



freeland

Promoting STEAM through participatory urban regeneration

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Laboratory

Noise Detectives

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FREELAND laboratories follow the structure of Inquiry Based Learning, in 5 steps (orientation, conceptualization, investigation, conclusion and discussion), and for each step we suggest activities and methodological approaches that are engaging for the students such as brainstorming, hands-on, creative works. The activities described in the laboratory are suggestions that teachers can adapt or replace with similar activities suitable to students' age and school type.

The a	Noise Detectives
Duration:	2,5 hours outdoors & 2.5 - 3,5 hours indoors
Tools:	Worksheet to print, Pen and notes
Technologies:	Mobile phones for photos, audios and videos, app sound meter, laptop and software for creating presentations and videos
Subjects:	Science (Physics), Mathematics, Civic education, ICT, social science
Students' age	Any
School type	Any
Disciplinary contents:	<p>This laboratory focuses on indoor and outdoor noise pollution in an urban area.</p> <p>Sound is present at every moment of our lives and in every space we inhabit. Sounds can be natural, like the singing of birds, or artificial, like the roar of a car engine driving down the road or the noise from a construction site building a structure. The latter are referred to as noise. Noise is defined as a random or irregular sound, often characterized by a lack of harmonic structure, that may interfere with the perception of other sounds. When noise reaches certain intensity levels that can harm humans, we speak of noise pollution.</p> <p>For instance, prolonged exposure to loud noise can damage the inner ear, leading to temporary or permanent hearing loss and night-time noise (e.g. from traffic) can induce sleep disturbances.</p>

	This laboratory includes a series of educational and practical activities aimed at raising students' awareness about the noise around us and its causes, at measuring the effective level of noise and proposing solutions to improve the quality of a selected area
Learning objectives:	<p>Students will be able to</p> <ul style="list-style-type: none"> ● quantify qualitatively and quantitatively level of noise pollution using their senses and digital tools ● analyse and compare collected data ● present the results of their activities through video and/or presentation ● reflect on the impact of our daily activities and habits on the quality of a living space in relation to noise ● discuss scientific results and make relationships between diverse disciplines, in connection to noise pollution

For each phase of the IBL we provide a description of the suggested activities.

Orientation

Duration:	15 minutes outdoors or indoors
Tools:	No specific tools
Technologies:	No
Subjects:	Science (Physics), Civic education
Method:	Brainstorming

The teacher takes the students indoors (in corridors, in classroom, bar) or outdoors (in front of the school, in the schoolyard, in a neglected built space or in a park) and ask them: to close their eyes and listen to the sounds: they can hear:

“What sounds can you hear? Are they pleasant or disturbing?”

“Can you identify the source of each of them? Are they generated by natural phenomena or by human activities?”

“According to you, which can be classified as noise?”

Students should recall their prior knowledge and express their own opinion to answer questions, and the teacher should introduce the definition of noise.

Conceptualization

This phase concerns the creation of the question/s to be answered by an investigation.

Duration:	15 minutes outdoors or indoors
Tools:	No specific tools
Technologies:	No
Subjects:	Science (Physics), Civic education
Method:	Brainstorming

Following orientation, the teacher introduces the concept of noise and noise pollution.

Noise is defined as a random or irregular sound, often characterized by a lack of harmonic structure, that may interfere with the perception of other sounds

Noise pollution is the presence of excessive or disturbing sounds in the environment that can negatively affect human health, wildlife, and the overall quality of life. These unwanted sounds are typically caused by human activities such as traffic, industrial operations, construction, and loud music.)”.

“What types and levels of noise are present in this place?”

What are the sources of this noise?

Are they dangerous for human health?

Investigation

The investigation includes hands-on activities to answer the question posed in the Conceptualization *“What types and levels of noise are present in this place?”*

Duration:	30 minutes indoors, 2: hours outdoors
Tools:	For each group <ul style="list-style-type: none"> • pens • worksheet “Noise detection” (see appendix)
Technologies:	Mobile phone to take pictures, videos and record sounds, app for measuring sound/noise intensity (e.g soundmeter)
Subjects:	Science (Physics), Civic education, ICT
Method:	Hands-on laboratories

Planning and performing the activity

Notes: Teachers should make a field visit to the area with the students before starting the activity in order to select one or more points to monitor in the selected place (indoor the school and/or the neglected place). They can choose spots to be investigated taking into account characteristics like distance from sources of noise or places where persons use to meet or stay.

In order to answer the question, students will use two methods to measure noise pollution:

1. *personal perception of level of noise using a five grade likert scale: 1 (very quiet), 2 (comfortable), 3 (annoying), 4 (loud), 5 (very loud).*
2. quantitatively using an app (e.g. soundmeter). Acoustic sounds and noise are measured in dB, a unit of measure in logarithmic scale. Find the proportion between dB and how many times is the intensity of noise compared to the threshold of human hearing (TOH) in the “conversion table” in the Appendix.

Each student or group will measure the level of noise in each spot applying both methods. Firstly, they should describe the type of sounds that can be heard in each place and the source and if the sounds are pleasant or disturbing and record all the data in the worksheet. Then students close their eyes and assign a score to the noise according to the proposed likert scale, measure the level of sound with the app and record all the information on the worksheet. They can also record sounds and make videos using their mobile phone.

Suggestion for the teacher: If the study area is within walking distance of the school and along a safe route, the teacher can plan for measurements to be taken during the school day. Groups of students can go to the area in turn during breaks (e.g., 9:00, 10:00, ...) and take measurements in the same location using the form provided in the appendix.

Note for the teacher: The same sound can be measured with both methods and recorded by more than one student. These data can be used to do statistics on the variability of evaluation due to student perception (1 method) and variability linked to the sensitivity of the app for different smartphones (2 method).

Print the worksheets (Appendix) (one per group) to carry out the different laboratories and activities

Conclusion

This phase concerns the analysis of the qualitative and quantitative data gathered in the investigation.

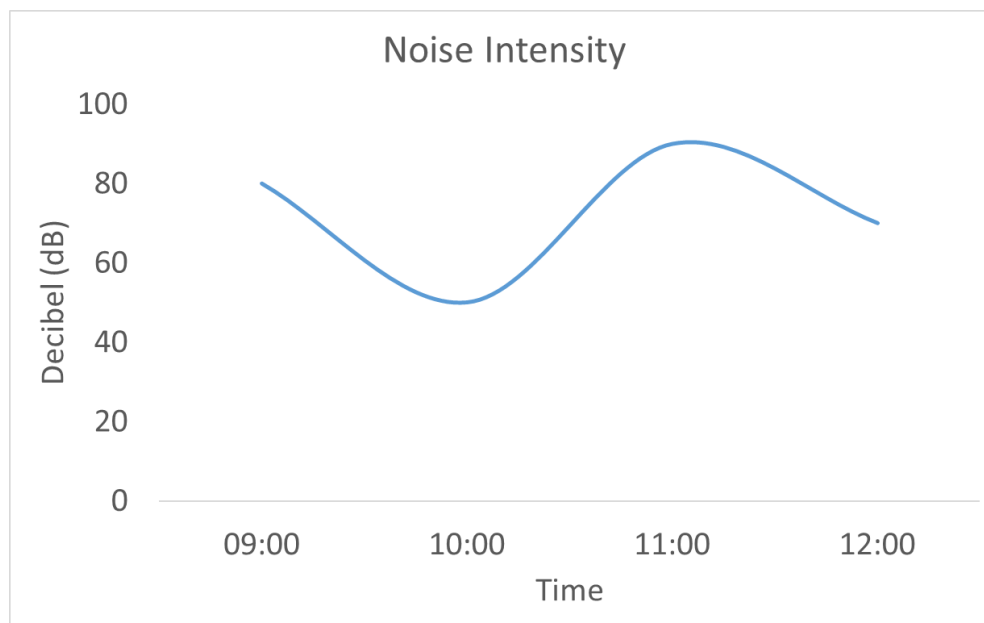
Duration:	1-2 hours
Tools:	Pencils and notes
Technologies:	PC or notebook
Subjects:	Physics, Civic education, Art, Mathematics, ICT
Method:	Report and analysis of the observations Mapping noise Draws of student's ideas of improvements/design projects

In Science and mathematics students gather all the results obtained from the investigations. They can arrange collected data for graph analysis in the platform

using the collected data. For the analysis, data on paper should be stored in a table (as in the figure) of a spreadsheet or csv file format.

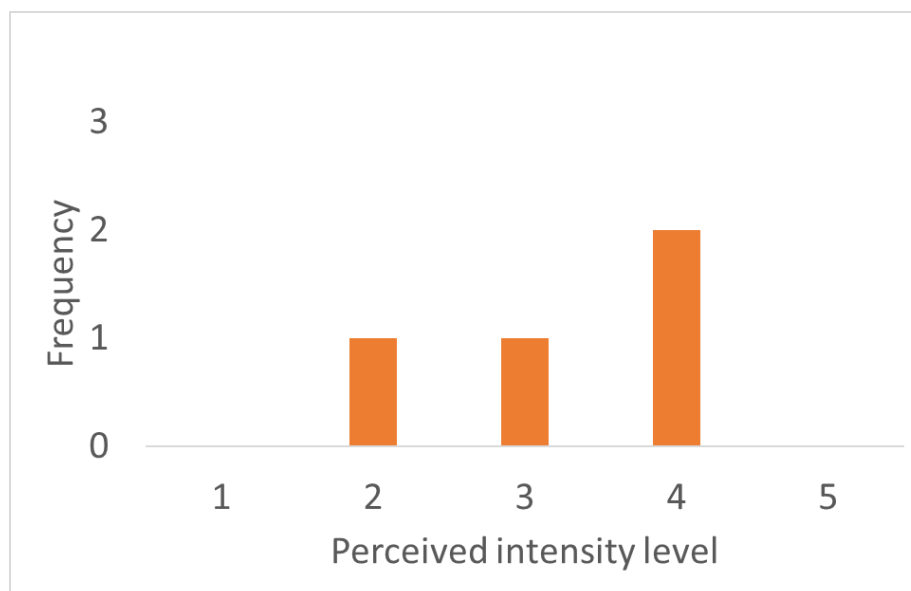
Time	Description	Source	Pleasance (Yes/No)	Perceived Intensity (from 1 to 5)	Noise Intensity (Decibel)
09:00	<i>The roar of traffic</i>	<i>Cars</i>	No	4	80
10:00	People talking	Persons	Yes	2	50
11:00	Heavy traffic	Trucks	No	4	90
12:00	<i>The roar of traffic</i>	<i>Cars</i>	No	3	70

For this laboratory we suggest to present data with a linear plot of the Noise Intensity vs Time (orange columns in the table). Here an example based on this data. This plot shows hourly variation of noise in the place.



Another optional way to present data is using histograms to present frequency of different perceived intensity of noise. In this case, students should calculate the frequency of each perceived intensity through the campaign (for instance in the example 1 and 5 levels were never scored, 2 and 3 levels were scored once and 4 level was scored twice. With this data you create the table in spreadsheet or csv format to be uploaded in the platform.

Perceived Intensity level (from 1 to 5)	Frequency
1	
2	1
3	1
4	2
5	



Histogram of perceived intensity resulting from frequency table

Tips for optional activity. They can also map the level of noise and highlight the quietest and the noisiest places. In this case they should also record the coordinates of the location using a gps device or the smartphone, or even at school finding the location in google map and displaying the coordinates of the place. They can produce a map of potential damage to human health using the “Recommended Exposure Limits figure” in the Appendix.

Discussion

In this phase students reflect on the findings. They are able to answer the original question and reflect on it.

Duration:	1 hour indoors
Tools:	Pen/notes/Powerpoint
Technologies:	PC
Subjects:	Civic Education, Art, ICT
Method:	Brainstorming, group work

Circle time or brainstorming can be useful to involve the students in the discussion phase which will finally answer the initial question. Based on the results obtained by the analysis of the data, each student will be able to tell which are the spots that are more affected by noise and can think / propose ways to reduce noise pollution to be implemented in the 3D modeling platform.

Students should be able to exactly indicate what they would like to add or change in the area and present their design projects or sketches of ideas, or verbal description for the 3D modeling platform. They can also link their proposal to Art. For instance, they can produce art objects or drawings inspired by the least or the most noisy places in the area and place them in those places to raise awareness of citizens and make those places more attractive. For instance, the “One Square Inch of Silence” environmental project (<https://onesquareinch.org/>) proposes to put a small red stone in a quiet spot in the Olympic National Park (USA), that acts as a small monument, symbolizing the need to preserve acoustic balance in its surroundings. Similarly students can mark noisy or quiet spots in the selected area with initiative similar to this project.



Outcomes:

- 3D visualization of the project (one student group will recreate the place virtually with the support of the [Platform](#)).
- Report or presentation or video, that can be evaluated by teachers following the school's evaluation grid.

Additional reading materials:

- Understand Noise Exposure:
<https://www.cdc.gov/niosh/noise/prevent/understand.html>

Appendix:

1. Worksheet: Noise detection
2. Table: Conversion from decibel (dB) to times of threshold of hearing (TOH)
3. Recommended Exposure Limits, Guideline from the National Institute for Occupational Safety and Health (NIOSH)

1. Worksheet: Noise detection

Group name: *Urban explorers*

School name: *Lyceum Copernico*

Country: *Italy*

Date: *20/11/2025*

Location: *Prato*

Description of the place: *small green area with concrete and grass surfaces, some trees and benches near a main street*

Time	Description	Source	Pleasance (Yes/No)	Perceived Intensity (from 1 to 5)	Noise Intensity (Decibel)
09:00	<i>The roar of traffic</i>	<i>Cars</i>	<i>No</i>	<i>4</i>	<i>80</i>
10:00	People talking	Persons	Yes	2	50
11:00	Heavy traffic	Trucks	No	4	90
12:00	<i>The roar of traffic</i>	<i>Cars</i>	No	3	70



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Fill in the table following this procedure:

fill the information in the table:

- **Group student name:** indicate the name of the group that makes the measurements
- **School name:** name of the school
- **Country:** country of the school
- **Date:** of the observation
- **Location:** name of the place
- **Description:** provide a brief description of the area:

For each fill a row with:

Hear and identify a type of noise/sound

- **Time:** hour of the measurement
- **Description:** provide a brief description of the sound/noise you hear
- **Source:** indicate the source of the sound/noise
- **Pleasance:** indicate if it is pleasant (Y) or disturbing (N)
- **Perceived intensity:** close your eyes and assigns an intensity to the sound/noise with a likert scale:: 1 (very quiet), 2 (comfortable), 3 (annoying), 4 (loud), 5 (very loud)
- **Intensity:** write the level of sound/noise in decibel measured by sound meter app.

2. Table: Conversion from decibel (dB) to times of threshold of hearing (TOH)

Decibel (dB)	Noise intensity vs TOH (Times of threshold of hearing)
0	1
10	10
20	100
50	10 ⁵
100	10 ¹⁰

3. Recommended Exposure Limits, Guideline from the National Institute for Occupational Safety and Health (NIOSH)

Exposure Level per NIOSH REL

