4.4 Case study 4 (CS4 Slovakia)

Concept Focus	Properties of plastics Determination of density of plastics Combustion of plastics – Beilstein's test for halogens
Activities implemented	Activities A-B
Inquiry skills	Forming coherent arguments
Scientific reasoning and literacy	Scientific reasoning (forming conclusions) Scientific literacy (explain phenomena scientifically, understanding properties of plastics and how they are utilised in everyday life)
Assessment methods	Self-assessment Worksheets
Student group	**Grade:** 9th grade (lower second level) **Age:** 15 years **Group composition:** mixed ability and gender; 16 students; some of the students were from a disadvantaged background. **Prior experience with inquiry:** No prior experience

In this case study, two activities were realised in a class with lower grades. At the end of the lesson, students assessed their understanding of plastics and their properties through metacognition – answering questions about what they had done, what they learned from it and how that knowledge might be applied. Assessment of skill in *forming coherent arguments* and *scientific reasoning* was carried out by the teacher, who reviewed student artefacts.

(i) How was the learning sequence adapted?

The **Polymers** SAILS unit was partially implemented; teacher focused on activities A and B, which were implemented in a single lesson without changes. Students worked in groups and performed inquiry-based activities on determination of density of plastic materials and combustion of plastics, including Beilstein's test for halogens.

The students formed self-selected groups of four students – three groups of only boys and one group of girls. A leader for each group was selected through discussion with other members of the group. Group leaders were usually those who have good results at school and have good organisational skills. Other group members trusted them.

(ii) Which skills were to be assessed?

Scientific literacy (understanding the properties of plastics, understanding the use of plastics in everyday life), and *scientific reasoning* (formulation of conclusions) were assessed through student self-assessment. At the end of the lesson, students assessed their understanding of the density of plastics on the basis of metacognition, by answering the following questions:

- What did we do?
- Why did we do it?
- What have I learned today?
- How can I use it?
- What questions about the topic do I still have?

In addition, *forming coherent arguments* (argumentation) and *scientific literacy* (explaining phenomena scientifically) were assessed by evaluation of student answers to three questions in their worksheets:

- What do we prove with Beilstein's test?

- How would you determine density of plastics?
- What new information about plastics have you learned?

(iii) Criteria for judging assessment data

On the basis of self-assessment, students assessed their understanding of plastics and their properties. Metacognition was used for this purpose. After teaching, students filled out a questionnaire, in which they answered questions about what they had done, what they learned from it and how that knowledge might be applied (Figure 1).

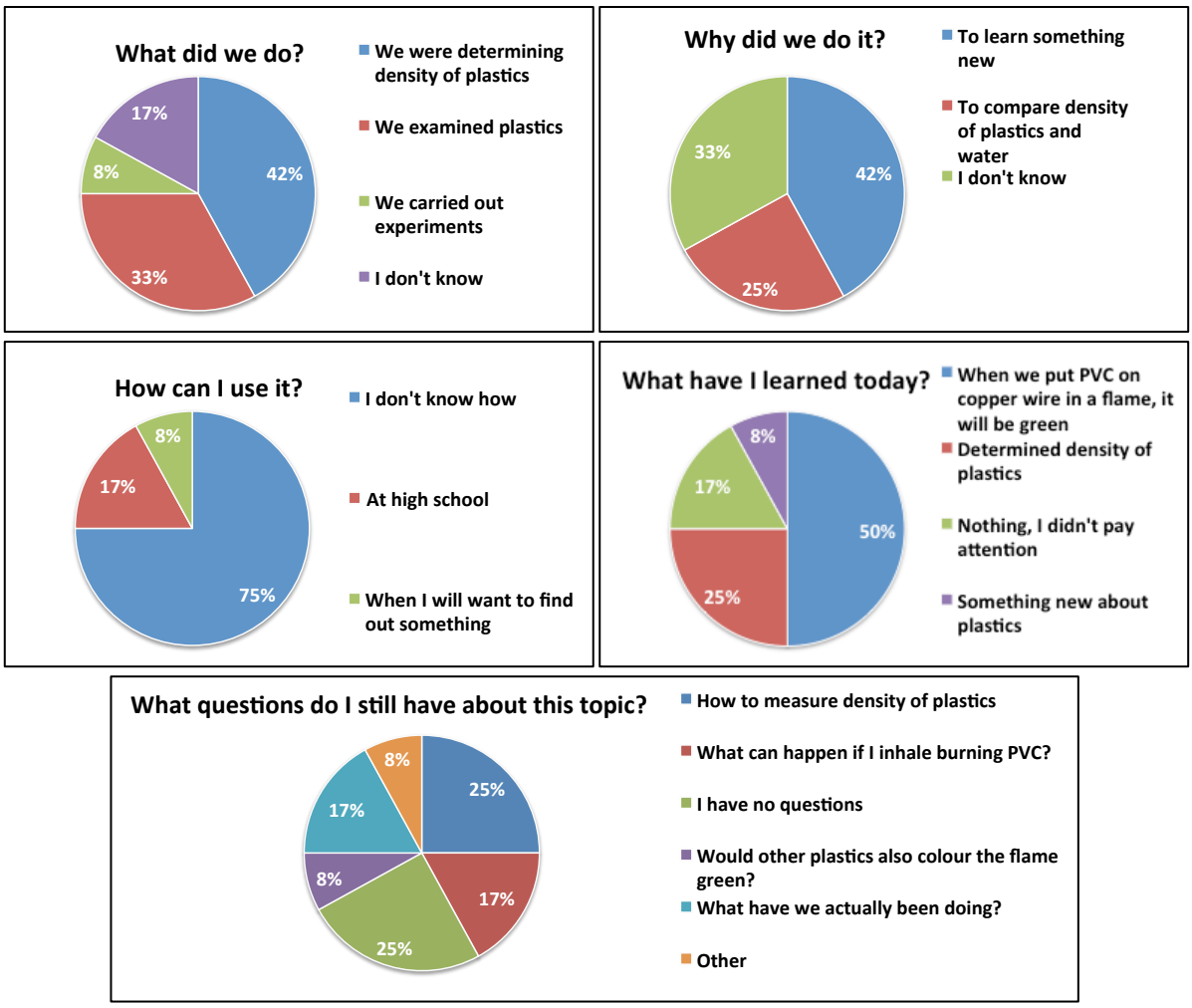


Figure 1: Evaluation of student responses to metacognition questionnaire

(iv) Evidence collected

Teacher opinion

Some students had problems filling out the questionnaire; they had difficulty with verbalisation (they did not know or did not want to produce more complex answers). They had poor vocabulary and speaking skills, and demonstrated disinterest in chemistry. However, for others, the topic was interesting – they were curious what could happen to them if they inhaled the gases that are produced during the combustion of plastics, and whether other plastics would colour the flame green on copper wire.

It was the first time I used metacognition, therefore, it is possible that students are not used to answers questions such as: "What did I do? Why did I do it?" They are not used to formulating conclusions about their activities. However, I think that this type of assessment is significant for the

teacher. If the teacher knows about students' lack of knowledge and skills, they can guide students correctly.

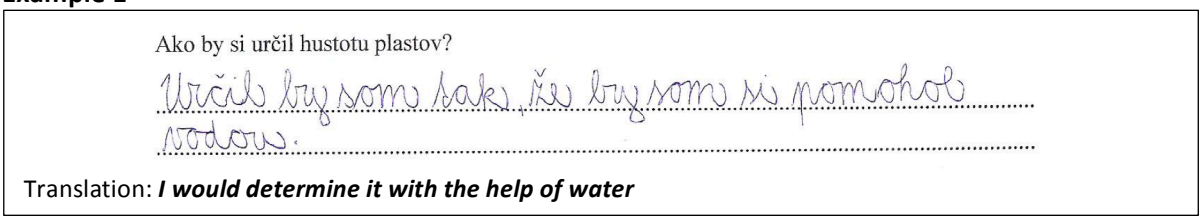
Observer notes

Activities and assessment of students were realised in a class with lower grades. The teacher regularly observes students' disinterest in all chemistry and knowledge as such. The results of metacognition also support the observation. Up to 17% of students stated that they do not know what they did and 8% of students realised only the fact that they had performed experiments.

Sample student artefacts

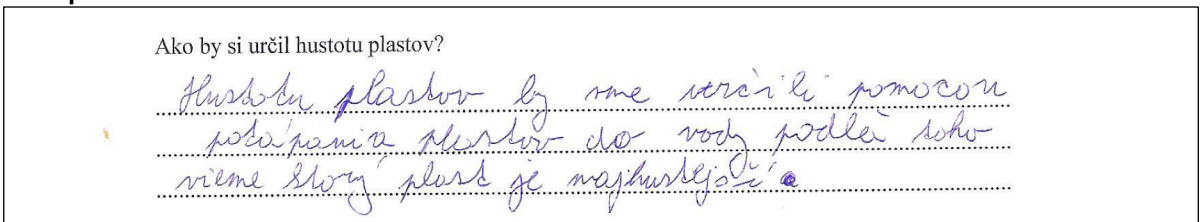
To assess student skills in argumentation and in formulating conclusions, teacher evaluated the answers to the question "how would you determine the density of plastics?"

Example 1



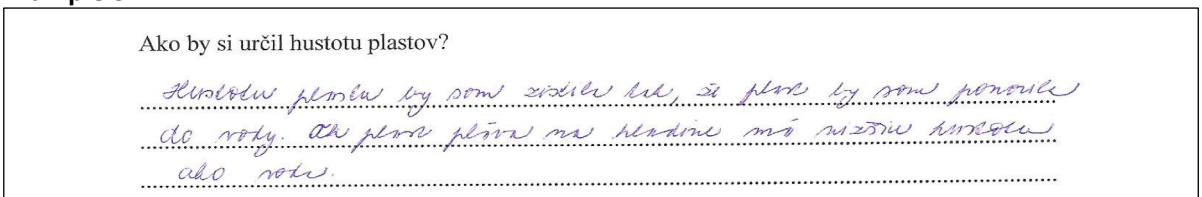
Translation: ***I would determine it with the help of water***

Example 2



Translation: ***I would determine density of plastics by dipping plastics in water, according to that, we know which plastic has the biggest density***

Example 3



Translation: ***I would find out density of plastic by dipping it in water. If the plastic floats on surface, it has lower density than water.***

(v) Use of assessment data

Next time the teacher would probably not let the students form groups on their own. The teacher will be using metacognition more often, because she thinks that if students used it more regularly, they would not have problems at expressing themselves and self-assessment. Based on knowledge of this class, the teacher will try to prepare inquiry-based activities focused on food, cigarettes, energy drinks and why plastics and tyres should not be burned.

(vi) Advice for teachers implementing the unit

This method of assessment strengthens the teacher-student relationship, which is very important for the confidence of students in their teacher. It creates feedback, which helps to form the teacher´s

ideas in the lessons and helps the teacher with his work. The teacher gains knowledge about subjective feelings of students, e.g. about work in groups.

Samples of case studies will be a part of research base for effective use of tools of formative assessment for determining effectiveness of inquiry method in teaching. They also provide information about significance of implementation of formative assessment into teaching IBSE to solve Slovak students' problems, which were found out in international testing by PISA, such as increase of total success, development of communicative competence, inquiry skills, such as formulation of conclusions, development of argumentation skills, development of competence to learn how to learn, etc.