NATURE-BASED SOLUTIONS LEARNING SCENARIO

A Green School is a Healthy School

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A Green School is a Healthy School

Anna Koc

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ABSTRACT

The main goal of this learning scenario is to help students realize that the school environment, where they spend a lot of time, is very important for their health, well-being, concentration and studying efficiency. The aim is also to help students become more conscious about the natural environment's impact on their health. To do so, the first action would be to measure certain air-quality parameters at school. A brainstorming activity will then take place. The students will discuss how to improve air quality at school and then further debate on how they could make school spaces greener. If needed, they could set up a green-wall concept for their school, and eventually build it.

Keywords

Air-quality improvement, Public Health, CO_2 sensor, CO_2 Measurements, nature-based solutions, Green Walls

1. Introduction

> *"Nature-based solutions (NBS) are solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes, and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services."*
> https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en

To use this Learning Scenario more effectively, teachers are encouraged to:
- Check out the list of recent EU publications on Nature-Based solutions
- Read about Nature-based solutions: Transforming cities, enhancing well-being (also available as a PDF)
- Contact local NBS practitioners or scientists working in their area (they can be found through Oppla).
- Use the "Ask Oppla" service to request help in case of any technical/scientific question on NBS.

2. Overview

Overview	
Subject	Chemistry, Natural Sciences, Science, Biology, Guidance lessons, ICT[1]
NBS topic	Public health, well-being, and air quality
Recommended age of students	15-19 years old
Preparation time	1h – 10 hrs depending on the chosen activities
Teaching time	5 lessons (45 min): Introducing NBS CO_2 sensor construction (optional if the school has no sensor yet) CO_2 measurement How to make our school greener?

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[1] This LS lends itself very easily to the possibility of collaboration between teachers and subjects.

Overview	
	Action resulting from the discussion "How to make our school greener?" – transforming a yard from concrete to lawn
Online teaching material	Lesson 1: Example scientific papers: • WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide • The impact of green space on heat and air pollution in urban communities: A meta-narrative systematic review • Phyto-sensor • Planting Healthy Air Interactive questions: https://www.menti.com/ Creating a mind map: https://www.mindmup.com/ or https://www.xmind.net/zen/ Lesson 2: How to build a CO_2 sensor: https://www.hackair.eu/tutorials/ or http://luftdaten.org.pl/index.php/instrukcja/ Lesson 5: How to create green wall (Polish): https://ogrodosfera.pl/blog/jak-zbudowac-ogrod-wertykalny https://www.sempergreen.com/pl/rozwiazania/zielone-sciany/korzysci-jakie-daja-zielone-sciany http://hadart.pl/oferta/zielone-sciany/ https://zielone-sciany.pl/ https://homelook.pl/wertykalny-ogrod/ How to create a green wall (English) https://www.archdaily.com/882285/how-to-build-a-diy-vertical-garden https://www.youtube.com/watch?v=0-0Vk1WVH_k https://pdfs.semanticscholar.org/ee06/8d428e93f40459c9512eeadae8341ee52246.pdf https://www.gardenersworld.com/how-to/diy/how-to-create-a-living-wall/ https://www.hgtv.ca/diy/photos/diy-how-to-make-your-own-living-wall-1927688/#currentSlide=4 https://balconygardenweb.com/diy-indoor-plant-wall-projects-living-wall-ideas/ HackAir (https://hackair.eu) can also be used for rough measurements of air pollution for less experienced teachers regarding ICT and younger students.
Offline teaching material	Papers, markers
NBS resources used	https://connectingnature.eu/ https://www.hindawi.com/journals/usr/2015/137027/ https://www.gla.ac.uk/myglasgow/news/campus/headline_602002_en.html https://oppla.eu/casestudy/18430 https://oppla.eu/casestudy/19448 https://urbannext.net/aime-cesaire-primary-school/ https://portals.iucn.org/library/node/46191

Overview	
	https://www.researchgate.net/publication/318204825_Urban_natural_environments_as_nature-based_solutions_for_improved_public_health_-_A_systematic_review_of_reviews https://www.co2meter.com/ CLEVER Cities: https://clevercities.eu/ Other useful resources: For effective usage of these resources' teachers need to be well prepared and have an overall understanding of NBS. In order to become more knowledgeable and understand NBS, I recommend using these resources https://naturvation.eu/, and https://naturvation.eu/learn Some useful links: For NBS introduction https://www.nature-basedsolutions.com/ https://www.naturebasedsolutionsinitiative.org/what-are-nature-based-solutions/ List of indoor plants https://www.co2meter.com/blogs/news/782922-nasa-compiles-list-of-best-plants-to-clean-indoor-air 770https://www.matec-conferences.org/articles/matecconf/pdf/2017/17/matecconf_iscee2017_05004.pdf

3. Integration into the curriculum

Chemistry

- The student describes the properties of carbon (IV) oxide.

Science

- Biological aspects of health;
- Internal and external factors affecting health;
- Observation and experiments in chemistry and biology.

Biology

- The student conducts and documents biological observations and experiments;
- The student understands the importance of protecting nature and the environment and knows and understands the principles of sustainable development;
- The student presents a respectful attitude toward themselves, all living beings and the environment;
- The student is able to describe attitudes and behaviours of humans who responsibly use natural and environmental assets.

4. Aim of the lesson

- Provide general knowledge about NBS
- Implement ideas on how to improve school atmosphere
- Plan the changes in school life and atmosphere – "How to make our school greener?"

5. Outcome of the lesson

- Understand what NBS means
- Elaborated discussion and findings via presentations and teamwork on how to make the school greener.

6. Trends

- Student-Centred Learning: students and their needs are at the centre of the learning process.
- Learning materials: shift from textbooks to web resources and open source books.
- STEM Learning: increased focus on Science, Technology, Engineering, Mathematics subjects in the curriculum.
- Project-Based Learning: students receive fact-based tasks, problems to solve and they work in groups.
- Collaborative Learning: a strong focus on group work.
- Assessment: the focus of assessments is shifting from "what you know" to "what you can do."

7. 21st century skills

- Information Literacy – reading a scientific paper and selecting the most important information.
- Collaboration – working in the groups, creating mind maps.
- ICT (Information, Communications, and Technology) Literacy – creating a self-made CO_2 sensor.
- Communication – discussions with other students.
- Critical Thinking and Problem Solving – looking for a solution to the problem.
- Flexibility and Adaptation – finding a solution that will be possible to adapt at school, for example with small budget.
- Creativity and Innovation – doing green walls inside of school buildings.

8. Activities

Name of activity	Procedure	Time
	Lesson 1	
Group work	The class is divided into groups of 4 students. Each group receives a scientific paper or some additional materials. Students should list ideas based on the guiding questions they receive with the scientific paper. They then can exchange information and brainstorm on how they could initiate change in local habits and culture. Two of the papers focus on the impact of air pollution in health and the other two on the possibilities of NBS to tackle air pollution. Paper 1: WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide Guiding questions: • What are the most dangerous for our health air pollutants? • What health impact do those pollutants have on our health? Paper 2: The impact of green space on heat and air pollution in urban communities: A meta-narrative systematic review (focus on 'Background: heat, air quality, green space and health' p. 7-10 and on 'Green Buildings overview' p. 17- 18) Guiding questions: • Present in the class some data that explain the connection between the rise of temperature and mortality rates. • What pollutants participate in this phenomenon? • What impact can green buildings have for air pollution? Paper 3: Phyto-sensor (focus on "Planting Scenarios" p. 67 and on "Resources" p.72) Guiding questions: • What are the main scenarios you, as students, can implement to improve the air quality of your school?	15 min

Name of activity	Procedure	Time
	• Propose some plants that could reduce air pollutants. Take into account your region's climate, the care those plants need and the space you have at your disposal. Paper 4: Planting Healthy Air (focus on p.21-23) Guiding questions: • What are the benefits of Nature based Solutions? • What needs to be taken into account when in the process of creating green spaces?	
Discussion and Mind map	Discussion of all groups started using Mentimeter – "What does NBS mean to you?" Discussion on mind map – "What are the features of a successful Nature-Based Solution?". Mind map can be created with MindUP, XMind, or on paper.	15 min
Brainstorm	How is our health affected by the environment at school?	15 min
Lesson 2	
Group work **Construction of CO_2 sensor**	*(In case there is no sensor for lesson 3 at school)* Here a collaboration with an IT teacher could be useful. Based on the instructions given by the producer construct a CO_2 sensor, for example using the following link https://www.hackair.eu/tutorials/. Otherwise, many suppliers can be found online.	45 min (or longer)
Lesson 3	
CO_2 measurements in groups	• Collaborative group work based on the Table provided as example in Annex 1. • CO_2 sensor is needed: it can be built (Lesson 2) or bought (many suppliers can be found online). • To fill out the whole table all measurements should be done repeatedly in the same classroom in different conditions, for a set number of days. • It can be repeated in different months/seasons. • Each group of 4 students should repeat each measurement at 3 - 5 times and calculate mean value. • Analysis of precision and accuracy between groups would also take place.	45 min (repeated regularly, based on the chosen conditions)
Lesson 4	
Discussion	Analysis of results obtained during lesson 3.	10 min
Brainstorm	In groups of four students should list ideas on how to improve the atmosphere in their school.	20 min
Mind map	Create a mind map with ideas on how to improve school, that can be further used in discussion with Principal or City Hall about financial support for school atmosphere improvement.	15 min
Lesson 5	
Group work	In their groups of four, students come up with solutions to create green walls at school. This activity should be introduced as the beginning of a change in the cultural mentality. Students become active change agents of their own community.	45 min

Name of activity	Procedure	Time
	Students may use following ideas or come up with their own: *In Polish*: • https://ogrodosfera.pl/blog/jak-zbudowac-ogrod-wertykalny • https://www.sempergreen.com/pl/rozwiazania/zielone-sciany/korzysci-jakie-daja-zielone-sciany • http://hadart.pl/oferta/zielone-sciany/ • https://zielone-sciany.pl/ • https://homelook.pl/wertykalny-ogrod/ *In English*: • https://www.archdaily.com/882285/how-to-build-a-diy-vertical-garden • https://www.youtube.com/watch?v=0-0Vk1WVH_k • https://pdfs.semanticscholar.org/ee06/8d428e93f40459c9512eeadae8341ee52246.pdf • https://www.gardenersworld.com/how-to/diy/how-to-create-a-living-wall/ • https://www.hgtv.ca/diy/photos/diy-how-to-make-your-own-living-wall-1927688/#currentSlide=4 • https://balconygardenweb.com/diy-indoor-plant-wall-projects-living-wall-ideas/ School green wall should contain a project with list of needed materials and costs. In the future this activity might expand and include more educational or regional stakeholders. This activity aims to build the foundation for an eco-justice mentality.	
Possible Extra Activity	Students could create an Arduino-CO2 sensor system and collect data using created webpage for longer period. Creating an Arduino CO2 sensor – one to install outside of the classroom, and second – inside would be ideal. Conditions inside of the classroom should be planned by students in a similar way as in Lesson 3 of LS. Data should be collected with the proper amount of repetition (at least 5), with outside conditions/CO2 level taken into consideration. Steps to follow: Connecting Arduino with CO2 sensor • https://create.arduino.cc/projecthub/alfred333/co2-monitoring-with-k30-sensor-86f6d9 • https://www.dfrobot.com/product-1023.html Creating a webpage with Arduino • https://www.arduino.cc/en/Tutorial/WebServer • https://create.arduino.cc/projecthub/kutluhan-aktar/how-to-create-a-website-communicating-arduino-by-using-php-ce5232 • https://www.thegeekpub.com/16569/controlling-an-arduino-from-a-web-page/ • https://www.instructables.com/id/Getting-Arduino-data-to-a-web-Page/ Using R software. • https://cran.r-project.org/manuals.html	

9. Student feedback

- Basic associations with "What NBS means for you?" using [Mentimeter](#).
- All students should fill out the questionnaire:
  1. What does NBS mean to you?
  2. Have you heard about it earlier?
  3. Does it change the way you think about nature and the climate?
  4. Would you like to implement NBS in your surroundings?
  5. Will you try to get further information on this subject?
  6. Was the lesson interesting for you?
  7. What were the 3 key messages you take home from the lessons?
  8. Would you change anything in the coursework?

10. Teacher's remarks

Considering the recent COVID-19 pandemic, the learning scenario was adapted to online learning (see [Annex 2](#)).

From one point of view, students were interested in the possibility of reading something other than rough school materials; but on the other hand, we struggled at the beginning because of their tiredness from having to learn everything by themselves. Luckily, the subject interested them so much, that they quickly found themselves feeling good with online learning. After reading the materials that I sent them, we had an online session for discussion. They were well-prepared for the discussion as they already searched for NBS solutions on the Internet. They found some interesting examples, although they had some problems with connecting such solutions with our country. Fortunately, in addition to the materials that can be found on the Oppla webpage, I recently found an article describing the changes in one Warsaw district. The community office decided to make a nice change in one yard – from concrete to lawn, with the reason being tackling climate change. This brief piece of information helps students realise that we can start from something small. As most of our students are highly concerned about climate, this discussion was very interesting and, I believe, opened their eyes to new solutions.

The second online session was devoted to air quality at our school. As we did not have the results of measurements, I asked students to find some information on what we should do to have better air quality in the school building. Students found some solutions, and some of them liked the ventilation of classrooms, which was a great beginning for further discussions. We finished with the list of ideas on how to make the air fresher.

During the third session, I was describing and showing students ideas on how to make a green wall or at least green boxes. We gathered some ideas on what we could do in our school when we finally get back there.

Taking into consideration the skills my students were expected to develop, I was able to practice together with students their communication skills and also critical thinking and problem solving. They proved their flexibility and adaptation in finding a solution. Because they were reading, they also improved their information literacy skills. I should have put more emphasis on group work, which I am planning to do in further usage of this topic.

Annex 1: CO2 measurements in groups Table

Description	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean value
Classroom without plants in the morning						
Classroom without plants in the late afternoon without opening the window all day long						
Classroom without plants in the late afternoon with window being open all day long						
Classroom with plants in the morning						
Classroom with plants in the late afternoon without opening the window all day long						
Classroom with plants in the late afternoon with window being open all day long						

Annex 2: Implementation during online teaching.

Name of activity	Procedure	Time
Lesson 1		
Lesson preparation	Before the lesson, students get materials for reading.	1 week before
Discussion and List of ideas	Discussion of all groups started using Mentimeter – "What does NBS mean for you?" Responses were added on the online whiteboard.	40 min
Lesson 2		
Discussion	What do you think about the atmosphere in our school?	15 min
Brainstorm	How we can improve air quality at school?	40 min
Mind map	Create a mind map with the ideas on how to improve the school, that can be further used in discussion with the principal or City Hall about financial support for the improvement of school atmosphere.	15 min
Lesson 3		
Discussion	Together on a shared screen, students are watching different applications of green walls and green boxes. Discussion on if it would be possible to install it at school. Students may use following ideas or find their own: • https://ogrodosfera.pl/blog/jak-zbudowac-ogrod-wertykalny • https://www.sempergreen.com/pl/rozwiazania/zielone-sciany/korzysci-jakie-daja-zielone-sciany • http://hadart.pl/oferta/zielone-sciany/ • https://zielone-sciany.pl/ • https://homelook.pl/wertykalny-ogrod/ School green wall should contain a project with list of needed materials and costs.	45 min.

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About the NBS project

The NBS project is initiated and funded by the European Commission Directorate-General for Research and Innovation and coordinated by PPMI, in collaboration with European Schoolnet (EUN). PPMI (www.ppmi.lt/en) is a leading European research and policy analysis centre, aiming to help public sector and civil society leaders from around the world, presenting evidence in a way that is simple, clear and ready to use. European Schoolnet (www.eun.org) is the network of 34 European Ministries of Education, based in Brussels. EUN aims to bring innovation in teaching and learning to its key stakeholders: Ministries of Education, schools, teachers, researchers, and industry partners. Find out more about nature-based solutions: https://ec.europa.eu/research/environment/index.cfm?pg=nbs and all the NBS Learning Scenarios created in this project as well as the overall reports can be found at http://www.scientix.eu/pilots/nbs-project

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The main goal of this learning scenario is to help students realize that the school environment, where they spend a lot of time, is very important for their health, well-being, concentration and studying efficiency. The aim is also to help students become more conscious about the natural environment's impact on their health. To do so, the first action would be to measure certain air-quality parameters at school. A brainstorming activity will then take place. The students will discuss how to improve air quality at school and then further debate on how they could make school spaces greener. If needed, they could set up a green-wall concept for their school, and eventually build it.

Studies and reports