4.5 Case study 5 (CS5 Sweden)

Concept focus	Density Assessment of inquiry skills
Inquiry skills	Developing hypotheses Planning investigations
Scientific reasoning and literacy	Scientific reasoning (recording data and observations) Scientific literacy (critiquing experimental design)
Assessment methods	Classroom dialogue Teacher observation Peer-assessment
Student group	**Grade:** A group of teachers (teach at lower second level) **Age:** In-service teachers, aged 28-64 years **Group composition:** 7 teachers (4 women, 3 men), worked in two groups with 3 or 4 members. One acted as an observer while the other group members performed the inquiry. **Prior experience with inquiry:** Yes, some prior experience. Their teacher experience was between 5-37 years.

In this case study, a group of in-service teachers investigated the floating properties of clementines. Teacher observation and peer-assessment were used to evaluate skills in *developing hypotheses*, *planning investigations*. *Scientific reasoning* was developed through collecting and recording of scientific data, while critiquing experimental design enriched *scientific literacy*.

(i) How was the learning sequence adapted?

This implementation of the **Floating orange** SAILS unit was with a group of teachers, who attended a workshop at university to learn about the SAILS units and their implementation. At the beginning of the session, the university teacher placed a clementine in a vessel with water to demonstrate that the clementine floats. This led to a spontaneous discussion about whether or not all fruits float in water. The teacher held up three different types of clementines and asked some general questions: "Do all clementines float? If yes, do all clementines float in a similar way?" Each of the teachers were then asked to write some questions which were possible to investigate. The questions were gathered on the white board and discussed.

Examples of questions discussed

- Does the same volume of the clementine lie above the water line always?
- Can the temperature or the salinity affect the floating behaviour of the clementine?
- Do all clementines float in a similar way?
- What happens if you make a hole, peel or cut the clementine into two halves?
- Have different types of clementines the same density?
- Is there more air in some clementines?
- Do ripe clementines float differently compared to un-ripened ones?
- Does the peel float better than the fruit?

In the end, two groups were formed and each group of teachers chose one question to investigate. One teacher acted as an observer, who made observations without making any comments while the other group members carried out the investigation.

Carrying out the investigation

Group A chose to investigate the question "Does the temperature affect the floating behaviour?" and sought to investigate if they could discover any difference between how the clementine floated if the water temperature was 4 °C, compared to if the water was warmer. To do this they followed three steps:

1. Mixed ice with cold water and stirred until the water temperature was close to 4 °C.
2. Placed a clementine in the water vessel and drew a line on the peel where the water line was.
3. The group placed the same clementine in warmer water and compared to the earlier drawn line.

The group concluded that their investigation demonstrated that the temperature is of importance for how high the clementine floats. There were discussions around if you really could see any difference or if the group observed what they wanted to observe.

For group B, they chose to investigate the research question "Do two different clementines have the same density?" by comparing two different types of clementines. The procedure was as follows:

1. Measured the weight of the two clementines.
2. Measured the volume of the two clementines through carefully pushing them down in a vessel with water. The volume of water that was spilled was measured.
3. The group divided the weight by the volume to determine the density.

The group concluded that their investigation did not give a reliable answer to their research question. There were many measurement errors identified.

After the investigation

1. The observers gave feedback to their groups, based on notes taken during the discussion and lab work. They reported how they had perceived the working process and the performance.
2. The groups reported on their investigation; what they had done and if they had got any answers to their questions. The observers declared how they had experienced their role.
3. The final discussion concentrated on difficulties and what the participants had learned. This discussion focused on the peer-assessment part, identifying the advantages and disadvantages of this kind of peer-assessment.

(ii) Which skills were to be assessed?

The following skills were assessed:

- *Developing hypotheses*, that is, the students' capacity to formulate a research question that is possible to work with systematically.
- *Planning investigations*, looking at how the student uses the equipment.
- The student's capacity to give suggestions how to improve the investigation, which is an aspect of *scientific literacy*.
- The student's capacity to document her investigation, which is an aspect of *scientific reasoning*.

The assessment was based on the knowledge requirements at the end of year 6 in the Swedish compulsory school system. The teachers thought that the unit was suitable for use at lower second level. A rubric for assessment of the four skills was provided, which was regarded as appropriate (Table 1). The teachers thought it was excellent to use the formulation from the science syllabus.

During the workshops, the groups were observed both by two teachers from the university and a colleague. The colleague focused on performing peer-assessment, trying to observe which ideas that were formulated and which of them that was chosen in the end. The observer also tried to see how

they used the lab material and if they really investigated their question. The observer also looked at collaboration; did they work together or not?

Role of the observers

- If the investigations were made systematically. This was observed through peer-assessment.
- How the peer-assessment was performed. This was observed by the university teachers.

Table 1: Assessment of skills developed in the Floating orange SAILS unit

Skill	E	C	A
Developing hypotheses **Forming a research question**	The student contributes to formulating simple questions and planning which can be systematically developed.	The student formulates simple questions and plans which can be systematically developed after some reworking.	The student formulates simple questions and plans which can be systematically developed.
Planning investigations	The student uses equipment in a safe and basically functional way.	The student uses equipment in a safe and appropriate way.	The student uses equipment in a safe and effective way.
Critiquing experimental design (scientific literacy)	The student contributes to making proposals that can improve the study.	The student makes proposals that after some reworking can improve the study.	The student makes proposals that can improve the study.
Documentation and observations (scientific reasoning)	The student draws up simple documentation of their studies using texts and pictures.	The student draws up developed documentation of their studies using texts and pictures.	The student draws up well-developed documentation of their studies using text and pictures.

(iii) Criteria for judging assessment data

The teacher made observations about how practical and comprehensible the designs were and to what extent the individual students participated in the planning.

(iv) Evidence collected

Teacher's opinion

The unit worked well (Figure 1). The teachers chose those questions they really were interested in and wanted to investigate. The discussions that followed the investigations were fruitful. The teachers were inspired to work with similar investigations with their students.

The methodology of the unit was reported as interesting and a possible way to work with students. An advantage is that all students are seen and get a response immediately after the investigation. It can contribute to the student's ability to perform better at inquiry-based tasks. It can also contribute to the student's capacity to give and to receive response. Both the investigators' and the observers' reports were positive. There was large possibility to influence the design of the inquiry. Also the observers felt that they had learned more about inquiry through observing. Another advantage is that the teacher can choose where to provide support in the classroom.

Sample student artefacts

Figure 1: Images from the implementation.