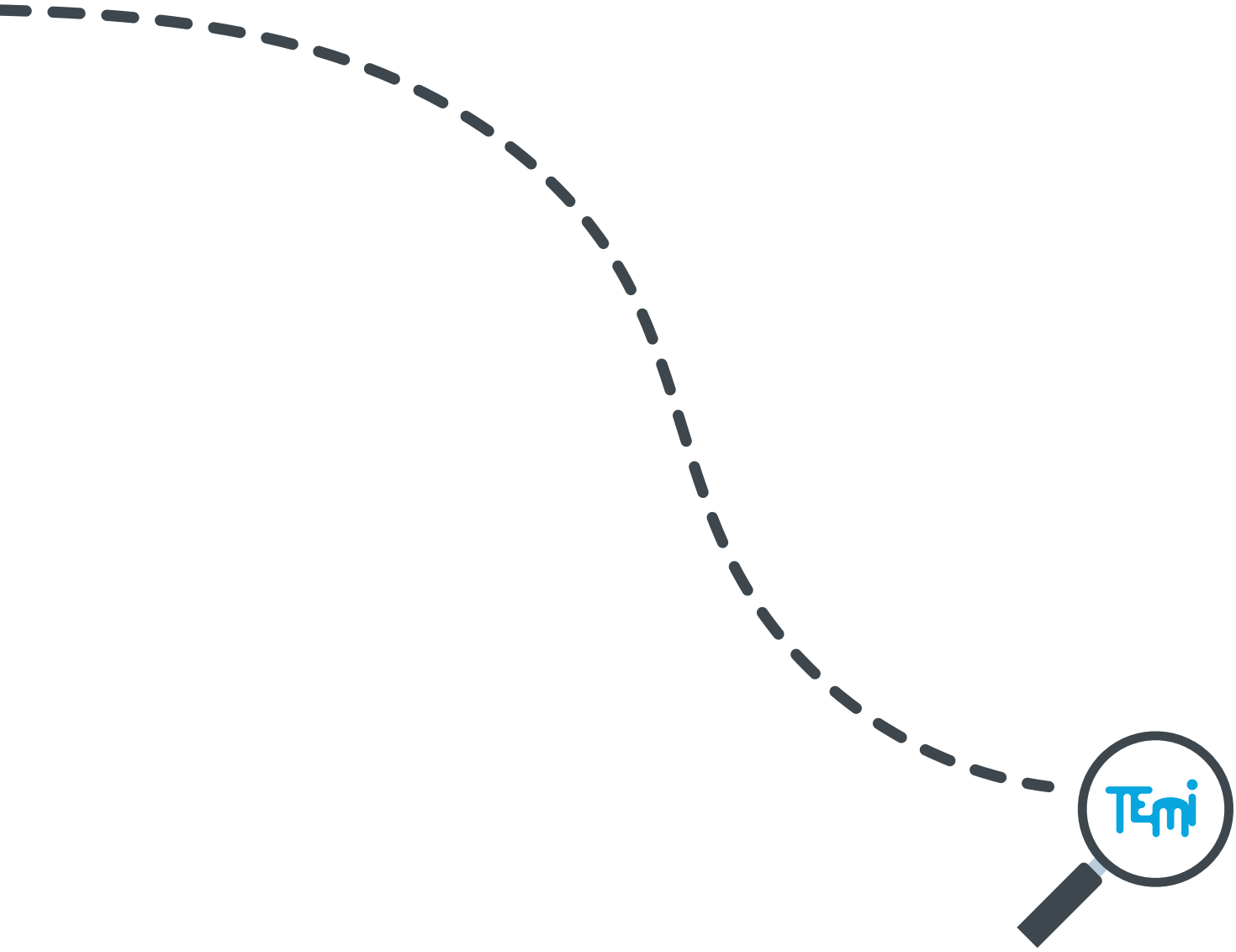

# The sea-sand overseas

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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## What's the mystery?

The mystery deals with sand that stays dry when water is poured onto it. Students are requested to find ways to build sand castles with this 'dry' sand.

### DOMAIN(S)

Chemistry.

### SUBDOMAIN KEYWORDS

Chemical bonding, hydrophobic and hydrophilic properties.

### AGE GROUP

**15** to **17** years old.

### EXPECTED TIME FOR THE MYSTERY

Approximate time for teacher preparation: **About an hour** to prepare materials. **About an hour** to practise the story.

Approximate time in classroom: Between **four 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

No safety concerns. The materials are not toxic.

**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

- One spoon of regular sand on a petri dish per group.
- One spoon of magic sand on a petri dish per group.
- 50 ml of water.
- 2 x 100 ml beakers.
- 2 droppers.
- During the enquiry (the extend stage), the materials depend on the research questions of the students. They may need different solvents: oil, acetone, ethanol, hexane, heptane (hydrophobic solvents which are allowed in school), soap, etc.

### LEARNING OBJECTIVES

Exposing students to practical issues related to hydrophobic and hydrophilic interactions and compounds.

# Guidance notes for teachers



## Engage

CAPTURE STUDENTS' ATTENTION

The teacher tells a story about a friend who is an expert in building sand castles. The friend registers to attend a competition in a faraway place* where he has to build a castle with a strange kind of sand (the hydrophobic sand). Students are asked to help him build a sand castle with this sand.

*The teacher can tell students about a true competition that is being held; for example: http://newzealandsandcastlecompetition.co.nz/ www.ussandsculpting.com/

## Explore

COLLECT DATA FROM EXPERIMENTS

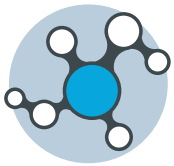
Students examine the 'dry' sand and the regular sand in order to find a solution to the problem of building a sand castle with the dry sand. They experiment with the sand, testing different solvents which will wet the sand and cause it to stick, thus allowing a person to build a castle with it.


## Explain

WHAT'S THE SCIENCE BEHIND THE MYSTERY?

The phenomenon can be explained by taking a closer look at intermolecular forces and hydrogen bonding in particular. Regular sand can form hydrogen bonds with water, thus wetting the sand grains and allowing them to stick together, with the water acting as glue.

Sea-sand (the 'dry' sand) is a common aggregate that has been processed and coated with a hydrophobic material, thus preventing the grains of sand from forming hydrogen bonds with the water. The sand repels water, but it can absorb oils, other hydrophobic solvents, and pollutants.



## Extend

WHAT OTHER RELATED AREAS CAN BE EXPLORED?

Students can design their own enquiry based on prior knowledge related to chemical bonding and based on exploration with the sand (see 'explore' above). Here, they can check how different solvents wet the sand and allow it to stick together in order to form a castle.

## Evaluate

CHECK THE LEVEL OF STUDENT SCIENTIFIC UNDERSTANDING

Students can prepare a lab report aligned with the curriculum, which assesses skills such as making observations, asking questions, designing an experiment, writing explanations, hypothesising, etc.

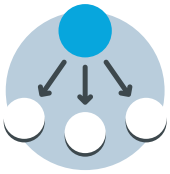
The results and conclusions can also be presented in a dramatic way (e.g. three still pictures).

## Showmanship

TIPS ON HOW TO TEACH AND PRESENT THIS MYSTERY

The full story for the engage stage can be seen in the following video on the TEMI Youtube Channel:
www.goo.gl/tUDaq5
playlist > Science - The biggest drama in the class

In order to fully engage the audience, it is best that the teacher adds some of his or her own personal details to the story. For example, the teacher can mention from where they know the sandcastle-building friend. They can mention their place of birth and that they were friends from nursery school. In short, personal details added to the story can make it more vivid, credible, and engaging.



## GRR

TEACHING SKILLS USING GRADUAL RELEASE OF RESPONSIBILITY

This activity is open ended.

In the engage, stage the teacher just tells a fictional story with no demonstrations. Since this activity deals with materials from students' everyday lives, there is no need to demonstrate.

In the explore stage, students are given the freedom to conduct their own enquiries into the phenomenon. The students can pace this enquiry, with the teacher offering minimum support. At this stage, students should arrive at a solution about how to make the sand stick.

In the extend stage, students devise their own enquiry activity. Here they ask their own enquiry questions, design their own enquiry experiments, order materials, and conduct the experiments. This might be a big leap for some students; at this stage, they will need the teacher to guide their planning. The teacher's role, however, should be that of a consultant rather than an instructor.

## Resources

Website for sea-sand:
http://sealsand.com/index-1.html

http://stwww.weizmann.ac.il/g-chem/temi/sand3.html

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**STUDENT WORKSHEET**

Our good friend James is a champion sandcastle builder. He has won every competition in Europe. However, one day he went to a competition in Australia and all he got was this magic sand. At first he was convinced he would lose. But guess what! He built a sand castle after all! Now it's your turn: can you build a castle?

## Engage

WHAT'S INTERESTING?

**Task:** James provided us with two types of sand: regular and special sand.

Add some drops of water to each type of sand to see what James saw when trying to build the sand castle in Australia.

## Explore

WHAT'S HAPPENING?

**Task 1:** Try building a sandcastle from the special sand. Do you need any extra tools or materials?

**Task 2:** Explore the behaviour of the sand with the tools and materials you requested.

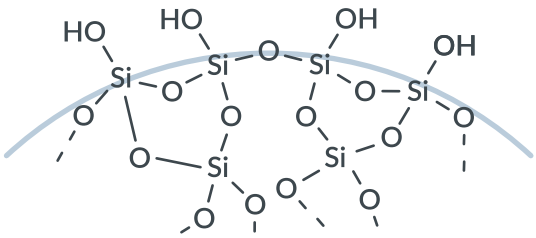
## Explain

WHAT'S CAUSING IT?

**Task 1:** Explain the properties of the 'special' sand that prevent water from wetting it?

**Task 2:** What do you think the chemistry underlying the 'special' sand is?

**Task 3:** Look at the model on the below representing the surface of regular sand at the molecular level. How can you explain the fact that water wets this sand? In what way must the special sand be different from the regular sand on the below?




SAND SURFACE: MOLECULAR LEVEL

## Extend

WHAT'S SIMILAR?

**Task 1:** Write five questions that arose while exploring the 'special' sand,

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

**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.

## Evaluate

### WHAT'S MY UNDERSTANDING?

**Tasks** 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.

In the next lesson, you will perform the lab experiment you devised.