BRITEC – Bringing Research Into the Classroom

Learning Scenario

1. Title

In Dutch: Impact van verkeersgeluid op de mens "Bouw een eigen hinderfunctie"
In English: Impact of traffic noise on people "Build your own disruption function"

Author(s)

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Area of research

The impact of traffic noise on humans

Building physics: impact of building type (classical building or 'passive building') on noise transmission in our classrooms.

Subject(s)

Industrial Science, Physics, Biology, Geography and Mathematics in an interdisciplinary approach.

Topic

The impact of traffic noise on humans

Building physics: impact of building type (classical building or 'passive building') on noise transmission in our classrooms

Age of students

16 to 18 years

Students of the field of study IW, classes 5IW and 6IW (IW = Industrial Science)

2. Introduction

Contribution of the CS project to Science in general

Traffic doesn't only impact our health through air pollution, but also through ambient noise. Globally, more attention is given to air pollution, but with the Belgian BRITEC-topic of „Sound measurements in relation to mobility" our students are helping the researcher to measure noise pollution in locations where our country has no monitoring yet, which is mainly on local roads.

In this project the students make a full environmental impact study and go through the full DPSIR scheme ('driving forces', 'pressure', 'state', 'impact', 'response'). Their measurements and countings will ultimately help to improve the mathematical models that are used to make Flanders 'noise map' on a high spatial resolution.

Note: What is described above is carried out by our students of 5IW and 6IW.
There is also one student of 6IW who will carry out research on the transmission of sound within the building. This was not proposed by the scientist, but he did agree for us to use the sensors and to help us in case we have questions. As part of the individual research the student has to do for his '*integrated task*' (an assessment/thesis each student has to make in their final year at school), he is using the BRITEC sensors to measure noise levels in four classrooms at school. During one full week, he will measure noise levels in two classrooms on the ground floor, of which one is located in the old building (traditionally built, without isolation) and one in the school's newest building (passive building). During the second week, he will repeat these measurements in classrooms on the first floor of these two buildings. For the practical part of his integrated task, the student will program two new sensors in Arduino and construct a suitable housing for them. He will then conduct measurements and analyse the results by comparing them with the results from the sensors provided by BRITEC.

Aim of the activities plan and learning objectives

Prerequired knowledge: for the correct interpretation of all the noise measurements the students must construct a disruption function. Therefore, the students need to **program in Excel** and need **logarithms** to come to decibels.

Students specifically learn about all the steps in an Environmental Impact Study, using the DPSIR-scheme (('driving forces', 'pressure', 'state', 'impact', 'response'). They acquire the general 'research investigation skills' they need to get by our Government.

Detailed learning outcomes:

Driving forces: Students learn about 'noise': what is it? (physics: waves) how is it measured? What is a decibel?

Pressure: Students learn where to find official surveys and information from the government and from scientists. They check for coordinates of their homes and learn to convert them from GPS to local coordinates (and the other way around). They fill in the survey and get more aware of the relationship between noise and their own feeling of wellbeing, and about the difference in experienced arousal depending on the source or type of the sound.

They do countings of traffic in front of their houses and learn how to transfer and integrate their answers into excel.

State: students learn about sensor measurements and they learn to read values from maps (noise maps). They compare their traffic countings with the noise levels deduced from noise maps, and make graphs in Excel. They learn to apply trend analyses and try to explain the difference between the countings and the noise levels as deduced from the noise maps. They learn to calculate 'weighted averages' as they summarize their countings into one single number as a proxy for the countings (called 'weighted traffic', in which a bycicle counts for less than a truck for example).

Impact: students learn what a disruption function is and how it is constructed. They learn to analyse the data from the sensors, in Excel (e.g., min, max, count, log) and learn different functions and cell formats in Excel.

Response: students learn to think about possible measures one can take to reduce not only the noise levels but more importantly the disturbance by noise. They learn that measures can be taken at a remediating (often local) level, or can be taken at the root or cause of the problem. They get to know the complexity of environmental problems.

Summary of activities

Number of activity	Name of activity
1	Survey
2	Traffic counts
3	Measurement of noise exposure at student's homes
4	Interpretation of noise measurements
5	Finding additional information from noise maps

6	Constructing a disruption function
7	Formulating possible measures to reduce exposure

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

First Part: Aim of the activity

In this project the students make a full environmental impact study and go through the full DPSIR scheme ('driving forces', 'pressure', 'state', 'impact', 'response'). Their measurements and countings will ultimately help to improve the mathematical models that are used to make Flanders 'noise map' on a high spatial resolution.

***Driving forces*:** the need of transport and displacements for our humans in the context of social activities is the main driving force of the noise pollution.

***Pressure*:**

- [activity 1] Start completing a survey: the scientist (Dr. Luc Dekoninck) extracted relevant noise-related questions from the Standard Environmental Survey ('Standaard LeefomgevingsOnderzoek') that the Flemish Government applies once every five years among its citizens. You can find the questions in the Annex of this report (p. 159-166). The document is in Flemish.
- [activity 2] Carrying out traffic counts: in front of student's home, in an industrial area and in front of our school. This happens twice a day during rush hour, for the duration of one hour each.

***State*:**

- [activity 3] Measurement of noise exposure by use of a noise sensor placed at student's homes, in the industrial area of Londerzeel and at our school. We are placing four noise sensors at varying distances (1m, 100m, 200m, 300m) from a busy highway near the industrial zone of Londerzeel.
- [activity 4] Interpretation of the noise measurements (both the measurements we obtained from the sensors, as well as the measurements or noise levels we deduced from existing noise maps of Flanders).
- [activity 5] Finding additional information from noise maps.

Impact:

- [activity 6] In order to assess the impact of the noise on us as humans, we construct a 'disruption function' (based on the noise map, the traffic counts and the survey).

A disruption function is a graph of the percentage of people indicating they are hindered by a certain degree of noise. This graph will look different for different types of noise (e.g. the sound of a train may cause more/less arousal in people than the sound of a car with the same level of decibels). The disruption function will thus show the amount of people indicating they are strongly disturbed by the noise, at each dB-level.

Response:

- [activity 7] List of possible measures to reduce exposure in/around the home, in the industrial area at Londerzeel and at our school.
- Discussion and awareness rising.

Second Part: Suggested procedure

Survey (1) + traffic counts (2)

Preparation time	1 h
Teaching time	1/2 h
Online teaching material	None Some extra background information added by the scientist for the purpose of the European MOOC: Fields et al. 2001: Standardizd general-purpose noise reaction questions for community noise surveys: research and recommendations. DOI: 10.1006/jsvi.2000.3384 Jeon et al. 2008. Community annoyance from road traffic noise and construction noise in urban spaces. http://www.icben.org/2008/PDFs/Jeon_et_al.pdf Interesting extra information for The Netherlands: Onderzoek Beleving Woonomgeving (OBW) 2019 (cbs.nl)
Offline teaching material	All the documents are made by the very enthusiastic researcher (Dr. Luc Dekoninck) and adapted to our school by teacher Wim Van Buggenhout.
Citizen science purpose of the activity (if any) *	I only mention the purpose of the citizen science project. The survey and traffic counts are meant as a preparation for constructing the disruption function.

* Guidance for teachers	Traffic counts: during the morning- and evening rush hour students count every person, biker, car or truck or other device that passes their home. They do this in a simple excel spreadsheet. The spreadsheet for counting traffic contains a column for each type of traffic (e.g. walker, biker, car, truck, bus) that passes by. In each row you can fill in the date and hour during which the respective counting was done. From there, you can calculated a weighted average of the countings (with walkers and bikes having a 'lower weight' [or importance] than trucks and busses).

Measurement of noise exposure at students' homes (3)

Preparation time	1 h
Teaching time	1/2 h
Online teaching material	The measurements made by the sensors are made available to us by the scientists at http://ssmdb.intec.ugent.be:8080/node/status
Offline teaching material	All the documents are made by the very enthusiastic researcher (Dr. Luc Dekoninck) and adapted to our school by teacher Wim Van Buggenhout. Noise sensor
Citizen science purpose of the activity (if any) *	This activity is also a preparatory activity in order to construct the disruption function. For the researcher it is also important to have more data on noise measurements at location where our country is not measuring at the moment. Procedure Activity 3: students only have to install the noise-sensor at their home. The data are transmitted automatically and we get them in Excel, provided by the researcher.

Interpretation of noise measurements (4) + Finding additional information from noise maps (5) + Constructing a disruption function (6) + Formulating possible measures to reduce exposure (7)

Preparation time	4 h

Teaching time	16 h
Online teaching material	Different kinds of websites regarding the subject.
Offline teaching material	All the documents are made by the very enthusiastic researcher and adapted to our school by teacher Wim Van Buggenhout.
Citizen science purpose of the activity (if any) *	I mentioned the citizen science purpose: for the researcher is important to have more data on noise measurements at location where our country is not measuring at the moment. Procedure Activity 5: Finding additional information from noise maps: we can find this on the internet or get it from the researcher. For Belgium: https://omgeving.vlaanderen.be/geluidsbelastingkaarten and http://www.geopunt.be/search?facet=all&q=geluid For European noise related information you can check https://noise.eea.europa.eu/ or https://www.eea.europa.eu/themes/human/noise/browse-products/data-and-maps and https://www.eea.europa.eu/data-and-maps/data/data-on-noise-exposure-7 The Netherlands: Onderzoek Beleving Woonomgeving (OBW) 2019 (cbs.nl) Procedure Activity 6: For the correct interpretation of all the noise measurements the students must draw a disruption function.
*** Guidance for teachers**	For Activity 6: For the correct interpretation of all the noise measurements the students must draw a disruption function. For this, the students need to program in Excel and need logarithms to come to decibels. They need knowledge of mathematics and physices to realise this.

Third Part: Advice on methodology

Every document, photo, information in the Excel-files must have a specific filename or system of filenames that you use consistently. That is very important. E.g. for pictures of the installed sensors: Photo_NodeID_4_p1.jpg (= picture 1 of sensor 4). For the traffic

countings you can ask every student to name their files Trafficcounting_Schoolname_Studentname.xlsx.

Fourth Part: Educational analysis

Project-Based Learning
Collaborative Learning
Flipped Classroom (see https://facultyinnovate.utexas.edu/sites/default/files/utflipquickstartguide120516-2.pdf)
Student Centred Learning
STEM Learning
Outdoor Education
Peer Learning
Personal Learning Environment
Cloud Based Learning
Visual Search & Learning
Mobile Learning
Augmented Reality
Learning materials

4. Assessment after implementation of the activities plan

Student´s learning

The students had to write a report (in MS Word) of the online lesson which was evaluated.

For the activities undertaken at home we evaluate the document that is sent via the school platform our school uses (called Smartschool).

The construction of the disruption function and its interpretation must be done at school, so that the teacher operates as coach/mediator. We evaluate the students permanently during this work at school.

Students do also peer- and self-evaluation.

Citizen Science experience

My apologies for not naming them, because there were too many (small) problems to mention, however they all got solved though. One part of the problems was related to technical issues, because I was the very first teacher to test the education and measurement activities and hence some small bugs needed to get worked out of the setup. We've provided feedback to the scientist and jointly worked our way around those bugs. The activities are now perfect for other teachers.

5. Bibliography

Own work.

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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.