EDUCATIONAL ACTIVITIES

Multimodality of transport and impact on climate change

> 5th yr primary
> 2nd yr high
> Divisible activity
> Mathematics
> Citizenship

The steps are more like a complex reinvestment situation.
In this sheet, the main skills are listed..

The choice of a means of transport is not always obvious. Several parameters must be taken into account (time, price, pollution). The aim of this activity is to provide students with all the information they need to make an informed choice. They will also have the opportunity to understand that transport produces CO2 and contributes to climate change.

Activity menu

Stage 1 : Highlighting the production of CO2 by engines
Stage 2 : Multimodality and choice of the most appropriate form of transport

Educational objectives

- Understanding the relationship between travel and climate change
- Enabling students to make a choice based on complex criteria

LINKS WITH BELEXPO

Material

Available
- Teacher's sheet
- Students' sheet (1 per student)

To be provided (per group)
- 1 tealight
- 1 jam jar with its lid
- Matches (long) or 1 lighter (long)
- Lime water (sold in chemists or pharmacies)
- 1 straw
- 1 glass of water
-

LINKS TO THE REFERENCE SYSTEMS

- **Mathematics**
- **Cross-curricular skills**
- Resolve, reason and discuss

- Treatment of data
- Interpreting tables, graphs and diagrams

- **Citizenship**

Engaging in social life and democratic space: taking into account local and global interconnections in the environment
Building autonomous and critical thinking:adopting a position in an informed way

Methodology

Introduction

Explain to the students the purpose of the activity (see *Objectives*) and the different stages (see *Menu*)

Stage 1 : Highlighting the production of CO2 by engines

- The teacher asks the pupils about the notion of pollution:
  «Why do we say that a car pollutes?»

Pupils may refer to the smell or colour of exhaust fumes. At this stage, it is important to stress that CO2 is an odourless and invisible gas.
The teacher asks questions about what enables an engine to work.

The concepts of energy, petrol, oil, gas, etc. will be found in the students' answers.

- The teacher invites the students to question the emission of gases when something is burned and provides heat (as in an engine).

Hypothesis 1 : Gases are emitted when a hydrocarbon is burned.

- In order to verify this, the teacher invites the students to carry out an experiment in sub-groups.

Experiment 1

- Place a candle in a jar, light it and close the lid.
- Observe what happens.

=> Rapidly the flame flickers then fades and finally goes out.
Conclusion 1: Something other than oxygen is emitted which is invisible and odourless.

- As a group, ask the pupils about the gas emitted.
- The notion of CO2 will quickly be put forward. It is the same gas that is emitted when we exhale (often called « poor air »).

Hypothesis 2: The gas emitted is CO2.

- To check that the gas emitted contains CO2, the teacher proposes a second experiment.

Experiment 2

- Blow (gently) with a straw into a glass containing limewater. This liquid becomes cloudy in the presence of CO2
- Observe what happens.

=> The CO2 contained in the expelled air turns the water cloudy.
Conclusion: The air contains CO2..

- Pour +- 3cm of limewater in the bottom of a jar, put in the tealight candle (without wetting it) then light it and close the jar with the lid.

=> La flamme de la bougie vacille, puis s'éteint. L'eau de chaude devient laiteuse.
Conclusion 2 : The combustion of a hydrocarbon emits CO2.
This experiment highlights the emission of CO2 during combustion.

To take this further: Some pupils will have noticed a release of smoke.
These are in fact particles that are emitted, but are not CO2.
Another observation: there is mist on the walls of the closed jar. This is because combustion consumes oxygen (O2 in our air) and transforms the chemical energy of a hydrocarbon into heat. This reaction produces CO2 and H2O in gaseous form (water vapour).

Stage 2 : Multimodality and choice of the most suitable forms of transport

2.1. Reviewing modes of transport

Before going any further, it is important that the students understand the principle of multimodality.

- The teacher asks the students about the different types of transport available.
- Either individually or in sub-groups the students list all the forms of transport that they know.

- The replies are collected and noted on the board.

A helping hand with methodology
To go further, or with older students, the teacher can also ask the students to specify the type of energy used by each means of transport found, whether it is polluting or clean and whether it is shared (see teacher's sheet).

During the pooling of information, it is interesting to allow the students to realise that there is not just one way of getting around and that the same place can be reached in different ways.

It is interesting to get students to distinguish between two categories of transport: passenger transport and freight transport. For ease of reference, we advise the teacher to continue working only on passenger transport.

2.2. Analysis of travel to the exhibition

As a group, the pupils review the route taken to get to the exhibition. With the exception of the Ranking column, they complete the Line Journey made (student sheet 1).
To calculate the C02 emissions per pupil, they should use table 2 (teacher's guide: table 2).

2.3. Comparison with other journeys

- In sub-groups, students consider alternative routes using a mapping site (free maps or other applications) which allow them to simulate different journeys and to estimate the various travel times.
- Once they have identified the routes, they complete the table and make the necessary calculations. The table allows them to compare the different possibilities.

Sample chart
In the example above, the preferred means of transport was by bike.
In fact, most of the journey was along a green trail and a bike track.

Journey	Duration	Price / pupil	CO2 emission / pupil	Rank
Bike	20 min	0 €	0 g	1
On foot	1h55	0 €	0 g	5
Private coach	18 min	6 €	142 g	2
Bus + Metro + Walking	43 min	0 €	344 g	4
Tram + Walking	49 min	0 €	215 g	3
Everyone uses a car	18 min	2,60 €	1130 g	6

- Pooling of results and sub-group actions

A helping hand with methodology
Even if the distance is not given in the table on sheet 1, it is necessary to collect this information in order to calculate the CO2 emissions..
This activity can of course be carried out on other outings. The greater the distance, the more interesting the experiment.
In order to lighten the task of the youngest pupils, it may be appropriate to:

- divide the work between the pupils, with each sub-group calculating a simulation (group 1: bus journey, group 2: tram + walk, etc.
- limit the number of simulations. The point is not to consider every possibility, but to see that the mode of travel can have an impact on the environment..

For older students, the teacher can complete the table by asking them to specify the type of energy used by each means of transport, whether it is polluting and whether it is shared (Teacher's guide: table 1).

If different modes of transport are proposed to reach the museum within the same journey, take into account the entire proposal. This will make the task all the more interesting.

For younger pupils, the teacher can identify the various possible routesbe forehand.

In order to reduce the complexity of the task, the teacher can provide the students with public transport fares, the price of petrol, diesel, etc. Otherwise, the students will have to look for the information before doing the calculations.

2.4. Choice of preferred modes of transport

- The teacher will suggest each time that the students vote for a preferred type of transport, according to a proposed criterion (teacher's sheet, table 3).
- For each round, the teacher proposes 1 different criterion. The teacher determines the number of rounds according to the number of criteria he/she wants to deal with. The students are divided into pairs.
- For each round, the teacher writes the distribution of votes on the board.
- After each vote, the pupils are invited to justify and debate their choices.
- When the teacher has proposed all the criteria he/she wishes, the class observes the distribution of votes.
  «Are there routes that have received more votes?
  Do some routes meet several criteria?"
- To conclude, each pair proposes its final ranking (from the route it favours the most to the one it favours the least) and specifies the reasons.

Helping hand
The choice of a means of transport is sometimes based on personal criteria and the choice of one person does not always suit the others. The point is to be able to argue for one's choices by making a connection with what has been experienced during the activity and at the exhibition.

If the pupils focus solely on the duration, it may be useful to ask them what other criteria would be decisive in the case of several journeys of the same duration.

The teacher can propose more complex, «more subjective»; criteria from the outset (e.g. the route that provides the most potential for relaxation) to encourage debate

among the pupils.

TEACHER'S SHEET

Some benchmarks

Table 1

Type	Energy used	CO2 emissions	User
Bike	Mechanical	Clean	Individual
On foot	Mechanical	Clean	Individual
Car	Fossil / Electric	Polluting	Individual / Shared
Bus	Fossil / Electric	Polluting	Shared
Tram	Electric	Polluting	Shared
Metro	Electric	Polluting	Shared
Train	Fossil / Electric	Polluting	Shared
Motorbike / Scooter	Fossil / Electric	Polluting	Individual / Shared
Private coach	Fossil / Electric	Polluting	Shared
Boat	Fossil	Polluting	Shared
Plane	Fossil	Polluting	Shared
Taxi	Fossil / Electric	Polluting	Shared
...	...	...	...

Table 2

The environmental impact can be very different from one mode of transport to another. We saw earlier that all engines emit CO2 and thus contribute to the greenhouse effect (and therefore to climate change).
The teacher can use the table below to compare the environmental impact of the different modes of transport considered..

Type	CO2 / Km / Passenger
Bike / Walking	0 g
Metro	20 g
Tram	30 g
Bus	110 g
Train	26 g
Coach at 50% capacity	32 g
Coach at 100% capacity	16 g
Car (driver only)	190 g
Car shared by 2 people	95 g
Car shared by 4 people	47,5 g

Source : stib.be et Bruxelles-Environnement via : http://www.enquetemobilite.irisnet.be/static/impact_fr.pdf

Further information

For high school teachers:

1 metric ton of CO2 is approximately equivalent to:

- 1 single ticket Brussels / New York by plane for one person (taking into account the CO2 emitted and the impact of other greenhouse gases, including white condensation trails -> H2O).
- 6 one-way flights from Brussels to Lyon for one person (taking into account the CO2 emitted and the impact of other greenhouse gases, including white condensation trails -> H2O).
- Heating one apartment for one year (Source CO2 logic).

One Atomium ball could contain 5 tonnes of pure CO2.
The average Belgian's CO2 emissions are equivalent to the contents of more than 2 Atomium balls each year.
On the scale of Belgium, the equivalent of the contents of 30 million Atomium balls is emitted every year. Imagine 30 million Atomium balls in the sky...

What volume does 1kg of CO2 represent?
1kg of CO2 = 0.51 m³ (i.e. a cube of about 80cm on its side)

Calculation details:
1. Calculate the molar mass of CO2 = 44 g/mol (CO2 = 12 g + 2X16 g = 44 g)
2. Calculate the quantity of substance 1 kg of CO2 = 22.73 mol (1000 g / 44 g/mol)

Molar volume = 22.4 l
(normal temperature and pressure conditions: 0°C and 1 atmosphere)

3. Calculate the volume of 1 kg of CO2 = 22.73 mol × 22.4 L/mol = 509.2 L = 0.51 m³

Table 3 : examples of criteria and voting chart

Criteria	Votes			
	Journey 1	Journey 2	Journey 3	J ...
The journey that would be the quickest	6 pairs		9 pairs	
The journey that would cost the least	2 pairs	3 pairs		10 pairs
The journey that would generate the least CO2				
The journey during which we would be the safest				
The journey that would cause the least congestion in the city				
The journey that would most reduce noise pollution				
The journey that would allow us to relax the most				
...				

STUDENTS' SHEET

Journeys: comparisons

Journey	Duration	Price/student	CO2 emission/ student	Ranking
Journey undertaken				

Other journeys	Duration	Price/student	CO2 emission/ student	Ranking