ink works.



Extend

WHAT'S SIMILAR?

Task 1: Write down five questions that arose while exploring the issue of the missing ink.

Task 2: Choose one of the questions that you would like to investigate regarding the 'ink' and formulate this question clearly as an enquiry.

Task 3: Clearly formulate a hypothesis that relates to the question that you chose to investigate. Give reasons for your hypothesis based on correct and relevant scientific knowledge.

Task 4: Plan an experiment that will check your hypothesis.

- Detail all the steps of the experiment, including the control stage.
- List the equipment and materials needed on the equipment request form.
- Consult with the teacher and make changes if necessary.
- Submit the list of equipment and materials to the laboratory technician.

Evaluate

WHAT'S MY UNDERSTANDING?

Task 1: Prepare a lab report.

Task 2: Draw a picture that 'uses' the phenomenon of the disappearing/ reappearing ink to express an idea. If you want, think of a creative way to present the change to the class.

Task 3: Present the enquiry and your drawing in class.