4.2 Case study 2 (CS2 Ireland)

Concept focus	Introduction to electric conduction and electric circuits Drawing electrical circuits
Activities implemented	Activities A-C
Inquiry skills	Planning investigations Working collaboratively (debating with peers)
Scientific reasoning and literacy	Scientific literacy (searching for information; use of scientific language, explaining electrical conduction scientifically)
Assessment methods	Classroom dialogue Teacher observation Peer-assessment Worksheets Student devised materials (mind maps)
Student group	**Grade:** lower second level **Age:** 13-14 years **Group composition:** all female, mixed ability; 2 different classes (24 students per class); 2-3 students per group **Prior experience with inquiry:** No prior experience

This case study details an interesting use of mind maps, whereby the teacher allowed students to modify their mind maps at the end of the lesson and to add new words and connections. In a different class, the mind map exercise was used as a revision exercise. The teacher used a rubric to assess students' mind maps. Students were assessed both as they worked, by listening to student conversations, and after the lessons, through collection of mind maps and circuit models.

(i) How was the learning sequence adapted?

The unit was designed for use with lower second level students, and was implemented with two groups aged 13-14 years. Each group were at different stages in their prior knowledge of the topic. One group had just covered static electricity but had no prior knowledge of electric conduction or electric circuits. The second group had most of the relevant content already covered. The unit was altered slightly for both groups. Students were asked to draw a mind map (brainstorming exercise). At the end of the lesson, students were asked to modify the mind map by drawing new links and adding new words. Some of the activities towards the end of the unit were left out (question 11, challenge activity). As suggested, students were also asked to draw simple electric circuits, but like the mind maps, students were allowed to update or modify these at the end of the lesson. The second group of students had already covered most of the content, so the construction of a mind map was used as a revision exercise.

(ii) Which skills were to be assessed?

Along with the inquiry skills suggested in the unit plan, other skills that were identified and assessed were *construction of models* and debating with peers (*working collaboratively*). Students were assessed both as they worked (by listening to student conversations) and afterwards (collection of mind maps and circuit models).

An alternative final/summative assessment was used. Students were required to plan an investigation. The plan then had to be implemented and adjusted as appropriate. All adjustments had to be noted and results recorded. Students then had to interpret their results to make a generalisation.

(iii) Criteria for judging assessment data

A rubric was used for the assessment of the students' mind maps and circuits. The rubrics each had four levels, ranging from lower to higher order thinking. For the mind maps, an item at the lower end of the scale would just be a list of recalled words, where at the upper end of the scale students needed to make relationships and cross links between the words listed (Table 1).

Table 1: Rubric for assessment of mind maps

Assessed Skill	Level 1	Level 2	Level 3	Level 4
Mind maps	Simply recalling words	Individual words explained as ideas	Some cross-linking of concepts	Full map showing many cross-links/relationships between many/most of the words listed

Similar to the assessment used with the mind maps, assessment of circuit models also looked for four levels of thinking (Table 2). At the lower end of the scale students would just draw a circuit correctly, with correct symbols. At the higher level of thinking, students must reference the flow of electrons, along with detailed explanations as to why electrons flow and a reference to energy or energy conversions.

Table 2: Rubric for assessment of circuit drawing/models

Assessed Skill	Level 1	Level 2	Level 3	Level 4
Scientific literacy: circuit model/drawing	Circuit symbols drawn and connected correctly	...and reference to flow of electrons/direction of current	... and indicating that electrons already present throughout the wires, etc., begin to move as soon as switch goes on and some explanation as to why they begin to move (reference to battery/potential difference, etc.)	...and an explanation of energy conversion, i.e. electrical energy – light energy in the bulb and/or reference to how kinetic energy of electrons does not change

(iv) Evidence collected

Teacher opinion

The teacher found the unit beneficial, both as a way of teaching about electric conduction and as a revision exercise. There were some suggestions for improvement in some of the sections in the unit. The mind map in Activity A was seen as useful exercise. This teacher used the mind map before and after the unit. Students were assessed on what changes they made to the mind map, which gave the teacher a clearer picture of the students' ideas of what it means for something to be a conductor of electricity. Students' discussions were also assessed.

It was felt that that Activity B, where students had to draw a simple electric circuit, worked well. A suggestion for an extension to this activity is asking students to draw what they think is happening inside the wires. Activity C was implemented as a homework exercise.

> ***"The added homework activity allows the teacher to assess whether the skills learned in planning this activity have been learned sufficiently to allow them to be transferred to another activity. This assessment provides the opportunity for the teacher to assess whether students can plan an appropriate investigation"***

It was felt that the conductivity table was a useful way of assessing students' skill in *developing hypotheses*. However, some changes were suggested.

> ***"Good assessment of students' ability to hypothesise. However I feel it would be better to get students to explain WHY they made the prediction. This helps teacher assess argumentation and justification skills and means that students who just guess correctly are not assessed as being at the higher end of an assessment scale"***

In general students were assessed both as they worked and by looking at their work afterwards. Peer-assessment took place among the students before work was collected. The teacher decided not to use the "challenge" activity, as it was felt that it did not align well with the rest of the unit.

> ***"I did not think this activity contributed to this lesson. I understand that argumentation is considered an important skill but think it is a stretch to include this here. Other possible research question which would tie in with the additional assessment activity would be to ask the students to research whether all metals conduct electricity as well as each other, or to research whether temperature for example affects conductivity. This research might prepare them for the additional assessment activity attached."***

Sample student artefacts: Mind maps

Figure 1 shows examples of mind maps drawn at the beginning of the unit, while Figure 2 shows an example of a mind map drawn at the end of the activities.

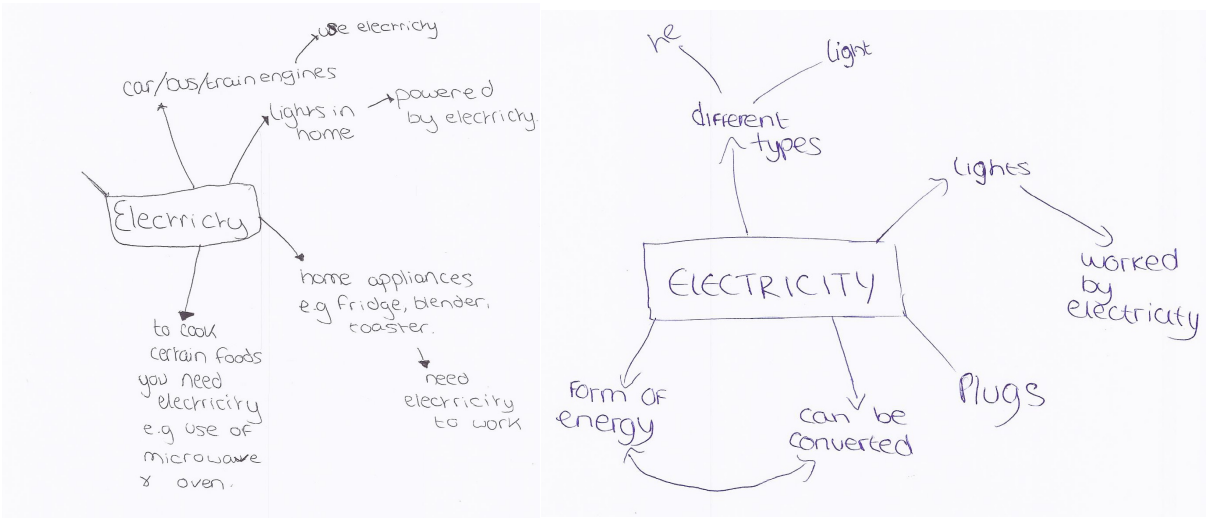

Figure 1: Examples of mind maps on level two of the scale. The maps show some ideas explained, but there are little or no links made between concepts.

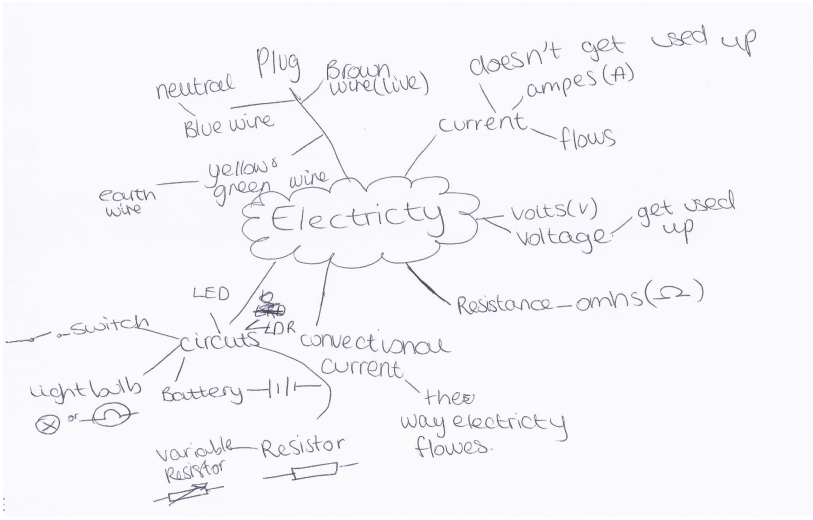

Figure 2: An example of a mind map at level 4. There are many links made between words, with some explanations present.

Sample student artefacts: models of circuits

In activity B, students were asked to draw circuits and explain what is happening inside the wires. Figure 3 hows an example of a circuit model at level 3 of the assessment scale. The student has drawn a correct circuit, and gone into some detail describing what happens when you turn on the switch. Figure 4 shows a circuit model at level 4 of the assessment scale. Here the student has included some discussion about energy and electron flow.

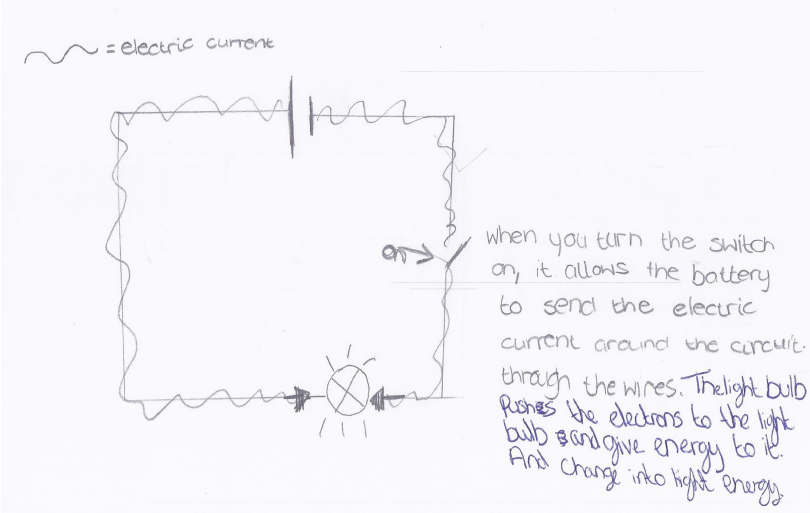

Figure 3: A simple circuit model (Example 1)

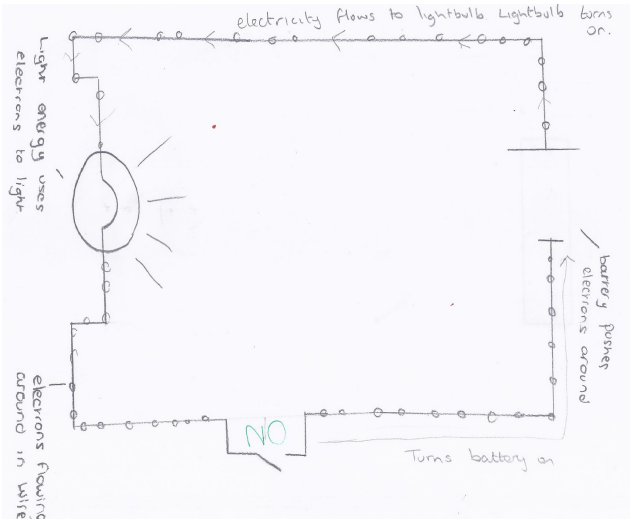

Figure 4: A simple circuit model (Example 2)