4.3 Case study 3 (CS3 Germany)

Concept focus	Protection from UV radiation
Activities implemented	Activities A and B
Inquiry skills	Developing hypotheses Planning investigations (carrying out investigations)
Scientific reasoning and literacy	Scientific reasoning (data analysis)
Assessment methods	Classroom dialogue Teacher observation Presentations
Student group	**Grade:** 9th grade (lower second level) **Age:** 14-15 years **Group composition:** mixed ability and gender; 30 students; public school with no entrance exam **Prior experience with inquiry:** Some prior experience

The focus of this implementation was the question "Does water protect against sunburn?" The teacher provided an overview of the steps in the inquiry process and worksheets to guide the students. The skills identified for assessment were *developing hypotheses* and *planning investigations*. Assessment methods include teacher observation and classroom dialogue, using "traffic light cups" to focus the teacher's support. Students prepared a final poster presentation, which was also assessed.

(i) How was the learning sequence adapted?

The **Ultraviolet radiation** SAILS unit was implemented by an experienced teacher, who was part of cohort 1 (teacher education programme) and had experienced the UV radiation unit during a SAILS workshop. Activities A and B were investigated and the learning sequence followed the steps described in the unit with no significant modifications. In preparation, the unit was translated and the materials (UV beads, UV LED flashlights) were provided by the SAILS team.

As a starting point for the lesson the teacher showed a comic that illustrates two persons lying on the beach. The first person asks: "Don't you want to come to the shade under the umbrella?" And the second answers: "No, I will have a swim and in the water I can't get sunburn." Referring to the comic students reported about experiences with sunburns and their knowledge about UV radiation. The teacher observed different students' opinions about UV radiation transmissibility of water.

The question "Does water protect against sunburn?" was the topic for further investigations. Therefore the teacher displayed graphically an overview that contained different steps in the inquiry process (propose hypotheses, plan an investigation, carry out an investigation, etc.) and posed the first question of the UV radiation unit Activity A: "How can you reveal UV rays?" To support students' planning the teacher provided a list of materials that could be used for the investigation and supplied worksheets. In their first step, the students had to formulate hypotheses and subsequently carry out the investigation. After accomplishment of the investigation, the teacher posed a second question from the unit, namely Activity B: "How can you protect yourself against the sun's ultraviolet rays?" referring to the comic at the beginning of the lesson. A second investigation period started. At the end of the lesson students had to document their working processes in a poster.

(ii) Which skills were to be assessed?

This activity addresses *developing hypotheses*, *planning investigations* (including carrying out the experiment) and *scientific reasoning* (data analysis and presentation of results).

Developing hypotheses constituted a difficulty for some of the students at the beginning of the lesson. By observations and a progress report the teacher noticed diverse abilities. Only a few students were able to formulate hypotheses very systematically, but for those who could their considerations revealed an appropriate experimental approach. Some other student groups needed help from the teacher. They were not able to identify and to control variables in an experimental approach. The teacher gave advice to do a qualitative evaluation of some material with the UV flashlight. On this basis they should than try to formulate presumptions for other materials.

Thereafter, *planning investigations* and the accomplishment of the experiments didn't pose a problem for the students. Diverse materials were tested about their interaction with the UV radiation. Some groups even considered a control approach and tested the materials under the same conditions with a halogen lamp.

In the second investigation period, students investigated Activity B: How can you protect yourself against the sun's ultraviolet rays? The teacher reported that students could more easily *develop hypotheses* or presumptions and carry out investigations in this lesson. The difference in quality of *planning investigations* and carrying out investigations were mainly observable in the grading of students' written work. Most groups worked in an explorative way. Only some students connected the steps of formulating hypotheses and examination in a systematic way.

As an additional assessment tool the teacher used a method called "traffic light cups". The methodological approach allows students to indicate their need for help during practical work by using different coloured cups (red cup: we need help urgently, yellow cup: we need help but have some time, green cup: no problems). This method facilitates focused and purposeful feedback by the teacher. The students used the method during both investigation phases.

A final assessment was given by a poster presentation. The poster encompassed the hypotheses and experimental approaches of each student group and was an opportunity to evaluate their *scientific reasoning*. At the end all groups figured out that water is not an appropriate manner to protect against UV radiation.

(iii) Criteria for judging assessment data

The teacher assessment was focussed on the skills of *developing hypotheses* and *planning investigations* (including carrying out their investigations). The skills were assessed by observation, progress reports during the investigation and the revision of a poster presentation. Additionally the cup method was used during the investigation process. The interview with the teacher showed that the assessment tools reveal a variance in students' skills, which can be summarised mainly by the degree in planning and carrying out an investigation systematically.

(iv) Evidence collected

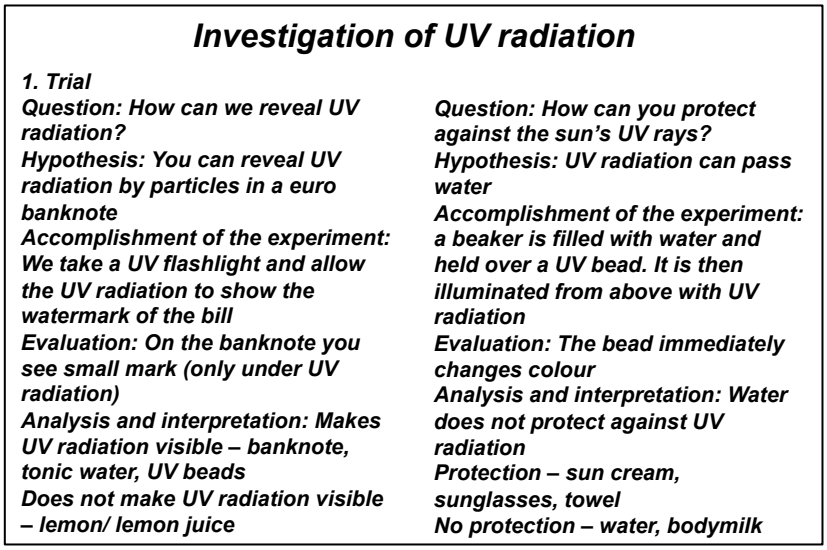
Teacher opinion

The teacher described the lesson as very positive, because students were focussed and motivated about their investigations. The observations, the progress reports during the investigation and the revision of the poster presentation showed a qualitative distinction in the students' skills.

The rubric system of the UV radiation unit was shown to the teacher ahead of the lesson. She told me that she was unable to use the rubrics because she had no time to allocate students in the rubrics during the experimental process. Her conclusion was that the rubrics could on the one hand be used in a team teaching situation (two teachers) or on the other hand must be adapted as a self-assessment tool, e.g. I was able to control variables by myself (Likert scale).

Sample student artefacts

The teacher observed students as they planned their investigations, and noted some consideration of variables. For example, one group controlled exposure time by using a stopwatch on a mobile phone. In addition, the teacher evaluated the student posters presented at the end of the lesson. Two examples are detailed, Figure 1 shows a well-elaborated poster, in which students very systematically detail their implementation and results. Figure 2 shows a less well-elaborated poster, which simply contains the two questions and a missed description of procedures and results for the investigations.



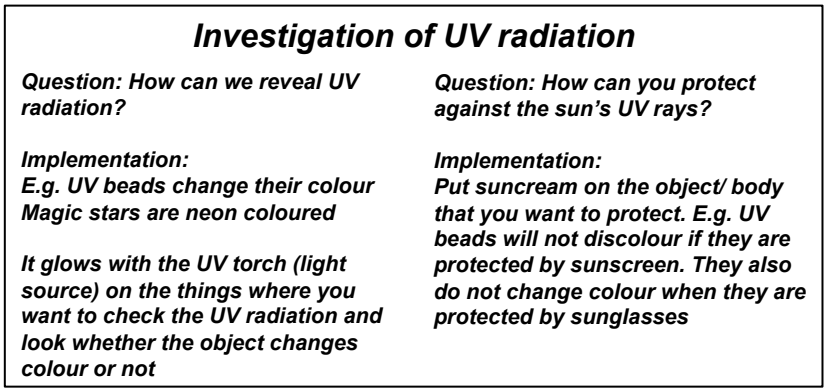
Investigation of UV radiation

1. Trial

Question: How can we reveal UV radiation?
Hypothesis: You can reveal UV radiation by particles in a euro banknote
Accomplishment of the experiment: We take a UV flashlight and allow the UV radiation to show the watermark of the bill
Evaluation: On the banknote you see small mark (only under UV radiation)
Analysis and interpretation: Makes UV radiation visible – banknote, tonic water, UV beads
Does not make UV radiation visible – lemon/ lemon juice

Question: How can you protect against the sun's UV rays?
Hypothesis: UV radiation can pass water
Accomplishment of the experiment: a beaker is filled with water and held over a UV bead. It is then illuminated from above with UV radiation
Evaluation: The bead immediately changes colour
Analysis and interpretation: Water does not protect against UV radiation
Protection – sun cream, sunglasses, towel
No protection – water, bodymilk

Figure 1: Example of well-elaborated student work



Investigation of UV radiation

Question: How can we reveal UV radiation?

Implementation:
E.g. UV beads change their colour
Magic stars are neon coloured

It glows with the UV torch (light source) on the things where you want to check the UV radiation and look whether the object changes colour or not

Question: How can you protect against the sun's UV rays?

Implementation:
Put suncream on the object/ body that you want to protect. E.g. UV beads will not discolour if they are protected by sunscreen. They also do not change colour when they are protected by sunglasses

Figure 2: Example of less well-elaborated student work