

## 4.1 Case Study 1 (CS1 Ireland)

<b>Concept focus</b>	Environmental impact of household chemicals
<b>Inquiry skills</b>	Developing hypotheses Planning investigations
<b>Scientific reasoning and literacy</b>	Scientific reasoning (identifying variables)
<b>Assessment methods</b>	Classroom dialogue Teacher observation Worksheets
<b>Student group</b>	<b>Grade:</b> two classes – one 2 <sup>nd</sup> year (lower second level, 20 students) and one transition year (upper second level, 11 students) <b>Age:</b> 13-14 and 15-16 years <b>Group composition:</b> mixed ability, single sex (female) <b>Prior experience with inquiry:</b> Little or no prior experience with inquiry

This case study describes implementation with two separate classes – one theoretical planning activity at lower level and full implementation with an upper second level class. The teacher provided a worksheet to guide the students in both classes. Students' skills in *developing hypotheses* and *scientific reasoning* were assessed using the criteria from the rubrics in the unit. The teacher gave observational feedback to the students as they worked through the unit and reviewed their worksheets during the process.

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

The **Household versus natural environment** SAILS unit was implemented in two classes – one lower second level (2<sup>nd</sup> year) and one upper second level – with some modifications. Both classes were all-female and mixed ability. The upper second level class were a group from transition year (4<sup>th</sup> year), an optional year offered to students at senior cycle with the purpose of providing broad educational experiences in order to increase maturity, personal development, learner responsibility, transferrable skills and decision making before proceeding to further study. The teacher used a *guided inquiry* approach in both classes, and designed a worksheet for use by the students. The transition year students completed all parts of the unit, theoretical and practical, whereas only the theoretical part was completed by the 2<sup>nd</sup> year class.

For the upper second level class, because of the limited time available and the limited prior experience of the students with inquiry, the teacher designed a worksheet-style version of unit for use by students (Figure 1). The worksheet-style version of the unit helped guide the learning, while still allowing inquiry skills be used. An additional page was provided, which consisted of a blank table of results, in which students could record their results. The benefit of the worksheet was that it enabled all students to achieve some level of success. The negative of using the worksheet is that it is somewhat prescriptive and limiting, especially for the more able students. The students carried out:

- A discussion on the topic
- Hypothesis construction
- Experiment design
- Assessment/feedback using rubrics in unit

### Household vs Natural Environment

**Topic:** The ecological consequences of the use of cleaning agents at home e.g. detergents, polishes, sprays etc.

**Scientific content** - main concepts that will be covered:

- Properties of cleaning and washing agents
- Eco-toxicology

**What you have to do:**

1. List as many cleaning and washing agents that your family use at home.

Commercial name of cleaning/washing agents	Can you find the active ingredient in this cleaning/washing agent	Suggest possible consequences of the use of this cleaning agent on the environment (may form a hypothesis)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

2. **Design an experiment** where you can **investigate the effect** of a cleaning agent on **one aspect** of the environment, e.g. soil, water, plants, air.

Names in group:

1. \_\_\_\_\_

2. \_\_\_\_\_

**In pairs, discuss the following and use the table below to help structure your planning:**

- What aspect you would like to investigate
- Write down a hypothesis.
- Identify and define variables e.g. *different concentrations of the laundry detergent*
- Plan/design the experiment to check your hypothesis.
- Decide what you think you will observe or measure and in which way.
- List equipment you think you need.
- Write down the plan.

<b>Active ingredient and Aspect of the environment selected</b>	
<b>Your hypothesis</b>	
<b>Identify and define variables</b>	
<b>Outline plan/design of your experiment</b>	

<b>What will you observe and measure?</b>	
<b>How will you measure things?</b>	
<b>List equipment needed</b>	
<b>Write your plan down</b>	

3. **Perform/conduct/carry out the experiment** finding out the impact of the chosen cleaning agent on the environment.

4. **Collect data - record your observations** "How did the plant (i.e. cress) change under the influence of the cleaning agent (e.g. laundry detergent)?" Analyse the data looking for trends and relationships.

5. **Present results** of your group work to the whole class using a **table and graph**. Draw appropriate conclusions based on evidences. Compare your results with results of other groups if possible. Identify any possible sources of inconsistency.

6. **Discuss with your peers, recommendations for the everyday use of cleaning/washing agents in your home.** What did you find? How should it be? Why isn't it as it should be? What can be done? Discuss in group and **present as a poster**.

*Search the Internet or other sources and find out professional ecological tests. Describe two examples – what and which way they test. Quote the sources.*

**Planned Experiment**

Product Name	Active Ingredient	Aspect of Environment
Domestos Bleach	Sodium hypochlorite	Water
Mr. Muscle	Ammonia	Soil
Vinegar	Ethanoic acid	Air
Ariel Washing tablet	Enzymes	Plant

**Questions**

Fill in the table below:

Product Name	What the commercial company says about the product	What you say about the product (following your investigation)

What did you learn?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

New Vocabulary:

**Figure 1: Worksheet for students in CS1 Ireland**

The groups discussed the following questions/suggestions before they were given the adjusted worksheet version of the unit. The students understood that success in the unit would be measured

by their being able to complete any or all of the suggestions. The upper level class were given the evaluation criteria during the first lesson. They were asked to:

- Record the aspect that they would like to investigate.
- Write down a hypothesis.
- Identify and define variables e.g. different concentrations of the laundry detergent
- Plan/design the experiment to check your hypothesis.
- Decide what to observe or measure and in which way.
- List equipment they would need.
- Write down the plan.

Again, the teacher designed a worksheet-style version of unit, for use by students at lower second level. The students carried out a discussion on the topic, hypothesis construction and experiment design. They did not carry out the investigations. The teacher provided them with the evaluation criteria during the second lesson.

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

The skills identified for assessment were *developing hypotheses* and *scientific reasoning* (identifying variables). The skills were assessed using the criteria given in the rubrics in unit. The teacher gave observational feedback to the students as they worked through the unit. She collected the worksheets during the process, reviewed their work, returning it for them to continue and complete.

Most students struggled with coming up with an experimental plan that had a clear hypothesis, only one variable and what to measure to get results to prove or disprove their hypothesis. Most students gained a better understanding of what an active ingredient was, what an aspect of the environment was, and how that could be affected by active ingredients.

### **(iii) Evidence collected**

#### **Teacher's opinion**

The teacher found the topic was immediately engaging for the students because of its general and relatable nature. Students engaged with the concept that various substances available at home, which have active ingredients can impact on the environment. They struggled with how this could be investigated by research or by experiment.

The older students grasped the overall concept that cleaning agents need to be regulated to help the environment. Concentrations and dilution series were introduced to this age group. Most students could identify the variables and a suitable control. The term "active ingredient" was learned and understood by all. Students identified the variable as their chosen active ingredient, which they used at one concentration to test the impact on their chosen aspect of the environment (water, soil, or living organism). Most of the students identified their control as using water instead of the active ingredient. The idea of using a dilution series involving the variable was suggested to some groups, where relevant, which some crudely carried out. Measurable results from student's experiments involved pH changes, visible physical changes, and colour change, which they compared with their control. Students recorded their observations such as change in pH, visible physical changes, or colour change. Their conclusions varied from "the plant was dead after 4 days" to "the leaf changed colour" or "the pH changed from neutral to acid."

A discussion followed their conclusions, which was designed to prompt the students to consider how they could improve their experiment and prove/disprove their hypothesis. Students struggled with forming a suitable hypothesis and deciding how to conduct an investigative experiment. They did not know how to use results from their experiment to determine if their hypothesis was true or not.

Overall, the upper second level students learned:

- Many examples of unsuitable hypotheses, and now have some idea how to word one.
- The importance of a clear hypothesis.
- How to start an investigation by experiment.
- That the experiment is linked to the hypothesis.
- New words/terms and the importance of precise language in science.
- Some big chemical names for many household cleaning products.

The younger students grasped the overall concept that cleaning agents need to be regulated to help the environment. The term “active ingredient” was learned and understood by all. Lower second level students struggled with:

- Forming a suitable hypothesis.
- How to design an investigative experiment.
- What the variables were and a suitable control.
- Linking the experiment with the hypothesis.

The younger students were more thorough in finding out about the active ingredients and the known effects they have on the environment than the older group.

In conclusion, this unit has a lot of appeal for both teacher and students. For teachers, it was easy to source the key chemicals (household cleaning agents) and most of the suggested experiments involved simple equipment and readily available testing materials. Homework was easy to give as everyone has household cleaning agents at home and most have access to the internet. For the students they found the topic interesting and relatable to everyday life. Most students enjoy having homework that involves the internet. Getting to use and learn big chemical names for everyday household products also proved interesting and engaging for the students.

The teacher found that it was a topic that you could leave and return to and yet manage to pick it up again quite readily, which made it easy to carry out as additional work with the 2<sup>nd</sup> years, in what is already a very full syllabus at junior cycle. Most students easily grasped the core concept of the impact on the environment of various substances available at home, but many struggled with setting up simple experiments to show what the environmental effects of the incorrect use of detergents can be. Most of the older students could identify the variables and a suitable control but struggled with forming a suitable hypothesis, conducting an investigative experiment and determining from their experiment if their hypothesis was true or not. The younger students struggled with forming a suitable hypothesis, designing an investigative experiment, identifying variables and determining suitable controls and linking the experiment with the hypothesis.

#### **(iv) Advice for teachers implementing the unit**

- The worksheet-style version of the unit prepared by the teacher helped guide the learning while still allowing inquiry skills to be used (Figure 1).
- The rubrics given in the unit were helpful in guiding assessment, except the self-assessment one, which did not provide any really useful feedback.
- The overall layout of the unit using the numbered headings was clear and easy to follow, but within the numbered sections it was confusing and difficult to follow, especially references to the more guided version.
- More structured, focused time on the internet after initial discussion and before experiment design would be beneficial.