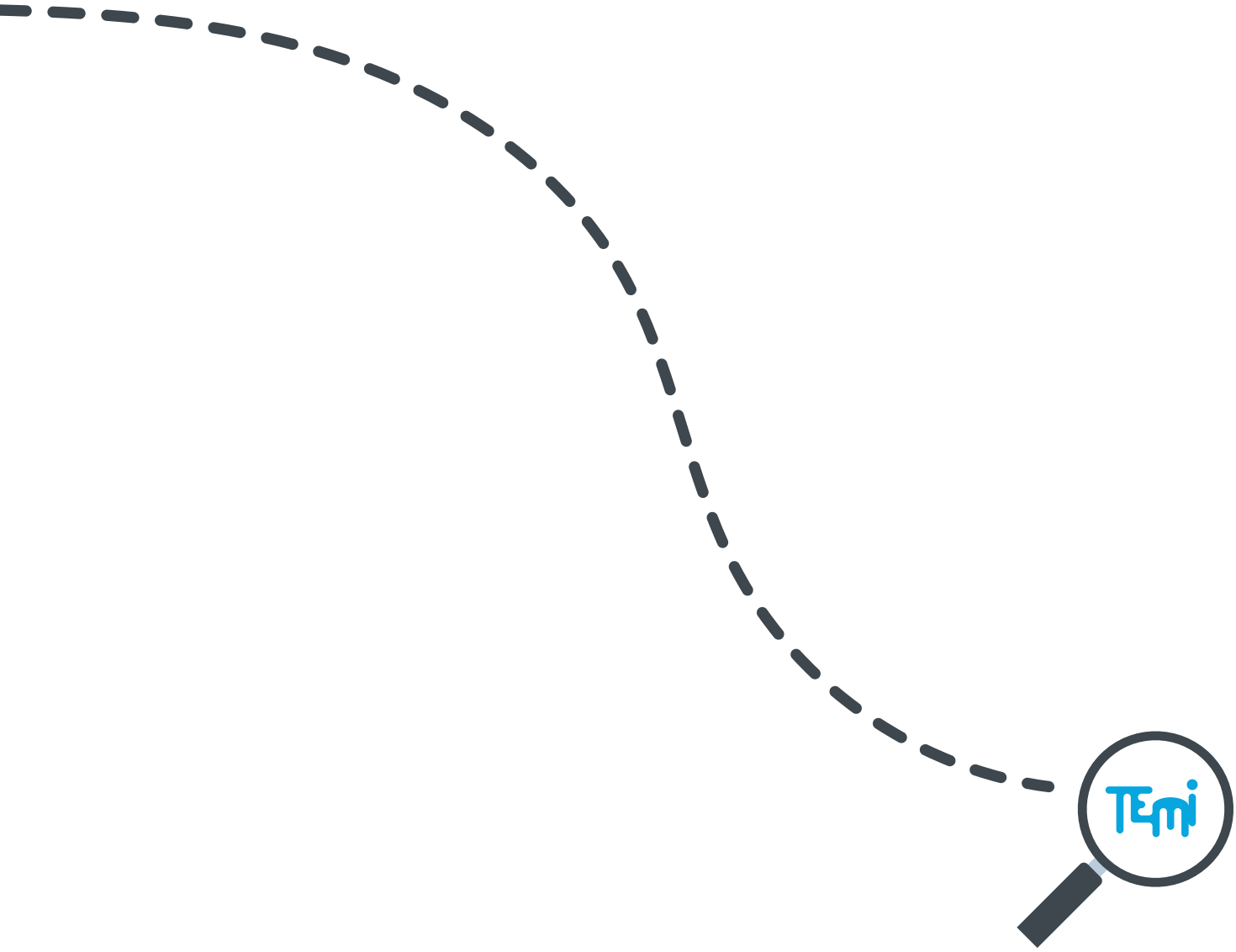
The chameleon bubbles

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**

This research project has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 321403.

teachingmysteries.eu

FP7-Science-in-Society-2012-1, Grant Agreement N. 321403

Co-funded by the Seventh Framework Program of the European Union

The chameleon bubbles

What's the mystery?

Chameleon bubbles are alginate bubbles that emerge when a sodium alginate solution is dropped into a calcium chloride solution – just like how bubbles in bubble tea are made.

The bubbles can change their colour with respect to the substance with which they are filled. In this case, the bubbles are filled by an acid-base indicator solution; so, adding acids or bases in the outer surrounding leads to colour changes inside the bubbles by diffusion and pH change – just like how a chameleon can change its colour. Since acids and bases are colourless liquids, adding them to the solution around the bubbles leads to mysterious colour changes.

DOMAIN(S)

Chemistry, acid-base chemistry.

SUBDOMAIN KEYWORDS

Sodium alginates, acids, bases, indicators, semi-permeable membrane.

AGE GROUP

14 to **15** years old.

EXPECTED TIME FOR THE MYSTERY

Approximate time for teacher preparation:
15 min.

Approximate time in classroom:
90 min.

SAFETY/SUPERVISION

Students should wear safety goggles and lab coats. Acids and bases are corrosive.

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

- Sodium alginate
- Calcium chloride
- Diluted hydrochloric acid
- Diluted sodium hydroxide solution
- Salad herbs
- Vinegar
- Vegetable oil
- Red cabbage indicator
- Other indicators.

LEARNING OBJECTIVES

Students can learn about acids, bases, indicators, neutralisation, and diffusion through semi-permeable membranes.

Guidance notes for teachers

THE 5E MODEL

Engage

CAPTURE STUDENTS' ATTENTION

Students generally know about bubble tea. However, bubbles that change their colours are unfamiliar to students. The teacher can engage students with a fictitious story about a child's birthday. Someone prepared bubbles for lemonade and put red cabbage juice or radish extract inside them. Once these were put into the lemonade, they started to change their colour. This helps the children to become curious about why this happened.

Explore

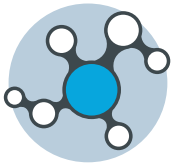
COLLECT DATA FROM EXPERIMENTS

1. The colour within the alginate bubbles changes with the addition of acids and bases; this begins a process of neutralisation. The effect of the semi-permeable membrane of the alginate bubbles can be observed.
2. Testing the behaviour of an alginate solution indicates the special character of this substance. Proper work is necessary to prevent the formation of lumps.
3. Alginates do not form homogeneous solutions in some surroundings; instead, some kind of glue or gel is formed. When testing the (vinegar-oil) salad dressing herbs get into some kind of suspension. In an aqueous solution, the water would separate from the oil again.

Explain

WHAT'S THE SCIENCE BEHIND THE MYSTERY?

With the addition of an acid, the oxonium ions diffuse through the alginate membrane inside the bubbles. With the addition of a base, the hydronium ions diffuse through the membrane. Any acid-base indicator will indicate the corresponding pH change and processes of neutralisation. Alginates are polysaccharides. Positively charged calcium ions insert themselves between negatively charged alginate molecules. Sugar molecules create a network, thus forming a semi-permeable membrane.



Extend

WHAT OTHER RELATED AREAS CAN BE EXPLORED?

The students can search for information about the hype surrounding the bubble tea business in 2010. They can then comment on the topic and discuss the very critical attitude of the media towards bubble teas. Students can also find more information on the technical use of semi-permeable membranes and learn about molecular gastronomy.

Evaluate

CHECK THE LEVEL OF STUDENT SCIENTIFIC UNDERSTANDING

Reference can be made to the idea of environmentally friendly packaging, since plastic water bottles could be replaced with ones made from alginates. The practicality of this idea can be

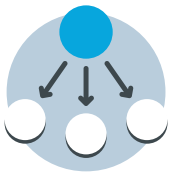
assessed. Based on the experiment, the students can estimate the carrying capacity of the semi-permeable membrane and use the findings to devise an opinion.

THE 5E MODEL

Showmanship

TIPS ON HOW TO TEACH AND PRESENT THIS MYSTERY

The engage phase can be structured by telling a story about a child's birthday, where the parents wanted to make the lemonade more exciting by adding homemade bubbles filled with some vegetable-based coloured liquids. The story can be supported with an experimental presentation. The bubbles are put into lemonade. After a short time, the colour changes. This can be seen more clearly if the bubbles are removed from the lemonade and placed in a petri dish in front of the students.



GRR

TEACHING SKILLS USING GRADUAL RELEASE OF RESPONSIBILITY

The mystery is presented as a guided enquiry (level 2). The students complete the tasks in order to investigate alginates and colour changes. A variety of materials is made available to the students so that they can solve the mystery autonomously and find an explanation on their own.

Solving the mystery: by producing and examining the alginate solution, the students realise that this is not an aqueous solution; rather, it is a gel.

By bringing the bubbles into contact with various household acids and bases, a colour change can regularly be observed. The colour appears slowly in the shell; before long, the bubbles are coloured completely. It can be observed that the alginate shell works as a semi-permeable membrane. This can be passed by oxonium and hydroxide ions, but not by the bigger indicator molecules. Using the various acids and bases, it becomes clear that there is an acid and base reaction taking place: the indicator demonstrates this.

Resources

Brandl, H. (1998). Trickkiste Chemie. Bayerischer Schulbuch Verlag, München.

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STUDENT WORKSHEET

My friend Sara works in a school kitchen. She is preparing treats for her daughter's birthday. At the moment, Sara is preparing bubbles for bubble lemonade: a drink similar to bubble tea. The guests can put the bubbles in their drinks if they like. Of course, the children also start playing around with the bubbles. However, one of them suddenly cries out. There's something really strange happening: check out what the child experienced.

Engage

WHAT'S INTERESTING?

Task: Drop sodium alginate solution with a plastic pipette into the calcium chloride solution.

Examine the behaviour of the bubbles with the following materials and chemicals: glass beaker (fill with water), spoon, petri dish, knife, diluted hydrochloric acid, and diluted sodium hydroxide solution.

Describe your observations and suggest questions.

Explore

WHAT'S HAPPENING?

Task 1: Suggest ideas to solve the mystery of the chameleon bubbles.

Task 2: With the materials (scales, spatula, thermometer (70°C), sieve, glass rod, hot plate with magnetic stirrer, and beakers (250 ml and 50 ml)), produce sodium alginate and sodium alginate solution. Describe the properties and behaviour of the sodium alginate solution.

Task 3: Examine the behaviour of the sodium alginate solution when it comes into contact with salad dressing made from oil, vinegar, and herbs. Use sodium alginate solution, salad herbs, vegetable oil, vinegar, water, beakers, a hot plate with magnetic stirrer, test tubes, and a test tube rack.

Task 4: Examine the behaviour of the sodium alginate solution in a calcium chloride solution with different pH values. Use glass beakers, glass rods, tweezers, a pipette, a microscope, diluted hydrochloric acid, diluted sodium hydroxide solution, a red cabbage indicator, and other indicators.

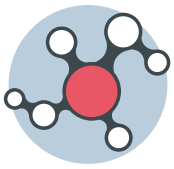
Explain

WHAT'S CAUSING IT?

Task 1: Write down your observations about the properties of the sodium alginate solution.

Task 2: Explain how the colour change in the balls occurs.

Task 3: Search the Internet for the phenomenon of spherification and explain it using the following terms: calcium ions, alginate molecules, membrane, positively charged, negatively charged, networking, semi-permeable.



Extend

WHAT'S SIMILAR?

Task: Bubble tea was a very popular trend that spilled over from China to Europe a few years ago. However, it vanished just as quickly as it emerged. Many of the newly opened stores had to close.

Search the Internet to find out about the history of bubble tea. Rate how the media handled this product and form an opinion.

Evaluate

WHAT'S MY UNDERSTANDING?

Task: The environment plays a big role in our society. So the idea quickly emerged that alginate membranes could be used to transport water. This means that plastic bottles might be replaced in the future by edible packaging.

Give your opinion on this idea. Think about the criteria that such a package needs to meet and whether this can be guaranteed. Include your results from the experiments for evaluation.