4.4 Case study 4 (CS4 United Kingdom)

Concept focus	Recognition of variables to be tested or controlled Presentation of data Writing conclusions and evaluations of work
Inquiry skills	Developing hypotheses Planning investigations
Scientific reasoning and literacy	Scientific reasoning (writing conclusions and evaluations) Scientific literacy (presentation of scientific data; communication of scientific information)
Assessment methods	Classroom dialogue Teacher observation Student devised materials (recordings, reports) Presentations
Student group	**Grade:** Year 8 (lower second level) **Age:** 12-13 years **Group composition:** mixed gender and ability (no entrance examination for this school); 24 students **Prior experience with inquiry:** None

In this case study, students developed their skills in *developing hypotheses*, in particular recognition of variables to be tested or controlled, and enhanced their *scientific literacy* through understanding relevant data and communicating this to others. *Scientific reasoning* was also assessed, looking at ability to write conclusions and evaluate methods. No formal rubrics were used for assessment; instead the teacher provided formative feedback on student presentations.

(i) How was the learning sequence adapted?

The **Collision of an egg** SAILS unit was implemented in full; the learning sequence followed the open-ended investigation as described in the unit. However, assessment tools from the original unit were not used; instead the teacher assessed using their own understanding of how to plan and do an investigation and used this understanding to give feedback on the written outcomes. There were no teacher demonstrations and no specific real life context set. Students' implementation required four lessons (60 minutes each) over a two-week period, with two lessons per week.

Learning sequence

1. Students were asked to choose their own groups of four and this tended to be based on their existing friendships and most were single sex groups.
2. Students groups were encouraged to discuss the topic of egg collision and think together about the factors that would determine if the eggs would be more likely to break or less likely to break, on impact with a surfaces.
3. Following this discussion, they came up with a basic plan on what to investigate, which was either the surface of impact, or height of drop, or both height and surface.
4. Students generated a list of equipment that they needed for their inquiry. They had to decide things such as surfaces that they would like to drop the egg on, the mechanism they would use to do the drop the egg and also state the different heights from which they would like to drop their eggs. This was to help them recognise the variables involved and try to ensure a fair test was undertaken.
5. Students were asked to justify their choice of variables – stating their hypothesis and the justification of their hypothesis. This was done verbally. The resource list was written and handed in so equipment could be available for the next lesson.

6. At the start of the lesson, students collected the equipment they had requested for their investigations. They wanted to go outside to carry out their investigations, so went to the school field where they carried out their investigation.
7. Students decided to record the egg drops using the camera and video facilities on their phones. No written notes were made at all by any of the groups. Students were encouraged to 'talk through' their investigation, as they record themselves undertake the investigation. Not having to write down notes seemed to motivate them. They enjoyed using their phones and talking things through.
8. Students returned to the lab and together in their groups they extracted the relevant data from re-watching the video and then recorded their data into a table of results. Each group created one table of results, not as individuals.
9. Students analysed their results together, and wrote up their investigation, with their conclusions and evaluations.

(ii) Which skills were to be assessed?

The following skills were assessed in this case study: *planning investigations*, *developing hypotheses* (recognition of variable to be tested or controlled), *scientific literacy* (understanding the relevant data and communicating this to others, presenting scientific data), *scientific reasoning*, through writing conclusions and evaluating of work, Modes of assessment used included:

- Group discussion of how they were going to carry out the task.
- Their written work on how they were going to carry out the task.
- Direct teacher observation of students doing the task.
- Written work on how the students collected, analysed and commented on their results

Developing hypotheses, planning investigations

The teacher assessed if students could recognise the variables to be tested or controlled. This was assessed in the first lesson as teacher talked with each group about their ideas and how to test out their hypothesis. The teacher was able to assess how students identified what variable to measure, and what variable to control and what variable to change.

Presentation of data (scientific literacy)

This was assessed in the students' written work about their tasks. The teacher would then agree with their hypothesis, and how they concluded their overall investigation.

Drawing conclusions (scientific reasoning)

To assess students' skills in writing conclusions, the teacher assessed the format of the students' written work.

(iii) Criteria for judging assessment data

The teacher identified several criteria for judging the students' skills.

- The ability for students to identify the variables – in this case, either the height of drop, or surface on which the eggs were dropped, or both.
- The ability for students to recognise the dependent and independent variables, and the control variable in this task.
- How students would plan the experiment – in this task, the teacher only provided students with hen eggs. They were told to think and come up with other equipment that they would need for their chosen investigation.

The teacher identified in advance what she expected the students would be capable of achieving:

- Groups of students were expected to plan their group experiment to investigate the task – this included them having to think about the task at hand, the time available and what to measure.
- They were expected to produce a list of equipment to the teacher, justifying the use of each. They needed to know how it related to the task and how they planned to investigate their hypothesis.
- They were expected to use their chosen equipment well to investigate their planned investigations – they also needed to reflect on their choices and their chosen equipment and think if it was the most beneficial or not to their planned investigation.

Formative assessment was done during the inquiry. When students were presented with the task, the teacher went to each group and questioned them on how they planned to approach the task and give reasons. The teacher also asked the students how they planned to use the equipment they had chosen, and how it related to their environment. The teacher did not make any notes on what different groups said.

Summative assessment was done after the actual investigation practical task had been done. The teacher commented on how it related to their original plan.

(iv) Evidence collected

Teacher opinion

All the students liked the idea of having the freedom to choose their own equipment in doing and solving an inquiry problem. They had not had this sort of choice before in their science lessons and it seemed to motivate and enthuse them more than 'normal' science practical lessons. They were only provided with one type of hens egg, but some expressed the idea of using different type of eggs and that it might make a difference, for example using a partridge egg compared to a goose egg. This showed they were thinking beyond the task as first described and this is a good scientific attitude to have.

Learners also enjoyed working outside, and the chance to record themselves using their phones; they liked "talking through" their investigation rather than writing. They stated this to the teacher and their level of enthusiasm was shown by the level of talk that was relevant to the task. Normally they would take their work books and record everything in writing.

The teacher observed that some groups worked better than others and stayed very focussed. This could have been avoided if teacher have chosen the groups for specific reasons, such as ensuring the mix of personalities were more likely to work well. However, all groups seemed to engage well with the activity.

The teacher observed that some students limited themselves in their investigation, and they finished their investigation long before everyone else. This could have been avoided if students were encouraged to investigate more variables, even investigating both variables of height and surfaces. The inquiry approach was very useful because students were given the freedom to decide what and how they wanted to do their investigation and with whom they would work. This seemed to motivate them and there were no incidents of unacceptable behaviour or work that was below their usual attainment within a science lesson.

The teacher did not use rubrics for assessment, as she did not want to interfere with the open inquiry process by emphasising formal assessment:

> ***"I am actually not sure why I did not use any rubrics, maybe I thought that they were 'clever enough' to produce good work. It could also be that, I did not want to 'grade' their work, for they were asking for graded work. I discussed with the class, the criteria, before the inquiry, and I told them that I was looking for specific details such as the use of variables, and how they were going to manipulate their variables, including any justifications if necessary. I also told them about the writing skills, and the good use of keywords in concluding and evaluating their work."***

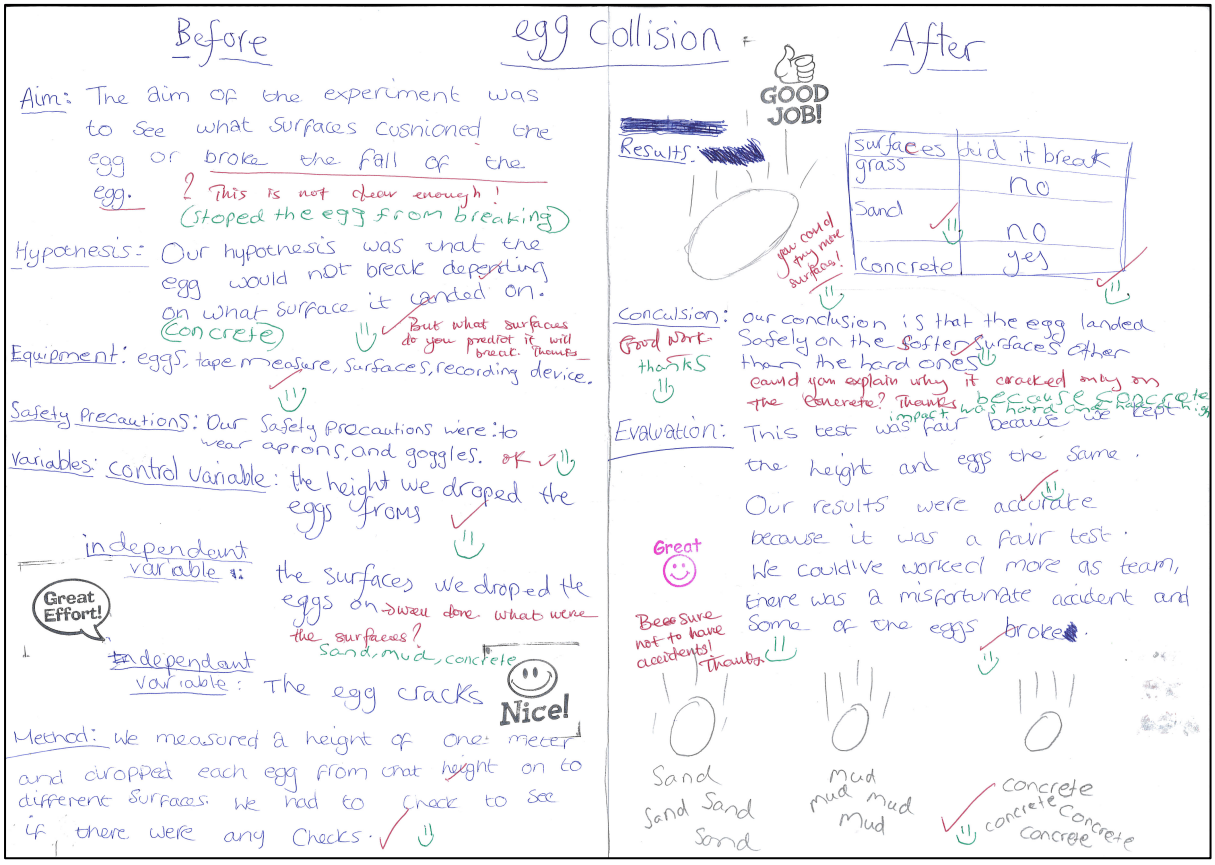
However, she does note that use of rubrics may be beneficial for the students, as they can see more clearly what is expected of them.

> ***"Honestly, I think by looking back, I should have given them a rubric as a criteria to look at, rather than assuming that they could do it. The reason is I am not that used to Inquiry myself, and I am grateful to SAILs for exposing me to Inquiry, and I would say, I am actually learning more and more, whenever I come to the meetings."***

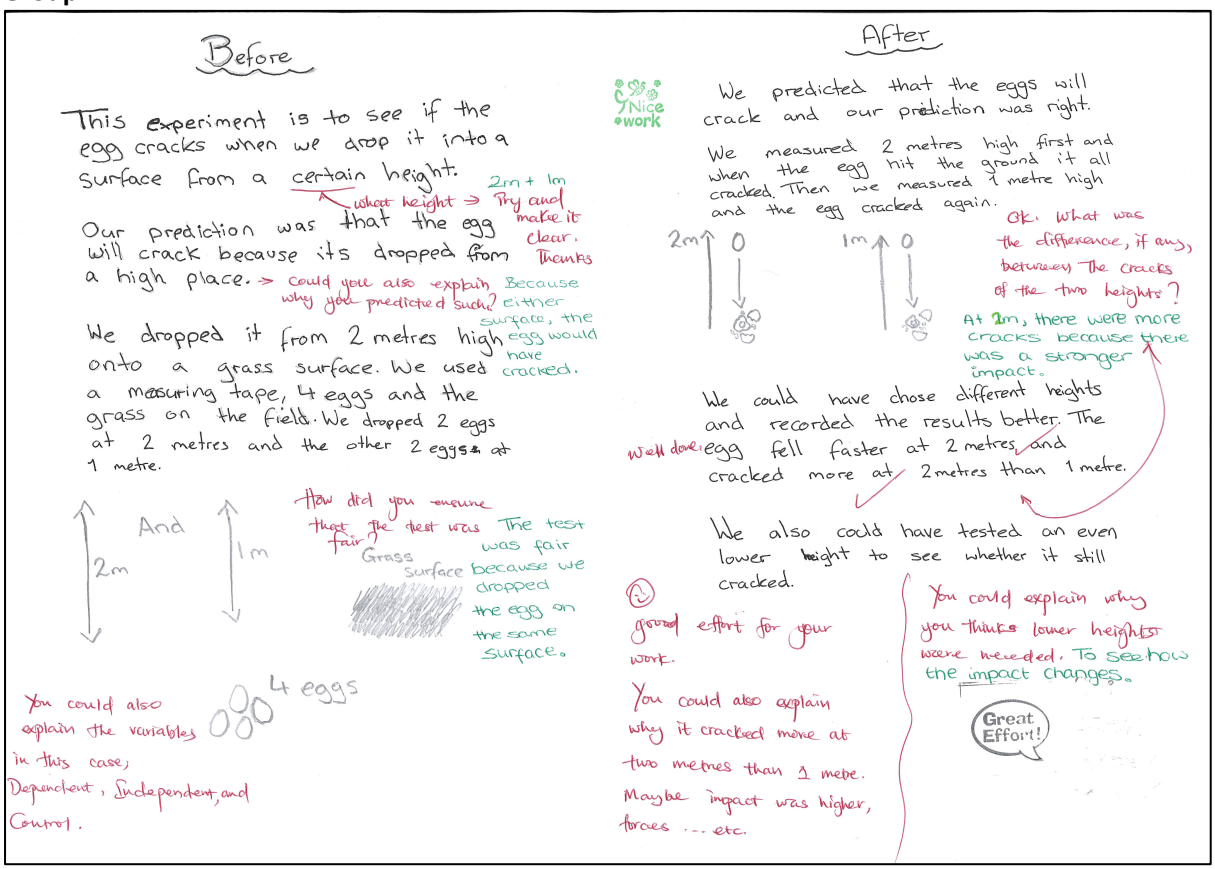
Sample student artefacts

Group worksheets, with teacher feedback comments and where the students have responded to the teacher's feedback are provided. In each the students first wrote in dark blue pen, after which the teacher provided feedback comments in red or using stickers. Students then responded to teacher feedback using a green/blue pen.

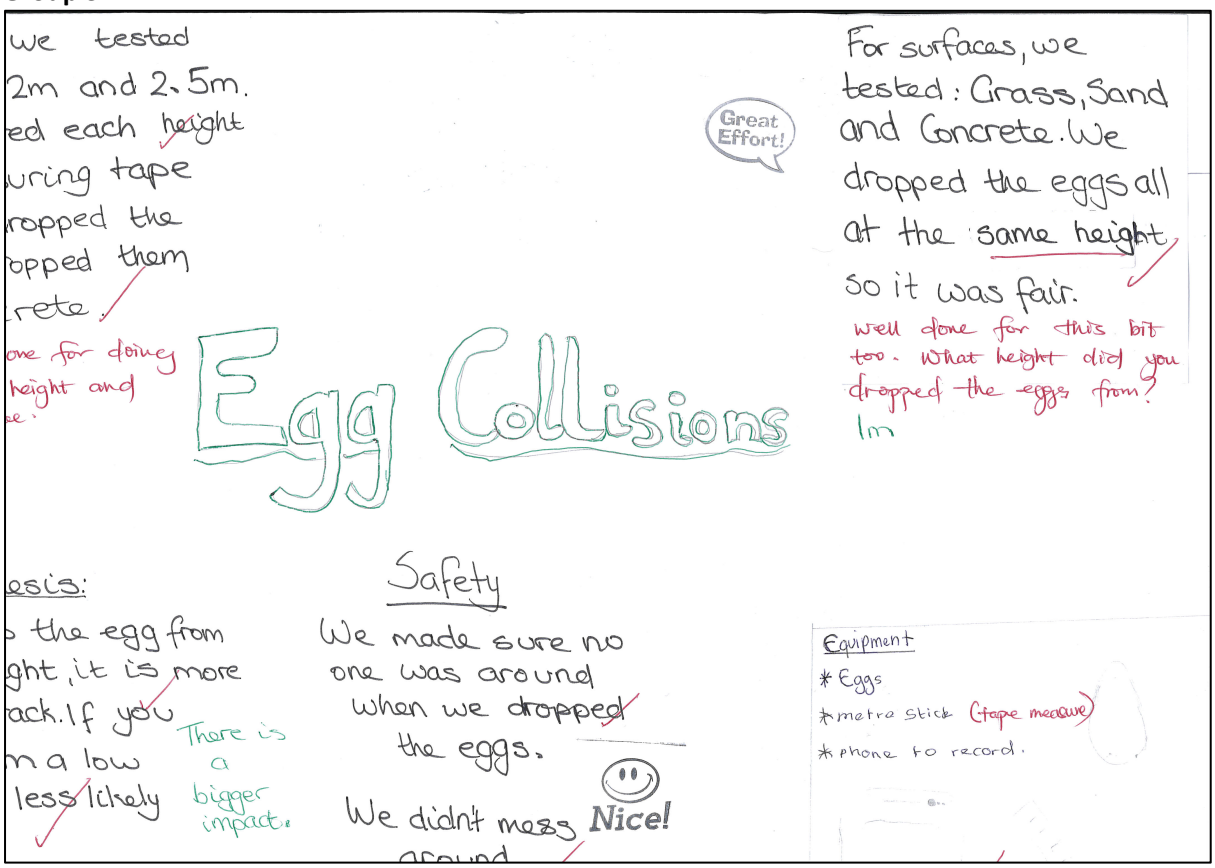
Group 1



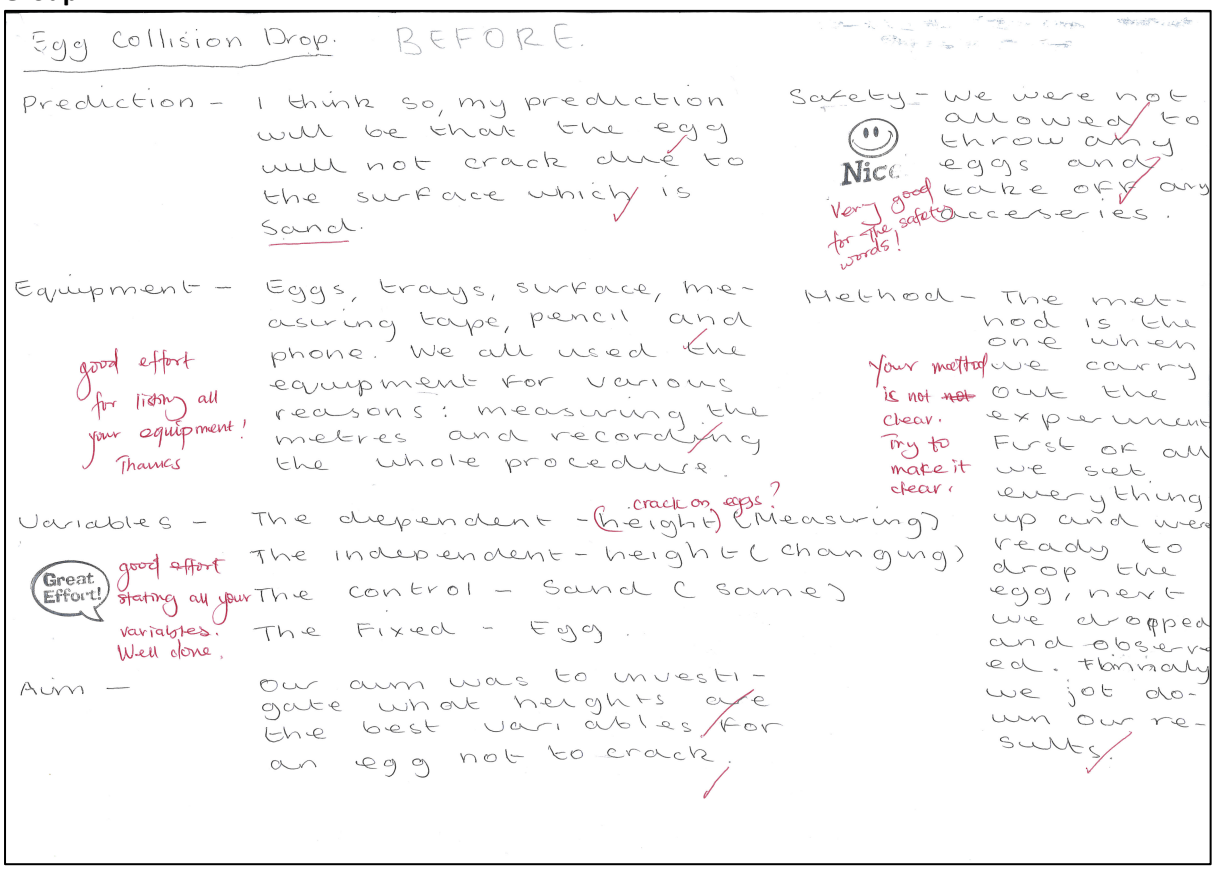
Group 2



Group 3



Group 4



(v) Use of assessment data

The teacher provided feedback to students both during and after the inquiry. Student had the opportunity to respond to the feedback.

- Oral feedback to students during their planning. This was mostly done during the first lesson and gave some guidance.
- The teacher commented with written feedback on the written work of students and they responded to these comments.

(vi) Advice for teachers implementing the unit

I recommend to teachers who are starting with inquiry-based activities to be supporters of students at individual phases and to gradually increase the level of difficulty. Students will acquire inquiry skills more effectively and will be open to new ways of acquiring knowledge.

Recommendations for new teachers includes:

- Practice with rubber eggs and using boiled eggs in the first instance as this will help students to try out their ideas and adjust them before using the real egg which might smash and make a mess
- Doing the inquiry outside the classroom helps to reduce the mess. It also helps the student to have the freedom of selecting different surfaces and heights.
- Allowing students to use recording equipment such as video camera or audio device to record their own projects and results that they then use to help write their report was a success. They really enjoyed using their phones to video and take pictures and it helped them to write their reports.
- Encourage more capable students of testing more variables, like investigating both height and surfaces; this is to avoid them finishing earlier than their peers.

- Create a rubric of statements about what quality will look like at different stages and share the rubric with the students, but don't have grades or levels on the rubrics.