BRITEC – Bringing Research Into the Classroom

Learning Scenario 3

1. Title

Air Quality

Author(s)

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Area of research

Indoor air quality and building physics

Subject(s)

This is being taught in the framework of the course called ‘Applied Sciences’. The content of the course is meant to provide a basis of scientific knowledge (e.g. biology, physics, chemistry) in function of, and in the context of, the general study area the students are focused on (e.g. students who study ‘wood and building’ will have different content in their courses of Applied Sciences than students who study ‘nursing’ as a general study line. In the course ‘Applied Sciences’ that we are teaching, they have a module called ‘building physics in function of the indoor environment and sustainability’, which focuses on the science (e.g. physics) behind architecture. I (Lore Jespers) have made an agreement with my colleague of mathematics that he will take up this project, or refer to it (as for the mathematical part of it) when he will teach about mathematical concepts that the students needed for this project but aren’t getting until later this year. That will obviously be during within the course “mathematics”.

Part of the module also teaches about our breathing metabolism, in which students assess the amount of CO_2 they breathe out, so it could perfectly fit into biology classes too if you want.

In terms of the corona pandemic it is very relevant too: the amount of CO_2 in the classroom can be used to assess the level of aerosols in the air and hence the risk of spreading any virus.

Age of students

6th grade, which means approximately 17-18 years (or older).

2. Introduction

Contribution of the CS project to Science in general

The building sector represents 40% of the end use of energy in Europe, being the largest energy consuming sector. This means that making buildings more energy efficient has a huge potential to reduce overall energy consumption in Europe and help battle climate change.

In terms of energy efficiency, however, school buildings are far behind the current trend of making buildings more efficient. Yet, they are being used all the time and by many people at once. At the same time, heating up a classroom and not opening te windows (to keep warmth inside the building) results in the fast accumulation of CO_2 (and VOC's: volatile organic compounds) in the indoor air, impacting the health and concentration of both students and teachers. Especially in the context of COVID-19, measuring CO_2-levels in the classroom is important, as it gives a signal of when the air needs to be refreshed to avoid spreading of the disease through aerosols.

School buildings and classrooms are often not accessible for scientists, so combining the educational materials provided by the scientist (Geert Bauwens, KULeuven, Belgium) with the measurements of the air quality (during a minimum of two weeks) creates a win-win situation for both parties. The researcher is investigating the current state (in terms of classroom indoor air quality) of schools in Belgium, in order to be able to give policy advice and provide efficient strategies to improve the air quality in schools.

Aim of the activities plan and learning objectives

Applying mathematical, scientific and technical-technological knowledge;

Collaborative learning,

Learning to collaborate.

Summary of activities

Number of activity	Name of activity
1	Introduction by the teacher, with information about our lungs function.
2	Experiment by the students: qualitative assessment of the amount of CO2 in the classroom air as well as the air people breathe out (test with lime water).
3	Experiment by the students: quantitative assessment of the amount of CO2 in the classroom air as well as the air people breathe out (using a tube, plexiglass box and CO2-sensor).
4	Data processing by calculating the volume balance & mass balance.
5	Monitoring C02 in the classroom during 2 weeks (by use of sensors).
6	Link the method of the volume balance to the values measured by the sensors in class.
7	Analyse the monitored CO2-curve in function of the IDA classes.
8	Check the ventilation flow by iteration (in Excel).
9	Calculate the ventilation rate.

3. Detailed description of each activity (to be completed as many times as activities are implemented)

First Part: Aim of the activity

Students learn to understand where CO2 originates from. Not just “from the lungs” but through specific processes in the cells (mitochondria).

Students get more aware of the fact that there is a lot of CO2 in the air they breathe out.

Students start working on hands-on tasks. They have to collaborate, and they witness the differences between different measurements.

Students need mathematical and scientific knowledge they acquired in the past school years, in order to get to a sound conclusion/result for the project.

The monitoring increases the level of engagement of both the students and other teachers in the school. What happens when I open or close the door? What is the impact of opening less or more windows?

In this task we estimate the levels of CO2 in the classroom in a theoretical manner. We subsequently compare these values with the real measurements. Students can reflect on the reasons why there’s differences between those values.

By studying the graphs we can estimate the level at which we surpass the treshold of "good air quality". By recording our actions in the class (like opening doors, windows, estimating the amount of students that are present in class, etc.) we can assess the different potential actions to take (at minimum) when CO2 levels are rising and air quality needs to be improved.

Mathematics is being applied here. Students try to derive the ventilation flow from calculations they make by iteration.

Once the ventilation flow is known, students can calculate the value of the ventilation rate (a factor often used in building works) (this links with the course "building").

Second Part: Suggested procedure

Preparation time	Students don't need to prepare anything beforehand.
Teaching time	First half hour: explaining how the lungs work.
Online teaching material	I used MS OneDrive to share a Word-document with my students, which they could work on or fill in. It was a pity though that the figures which I had included in the Word-file did not show clearly when they wanted to work on the document. Possibly because I extracted them from the PDF provided by the scientist, and something may have gone wrong in the conversion process.
Offline teaching material	Computers for editing their reports. A little pot with tubes and lime water (provided by the researcher) Cylinders and box with sensor (provided by the researcher) CO2- loggers (provided by the researcher) Folding rulers (to measure the dimensions of the classroom)
Citizen science purpose of the activity (if any) *	To measure the amount of CO2 in the classroom during 14 consecutive days, as to assess the current state of the air quality in Belgian schools. It is recommended to keep a diary of your activities in the class: when did you open the door and for how long? How many pupils were present in the class at any given time? When did you open the windows? This is good to compare with the CO2-measurements done by the sensors. .
*** Guidance for teachers**	See part 2: 'contribution of the CS project to Science in general'.

Third Part: Advice on methodology

The students were asked to do the reporting of the project in small groups, but the experiments were carried out with the whole group all together (it was a rather small class, though).

I spent four times two hours (in class) on this project (including introducing the students to the project, having an online lesson from the researcher, and filling in the online questionnaires for Britec, as well as carrying out the experiments).

If you have enough time, it could be interesting to spend more time on the experiments in class. We measured and calculated the amount of CO2 in the air breathed out by two students, but the results were very different. We did not have the time to repeat the experiment with more students though, so this impeded us to check why exactly the values of those two students were so different. I would advise to reserve more time for repetition of the experiment(s) so you can to a proper assessment of the situation together with your students.

Fourth Part: Educational analysis

Mainly: project-based learning (which is interdisciplinary), but also collaborative learning, and STEM of course.

4. Assessment after implementation of the activities plan

Student´s learning

The students have to write a report of the results and calculations. A template was foreseen for them, so they didn’t have to start from scratch but rather had to fill in the prepared template.

It might perhaps be nicer to give the students a bit more freedom with regards to the reporting phase, only providing them with a few starting points in order to let them work on it more independently. (This could be done in a context where teachers have more available time together with their students). Nevertheless, I do consider the idea of letting the students write (or fill in) a report is an excellent way to evaluate them.

You could give them some basic questions which they need to answer (e.g. ‘Introduction: what are the scientific questions we wanted to resolve with our experiments?’, ‘what is the relevance for society?’, ‘What is the relevance for science?’) or a general structure for their report (consisting of: an introduction, a description of the methods, a description of the results of the experiments, and a discussion on what these results mean (‘interpretation & discussion’) followed by a final conclusion or recommendation and summary.

Citizen Science experience

The scientist has been teaching one hour to the students directly. He explained them about his research on air quality and building physics, and about the experiments they would be going to do. The teaching did not run super smooth, because of technical reasons: it was held online because of Covid-restrictions, and some of our pupils did not bring earphones, resulting in a one-directional conversation, so there was not a lot of interaction or Q&A. A live lesson would have been more interesting.

It is important to engage the students as much as possible:

- What helped was to share the link to the online platform where they could see the CO2 values/monitoring, not only with the students, but also with other teachers in school.
- Give the students some time in advance to prepare questions to ask the researcher, it helps to increase their level of involvement.

License

About the BRITEC project

BRITEC – Bringing Research into the Classroom project (https://britec.igf.edu.pl/) aims to introduce the Citizen Science (CS) approach in schools as a way of engaging pupils in research practices. This project has been funded with support from the European Commission within ERASMUS+ Programme and is coordinated by the Institute of Geophysics, Polish Academy of Sciences