4.2 Case study 2 (CS2 United Kingdom)

Concept focus	Global warming
Activities implemented	Activities A-B
Inquiry skills	Forming coherent arguments Working collaboratively (communication)
Scientific reasoning and literacy	Scientific reasoning (argumentation) Scientific literacy (analysis and interpretation of scientific data)
Assessment methods	Classroom dialogue Teacher observation Peer-assessment Presentations
Student group	**Grade:** lower second level **Age:** 13-14 years **Group composition:** single sex (all-girls); high ability **Prior experience with inquiry:** No prior experience with inquiry

In this case study, the teacher adapted the unit worksheet to make it more appealing and challenging for this high ability class. Assessment focused on students' *scientific literacy* and skill in *forming coherent arguments*, as evidenced by their ability to interpret and use scientific data to form arguments. Teacher observation, classroom dialogue and peer-assessment were used to provide formative feedback.

(i) How was the learning sequence adapted?

The **Global warming** SAILS unit was implemented in a single 50-minute lesson. The teacher prepared a modified worksheet for the students, based on previous discussions with other teachers who had used the original unit unchanged. Those teachers had indicated that the original layout had caused a lot of confusion, for example the graphs contained non-English text. The teacher therefore looked for an English-only diagram to avoid this confusions and added images of girls speaking (implementation in an all-girl school). The teacher also felt that the data presented was not challenging enough, so more diagrams and graphs of data were added, to allow for more differentiation.

Another point that came up was that students did not quite take to the impersonal layout of the original activity. Therefore the teacher gave the students names, rather than just the description of "Student A" and "Student B." The students were given the chance to work in groups, rather than individuals, as they had not done anything like this lesson before.

The students always sit around "pods" that can sit six students. Although the class are all of high ability they are arranged in mixed ability pods, so that weaker students work with stronger ones. There is a narrow spread in ability. The pods can easily be worked so the students can work in pairs or groups of 3 students.

The teacher kept the description of performance levels in the rubrics, as the student were more used to that (levels and grades). A grade A would be the highest, while grades E would be the lower end.

(ii) Which skills were to be assessed?

The skills identified for assessment were *scientific literacy* (using scientific evidence, using scientific knowledge), *forming coherent arguments* and *scientific reasoning* (justifying arguments, providing

counter arguments and analysing argument). Students' skill in communication (*working collaboratively*) was also observed.

Peer-assessment with post-it notes occurred at the end of the session. The teacher gave students the last 10 minutes of the lesson to use feedback and improve some of their answers. They are not very good at this yet, so some did not bother to make any improvements. As students were less experienced with this peer-assessment approach to feedback, it was varied and often too vague to be helpful for improvement. However this is a group that can adapt very quickly, so the teacher is confident next time they would do a much better job.

The teacher walked around and observed the groups where peer-assessment was done in a way that did not give enough formative feedback, e.g. they just gave just a grade but no feedback. The teacher asked these groups to "include what went well (WWW) and even better if (EBI)…" as they are more familiar with that approach.

To address gender issues, the teacher adapted the visual layout of the unit activity to look more appealing. The teacher added two female images and gave them female names to make them more appealing to the all-girl class. The teacher thought that these adaptations to the unit presentation would appeal more to both boys and girls, because the style in which the questions are presented can have a big influence on how well students understand the content. The teacher would probably have chosen a student boy and girl rather than two girls for a mixed gender class.

The teacher asked students to make a poster per group, outlining their arguments. They were allowed to cut out the graphs and use them according to the criteria. These were evaluated by the teacher as part of the assessment process.

(iii) Criteria for judging assessment data

The teacher was looking for students to collaborate in lively discussions and produce posters that would be in accordance with the criteria given to students. The teacher was looking at which girls sat back and did not make any active contribution to the debate and which girls tended to dominate the discussion. Sometimes evidence is just too obvious and then one student just presents their idea and the other just says yes that is what they think. It is when neither of them is quite sure that it generates conflict, which is good because they can then start to see the evidence from different points and make up their minds about it.

The teacher took a position in the middle of the classroom and tried to observe lots of different conversations. If there was one particular person dominating a discussion, the teacher could move in and give advice or point out that particular students had not contributed within the previous few minutes or that another student had not yet spoken. In this way, the teacher ensured that all students expressed their opinions**.** As the plan was to carry out peer-assessment, there was a focus on formative assessment.

(iv) Evidence collected

Teacher's opinion

Students were fairly enthusiastic. I got the impression that they were glad that it wasn't just getting information from the textbook. They tend to make a moaning noise once they see that they have to work from the textbook or look at data. Let's be honest it's not the most exciting thing to do in a science lesson. However they got very quickly settled, decided very quickly which rubric they want to go for how they would achieve that. They were generally very efficient. There was only one student who took longer to get on with the task but thanks to her group members she was finally on board too.

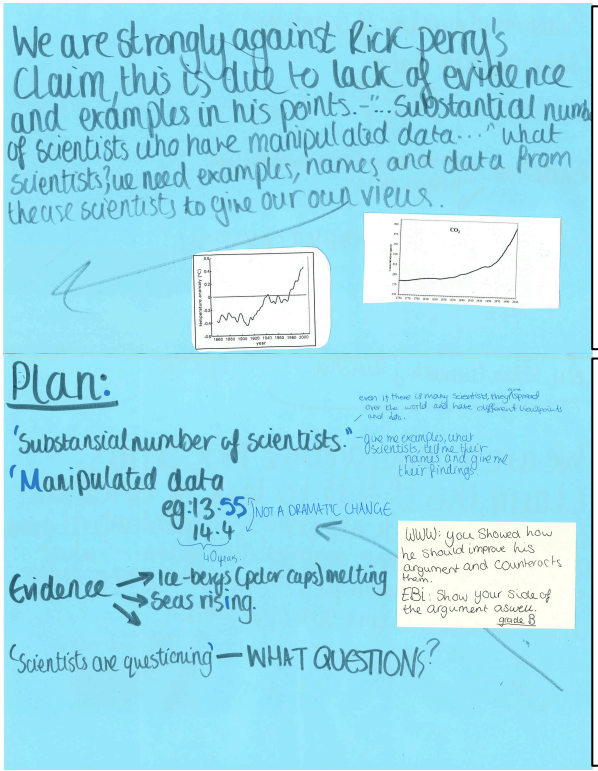
In usual science lessons when looking at data they moan a bit more or take a lot longer to get into it. They liked the idea of choice, as I didn't ask them to do all tasks but said depending on the degree of challenge they could start with task 1, 2 or 3.

Students had enough conflict generated from the data to have a high quality discussion, which was reflected on the posters collected. One of the issues was the poor peer-assessment. This definitely needs addressing in further session.

In these inquiry sessions I am only a facilitator. Most of my work is done before the lesson rather then in the lesson so I can actually concentrate on helping them, assessing misconceptions or observing just their skills and helping them to develop those. I probably should walk around and make little notes about what I see and hear going on, but I don't really do that. Partially because I think it is more beneficial for the individual if I talk to them and address issues there and then. When I write things down I feel like I am wasting time. I usually will assess the end product though.

Sample student artefacts

Figure 1 shows an example of a groups' poster for Activity B: Forming scientific arguments, where the group are arguing against the argument presented by governor Rick Perry. This poster was peer-assessed (on Post-it) and assigned a grade B. Feedback comments are "WWW you showed how he should improve his argument and counteracts them" and "EBI show your side of the argument as well."



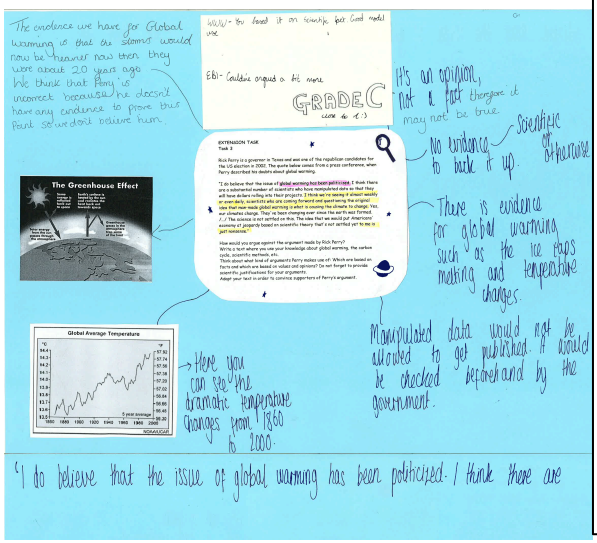
We are strongly against Rick Perry claim, this is due to lack of evidence and examples in his points.
"...Substantial number of scientists, who have manipulated data..."
What scientists? We need examples, names and data from theses scientists to give our own views

[graphs]

Plan:
"substantial number of scientists" – even if there is many scientists they are spread over the world and have different viewpoints and data - give me examples, what scientists, tell me their names and give me their findings
"manipulated data" e.g. 13.55/14.4 over 40 years, not a dramatic change
Evidence – icebergs (polar caps) melting – seas rising
"Scientists are questioning" – what questions?

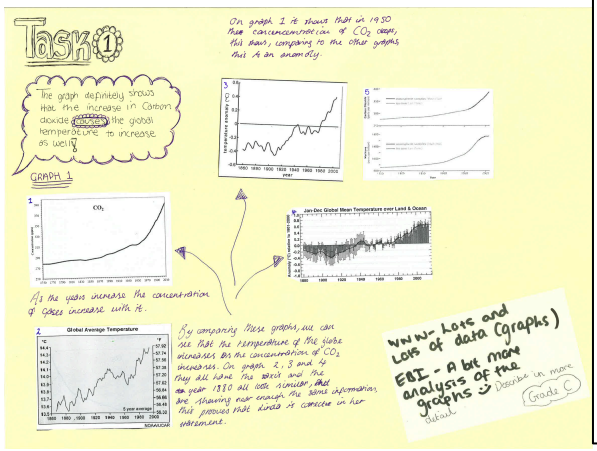
Figure 1: Example of student poster for Activity B: Forming scientific arguments.

The poster shown in Figure 2 was assigned a grade C when peer-assessed. The feedback comments state "WWW you based it on scientific fact. Good model use" and "EBI could've argued a bit more." Figure 3 is a further example assigned a grade C. Student feedback states, "WWW lots and lots of data (graphs)" and "EBI a bit more analysis of the graphs ☺ - describe in more detail."



The evidence we have for global warming is that the storms would be heavier now than they were about 20 years ago. We think that Perry is incorrect, because he doesn't have any evidence to prove this point so we don't believe him.
Its an opinion, not a fact, therefore it may not be true
No evidence to back it up – scientific or otherwise
There is evidence for global warming such as the ice caps melting and temperature changes
Manipulated data would not be allowed to get published. It would be checked beforehand by the government
[graph] ***– here you can see the dramatic temperature changes from 1860 to 2000***
I do believe that the issue of global warming has been politicised. I think there are [unfinished]

Figure 2: Example of student poster for Activity B: Forming scientific arguments.

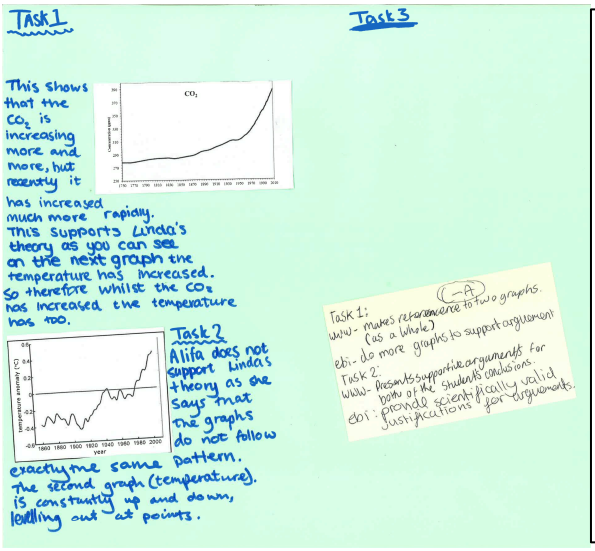


On graph 1 it shoes that in 1950 the concentration of CO_2 drops, this shows, comparing to the other graphs, this is an anomoly
The graph definitely shows that the increase in carbon dioxide causes the global temperature to increase as well!
[graph 1] ***as the years increase the concentration of gases increase with it***
[graphs 1-5] ***By comparing these graphs, we can see that the temperature of the globe increases as the concentration of CO_2 increases On graph 2, 3 and 4 they all have the axis and the year 1880 all look similar, are showing near enough the same information, this proves that Linda is correct in her statement***

Figure 3: Example of student poster for Activity A: Interpreting the evidence, task 1.

In the example shown in Figure 4, the group addressed both tasks in Activity A: Interpreting the evidence. These tasks were peer-assessed separately. The first task was assigned a grade of C, while task 2 received an A grade. Feedback comments for task 1 were "WWW makes reference to the two graphs (as a whole)" and "EBI do more graphs to support arguments," while feedback to task 2 states, "WWW presents supportive arguments for both of the student's conclusion" and "EBI provide scientifically valid justifications for arguments."

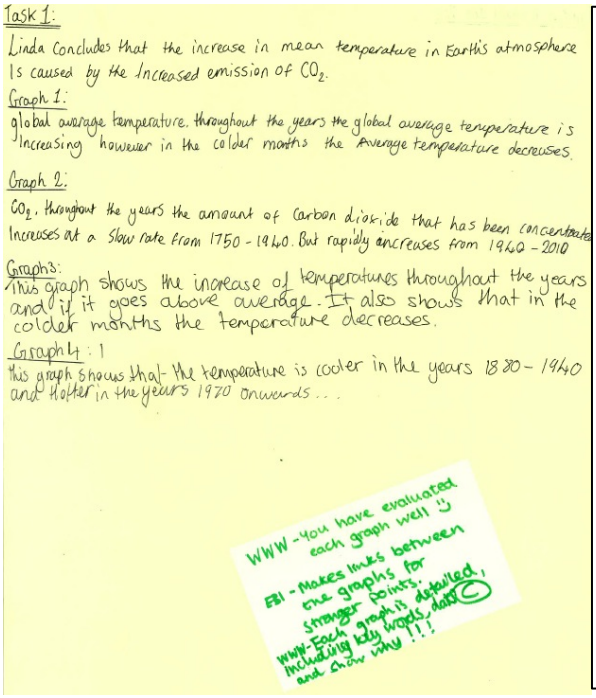
For the example shown in Figure 5, an overall grade of C was assigned, and feedback included, "WWW – you have evaluated each graph well ☺," "WWW – each graph is detailed, including key words, data and show why" and "EBI – makes links between the graphs for stronger points."



Task 1
This shows that the CO_2 is inceasing more and more, but recently it has increased much more rapidly. This supports Linda's theory as you can see on the next graph the temperature has increased. So therefore while the CO_2 has increased the temperature has too.

Task 2
Alifa does not support Lindas theory as she says that the graphs do not follow exactly the same pattern. The second graph (temperature) is constantly up and down, leveling out at points.

Figure 4: Example of student poster for Activity A: Interpreting the evidence, task 1 and task 2.



Task 1
Linda concludes that the increase in mean temperature in Earth's atmosphere is caused by the increased emission of CO_2

Graph 1 Global average temperature throughout the years the global average temperature is increasing. However in the colder months the average temperature decreases

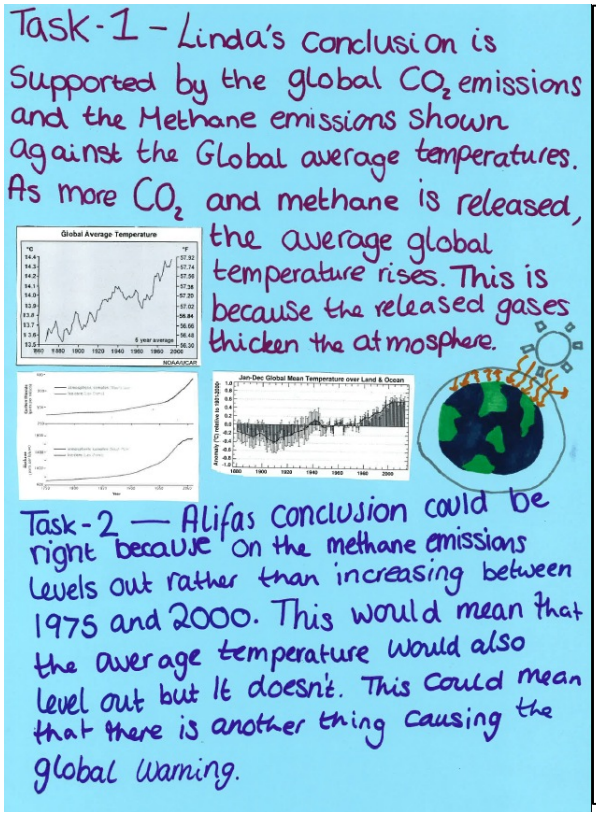
Graph 2: CO_2 throughout the years the amount of carbon dioxide that has been concentrated increases at a slow rate from 1750-1940. But rapidly increases from 1940-2010

Graph 3: This graph shows the increase of temperatures throughout the years and if it does above average. It also shows that in the colder months the temperature decreases

Graph 4: This graph shows that the temperature is cooler in the years 1880-1940 and hotter in the years 1970 onwards

Figure 5: Example of student poster for Activity A: Interpreting the evidence, task 1.

The students in the final example also chose to answer both task 1 and task 2 from Activity A: Interpreting the evidence, as shown in Figure 6. For the peer-assessment, the tasks were assessed together and given a grade B. Feedback comments (not shown on image) were "WWW: lots of scientific justification in all answers and used multiple graphs" and "EBI: Provide counter arguments. Use models and theories."



Task 1

Linda's conclusion is supported by the global CO2 emissions and the methan emissions shown against the global average temperatures. As more CO2 and methane is released, the average global temperature rises. This is because the released gases thicken the atmosphere

[graphs and diagram]

Task 2

Alifa's conclusion could be right because on the methane emissions levels out rather than increasing between 1975 and 2000. This would mean that the average temperature would also level out but it doesn't. This could mean that there is another thing causing the global warming

Figure 6: Example of student poster for Activity A: Interpreting the evidence, tasks 1 and 2.

(v) Use of assessment data

I will do more on peer assessment using Post-it notes. I believe it is a very important skill to have, just as much as self-assessment. Especially in approach of their exams, it will be important for them to reflect on whether their answer fits a question. Data will be used in connection with their termly assessment and their individual learning plans to help them improve on either their science understanding of global warming or data analysis skills.

To be honest I am still a bit unsure about which format my assessment descriptions should be in. I do not want to use level ladders but I think the rubrics look very much like level ladders to me.

(vi) Advice for teachers implementing this unit

Don't be put off if students find the interpreting of the rubrics hard and are less confident in giving good quality feedback. The more often they do it the better they will get.

I don't think most of my students recognised that the early data on the graphs must have been extrapolations rather than data collected at the time. I only interfered and asked guiding questions when absolutely necessary.