

#### 4.4 Case study 4 (CS4 Belgium)

<b>Concept focus</b>	Global warming
<b>Activities implemented</b>	Activities A-B
<b>Inquiry skills</b>	Forming coherent arguments Working collaboratively
<b>Scientific reasoning and literacy</b>	Scientific reasoning (argumentation, making comparisons) Scientific literacy (analysis and interpretation of scientific data)
<b>Assessment methods</b>	Classroom dialogue Peer-assessment Self-assessment Worksheets
<b>Student group</b>	<b>Grade:</b> 6 <sup>th</sup> year, upper second level; 3 separate classes <b>Age:</b> 17-18 years <b>Group composition:</b> mixed ability and gender; final year students, who will continue to university in mostly science or engineering studies. Students come from different socio-economic backgrounds – most of them middle class, some wealthy background. <b>Prior experience with inquiry:</b> No prior experience with inquiry in this form. They had experience through self-learning and inquiry based learning through lab situations.

This implementation describes an unusual use of assessment data. The proposed rubrics were used for teacher-, self- and peer-assessment of students' arguments. The teacher- and self-assessed scores were similar, but peers gave higher scores. This shows that students know that they do not have strong skills in using scientific knowledge and justifying argument, so they give themselves low scores. However, in peer-assessment they accept the opinion of the other groups as scientific fact.

##### (i) How was the learning sequence adapted?

When implementing the **Global warming** SAILS inquiry and assessment unit, the teacher made only minor alterations to the activities. The first part of the lesson introduced two graphs and the students had to first form arguments to support that global CO<sub>2</sub> emissions are responsible for global warming and second had to form arguments that there is no direct relation. The second part was a quote from Rick Perry, who declared that mankind is not responsible for global warming. The students had to analyse his quote for opinions, which were presented as facts and next they had to give a counter argumentation to his quote. Most of the students are fluent in English and are familiar with the subject of global warming, so the teacher did not translate the inquiry and assessment unit to Dutch. The document had good questions and formed a well-built lesson. The teacher only added space to answer the questions and after each rubric provided a place to give a score to themselves and to a peer group (Figure 1). The lesson was done in groups of 3 to 4 people.

<p><u><b>Self-assessment</b></u> <u>Using scientific information:</u> We will pick level ..... for task 1 because:</p> <p><u>Using scientific information:</u> We will pick level ..... for task 2 because:</p> <p><u><b>Finding of another group (peer-assessment)</b></u> <u>Using scientific information:</u> You get level ..... for task 1 because:</p> <p><u>Using scientific information:</u> You get level ..... for task 2 because:</p> <p><u><b>Task 3</b></u> Rick Perry is a governor in Texas and was one of the republican candidates for the US election in 2002. The quote below comes from a press conference, when Perry described his doubts about global warming. "I do believe that the issue of global warming has been politicized. I think there are a substantial number of scientists who have manipulated data so that they will have dollars rolling into their projects. I think we're seeing it almost weekly or even daily, scientists who are coming forward and questioning the original idea that man-made global warming is what is causing the climate to change. Yes, our climates change. They've been changing ever since the earth was formed. /.../ The science is not settled on this. The idea that we would put Americans' economy at jeopardy based on scientific theory that's not settled yet to me is just nonsense." How would you argue against the argument made by Rick Perry? Write a text where you use your knowledge about global warming, the carbon cycle, scientific methods, etc. Think about what kind of arguments Perry makes use of: Which are based on facts and which are based on values and opinions? Do not forget to provide scientific justifications for your arguments. Adapt your text in order to convince supporters of Perry's argument. Use the rubric to check your answer.</p>	<p><u><b>Self-assessment</b></u> <u>Analysing arguments:</u> Level ..... because:</p> <p><u>Providing counter arguments:</u> Level ..... because:</p> <p><u>Justifying arguments:</u> Level ..... because:</p> <p><u>Using scientific knowledge:</u> Level ..... because:</p> <p><u><b>Finding of another group (peer-assessment)</b></u> <u>Analysing arguments:</u> Level ..... because:</p> <p><u>Providing counter arguments:</u> Level ..... because:</p> <p><u>Justifying arguments:</u> Level ..... because:</p> <p><u>Using scientific knowledge:</u> Level ..... because:</p>
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**Figure 1: Sample pages from the worksheet, which was adapted to include self- and peer-assessment.**

## (ii) Which skills were to be assessed?

The activity was used in order to assess students' skills in *forming coherent arguments* and *working collaboratively*, as well as their *scientific reasoning* skills through building arguments from scientific data and their *scientific literacy* through analysing a quotation and distinguishing opinions from facts.

The students had to assess their own arguments by using the given rubrics – one for the first activity, which was to form arguments based on the graphs, and a second rubric about the analyses of the Rick Perry quote. They could give a number from 1 to 3 for each item. The arguments had to be based on the two given graphs and the quote.

## (iii) Criteria for judging assessment data

First the teacher also assessed the student's argumentations and gave a score using the rubric. Next, the teacher compared the three different scores they received for each task. The self-assessment was compared with the peer-assessment and with the teacher assessment.

For each question the teacher calculated the average by which the score given by self and peers differed from the score given by the teacher. To do this, the sum was calculated and divided by the number of answered scores (not every group gave an answer to every item). Therefore, a number with a maximum of 2 was obtained (if every group gave 3 when the teacher would give 1 or vice versa). The lower the number, the closer the self- or peer assessment was to the teacher score.

The assessment was summative in the form that it was first intended, because there was only this lesson, but the students were confronted with the analyses of the data. They were presented with the most common mistakes, in forming arguments as well as in judging their own argumentation and that of others.

#### (iv) Evidence collected

##### Teacher's opinion

Most students enjoyed the activity; it was different from what they are used to, so everything new is fun the first time. They found it however difficult to form arguments, because especially in sciences, this is not often done in class. Most of them had also great interest in the subject and were confronted during the exercise between fact and opinion, as was the main goal of the original lesson.

It was very significant that students who are aware of global warming found it easier to form arguments to support the idea of humans causing the effect, where giving arguments to counter the idea were more difficult. Some students from richer background, especially a student coming from a racing car background and a family in the car selling business did not believe in global warming and could not find arguments to support the idea that humanity is responsible and she supported Rick Perry's idea and could not counter it.

Assessment of the skills developed in this lesson was carried out using the proposed rubrics. However, students found the first rubric difficult to use, because there were three different criteria for only one skill. The second was easier to use, but in the using scientific knowledge skill they all gave themselves and especially peers high grades.

##### Observer notes

I would split the first skill in three different, more specific, skills. But for most part the system worked well. In general students need more lessons in analysing data and forming arguments.

##### Sample student artefacts

These students in the first example look in detail between the two graphs and make a good comparison (Figure 2).

check your answer.

De grafiek die de gemiddelde temperatuur voorspelt is ongeveer constant in de periode 1945 - 1975 terwijl er toch een sterke stijging naar te nemen is op de grafiek met CO<sub>2</sub> in diezelfde periode. ~~Maar~~ Tussen 1910 - 1940 stijgt de grafiek met de gemiddelde temperatuur terwijl de grafiek met de hoeveelheid CO<sub>2</sub> ongeveer constant is in die periode. Het is dus onmogelijk dat CO<sub>2</sub> ~~ook~~ een temperatuurstijging als gevolg heeft, in dit geval zou de temperatuur in 1910 - 1940 moeten stijgen en de hoeveelheid CO<sub>2</sub> in 1945 - 1975 ~~moet~~ tegen een constante moeten

Rubric (Task 1 and 2)

*The graph which predicts the average temperature is almost constant in the period 1945-1975, while we can still observe a sharp increase on the graph with CO<sub>2</sub> in the same period. Between 1910-1940 we can see an increase in the graph with the average temperature, whereas the graph with the CO<sub>2</sub> amount stays constant in the same period. It is therefore impossible that CO<sub>2</sub> has a temperature rise as a result, if this was the case, the temperature would have to show an increase between 1910-1940 and the amount of CO<sub>2</sub> between 1945-1975 should have come close towards a constant figure.*

Figure 2: Artefact 1.

In the next example, these students went into a little less detail, but are critical about what they get – not enough information, only two graphs (Figure 3).

- In de periode van 1920-1940 stijgt de temp. aanzienlijk, terwijl de CO<sub>2</sub>-uitstoot pas een grote stijging kent van 1950-1980.

- Curve 1 stijgt geleidelijker aan dan curve 2.

- Om een duidelijke conclusie te trekken bezitten we/hij te weinig informatie, je kan dit enkel waarnemen en logisch redeneren zonder er een ~~van~~ wetenschappelijk verklaring te geven

Rubric (Task 1 and 2)

- In the period 1920-1940 the temperature rises considerably, while CO<sub>2</sub> emissions have only showed a large increase from 1950 – 1980
- Curve 1 rises more gradually than curve 2
- To draw a clear conclusion we/he have/has too little information, you can only observe and reason logically without giving a scientific explanation.

Figure 3: Artefact 2.

For the third artefact, the students clearly believed global warming was due to manmade factors and did not do much trouble examining the graphs for part 2 (Figure 4).

Sommige dalen (minima) van de temperatuur-grafiek zijn niet te zien op de CO<sub>2</sub>-grafiek. Wanneer we afgaan op de vorige theorie zien we geen overeenkomsten.

Zie: dal 1900-1910 is niet te zien op de CO<sub>2</sub> grafiek

→ geen onderling, je zegt juist dat er een fit heeft.

Rubric (Task 1 and 2)

**Some dips (minima) in the temperature-graph can not be seen on the CO<sub>2</sub> graph. When we look at the previous theory, we see no similarities. See: dip 1900-1910, we can not find it on the CO<sub>2</sub> graph.**

Figure 4: Artefact 3.

We can see in the following text that students are well motivated but always come with their own interpretations instead of scientific arguments.

Het klimaat verandert inderdaad al doorheen het hele leven van de Aarde, maar de laatste jaren verandert het klimaat heel zorgwekkend. Er zijn ook wetenschappers die de opwarming van de Aarde niet als schuld van mensen zien, maar er zijn ook veel wetenschappers die zeggen dat dit wel waar is en Perry zegt dat zij hebben opgefeld met de resultaten maar ik zie geen enkele reden waarom zoveel mensen zouden liegen over zo'n belangrijke zaak.

Ook praat hij over het op het spel zetten van de Amerikaanse economie als we nu al voorbereiden op een hevige verandering in het klimaat, en groener beginnen te leven. Maar als we nu niet bewust gaan omgaan met onze Aarde, door vermindering van broeikasgassen en fossiele brandstoffen bijvoorbeeld, loopt het misschien helemaal mis met de Aarde want we weten nog altijd niet zeker wat het gevolg zal zijn ~~van~~ van onze overmatige omgang met onze planeet.

*The climate is actually changing throughout the life of the earth, but in recent years the climate changes are becoming very worrying. There are also scientists who do not blame people to be the cause of global warming, but there are also many scientists who believe this is the case, and Perry says they have been messing up the results, but I see no reason why so many people would lie about such an important matter. He also talks about putting the American economy at risk, if we already start preparing for a big change in the climate, and start to live "greener". But if we do not consciously take care of our earth by reducing emission and fossil fuels, for example, then it could go completely wrong with the earth because we still do not know for sure what will be the result of our irresponsible behaviour on our planet.*

Figure 5: Artefact 4.

In the example shown in Figure 6 you can find the criticism of some groups toward others. Clearly these students wanted to not only give constructive feedback, but also make fun of their classmates. Some remarks are correct, but others are over the top.

Where in the graphs can support be found for the conclusion made by Student A, that the increase in mean temperature in Earth's atmosphere is caused by the increased emission of carbon dioxide? Give supportive arguments for this conclusion with reference to the graphs. Use the rubric to check your answer.

Beide grafieken stijgen. Wow nieuw?  
Beide grafieken bestrijken dezelfde periode.  
zelfde x-as-1  
Wat is de naam van een woord  
Tydens de periode 1930 - 1990 stijgt de uitstoot van koolstof en verhoogt de temperatuur.  
dioxide

*dit is de bedoeling. ze hoefden dit te zijn. anders kan je geen conclusie trekken*

Both graphs rise. *Wow, are you serious?*

The two graphs represent the same to period. (same x-axis) *This is intended. It should be like this otherwise you can not draw a conclusion.*

During the period 1930-1990 there is an increase of carbon dioxide emission and an increase in the temperature.

Figure 6: Artefact 5.

#### (v) Use of assessment data

The teacher analysed the assessment of the different groups and questions, to examine how well the self- and peer- assessment matched that of the teacher (Table 1). For each group and question the score as given by the group, by a peer group and by the teacher are shown. At the bottom of each column is the sum of the difference in score between self and peers (S-P), between self and teacher (S-T) and between peers and teacher (P-T). Below that, it is divided by the number of answers.

Table 1: Analysis of self-, peer- and teacher-assessment for each task and group

	Task 1			Task 2			Task 3											
	Using scientific information			Using scientific information			Analysing arguments			Providing counter arguments			Justifying arguments			Using scientific knowledge		
	Self	Peer	Teacher	Self	Peer	Teacher	Self	Peer	Teacher	Self	Peer	Teacher	Self	Peer	Teacher	Self	Peer	Teacher
Group 1		2	2		3	2		3	1		2	1		1	1		3	1
Group 2	2	2	2	2	2	2	3	3	3	2	1	2	1	1	1	2	2	2
Group 3	1	1	1	2	1	1	1	1	2	2	2	1	2	2	1	1	1	1
Group 4	1	1	2	1	2	2	2	2	2	2	2	2	1	1	1	1	1	1
Group 5	2	1	2	2	2	2		2	2		1	1		1	1		2	2
Group 6	1	2	2	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1
Group 7	2	2	2		1	1	2	2	1	2	1	1	2	2	1		1	1
Group 8	2	2	2	2	3	2	3	2	2	2	2	2	1	1	1	1	2	1
Group 9	2	3	3	2	1,5	2	1	2	1	2	2	1	1	1,5	1	1	1,5	1
Group 10	2		1	2		1	3	1	1	2	2	1	1	2	2	1	1	1
Group 11	2	1,5	1	2,5	3	2	3	3	2	2,5	2	2	1,5	2	2	1	1	1
Group 12	2	3	3	2	2	3	2	2	2	2	2	2	2	1	1	2	2	1
Group 13	1	1	1	2	2	2	2	1	1	2	1	1	1	1	1	1	2	1
Group 14	2	1	2	2	2	2	2	2	2	1	2	1	2	1	2	1	2	2
Group 15	1		1	2		2	2	2	2	1	1	1	1	2	1	1	1	1
Group 16	1	2	1	3	2	3	3	1	1	2	2	1	2	3	2	2	2	2
Group 17	2	3	3	2	2	2		3	2		2		2	2		1	2	2
Group 18	2		2	2		2	2		2	2		1	2		1	2		1
	S-P	S-T	P-T	S-P	S-T	P-T	S-P	S-T	P-T	S-P	S-T	P-T	S-P	S-T	P-T	S-P	S-T	P-T
	7,5	6,5	4,5	5	4,5	4,5	7	9	6	5,5	7	7	7	4,5	6,5	4,5	3	5,5
	0,5357	0,3824	0,3	0,3846	0,2813	0,3	0,5	0,5625	0,375	0,3929	0,4375	0,4375	0,5	0,2813	0,4063	0,3214	0,1875	0,3438

Some students did not understand the tasks given and give themselves a higher score because of misinterpretation; most of them give honest feedback. Task 1 and 2 were scored rather well and most of them gave a score similar to the teacher's marking. The students' skill in using the scientific information was good and also well scored. For assessment of skill in analysing arguments and



providing counter arguments, the analysis shows clearly that the students have no experience with this subject. They give themselves and their peers too high of scores.

The students' skills in justifying arguments and using scientific knowledge are better scored, especially by self-assessment. The teacher and self-scores are close together, but peers give higher scores. It shows that they do not well know how to use the scientific knowledge and justify the arguments and they start using opinions. They know this about themselves, so they give themselves low scores, but the other groups accept the opinion of the other group as scientific fact. This is exactly what people misinterpret in political speeches like Rick Perry's. This point was given in each class as feedback and well received by the group. They realised they should analyse better what was said and learn to separate opinion from fact.

With this particular batch of students there were no further follow-up in the learning as they were at the end of the year and exams were close. However, it should be kept in memory by the teacher and maybe can be used next year together with language teachers, thus enabling students to learn how to read scientific texts.