

4.1 Case study 1 (CS1 Denmark)

Concept focus	Introduction to UV radiation – properties, sources, detection, protection
Activities implemented	Activities A, B and D
Inquiry skills	Developing hypotheses Planning investigations Forming coherent arguments
Scientific reasoning and literacy	Scientific reasoning (drawing conclusions)
Assessment methods	Classroom dialogue Presentations
Student group	Grade: grade 9 and 10 combined; 2 classes (lower second level) Age: 14-16 years Group composition: mixed ability and gender; 24 students Prior experience with inquiry: Some prior experience

In this case study, three of the activities from the UV radiation unit were trialled. Students' skills in *developing hypotheses* and *planning investigations* were assessed. The teacher used the assessment rubrics as an inspiration for guiding the students in their work and provided formative assessment as feedback. At the end of the implementation, the students gave oral presentations of their work and engaged in peer discussion about the overall results.

(i) How was the learning sequence adapted?

One teacher implemented the **UV radiation** SAILS unit with two different classes of grade 9 and 10 students. Activities A, B and D were investigated and the learning sequence followed the steps described in the unit with no significant modifications. The teacher used the same work plan for the two classes. The unit was implemented with group working (4-5 students in each group) during a 90-minute lesson. The teacher was experienced in teaching through inquiry, and students had some experiences with inquiry. Skills assessed in this implementation were *developing hypotheses*, *planning investigations* and *forming coherent arguments*.

The concept of UV radiation was introduced through a whole-class brainstorming exercise, based on concepts within the area of UV radiation. The class was then divided into groups of 4-5 students (of mixed ability and gender) and were given 10 minutes of research time on the internet to find out more about UV radiation. After this research, teacher introduced Activity A: How can you reveal UV rays? Each group was given the task to find things that could be used as UV indicators. The class was asked to pay specific attention to their planning of such identifications and asked to be aware of different variables. The groups then planned and carried out experiments with different materials including white paper, UV beads and tonic water and found different indicators for UV radiation.

Then the class was asked to investigate Activity D: Measure UV radiation from different sources. The students again planned their investigations in groups and carried out these investigations. The students' investigations ranged from investigating lamps in the room to investigating sunlight in the open.

After these experiments the students were given their third task, namely Activity B: How can you protect yourself against the sun's UV rays? Again the groups planned investigations and carried them out. There was good collaboration between the group members. The results from the three investigations were then put into an oral group presentation with special emphasis on the hypothesis, the planning, and the conclusions. After each groups presentation there was a discussion among peers on the group work and their conclusions. The teacher ensured that every group was

questioned; if no questions were posed she used strategies like feeding back and hints to get the peers to ask the groups about their work.

(ii) Which skills were to be assessed?

The teachers had read the SAILS rubrics assessment tool before the lesson. In her planning, she found that focussing on *developing hypotheses*, *planning investigations* and *forming coherent arguments* (forming conclusions based on scientific evidence) was the most suitable approach for her planned implementation.

The assessment during the students work was carried out as oral conversations where the teachers addressed the specific focus points of the unit. The teachers used the assessment rubrics as an inspiration for her guidance of the students in their work and thereby giving formative assessment as feedback.

(iii) Criteria for judging assessment data

In the judging of assessment data the criteria were focused on students' learning and development within the areas of *planning investigations* and carrying out an investigation. The teacher had beforehand studied the assessment rubrics but did not use them as a tool in the lessons when assessing the students.

The teacher carried out the assessment without any guidance or help from other teachers or researchers. In the follow up interview she mentioned the possibility of using the rubrics as self-assessment tools for the students. Furthermore the students ended the lessons with a presentation and a peer discussion on their hypothesis and their methodology. This gave not only the teacher a clear indication of the students' understand of variable control but also the students' gained more insight to the processes of planning and carrying out investigations in the future. Peer discussion is a tool that provides both assessment of the learning and feedback for future learning.

(iv) Evidence collected

Teacher opinion

In the brief discussion following implementation and especially in the follow up interview, the teacher talked about the students' work and her own perception of the students' processes during their work. Even though the teacher had a clear intention of using the developed rubrics for assessing the students' work she found it difficult to keep track of both students' work and rubrics at the same time. Her usage of the rubrics as assessment tools was therefore limited to inspiration from the rubrics in her talks with the students during their work. She found them very useful as inspiration and after implementing the SAILS unit, the teacher decided that for the next inquiry lessons she would provide the rubrics to the students as self-assessment tools. Her conclusion after the implementation was that even though it is difficult to make practical usage of the rubrics in real-time, the rubrics are a useful tool both for the teachers planning and for the students' work.

What she also found out was that even though she had experience in letting the students do inquiry in her lessons, she herself was not fully aware of the change in her own role as teacher and supervisor for the students (Figure 1).

“It actually demands that you can do – I think – your relational work better, because you cannot cold and clear say: “Have you put your mark in the right summative ...”. You actually have to have much more dialogic teaching ... or yes. You can actually by doing the other form go through with a teaching where you have communication between the class and ... well monologue – well it could be, but then it is a class discussion. Here it demands that you actually approach each of the students to be able to judge them.”

Figure 1: Teacher feedback after the implementation of unit UV radiation

Observer notes

During the lessons I was an observer in both classes. The framing of the lessons as described seemed to fit the students. Students were experienced with researching information and taking part in brainstorming sessions. This gave the lessons a good start. A general problem observed was that the students, despite clear instructions, did not discuss their inquiry plans with the teacher. They often went from questions to investigations without reflection on the planning process. This led to many experiments with very weak or even generation of false conclusions after the investigations. A very good thing about the lessons was the common presentations often caught these weak investigations and the discussions seemed to lead the students towards a higher understanding of doing inquiry.

Sample student artefacts

Shown below are some images of the students carrying out their investigations. Figure 2 shows a group of students setting up an experiment where they want to see if there is any difference in how fast UV beads changes colour depending on the distance to the light in the ceiling. The students have a good understanding of controlling variables and planning experiments and have a good chance of drawing correct scientific conclusion from their inquiry.



Figure 2: Students investigating effect of distance from light source

A group of students wanting to investigate the effect of different types of sun blockers are shown in Figure 3. They have a weaker understanding of controlling the variables and are carrying out their investigation without controlling the different types of beads, the amount of sun blocker used and the thickness of the layer of sun block. However, they have discussed the irradiation time and the different categories of sun blockers. They may come up with a result of their investigations, but the results will be scientifically weak.



Figure 3: Students investigating effect of different types of sunscreen

(v) Use of assessment data

The lesson is very good for differentiation between students' competencies since there is a good possibility in working at different levels with the inquiry processes. In general we found that students enjoyed the activity very much – some due to the new knowledge on UV radiation and protection from the sun, others due to the nice colours from the fluorescent items.

(vi) Advice for teachers implementing the unit

Based on this implementation, the teacher advises future teachers to create groups according to their abilities, placing students of similar ability together. Another issue is that the content knowledge needed for doing this exercise exceeds the understanding of some students. Future teachers should be aware that the concept of invisible light is hard to understand for many students. So in order to do inquiry with UV radiation the students need to have a proper understanding of the content knowledge beforehand.