

4.3 Case study 3 (CS3 Turkey)

Concept focus	Simple electric circuits Electrical conductivity of everyday materials
Activities implemented	Activities A-C
Inquiry skills	Developing hypotheses Forming coherent arguments
Scientific reasoning and literacy	Scientific literacy (explaining electrical conductivity scientifically)
Assessment methods	Classroom dialogue Worksheets
Student group	Grade: 6 th grade (science applications class) Age: 16 years Group composition: mixed gender and ability; 16 students (9 boys, 7 girls) Prior experience with inquiry: None

In this case study, many skills were identified for assessment, but particular details are provided for assessment of *developing hypotheses*, including generating inquiry questions, and *forming coherent arguments*. The teacher used short quizzes, question and answer sessions, and classroom discussions for assessment of student knowledge. Some of the assessment took place in the classroom, but because of limited time, some assessment had to be done after the class, such as reading short quizzes or marking using rubric tables.

(i) How was the learning sequence adapted?

The teacher chose to implement the **Electricity** SAILS inquiry and assessment unit as this topic is part of the curriculum, and the students had learned about it recently. Activity A was implemented without modification. The teacher started the lesson with a class discussion. She first asked, “How do we see?” After a short discussion, the teacher then changed the discussion into the relationship between sunlight and seeing by asking following question: “what would happen if the sun disappeared?” After a short discussion, she asked, “What did humans do when there was no electricity to create light?” She tried to get students to express their opinions as much as possible by choosing different students to speak, not only the ones that raised hands. The question and answers discussion went on for about 10 minutes. Students answered questions while the teacher gave some feedback. The feedback was in the form of asking other questions. She tried to refrain from giving a correct answer to let students express their opinions without being influenced by the teacher. She said to students a few times, “Ok. I won’t make a comment now; we will talk more about it later.”

After the question-answer and discussions, the teacher passed out a worksheet to students (as per original unit, no modifications). She asked them to work individually and to draw a concept map about electricity, as it was suggested in the unit. However, she did not talk about it in detail. In only a few minutes, students drew a concept map on the worksheet, and then the teacher asked a few of them to read out loud what they have drawn. Students just listed the concepts that they have written down. Then the teacher asked students to find scientific and daily language words related to electricity. Students gave examples like button-circuit switch, dial button-rheostat, cable-conductor, lamp wire-tungsten, etc. After this they talked about the meaning of words in their concept maps.

Before the next section of the unit, the teacher asked students to write the materials that they brought to the class into the table in their worksheet and then write their predictions (hypotheses) about their conductivity next to them (Activity C). She then asked students to formulate a question based on the table in the worksheet. She asked, “Based on what is on the worksheet, what could be an appropriate inquiry question?” A few students offered good inquiry questions, while one offered

somewhat unrelated questions. The teacher gave feedback to students by reminding them that a good question would be a “how” question, not a “what” question. She then asked students to look at the table on the worksheet and form their questions accordingly. The student who had offered an unrelated question understood the teachers point and explained that he had not looked at the worksheet when he formed his initial question.

In the second part of the unit, students were to set up a simple electric circuit (Activity B). The teacher first asked students to draw a functioning simple circuit. She then asked students to list the components of the circuit could be left out as the circuit continued to function. Some students said, “lamp holder, circuit key, one of the wires” or other similar suggestions. Students seemed to know about how to set up a simple circuit. Unfortunately only one station in the laboratory had working electricity power at the time, so the teacher could not form groups. She set up a simple circuit using the power supply on the table. She then gave a table about the inquiry activity of the unit. Students were to add different objects to the circuit (such as hair comb, cooking pot, piece of wood, salty water, lemon, lemon juice, silver ring, gold bracelet, pencil graphite, different metals, etc.) that they brought to the class and predict the brightness of the lamp in the circuit. First they wrote their predictions to the table given by the teacher and then they made observations.

The teacher asked students to bring one of the things that they brought in to the station and add it to the circuit and observe the results. She first asked students to say their prediction and then do the observation. Students made different predictions about metal objects, but all metal objects provided a high brightness. Students made their predictions based on what they learned in their science classes. They thought metals like gold and silver would produce brighter light. However, the difference between different metals was not observable. Students had a big surprise when they tried the salty water. They all thought salty water is a good conductor, but the lamp was not lit at first. Then they increased the amount of salt in the water and they saw the lamp light just a little. They also observed gas formation on the wires that were dipped in the salty water. Then they concluded that salty water is not as good conductor as they thought. They had a similar surprise when they tried lemon and lemon juice. They all predicted that lemon juice would conduct electricity, but they could not get the lamp lit.

Students had different predictions about the pencil graphite. They then tried it and observed that the brightness of the lamp was less than metals but more than salty water. After their observations, students classified objects into three groups as conductors, semi-conductors and non-conductors. The class time ended after this activity.

(ii) Which skills were to be assessed?

During these activities, opportunities to assess many skills were identified, for example *developing hypotheses*, *planning investigations* (schematic drawings, planning experiment, conducting experiment), *forming coherent arguments* (drawing conclusions based on evidence) and *scientific literacy* (use of scientific language, different representations). In addition, the teacher identified three additional skills – generating appropriate inquiry questions, defining variables and determining the differences between dependent and independent variables – as relevant and important. The teacher felt that students needed to improve on these skills, and so focused on them during the unit implementation.

The teacher used short quizzes, question and answer sessions, and classroom discussions for assessment of student knowledge. Question-answer sessions seemed as a rapid way of collecting information from students. Some of the assessment took place in the classroom, especially the question and answer sessions and classroom discussions, but because of limited time, some assessment had to be done after the class, such as reading short quizzes or marking rubric tables. The teacher also assessed some student products such as worksheets that they completed during

the inquiry activity. There were rubrics suggested in the unit about certain inquiry skills, but the teacher did not use them during the class.

(iii) Criteria for judging assessment data

Developing hypotheses (asking inquiry questions)

Student can ask an appropriate inquiry question given a context. Student asks investigable inquiry questions that include “how” or “if” rather than “why”.

- **Example of a bad inquiry question:** “Does a metal pot conduct electricity?” This is not a good question because it has a yes or no answer and it does not imply an investigation.
- **Example of a good question:** “If we add more salt to a salt solution (which was part of the simple circuit), would it change the brightness of the light bulb?” This is a good question because it involves variables and it is possible for students to try and find the answer. It is a more appropriate inquiry question.

The teacher proposed a three-point scale for assessment of this skill and provided oral feedback to students, based on their responses. The possible outcomes are:

Point 1: Student’s question is not an investigable question.

Point 2: Student can ask an investigable question but irrelevant to the context.

Point 3: Student can ask an investigable question relevant to the context.

Developing hypotheses

Students can formulate hypotheses (predictions) based on a question. Hypotheses may include comparisons (e.g. metal will provide brighter light than graphite). Formulating a hypothesis that only had one independent variable or limited to few examples rather than being generalisable.

- **Example of a poor hypothesis:** “The metal object conducts electricity better than lemon juice.” This is a poor example of a hypothesis because it is limited to two examples.
- **Example of a good hypothesis:** “Metals conduct electricity better than electrolyte solutions.” This is a better example because it makes a generalisation.

The teacher proposed a three-point scale for assessment of this skill and provided oral feedback to students, based on their responses. The possible outcomes are:

Point 1: Students cannot formulate a good hypothesis.

Point 2: Student can formulate a hypothesis but with an inappropriate statement (e.g. lamp will light with salty water)

Point 3: Student can formulate an appropriate hypothesis and state it appropriately (e.g. gold will provide the brightest lamp).

Forming coherent arguments

Students can form coherent arguments related to an inquiry question, based on their observations. This skill was assessed more implicitly than the *developing hypotheses* skills during class discussions, mainly because of time constraints.

The teacher proposed a three-point scale for assessment of this skill and provided oral feedback to students, based on their responses during class discussions. The possible outcomes are:

Point 1: Students offer arguments that are not supported by observations and data.

Point 2: Students offer arguments partially supported by observations and data.

Point 3: Students offer arguments supported by observations and data.

(iv) Evidence collected

Teacher opinion

The teacher said that it would be difficult to use rubrics during the class. The rubric would not work very well to assess all of the inquiry skills because of lack of time and number of students. She said they could be used after the class based on student products or classroom observations. The teacher also thought that some of the assessment items (the ones that were about subatomic particles) provided in the unit were above the level of 6th grade students, so she did not plan on using them.

The teacher's expectation about asking inquiry questions was whether or not the question included "how" or "if" rather than "why." "How" and "if" questions usually can be answered by inquiry, while it is more difficult to answer "why" questions, for example "why does a napkin absorb water?" compared to "what happens if I use oil rather than water?"

Another expectation was about formulating appropriate hypotheses. A hypothesis should include only one independent variable. The teacher expected students to understand the differences between dependent and independent variables. When students specified variables, they should be able to tell which one is independent (the one they are changing) and which one is dependent (the one they are observing).

Finally, the teacher expected students to record data accurately and appropriately. This criterion included putting the data in the right place in a table, not missing data for recording, writing details about observations, etc.

Observer notes

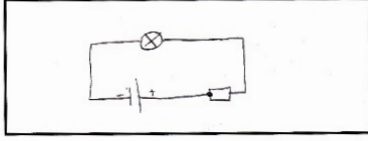
The lesson flowed rapidly and time was always a concern. The teacher wanted to get through the unit sections, so she did not have time to think about a rubric, classify certain students' skills based on the rubric and provide feedback to each student based on their need. There was no time for this process. Also the rubrics needed to be studied carefully by the teacher before the class, so she could use it more comfortably, but this seemed too difficult and time consuming on the part of the teacher, especially if every unit had a different rubric.

Sample student artefacts

The following worksheets are an example of student artefacts. The first worksheet included a concept map and definitions written by the student, the second worksheet included a table with list of materials and students predictions about their conductivity, the third worksheet included a drawing of a simple circuit and answers to questions and the fourth worksheet included student's thoughts about given concepts.



İnsanlar ; fen, teknoloji ve mühendislikte semboller resimlere tercih ederler. Yukarıdaki sembolleri kullanarak aşağıdaki kutucuğa basit bir elektrik devresi çiz.



4- İletkenlik materyalin özünde olan bir özellik midir yoksa sonradan mı oluşur ? Düşünceni açıkla.



İletkenlik metalin yapısında vardır. Katı maddeler için. Ancak bazı katı maddeler örneğin tuz gibi suda çözündüğünde elektrik akımını iletir.

5- İletken ve iletken olmayan materyallerle ilgili arkadaşlarınızla beyin fırtınası yaptıktan sonra aşağıdaki cümlelerdeki boşlukları tamamla.

Katı metaller, bakır, gümüş gibi elektrik akımını ileten maddelere iletken maddelere, seramik, plastik gibi yalıtıcı denir.

6- Hava elektrik akımını iletir mi, iletmez mi? Arkadaşlarınızla tartış ve 1-2 özet cümleyle vardığınız sonucu aşağıdaki boşluğa yaz.

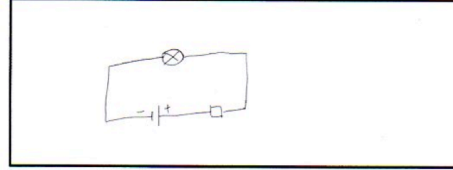


Hava bazı durumlarda iletken hale geçebilir. Örneğin yıldırım simsek gibi olaylarda.

3.



In science, technology and engineering, people use schematics rather than pictorial drawings. Using the symbols listed above, draw in the box below a simple electrical diagram.



4. Is conductivity an inherent property of an object, or a property of a material the object is made of? Explain your answer.



Conductivity is an inherent property of metal (For solid matter). However sometimes solid matter like salt conducts electricity when dissolved in water.

5. After a brainstorming with your peers about the common names of conducting and non-conducting materials, complete two sentences below.

Solid materials, like copper, silver conducting an electric current are called conductors. Materials not conducting an electric current, like sugar, plastic are called insulators.

6. Discuss with your peer if the air can or cannot conduct an electric current. Write down 1-2 sentences summing up your discussion.



Air can become conductive in certain situations. For example in events like thunder, lightning.

7- Sınıftaki hava elektrik akımı üretirse uygun bir deneyle kontrol et. Deney düzeneğini ve gözlemini tarif et.



Sınıftaki hava elektrikli iletken ile tehlimesi için yıldırım ve simsek gibi bir olayın gözlenmesi gerekir.

8-



Bulutlu ve fırtınalı havalarda çıkan ışığın nedenini internet ve diğer kaynaklardan araştırarak, 3-4 cümleyle ifade et.

Bulutların elektrikleşmesi sonucu yük toplaması ışığın meydana gelmesini sağlar.

9-Elektrik ve iletkenlikle ilgili olarak sonraki ders ya da evde keşfetmek istediğin diğer konular ve sorularla ilgili öneride bulun.



Güvenlik Notu : Elektrikli araçlara dokunmadan önce daima ellerinizin kuru olduğundan emin olun. Asla parmaklarınızı elektrik kontağının içersine sokmayınız.

CHALLENGE : Sınıfta elektrik cihazına takılı hiçbir araç olmadan küçük bir ışık deneyi öner.

ÖDEV : İnsanlar için elektrik her zaman tehlikeli midir? sorusuna dayalı kısa bir essay yaz.

Hayır, gerekli yalıtım yapılsa ve özellikle ıslak elle prizlere dokunulmazsa tehlikeli olmaz.

7. Check with an appropriate experiment if the air in the classroom conducts an electric current. Describe experimental setup and your observation.



Air in the classroom does not conduct electricity. For it to conduct electricity, there should be an event like thunder or lightning.

8.



Search the Internet or other sources and find out how the lightning is formed during the thunderstorm. Write down 3-4 main steps, required to form a thunderstorm cloud and lightning.

As a result of clouds electrification current discharges which create lightning.

9. Propose other topics or questions related to electricity or conducting, you would like to explore during the subsequent lessons or at home.



Safety note: A human being conducts an electric current. Always make sure that your hands are dry before you handle any electrical equipment. Never put your fingers into an electrical contact.

Challenge: Propose an experiment showing in the classroom a small lightning without use of any device plugged into the mains.

Homework: Using argumentation, write a short essay based on question: „Is the electric current always dangerous to a human being?“

No, if necessary insulation is made, and the plugs are not touched with wet hands, it won't be dangerous.

(v) Use of assessment data

Based on the feedback from the results of assessment of inquiry skills, the teacher suggested some changes that she will make in future implementations. In the conductivity table, another column should be added for investigating changes to materials, rather than changing the material itself. For example, changing the amount of salt in salt solution, changing the length and thickness of a wire, etc. This would give a chance to students to try more things. Another change may be giving a better definition of materials to use in the activity.

We tried to teach inquiry skills one by one with a progression. Their assessment may be similar in that every week we can focus on one or two skills to assess, which may make it more manageable. The assessment should be applied to the whole class rather than choosing a few students. The rubric may be simplified and number of categories may be decreased and their definitions may be simplified.