4.4 Case study 4 (CS4 Poland)

Concept focus	Environmental impact of household chemicals
Inquiry skills	Developing hypotheses Working collaboratively
Scientific reasoning and literacy	Scientific literacy (searching for information, presentation of scientific results)
Assessment methods	Classroom dialogue Teacher observation Self-assessment Student devised materials (documentation of inquiry) Presentations
Student group	**Grade:** upper second level **Age:** 17 years **Group composition:** mixed ability and gender; 16 students **Prior experience with inquiry:** No prior experience with inquiry

The unit was implemented in full in this case study, and an additional factor for investigation was added – influence of salt on plants. This was to mimic conditions after salting roads in winter. Assessment of students' skills in *developing hypotheses*, *working collaboratively* and their *scientific literacy* was based on final reports prepared by students in form of multimedia presentations. The teacher used three-level rubrics to identify performance level and provided both formative and summative assessment.

(i) How was the learning sequence adapted?

The **Household versus natural environment** SAILS unit was implemented in full, with minor modifications. As suggested in the unit, to start the lesson, the teacher asked the students to "make a list of washing and cleaning agents used in your home by your families." Based on the students' prior knowledge (from primary school, lower secondary school, from other subjects such as biology, geography) the teacher suggested a discussion about the possible consequences of using the chosen cleaning agents: "Sewage from households (for example from washing machine) are thoroughly purified in wastewater treatment plants, so that they can be poured into the surface waters system. What would happen if our sewage were poured into the environment without earlier purification?"

Modifications of original scenario

Apart from the influence of detergents on plants, one more experiment was carried out: the influence of table salt on plants, because it is an important topic and it connects well with issues mentioned in the scenario. We concentrated rather on biological than on chemical details. We are also planning an experiment with vinegar (watering plants with different solutions of vinegar) to show the influence of acid rains on living organisms.

(ii) Which skills were to be assessed?

The activity was used in order to assess students' skills in *developing hypotheses, working collaboratively* and *scientific literacy.*

(iii) Criteria for judging assessment data

Assessment of students' skills in *developing hypotheses*, *working collaboratively* (teamwork) and their *scientific literacy* (presentation of scientific data and searching for information skills) was based on the final reports prepared by students in form of multimedia presentation.

Developing hypotheses

The students form an essentially proper research hypothesis, referring to a given experiment. This was assigned a grade of 0 (incorrect) or 1 (correct).

Working collaboratively

Two assessment tools were used for evaluation of students' skill in *working collaboratively*. The teacher rubric assessed teamwork (cooperation and collaboration), using a three-level scale up to a maximum of 6 points (Table 1). Students also completed a self-assessment questionnaire, which allowed them to reflect on their strengths and weaknesses in *working collaboratively* (Table 2).

Table 1: Teacher rubric for assessment of working collaboratively

Inquiry skills	Standard (2 points)	Whole (4 points)	Extended (6 points)
Working collaboratively (teamwork)	Not all members of the group were involved in the work.	All members of the group were involved in the work. Some small disagreements/conflicts.	Very good cooperation and involvement of all members of the group.

Table 2: Student self-assessment

Assessment criteria	Seldom	Sometimes	Often
1. Effort: I contributed as much as I could to group discussions and to the work required			
2. Risk-taking: I took risks by exploring something new to me			
3. Cooperation: I worked cooperatively with other members of my group			
4. Respect: I listened to others' ideas, respected them, considered their points of view			
5. Collaboration: I was flexible and willing to follow others but also took initiative when needed			

My two most important strengths in group work (from the list above) are:
.....
Two skills in group work (from the list above) which I need to work on are:
.....

Scientific literacy – presentation of scientific data, searching for information

The teacher used a three-level rubric to assess students' skills in presenting scientific data and searching for information (Table 3).

Table 3: Assessment criteria for scientific literacy

Inquiry skills	Standard (2 points)	Whole (4 points)	Extended (6 points)
Data presentation	Content layout is not clear. Features of the presentation software used to a small extent. Presentation not very interesting. Lack of self-confidence in the person who made the presentation. The information/content presented is not interesting, with spelling and punctuation mistakes. Chosen information is of little interest. The results are presented only descriptively. The conclusions are not drawn properly and are without additional support.	Content arranged properly. Features of the presentation software used to a large extent. Presentation interesting but students not well prepared. Information/content is connected with the topic, not many spelling and punctuation mistakes. The results are presented in tables and diagrams (proper descriptions, axes). The conclusions are drawn properly but not completely supported by additional literature.	Content arranged properly and with clarity. Features of the presentation software fully used. Presentation presented in a very interesting way. Accompanied by ingenuity and originality in presentation manner, arousing listeners' interest. The topic is elaborated in a very interesting way. All information is included without mistakes. The conclusions are drawn properly and fully supported by literature.
Searching for information	Only basic resources needed for realisation of the task were used. Basic information was found but without analysing it. No quoting, no summarising.	Appropriate resources were used for the work. Information was found, quoted and summarised in a partially proper way.	Various resources proposed and used in the work. Various sources of information were used, and essential information was selected. Information was found, quoted and properly summarised.

(iv) Evidence collected

Sample student artefacts – evaluation of one groups' submission

I. Marks obtained in developing hypotheses
Properly formulated hypothesis: 1/1 point

II. Marks obtained for presentation of scientific data
The group presents the results only in descriptive way; they draw correct conclusions supported by additional literature; lack of diagrams or tables for the data visualisation. The topic properly prepared. Information connected with the topic.

III. Marks obtained for searching for information
The group used various sources, selected information, found additional information, quoted them, summarised them properly.

IV. Marks obtained in working collaboratively
Two from among three members of the group chose mostly "sometimes," one of them is strongly assertive and choose "often." For the question about strengths, one person chose "I listened to," another person "I worked together" and the third person "I took initiative." For the question about the skills that the students want to work upon, two students chose "I took initiative." Owing to that questionnaire it is easy to deduce which person is a leader.