

## 4.1 Case study 1 (CS1 Portugal)

<b>Concept focus</b>	Behaviour of oil in water
<b>Inquiry skills</b>	Planning investigations
<b>Scientific reasoning and literacy</b>	Not assessed
<b>Assessment methods</b>	Teacher observation Student devised materials (investigation plan)
<b>Student group</b>	<b>Grade:</b> 7 <sup>th</sup> grade (lower second level) <b>Age:</b> 12-14 years <b>Group composition:</b> mixed ability and gender; 20 students (13 girls, 7 boys); overall the students perform well in school subjects <b>Prior experience with inquiry:</b> No prior experience with inquiry

The **Black tide – oil in the water** SAILS inquiry and assessment unit was implemented in full, with a focus on development of students' skill in *planning investigations*. The teacher prepared a rubric that detailed success criteria for three dimensions of this skill – setting objectives, defining strategies and procedures, and selecting appropriate resources. The teacher provided written feedback to the students after an initial evaluation of their work, and carried out a second analysis at a later time.

### (i) How was the learning sequence adapted?

The **Black tide – oil in the water** SAILS inquiry and assessment unit was implemented as suggested in the unit, with little modification. This task has undergone a small change, as students were not asked to convert the value of the affected area indicated in the legend of the map, into km<sup>2</sup>. The investigative task was applied over four lessons of 90 minutes each. In class, students worked in groups of three or four members.

### (ii) Which skills were to be assessed?

Students' skill in *planning investigations* was evaluated using an assessment tool which assessed three dimensions – setting objectives, defining strategies and procedures, and identification and selection of appropriate resources. The assessment instrument used contains three performance levels, where level one corresponds to the lower level and level three to the highest level (Table 1).

**Table 1: Assessment of planning investigations**

Actions	1	2	3
Define goals	Does not define coherent goals according to the proposed problem.	Defines some coherent goals according to the proposed problem.	Defines coherent goals according to the proposed problem.
	Does not operationally define the variables.	Defines with some difficulty the variables at study.	Operationally defines the variables at study.
Define strategies and procedures	Does not define the necessary strategies and procedures to achieve the goal.	Defines with some difficulty the necessary strategies and procedures to achieve the goals.	Defines the necessary strategies and procedures to achieve the goals.
	Unclear planning requiring reformulation.	Planning well presented but requiring reformulation.	Clear, concise and complete planning.
Choice and use of resources	Does not select adequate resources according to the goals and strategies.	Selects some resources that are adequate to the goals and strategies.	Selects the resources that are adequate to the goals and strategies.

### (iii) Criteria for judging assessment data

The assessment tool was built before the implementation of the investigative task. Before using the instrument, teacher gave each group a written feedback about their work. Another important aspect was to analyse the students' work, after a specific period of time, based on the designed instrument. These two factors – written feedback and a second analysis – allowed the teacher and students to overcome some of the difficulties encountered in assessing the competencies associated with *planning investigations* and evaluation of students' work using the defined performance levels.

### (iv) Evidence collected

#### Sample student artefacts and teacher's opinions

The presented evidences are a transcription of students written work (*italic black*) and teacher written observations in their work (*italic red*).

Figure 1 shows an example of a group's experimental plan that was assessed as performance level 1. The teacher observed, "In the first part of the planning, this group did not answer the question 'How does oil behave when spilled in water?' That is clear, when students chose the title 'Water with oil or oil with water' in their planning. Rather, they present a second part, where they try to answer the question 'How do oil and water mix as a result of currents, waves and winds?'"

**Experiences (planning)**

**Students do not indicate the material they will use.**

**1st - Water with oil or oil with water.**

**The question asked was: How does oil behave when it is spilled on water?**

**Occurrence of oil in water.**

**For one graduated cylinder of water use half graduated cylinder of oil.**

**What is the volume of water in the graduated cylinder?**

**Recipient 1 – First one puts in a trough one added salt water and then added the simulated oil (should indicate the used volumes).**

**The oil fell on the bottom and immediately afterwards it rose and spread. The observations are presented in 2.4.**

**Occurrence of water in oil**

**For one graduated cylinder of oil use half graduated cylinder of water**

**Recipient 2 – Firstly we placed the oil and then the water was added. The oil remained at the bottom and the water rose to the surface.**

**I realize you are curious but the aim was not to answer the question.**

**Comparison – If there is more water than oil, the oil falls to the bottom and then rises up to the top. If there is more oil than water, the oil stays on the bottom and the water rises up to the top.**

**How have you made this observation? Did you try this? Was this what you observed?**

**Figure 1: Example of performance level 1**

Another group experienced some difficulty when defining the experimental strategies and necessary procedures to achieve the objectives, as shown in Figure 2. The group only indicates the ratio of the volume of water in relation to the volume of simulated oil that they will use and mention how they will simulate the effect of waves, winds and tides. However, they do not mention that they will use another container to act as control, which does not experience those effects. Their planning is unclear and lacks detail; students were expected to indicate, step-by-step, what they intended to do. The results/observations were described in the planning and not afterwards, for instance as an answer to question 2.4. Similarly, they do not indicate a list of materials required for implementation of the procedure, although some of the materials are referred to in the text related to planning.

**2nd – Effects of the currents, waves and wind**

**How does the mixing of oil and water occur due to currents, waves and winds?**

**For one graduated cylinder of water use half graduated cylinder of oil.**

**Waves: shaking the trough;**

**Winds: blowing through a straw;**

**Tides: using a glass rod.**

**The planning should be detailed.**

**The observations are presented after the planning in the answer to question 2.4.**

**Recipient 1: Waves**

**The oil spreads on the water's surface clouding it.**

**Recipient 2: Wind**

**The oil creates a surface layer on the water, also clouding it.**

**Recipient 3: Currents**

**The oil was on the bottom and the water was clouded.**

**The oil was not on the bottom as it was on the previous situations? Was the same simulated oil used?**

**Container 4: With nothing. What does "with nothing" mean?**

**The oil was on the top and on the bottom?**

**Carefully see what you have registered for container 1 (page one).**

**Comparison: We have observed that in all the containers the water was clouded, except in container 4.**

**Figure 2: Further example of performance level 1**

Figure 3 shows an example of a groups' work that the teacher has assessed as performance level 2. Students define some objectives that are consistent with the proposed problem. They define the variables under study; in particular they indicate that four containers are required and that the volume of the water and the simulated oil will be kept constant. They explain that in each of the three containers, they will simulate only one of the effects – wind, tides or waves. Also they indicate that they will use one more container where they will add the water and simulated oil without any effect. However, they do not understand the reason for using this container, since at the end of their planning, they write, “compare all containers.” It is not clear that these students understand the need and rationale for controlling variables in the experiment. Planning did not include a list of materials and equipment. The work plan was unclear; students mixed up the information related to the three effects. In order to make the planning more clear, students could have added subtitles in planning – wave effect, currents effect and tidal effect – in order to be more complete and detailed.

**2) Students do not indicate the materials they will use.**

**1st step – Put water in the container and add a mixture of 12 tablespoons of vegetable oil and 8 tablespoons of cocoa powder. This mixture of vegetable oil and cocoa is the simulated oil.**

**What was the volume of water used? Did you use that amount of simulated oil? You need to be clearer in your planning, that is, your planning needs to be more detailed.**

**2nd step – In that container we will put use a fan to simulate the wind.**

**3rd step – In another container we will use the same volume of preparation, equal to the one used before (with water and simulated oil). We will shake the recipient to simulate waves.**

**4th step – In another equal preparation we will agitate it with a glass rod to simulate the currents.**

**5th step – In another container we will put the preparation and we will do nothing else.**

**6th step – Compare all containers. Observe and register the results.**

**Figure 3: Example of performance level 2**

The example shown in Figure 4 was assigned a performance level of 3. Students define objectives that are consistent with the proposed problem, the experimental plan seeks to answer the question initially proposed. They define the variables under study; they refer to a control container – containing a given volume of water and simulated oil. The winds, waves and tides effects are simulated in each of the remaining containers – taking care to keep the volumes of water and simulated oil constants. They also understand the significance and the need to control variables, as in the planning it is clear that students intend to compare each of the containers with the control container. However, they do not indicate the list of materials to be used, although some of the required materials appear in the text of the plan. The plan also needs some rewording, because it is incomplete and the step sequence should be changed.

**2.1. Students do not indicate the materials they will use.**

**Wind's effect**

**1st – Prepare simulated oil: mix 12 tablespoons of vegetable oil with 8 tablespoons of cocoa powder.**

**2nd – Trough with water and simulated oil as control. Explain how.**

**3rd – Put 75 ml of water in a trough. Add 2 tablespoons of simulated oil. Trough with water and simulated oil to simulate the wind. How do you simulate the wind?**

**4th – Compare control trough with simulated wind trough. Register the observations.**

**1st\* 5th – In Each trough put has 75 ml of water.**

**2nd\* 6th – Add Each trough has 2 tablespoons of simulated oil.**

**\* These should be the initial steps.**

**Waves' effect**

**1st – Trough with simulated oil as control.**

**2nd – Trough with water and simulated oil to simulate the waves. How did you simulate the waves?**

**3rd – Compare both troughs. Register the observations.**

**4th – Each trough with 75 ml of water.**

**5th – Each trough with 1 tablespoon of simulated oil.**

**The previous steps are subjected to the recommendations as the previous ones. You should alter the sequence of the steps and the plan is incomplete.**

**Current's effect**

**1st – Trough with simulated oil as control.**

**2nd – Trough with water and simulated oil to simulate the current.**

**\*4th – Each trough with 75 ml of water.**

**\*5th - Each trough with 1 tablespoon of simulated oil. The volume of simulated oil should be the same.**

**\* These should be the initial steps of your plan.**

Figure 4: Example of performance level 3