4.2 Case study 2 (CS2 Hungary)

Concept focus	Behaviour of oil in water
Inquiry skills	Planning investigations Developing hypotheses Working collaboratively
Scientific reasoning and literacy	Scientific reasoning (defining variables)
Assessment methods	Classroom dialogue Teacher observation Worksheets
Student group	**Grade:** 8th grade (lower second level) **Age:** 13-14 years **Group composition:** mixed ability and gender; 23 students **Prior experience with inquiry:** Some prior experience with inquiry

In this implementation, the focus for assessment was on *planning investigations* and *working collaboratively*, as well as *scientific reasoning* in determining variables. The assessment was based on the students' worksheets and on responses to three questions asked by the teacher: "What variables did you notice during the experiment? Which variable or variables did you think were fixed? To what extent does your experiment support the idea of the group?" Assessment was formative and each group was given oral feedback.

(i) How was the learning sequence adapted?

The **Black tide – oil in the water** SAILS unit was implemented in as suggested in the unit, with little modification. Implementation was over two lessons (45 minutes each). The teacher did not prepare the simulated oil or salted water (simulated seawater) in advance of the lesson. The worksheet was phrased to suit the group of students; they were asked to record their experiences. Oral instructions were provided, to let the students know what equipment was available to them, and they could ask for any other equipment and materials they needed. The students were also told to define the fixed, independent and dependent variables and to support their hypothesis with their experiments.

Following teacher observation during the students' first attempts during the activity, the teacher changed her initial ideas about the implementation of the unit. The main question – "what happens to the oil in the water?" – does not make any reference to salt in the water, and the students did not at first mention the quantity of salt in the water when defining their variables. One group chose the surface of the container, the depth of the water and the ratio of cocoa powder to oil as variables. The teacher was astonished to find that two groups chose the position of the mixture as their variable. These two groups were not familiar with the concept of variables and so the teacher paid special attention to this question when discussing the students' experiences.

The facilitating questions, formed during the initial discussion, had brought up the issue of the composition of seawater but the students did not attach any significance to this. The students were reasonably motivated but they needed help to identify the variables. The process of designing the experiment proved to be easier but only one group made appropriate use of the variables. A big surprise was when the oil and cocoa mixture of one group sank in the water. This observation shifted the emphasis of the activity. The groups began to experiment with different ratios of oil and cocoa to find out which mixture would float and at first did not think of changing the composition of the water.

(ii) Which skills were to be assessed?

The skills assessed in this case study were *planning investigations* and *working collaboratively*, as well as students' *scientific reasoning* in determining variables. The assessment was based on the worksheets handed in by the students and on three questions asked by the teacher at the end of the second class period: "What variables did you notice during the experiment? Which variable or variables did you think were fixed? To what extent does your experiment support the idea of the group?" Another source of assessment was observation of the students' work during the completion of the task and I deviated from the pre-defined scoring rubric (Table 1).

Table 1: Assessment rubric used in CS2 Hungary

Skills assessed	Level 1	Level 2	Level 3
Formulating hypotheses	The student… …formulates a prediction about what will happen, but not explain why.	The student… …formulates a prediction about what will happen and explains why. The explanation builds on own (or others') experiences.	The student… …formulates a hypothesis, that is makes a prediction that is scientifically well-founded
Asking research questions	The student… …poses a number of questions, but does not make a distinction between questions possible to investigate and questions not possible to investigate.	The student… …with the support of others revises questions, so that they become possible to investigate.	The student… …revises own or others' questions, so that they become possible to investigate systematically

(iii) Criteria for judging assessment data

I took the students' performance to be satisfactory if they could identify the fixed variable and focused on the original problem. I hoped that they would also read and understand the passage because that would give a frame to the activity. During our discussion it was made clear that this step was crucial to complete the task but even though the students were given time to read, they were not disciplined enough to do so. Assessment was formative and each group was given oral feedback.

(iv) Evidence collected

Teacher's opinion

The students enjoyed the activity and they found it interesting, especially in the first lesson when the behaviour of the mixture deviated from what had been expected (Figure 1). The students' performance in the inquiry skills chosen as the focus of assessment was considerably poorer than expected, which was mainly due to their interpretation of the task. The first approach to assessment did not prove to be useful although we learnt from our experience that more time should be devoted to identifying variables in future activities.

The mixture of different vegetable oils and cocoa powders affects the model of the oil patch. It is best to use one type of oil and cocoa. The facilitating questions should guide the students towards making salted tap water or the student worksheet should specify the proportions since the students now have to deal with too many variables.

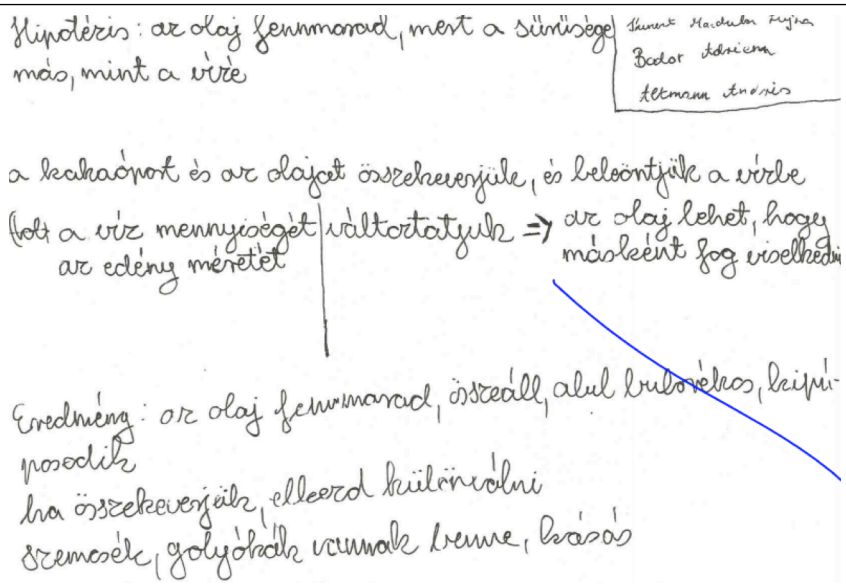
A positive experience was that the students were very happy to work on this problem and by the end of the second lesson they had identified the variables. Cooperation within the team was good in

every team. A negative experience is that the students failed to make use of their prior knowledge and had a lot of difficulty formulating questions in connection with the task.

Figure 1: The activity in pictures

Sample student artefacts

Only one group made use of their prior studies in formulating a hypothesis and only they interpreted the concept of variable correctly. They did not use research questions to prepare their design but wrote an outline instead (Figure 2). As shown in Figure 3, this group identified new variables during their investigation. However, they did not record their observations and the goal of their experiment accurately.

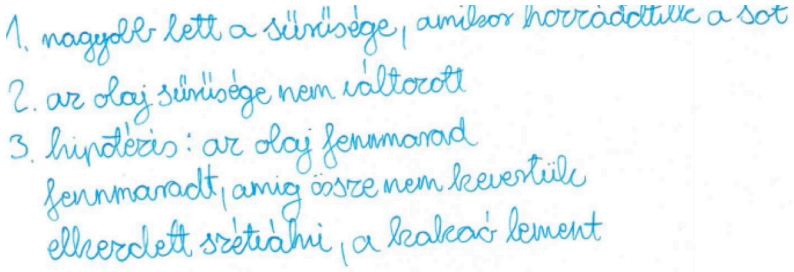


Hypothesis: the floating oil has a different density than water

Pour the cocoa powder mixed with oil into the water:
We change the amount of water with the shape of vessel – the oil may behave differently

Results: the oil is floating, packing, at the bottom of oil are bubbles and embossing
If it is mixed it starts to separate, speckles are included

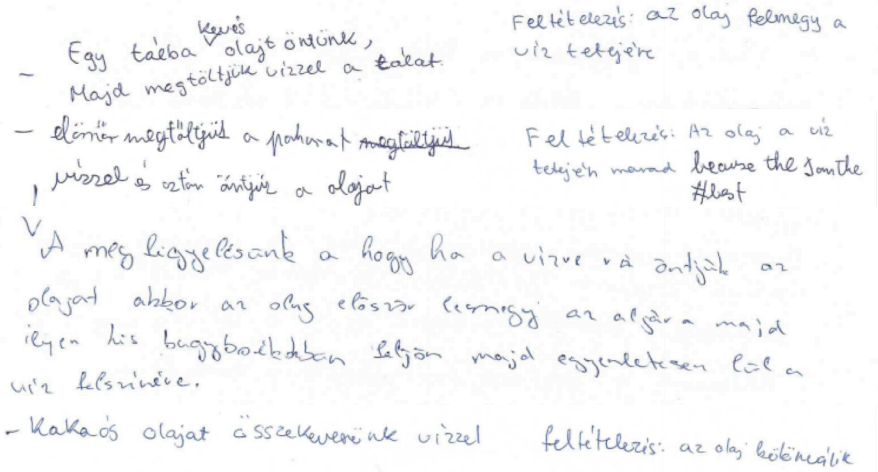
Figure 2: Example of students' work



1 Its density became greater when we added the salt.
2 the density of the oil didn't change.
3 hypothesis: the oil will float until we stir it. It began to separate, the cocoa went down

Figure 3: Example of identification of variables during investigation

Three of the groups focused on the separation of the oil and the cocoa in the water. These groups chose the ratio of cocoa and oil as the variable. They ignored the introductory passage and the core question when designing their experiment, for example in Figure 4.



We pour a little oil in a bowl and then fill it with water. Hypothesis: the oil rises to the surface of the water.
We first fill the bowl with water and then pour the oil over. Hypothesis: the oil floats in the water.
Our observation is that if we pour the oil over the water, the oil first sinks to the bottom and then comes up in little bubbles and then spreads on the surface of the water.
We mix a mixture of oil and cocoa with water. Hypothesis: the oil separates.

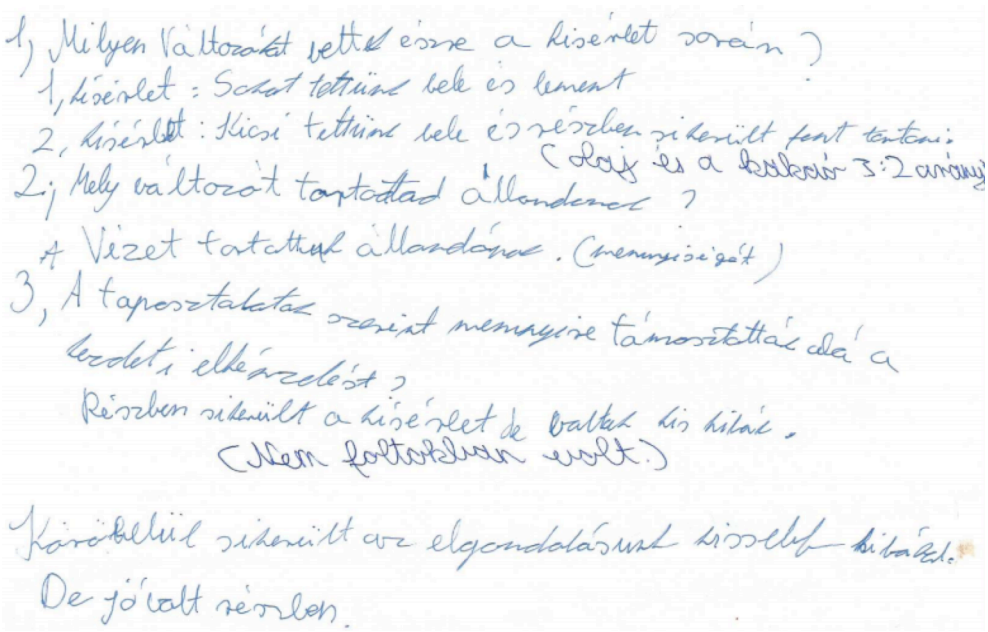
Figure 4: Example of planning an investigation

At the end of the second class period, the students had to answer three questions: "What variables did you notice during the experiment? Which variable or variables did you think were fixed? To what extent does your experiment support the idea of the group?" The answers confirmed what the teacher's observation had suggested: the majority of the groups could not identify the variables and did not know the meaning of variable or how to use a variable (Figure 5).

1 What variables did you notice? The oil covers the cocoa, the mixture floats in the water in bubbles.
2 Which variable did you think was fixed? water, oil.

Figure 5: Example of student responses to end of lesson questions

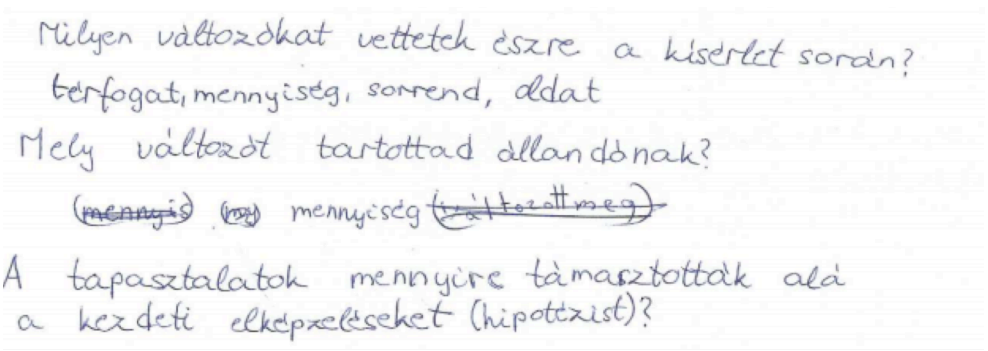
Two of the groups identified quite a few variables and interpreted them correctly, as shown in Figure 6.



1 What variables did you notice? 1st experiment: we put a lot in it and it went down. 2nd experiment: we put a little in it and partly managed to keep it afloat.
2 Which variable did you think was fixed? We though the water was fixed (its quantity).
3 To what extent did your experience support your starting idea? The experiment was partly successful but there were minor mistakes. (It wasn't in patches.) Our idea was more or less successful with minor mistakes. But it was good partly.

Figure 6: Example of student responses to end of lesson questions (good)

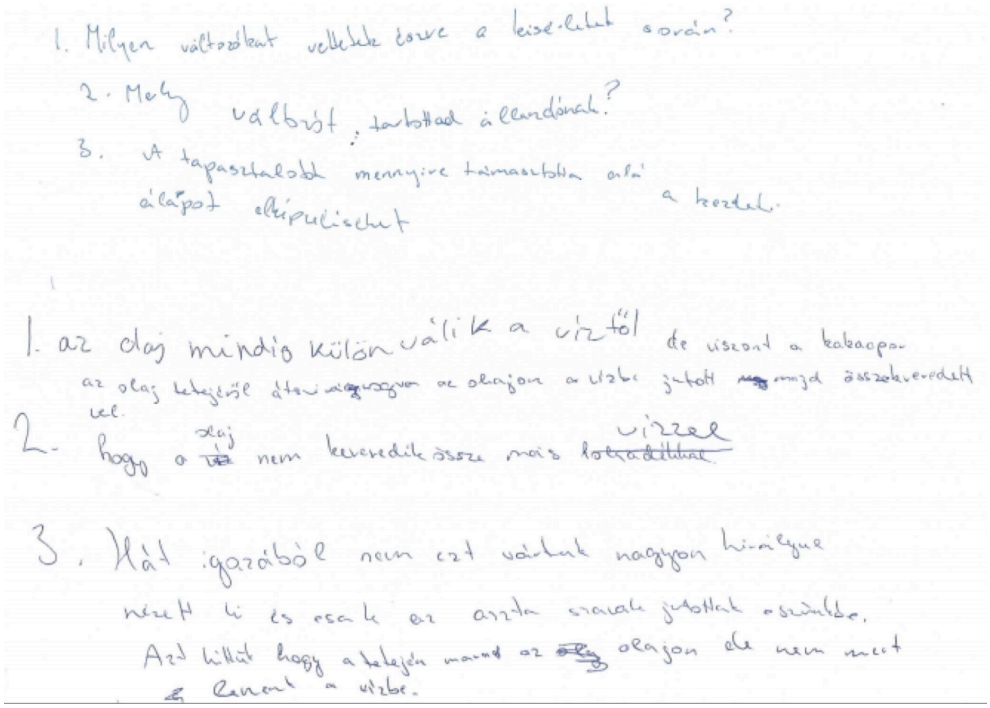
Another group could not express correctly which variable they thought was fixed, as shown in Figure 7.



What variables did you notice during the experiment? volume, order, solution.
Which variable did you think was fixed? quantity (some words are crossed out)
To what extent did your experience support your starting idea (hypothesis)? Not answered

Figure 7: Example of student responses to end of lesson questions

One group wrote down their observation that since the oil and cocoa mixture sank in the water and behaved in an unexpected way, they abandoned their original hypothesis and investigated the properties of the mixture instead (Figure 8).



1 What variables did you notice during the experiment?
2 Which variable did you think was fixed?
3 To what extent did your experience support your starting idea?
1 the oil always separated from the water but the cocoa came off the oil and got into the water and got mixed with it.
2 that the oil doesn't mix with the water.
3 Well in fact we didn't expect this it looked very cool and that's when we had this idea. We thought it would stay on top of the oil and wouldn't sink in the water.

Figure 8: Example of student responses to end of lesson questions

(v) Use of assessment data

I gave two types of feedback to the students after the completion of the activity:

- At the end of the first class period, because of the observed behaviour during the practical work, I discussed the importance of a plan and formulating questions in the work process.
- At the end of the second period, I evaluated the collected worksheets as we discussed the activity.

After this inquiry activity I used inquiry activities with more structure to assist the identification of variables and the formulation of questions.

(vi) Advice for teachers implementing the unit

After reading the passage individually and discussing it in groups, potential research questions should be discussed as a whole class and possibly variables and constants should also be listed. It is important for the success of the activity that the students know what variable data and what constant data are.