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NATURE-BASED SOLUTIONS IN EDUCATION VALIDATION REPORT

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Nature-Based Solutions in Education - Validation Report

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EUROPEAN COMMISSION

NATURE-BASED SOLUTIONS

Validation Report

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TABLE OF CONTENTS

INTRODUCTION

Citizens and experts have identified better awareness of the opportunities, benefits, and limitations of nature-based solutions as one of the main factors that could facilitate the transition to more sustainable cities and territories. Nature-based Solutions (NBS) use nature and ecosystems to deliver social, ecological, and economic benefits, increasing biodiversity and contributing to climate change adaptation and mitigation.

However, the educational potential of NBS remains largely unexplored, whilst innovative programmes and resources around NBS are currently missing from formal and informal education programmes for children and families. Building on scientific evidence and experiences from NBS projects in cities, this educational pilot study exploited recent research results to develop innovative educational programmes and resources that raise awareness on NBS and their benefits among children, young people, and their families.

The project was 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 institute, aiming to help public sector and civil society leaders from Europe and beyond, 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.

EUN's task in the NBS project was to coordinate the development of 15 learning scenarios[1] on how to integrate NBS across different subjects and age groups. The work was carried out with 15 teachers from seven different countries (Poland, Italy, Spain, Lithuania, Slovakia, Sweden, and Portugal) and two European Schools (from the French and Greek sections). PPMI was responsible for ensuring that the NBS content included in the learning scenarios was accurate. These learning scenarios were then tested in classes throughout Europe to see how teachers and students reacted to the materials and what could be further improved.

In this report, we provide an overview of the learning scenarios, the validation process, and the main results of the validation. At the end, we provide some conclusions and recommendations for future work.

About European Schoolnet

European Schoolnet (EUN) (http://www.eun.org/) is a network of 34 European Ministries of Education. As a major international think tank, EUN operates key European services in education on behalf of member Ministries of Education, the European Commission, and industry partners. It is acting as the interface between education policy and practice, and as the facilitator bringing Ministries of Education, schools, research, and industry into contact for fruitful exchange and collaboration.

In the area of Science, Technology, Engineering and Mathematics (STEM) education in particular, EUN was mandated by its Ministries of Education to develop action research initiatives focused on introducing innovative topics in classrooms, connected to real-life problems, and analysing the persisting lack of interest of young students in STEM studies and related careers. The present NBS project falls within this action line of EUN.

About PPMI

PPMI (http://www.ppmi.lt/) is a research institute founded in 2001 with more than 10 years of experience in conducting education policy analysis and evaluation at the EU level. With over 50 in-house scientists and researchers as well as a solid network of external collaborators and organisational partners in every EU Member State and numerous third countries, PPMI is a reliable knowledge provider to the EU institutions and agencies. Since 2015 PPMI has led the Network of Experts working on the Social dimension of Education and Training (NESET https://nesetweb.eu/) and delivered a Study on Supporting School Innovation across Europe1.

For DG RTD PPMI has been conducting important assignments such as Tracking of Research Results (2018 - 2022), Provision and analysis of key indicators in research and innovation (2018 - 2021). In

[1] Learning scenarios are stand-alone descriptions of educational activities to be carried out in classroom connected to a specific topic, including objectives, pedagogical methodologies, duration, target age, etc.

its assignments, PPMI typically acts as a bridge between cutting edge academic knowledge and public policy stakeholders or public service providers. Being one of the established knowledge providers to DG EAC and DG RTD, PPMI offers the extensive thematic expertise, the required methodological prowess, and the managerial capacity to lead the current assignment.

THE LEARNING SCENARIOS

Nature-Based Solutions (NBS) are solutions inspired and supported by nature and its ecosystems. As opposed to purely technological solutions, NBS are often cost-effective, while they simultaneously provide environmental, social, and economic benefits that build resilience to climate change. NBS bring more nature and biodiversity to cities, landscapes, and seascapes, through locally adapted and systemic interventions. Examples of NBS are green roofs and green walls to cool down cities in the summer, parks to combat pollution and provide leisure and exercise to citizens, green corridors connecting natural areas, urban food gardens, etc.

The teachers that participated in this pilot study developed 15 learning scenarios that show how to integrate NBS resources in the classroom. These learning scenarios are cross-disciplinary and promote interdepartmental collaborations, and they can be easily implemented and adapted in an array of subjects. The suggested ages vary widely depending on the learning scenario, and they reach from 6-7-year-olds to 18-19-year-olds. Furthermore, the learning scenarios include suggestions for how to implement them during online/remote teaching.

All the learning scenarios were planned out to promote pedagogical trends[2] and instil in students 21st-century skills.[3]

Some of these 21st-century skills are:

- Creativity: e.g., students think of various solutions for promoting a better lifestyle in their communities or encourage greener solutions to their schools' issues.
- Information/Media literacy: students explore examples of NBS, research similar solutions in other communities.
- Collaboration: e.g., students work in groups and engage in task division to produce outputs.
- Critical thinking: e.g., students learn that a debate on deforestation or climate change does not consist of two opposing camps only but involves many stakeholders with different perspectives.
- Communication: e.g., students present their work to the whole class and learn to put forth strong arguments based on facts.

Some of these pedagogical trends are:

- Project-based learning: e.g., students work in groups on a research project on greenhouses and the greenhouse effect, alternatives to waste management or investigate what are the views of their peers on climate change.
- Peer learning: e.g., students work in groups, evaluate the work of their peers, or develop assessment questions to assess their peers.
- Problem-based learning: e.g., students are introduced to a problem and challenged to find a solution together based on the information provided to them.
- Student-centred learning: the learning scenarios are not based on classical instruction by the teacher, but they are expected to actively engage students in the lessons.

We provide here an overview of the 15 Learning Scenarios developed and the actual learning scenarios can be found under http://www.scientix.eu/pilots/nbs-project .

[2] http://www.allourideas.org/trendiez/results
[3] https://www.battelleforkids.org/networks/p21

Let's make our school a Growing place! (LS01-Enrica)

Suggested Age/Subjects: 7-8 years old – Science, Art, ICT, English

This learning scenario stems from the need to improve the quality of 'Green Solutions' in schools. The aim is to involve students from an early age to be familiar with the topic of green area diffusion and would contribute towards building a sustainable, healthy, and resilient city, better adapted to climate change. In this context, students will debate and plan the construction of a green wall inside and outside the school using recycled materials.

GRETA – Green Relevant Environment to All (Understanding NBS) (LS02-Gabriela)

Suggested Age/Subjects: 13-14 years old – STEM, STEAM, CLIL

The climate change activist Greta Thunberg is an "influencer" of the teenage generation. What aspects of her presentation "Nature Now" make her a role model of learning more about NBS? By using their critical thinking, students discover more about the destruction of our environment and use self-studying methods to find a way to help nature recover from the destruction.

Deconstructing Climate Denial Speech and understanding the role of Nature-Based Solutions (LS03-Nicolas)

Suggested Age/Subjects: 15-17 years old – Biology, Ecology, Philosophy, Social Sciences

Recently scientists and experts released reports which should provide content to policymakers on the climate crisis. In this Learning Scenario, these documents are reviewed using the scientific method by analysing several graphs, figures, and short texts on climate change and NBS.

The Traveling Fox (LS04-Ralia)

Suggested Age/Subjects: 6-8 years old – Discovery of the World, Maths, Art, Language

In this learning scenario, students get familiarized with the concept of social and environmental justice through the story, photos, and videos of Foxy Travel – a fox who likes traveling across Europe. With the help of the Foxy's "environmental" photos, they will think about the socio-environmental fair neighbourhood in which they would like to live using recycled materials.

Transform your school/town: design a constructed wetland (LS05-Tullia)

Suggested Age/Subjects: 14-15 years old – Biology, Chemistry, Ecology, Engineering, Earth sciences, Design and Technology

Despite the lack of water during warm summers, it is often possible to observe the waste of water while watering gardens. In this lesson, students will learn about NBS for wastewater treatment, which can not only purify water from pollutants but provide numerous co-benefits. Through a project-based learning (PBL) approach, students will build a prototype of a constructed wetland.

Exploring ecosystem services and nature-based solutions to urban problems (LS06-Pernilla)

Suggested Age/Subjects: 12-18 years old – Biology, natural science

The purpose of this learning scenario is to explore an urban ecosystem of a city, analysing its ecosystem services and determining whether it acts as a nature-based solution to challenges such as diminishing biodiversity, urban heat islands and urban decay. This learning scenario uses Uppsala as an example but can be implemented in other places.

Nature Changing Our Surroundings (LS07-Ewa)

Suggested Age/Subjects: 6-9 years old – Primary, Biology, Natural Sciences

By analysing photos of different cities, students try to work out the logic behind using nature in solving problems that cities face. Then students try to define whether their school faces any of the problems in which nature could be of use. With the help of the teacher, students design a plan to address problems around their school using NBS and eventually implement their plan.

A Green School is a Healthy School (LS08-Anna)

Suggested Age/Subjects: 15-19 years old – Chemistry, Natural Sciences, Science, Biology, Guidance lessons

The main goal of this learning scenario is to help students realize that the school environment, where they spend a lot of time, is crucial for their health, well-being, concentration, and study efficiency. This is done by measuring air quality in the school and debating how to make school spaces greener. Students may work on a green wall concept for their school, and eventually build it.

Water Management at Urban Areas (LS09-Jose)

Suggested Age/Subjects: 12-13 years old – Biology, Geology, Earth Sciences

This learning scenario encourages students to learn and care about the importance of water management to tackle urban challenges such as floods and disruption of the water cycle in the urban environment via NBS. Through the activities, students will work as scientists following the approach of inquiry-based learning by following the design process as engineers (or landscape architects).

Nature-based solutions for Climate mitigation and adaptation (LS10-JuanCarlos)

Suggested Age/Subjects: 8-9 years old – English, Primary

Climate mitigation and adaptation are attempts to slow down the process of global climate change. This learning scenario looks, on the one hand, into green vegetation for health and well-being and, on the other, on participatory planning and actions, like creating a vegetable school garden that will reduce the greenhouse gases in the atmosphere and provide food and plants that improve the health and well-being of the students.

Green Jobs Create Economic Opportunities (LS11-AnaBelen)

Suggested Age/Subjects: 17-19 years old – Earth and environmental sciences

In this scenario, students reflect on how their future jobs can be based on NBS to transform their cities. The students must choose their role and decide the way to develop a green job and consider how it would be possible. This scenario will allow students to understand that green jobs can also be profitable.

School Garden, Street Garden (LS12-Costantina)

Suggested Age/Subjects: 14-17 years old – Agronomy, Statistics, Biology, Physics, ICT, Languages

Green areas are increasingly scarce in cities and schools and, oftentimes, abandoned or not properly maintained. These could become places of biodiversity, environmental education, healthy recreation for people, improving the ecosystems of cities. This activity aims to carry out a project with students, to connect uncultivated existent green areas, and external spaces of the school, with green cycling paths and walking tracks.

NBS to prevent forest fires and reduce risk disasters caused by deforestation (LS13-Elisa)

Suggested Age/Subjects: 14+ – STE(A)M

Nature-Based Solutions can reduce disaster risks connected with forest fires. This is a key issue in countries where climate change and desertification have increased the risk of forest fires and disasters, mainly caused by deforestation. With this learning scenario students will analyse risks and propose NBS based on the data resulting from scientific research, using digital competences and real-world problem-solving skills.

Waste Management of The Food Industry: Hazards, Risks and Solutions (LS14-Irena)

Suggested Age/Subjects: 16-18 years old – Biology, Chemistry, Physics, Economics

Uncontrolled landfill sites are increasingly being used as a method for food waste disposal, becoming sources of diseases, unpleasant odours, parasites, rodents, etc. In this learning scenario, students conduct an experiment in which food waste is converted to compost that is then used to grow some vegetables. In this way, the production of natural fertilisers and green energy with food initiatives are linked.

Participatory planning and governance in NBS: An example of a Small Eco-Transport (LS15-Marcin)

Suggested Age/Subjects: 15-20 years old – VET, Engineering, Technology, Physics

The purpose of the lesson is to introduce students, especially of technical high schools, to NBS. The learning scenario includes an introduction to NBS and their benefits, a discussion on issues related to small eco-transport systems and how to construct them in a city (e.g., shelters for e-bike-scooters with solar panels designed with green roof-wall infrastructures that promote biodiversity).

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PILOT STUDY: THE VALIDATION PROCESS

A pilot study is a brief and limited version of planned research. The goal of a pilot study is to refine materials and procedures (in this case, the 15 learning scenarios and their implementation) following a validation process. In this project, the validation was done in two ways:

1) The authors of the learning scenarios tried them with their students and collected results through a feedback questionnaire. Based on this implementation, the authors corrected and clarified parts of the learning scenarios.
2) The learning scenarios were tested (used in classes) by other teachers from different countries, disciplines, and school levels. The results of the testing were collected through a feedback questionnaire and stories of implementation (narratives on how the implementation progressed, addressing a set of guiding questions). The data from this testing was used to review and improve the learning scenarios.

While the pilot study offers essential insights into how learning scenarios on NBS can be developed and implemented in education, the results cannot be generalised due to the limitations in the sampling of teachers. A large-scale research project is needed to obtain statistically significant information and to draw conclusions about causality.

Testing by the authors

Of the 15 learning scenarios (LS), 14 were tested with students, while one was peer-reviewed by the lead teacher's colleague. All LS were primarily taught online due to Covid19 restrictions, through online platforms like Zoom, Google Meets, MS Teams and LiveWebinar. Over 1,000 students participated in the implementation of these LS, with an average classroom of 20 to 25 students. The biggest class had 150 students and the smallest had 8 students. There was a wide range of ages in the students that partook on these LS: the youngest was 6-year-old and the oldest was 19-year-old. Most students were between 15 and 17-year-old.

The subjects in which the LS were tested were very varied, from science courses like physics, biology, chemistry, environmental science, or geology; social science courses like design and technology or economics; to humanities courses like arts and English. The LS were also tested in general primary school subject courses. Overall, all teachers highlighted the previously non-existent or very basic knowledge of NBS of their students. One teacher mentioned that students had some basic knowledge of NBS concepts, but they did not know that these fell under the concept of NBS. In the peer-reviewed project, the teacher's colleague had a general knowledge of what NBS was but was curious as to why these were not more prominent in the curriculum.

Throughout the LS students learnt a variety of applications and different subjects related to NBS, but in general, and as highlighted by one of the teachers, students discovered that "NBS have the potential to provide multiple benefits across a range of sustainability challenges facing cities. [The students] can help to limit the impact of climate change and enhance biodiversity". These LS helped students to feel more engaged with their environments, their houses, their schools, and their cities, making students confront the problems that their environments face, and making the learning and solutions more real and factual.

The teachers highlighted, amongst other, the following personal benefits on applying their proposed LS in their classrooms: it taught students and teachers alike to be creative in their learning activities; it engaged families and communities into students' learning; it brought students closer to real-life problems and encouraged them to think 'outside the box'; it allowed teachers to introduce climate change issues into biology curriculum not as theoretical concepts but as tangible issues with practical solutions; teachers were able to use and highlight project-based learning strategies in the classroom.

In all the LS the teachers mentioned the importance of evaluation and used different methods to evaluate students' learning. While some LS imply the production of a prototype followed by an assortment of assessment rubrics, others leaned into the experimental side of the LS and evaluated through discussions, online games, learning diaries, or interactive maps. Overall, all LS had some sort of evaluative component put in place to connect the LS into the general course curriculum and highlight the importance of the LS as an intrinsic part of their courses as a whole.

When discussing the obstacles that teachers encountered when working on their LS, they emphasised three areas: time management, online teaching, and predominance of English-based materials. In the time management category, teachers mentioned the need for more time to properly develop and implement the LS, although this can be problematic as it might take valuable time, at the expense of other lessons/subjects. They also questioned the risk of ending with a superficial understanding of NBS if they did not have more time to engage students with these LS. Online teaching was the second issue raised, although this problem was not due to the LS projects per se, but the Covid19 situation, which hindered in some cases the possibilities of doing hands-on experiments in the classroom as initially planned. Finally, the third main problem they encountered was the limited availability of information in their desired languages. However, some teachers highlighted a positive aspect in this regard: having most of the materials in English helped students with their English learning.

When asked to think about improvements they would do to their LS if they were to teach them again, teachers mentioned the following areas: a few of the teachers would like to place more emphasis on NBS for energy production and infrastructure, and improved air-quality systems into their LS; teachers would like access to more NBS solutions in other countries to showcase the global (and not just local) aspect of their LS; following from one of the previous obstacles mentioned, they would request materials in advance and expand the time spend on their LS to improve the learning experience; and most of the teachers wanted to introduce more activities for the students to develop, create more group work activities, and even include visits from experts to the classroom to learn about NBS initiatives first hand. These improvements were then integrated into the LS.

Overall, it is important to note that none of the LS were designed for virtual teaching. The pilot teachers showed an exemplary work of creativity and commitment in finding ways of adapting their LS to online teaching, without compromising the quality of their learning scenarios. The tricks and tips to implement the LS online were included in the LS tested by the other teachers.

Validation by other teachers

The testing teachers included the pilot teachers that had to try out the LS of another colleague and Scientix Ambassadors.

Scientix Ambassadors are teachers that help share Scientix activities at national level and play an active role in supporting innovation in STEM education in their countries. Their work is essential for expanding and consolidating the community for science education in Europe. This community's core values reside in the sharing of good classroom practice, especially in STEM, and making sure that students are equipped with the skills needed to become successful adults. The Scientix Ambassadors Teachers' panel consists currently of 377 teachers. EUN launched a call for 30 Scientix Ambassadors to help test the LS (two per LS) which resulted on 48 volunteers. All were accepted for the testing and of these 42 managed to implement the LS with their students and provide the corresponding feedback questionnaire and story of implementation.

With the 15 pilot teachers and 42 Scientix Ambassadors, a total of 57 teachers tested the learning scenarios 58 times[4]. The 57 teachers came from 19 different countries (plus European Schools in Belgium). The widespread geographical distribution can be seen in Figure 1).

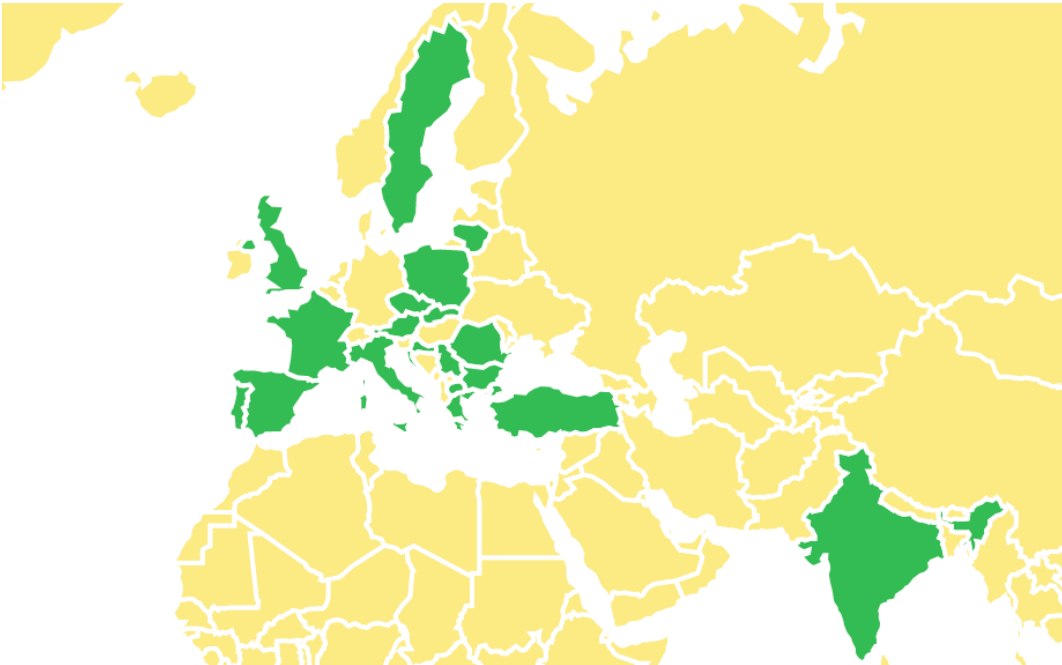

Figure 1: The 19 countries of the pilot and testing teachers (in green)

Each LS was tested by at least two other teachers (up to five in some cases) and from a minimum of two countries different to the origin country of the author of the LS. In Table 1, we show the LS ordered by the age group the LS has been designed for and include information on the country of the author and suggested subjects, total number of tests carried out and countries where they took place.

[4] One of the pilot teachers volunteered to test two LS.

Table 1: LS ordered by original target age, including information on the country of the author and suggested subjects, number of tests carried out and countries where they took place

	Country of author	Age[5]	Subjects[6]	TESTS	Austria	Bulgaria	Croatia	Czech	EU School	France	Greece	India	Italy	Lithuania	Northern Macedonia	Poland	Portugal	Romania	Serbia	Slovakia	Spain	Sweden	Turkey	UK
LS04-Ralia	EU School[7]	06-08	Maths, Art, Language	**4**	0	0	0	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0
LS07-Ewa	Poland	06-09	Primary	**3**	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0
LS01-Enrica	Italy	07-08	Science, Art, ICT, English	**3**	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
LS10-JuanCarlos	Spain	08-09	English	**5**	0	0	0	0	1	0	0	0	1	0	0	0	0	2	1	0	0	0	0	0
LS09-Jose	Spain	12-13	Biology Geology, Earth Sciences	**3**	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0
LS06-Pernilla	Sweden	12-18	Biology and natural science	**4**	0	0	0	0	1	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0
LS02-Gabriela	Slovakia	13-14	STEM, STE(A)M, CLIL	**4**	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0
LS05-Tullia	Italy	14-15	STEM, ICT	**4**	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0
LS12-Costantina	Italy	14-17	STEM + languages	**2**	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
LS13-Elisa	Portugal	14+	STEM	**4**	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1
LS03-Nicolas	European School	15-17	Biology, Ecology, Philosophy, Social Sciences	**4**	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0
LS08-Anna	Poland	15-19	Chemistry, Natural Sciences	**5**	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	2	0	0	0
LS15-Marcin	Poland	15-20	VET	**4**	0	1	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0
LS14-Irena	Lithuania	16-18	Biology, Chemistry, Physics	**5**	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	1	0	1	0
LS11-AnaBelen	Spain	17-19	Earth and environmental sciences	**4**	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0

From the stories of implementation and feedback questionnaires, we obtained qualitative information on each LS which was then used to review and improve the LS, collect overall information on the LS (overall qualitative results) and some quantitative information on the impact of the LS.

[5] Target age as defined by the author, but the testers also used the LS with students of other ages
[6] Main subjects (but more included in the LS)
[7] European School in Brussels

Qualitative results per learning scenario

Here we provide a summary of the qualitative information obtained per LS. The full report was provided to the authors to improve their LS.

LS01 – Let's Make Our School a Growing Place!

Due to Covid19, implementation was done remotely via online teaching. This meant both synchronously and asynchronously learning, with students doing a big amount of their work on their own. Some of the activities in the LS had to be omitted, like debates and speeches, and other oral exercises moved to written assignments. Students' ages ranged from 8 to 12 years old, and class sizes varied between groups of 14-15 students, and groups of 30 students. The most difficult task for all testers was the focus on improving the school environment, as they were acting in an online environment. However, some teachers devised ways to bring students to school at different times to implement this particular LS in the practical way it was intended.

Overall, the reviewing teachers stated that the following learning outcomes were achieved: understanding the significance of sustainable forests on our health and the environment, implementing the observation and interpretation of natural environmental transformations, and motivating and engaging students in ecological ways of thinking. Teachers highlighted the following needs to make this LS run smoothly: good communication with the families about what the school program entails and expectations towards them and their children, smooth collaboration with the schools' administration since the implementation takes place on school grounds. Teachers also reported that this LS has improved their students' engagement with their environments and has kept them motivated and creative in using recycled materials to build objects that they can use to create greener environments. Overall, this LS has managed to bring the outside world into their classroom and houses.

LS02 – GRETA: Green Relevant Environment to All (Understanding NBS)

The implementation took place online. Students' ages were primarily between 13 and 15 years old, but one of the implementations had younger students: 8 to 10-year-olds. The teacher in this last group decided to adjust the materials to fit students' ages, leaving out the 'heavier' parts containing words and situations that students would not be able to understand. They also condensed the work into a two-days' workshop. The other groups followed the original timeline and structure more consistently.

The major issue teachers found with this LS was students' knowledge of who Greta Thunberg is, and her relationship with the media, which they felt could overshadow the discussions of NBS and climate change. Several changes were introduced in the different implementations: a pre-discussion questionnaire was introduced to see what students knew about these topics, an environmental improvement campaign was introduced alongside the proposed poster creation and presentation, smaller groups during the discussions as to allow students to talk amongst them more freely, and group work during the poster preparation instead of a poster per student.

The '6 Thinking Hats' activity was met with mixed results. Some teachers implemented the LS do without it, as they felt the terms and conditions associated with the activity were too demanding for students this age, while other teachers highlighted how good this activity was, as it allowed their students to use different roles to focus on the same problem. Overall, teachers praised how this LS offers teachers specific topics and activities that can be easily adjusted for different age categories and groups; the LS's emphasis on engaging students with their critical thinking skills; how this LS is a great resource and example of Content and Language Integrated Learning methodology; and how the lessons are designed in a way that can be easily replicated to different geographical locations.

LS03 – Deconstructing Climate Denial Speech and Understanding the Role of Nature-Based Solutions (NBS)

Most implementation occurred online, apart from one case that was able to have both online and in class teaching. The ages of students for this LS were older than other ones, with students' ages varying between 15 and 19 years old. Teachers also varied the time spent with the implementation according to their schedules and syllabi, as they felt that more time was needed than the initially proposed. In some cases, the LS was expanded to three sessions of 90 minutes each, four sessions of 40 minutes each, or four sessions of 55 minutes each. Teachers praised the collaborative and interdisciplinary nature of the LS, as the implementation took place in subjects like chemistry, math, physics, or environmental sciences. They highlighted how this LS allowed them to approach different contents of different disciplines, in addition to themes that involve socio-scientific issues.

Overall, students were very pleased with the activities, even asking in some cases to participate more frequently in similar activities and themes related to the LS. Students enjoyed the variation of activities (diagrams, discussions, dialogues, examples of European works…), and highlighted the importance of finding research tasks that were both of regional and global importance. Students found the methodology proposed to be very different from the traditional classroom, and students appeared more involved and motivated to learn and discuss the topics presented.

When asked how the teachers would improve this particular LS they proposed the following ideas: integrating talks given by relevant NBS stakeholders into the courses; share students' work via social media, school websites, or poster events; find further resources and or scientific articles to complement what the LS already provides; develop laboratory practices; or build houses for pollinators in the schools, amongst others.

LS04 – The Travelling Fox

Implementation of this LS was geared towards younger students than other LS. Ages varied from kindergarten to nine-year-olds, with students averaging 7-8 years of age. Implementation was done both remotely and face-to-face, with students bringing global nature-based issues to the local sphere, by looking into their own neighbourhoods, and discussing both ideal neighbourhoods and neighbourhoods they would never want to live in. The LS was completed in a variety of subjects, including science, English, art, and ICT.

Overall, the materials provided were sufficient and engaging for the students, the LS was well-structured, it came with a list of very useful tools for its implementation, and the recommended 6 hours to fulfil the LS seemed the right amount. Some changes were added during the implementation. In one case, all written discussions and forms proposed in the original LS were done orally, as students were too young to write long answers. The hands-on activity and use of recycled materials in the classroom had to be changed to an oral discussion due to Covid19 face-to-face regulations. Teachers added that both the hands-on activity and the oral discussion could be combined in a future implementation. Finally, as this implementation deals with environmental situations throughout Europe, a teacher created a class stuffed-toy mascot in the form of a Fox that could bring and expand on examples that were more closely related to their country, bringing, once again, the global aspect of the LS into the local sphere.

LS05 – Transform Your School/Town: Design a Constructed Wetland

This LS deals with water management, and the students' ages varied between 10 to 12 years old to 15-16 years old. Lessons had to be online, which made the laboratory tests and creation of the prototype proposed difficult to execute, with most of the teachers replacing these activities with a theoretical discussion instead. Overall, the LS is a good introduction to problem-based learning and STEM activities, and all teachers agreed that the LS is well-designed, Nevertheless, time management was an issue: all teachers needed more time than the one specified in the LS. A solution could be dividing the NBS scenarios proposed into smaller sections or parts, so that students can tackle each problem in a timely manner. However, as the LS is flexible, even with limited hours, students get to learn the main characteristics, causes of water pollution, and solutions found in nature that the LS proposes.

A problem encountered was that some of the resources were not available anymore, which meant teachers had to improvise other options to those that the LS proposes. The resources that were no longer available have since been removed from the LS.

Teachers particularly praised this LS for its collaborative potential, as it could be implemented in partnership to students from other schools or countries, perhaps even as an eTwinning Project. Moreover, had the prototype build being able to be carried out, students could be encouraged to participate with their creations in science fairs and school presentations in their cities and countries.

LS06 – Exploring Ecosystem Services and Nature-Based Solutions to Urban Problems

Most teachers used this LS in their integrated science or biology course, although some collaborated with the art department as well. All classes were taught remotely except one, which combined online and face-to-face teaching. Almost all teachers included the LS within their course program, but one decided to use this LS as an extra-curriculum activity for their students. Students ages were very similar in all cases, with ages raging between 11 and 14. However, teachers noted how this LS is easy to adapt to different ages and levels, which is an asset. Moreover, another positive quality of the LS is the well-balanced combination between information sessions, personal and collective work, and group discussions.

The LS structure provided is well timed and planed, and it is coherent and easily adaptable, as it uses Google Maps to explore the urban ecosystem of the students' hometown. This also allows for students to explore other urban ecosystems they are interested in outside their area and can be used in the future to work with different schools in different countries to compare ecosystems and the problems and solutions they encounter. In this LS, students were able to engage with, define, and analyse current problems they encounter with urban development, and the LS serves as a solid introduction to the basis of urban ecology. Furthermore, this LS offers a new kind of pedagogical activity not seen in traditional lessons: the possibility to observe and understand the students' direct environment in a practical, and not just theoretical, manner. It also engages students in using their everyday tools (like smartphones) to collect data, which can teach students to use things they find in their homes or school environments as learning tools.

LS07 – Nature Changing Our Surroundings

There were two aspects that the teachers praised about this LS. First, the LS is easy to replicate and adapt to any age group, as the implementation proved: students' ages varied enormously from 8-10-year-olds, to 16-18-year-olds. This was possible due to how well organized the LS is, with the resources provided being more than sufficient, and the duration of the lesson and directions given being very well planned out and thorough. Teachers found the LS easy to use, with the structure being very clear and effective. Secondly, although all implementation happened online, the teachers believe that this learning scenario can easily be accomplished both online and face-to-face, something that they see as a big bonus, as opposed to other LS that may suffer depending on the mode of instruction.

The LS provides a source for good theoretical discussion of ecological education with interactive, fun, and age-specific activities that promote skills like creativity, communication, and critical thinking. Students are asked to problem solve, be active learners, study how small changes can have huge impacts, and how their actions play an important role in their environments. The proposed activities value imagination, team spirit, friendly competition, and gives students the opportunity to take on roles and responsibilities in their communities, in order to provide viable solutions for maintaining optimal living environments.

LS08 – A Green School is a Healthy School

The ideal age range that this LS proposes is 15 to 19 years old. Most implementation followed this age suggestion, although one of them had students that were 13 years old. This last group did not have any issues following the LS to completion, although the teacher made some modifications to suit the age group. This LS has a heavy IT component to it, which enriches different science course like ICT or biology, although it also improves second-language skills as the materials are in English. Students were very engaged with the creative part of the LS, as they had to come up with and implement plant-based solutions to their school's environmental problems. Overall, this was highlighted as the best outcome of the LS: that students were able to improve their school environments by creating tangible solutions that they could see working in real time.

Teaching from home did hinder some of the activities, as they were unable to build their own electronic sensors, nevertheless the LS offers alternatives like simple cardboard HackAir versions to measure air pollution that students were able to do from home. Students actively participated in discussions and idea sharing, and the LS helped them to become more conscious about how nature can offer solutions to every-day problems. Some teachers had a bit of difficulty with the computational aspect of the LS, but they were able to learn some basic knowledge of coding as well.

The implementation reinforced how this specific LS helped to combine distant topics like NBS and mechatronics easily, and how they can be implemented as vocational lessons within their curriculum. Furthermore, this NBS LS enabled students to become more environmentally responsible, and encouraged their critical thinking skills regarding the opportunities and challenges in their habitats. This LS promotes group work, problem solving, and fact-based tasks, and it teaches students how to project and build up electronic circuits. Furthermore, it encourages the mix of different areas of study, and the collaboration between departments in the schools.

LS09 – Water Management at Urban Areas

This LS was better suited for younger students, ranging between 10 and 14 years of age. It is divided into several activities to be done in different class sessions, although some of the teachers were unable to complete all activities due to the switch to online teaching. The LS is best implemented in courses like chemistry or geography, although its interdisciplinary nature means it can appeal to other subject areas. The teachers added some new sources to the LS complementing the already provided materials, which were perceived as very useful. Some of these new sources were added due to certain video links being inactive, or the need to find videos in the first language of the students.

Teachers felt the LS had a well-planned and thought out schedule, and the project activities and research the students need to perform to work as scientists are easily adaptable for both in class and at home exercises. Students were able to discover for themselves a series of concepts and ideas that were new to them, while at the same time developing their collaborative, cooperative, and communication skills. Furthermore, this LS emphasized 21st century competencies like critical thinking, civic awareness, and identification of solutions to everyday problems. Moreover, the way the LS is organized, allows the student to lead the activities, while the teacher acts as an observer and guide, which encourages students to take agency over the learning experience. The active involvement of the students in this LS is a real asset to NBS activities and learning.

LS10 – Nature-Based Solutions (NBS) for climate Mitigation and Adaptation

Teachers thought that this LS was better suited for younger students, so they implemented it with students ranging from 8 to 12-year-old. One of the best qualities of this LS is the creation of a vertical garden, which students were able to recreate from home when the LS was implemented online, or in their schools when the LS was implemented face-to-face. The LS also appeals to different subject areas like computer science, biology, art, and English language, which allows for collaboration amongst different teachers at the same school.

Students were so fascinated by the LS that they decided to continue working on it during the summer months, by taking care of the veggie gardens they planted. Several teachers have decided to continue with this project during the next academic year, and a couple of them have expressed interest in making it a yearly project. Along tangible outcomes like the recycled vertical garden, students develop their environmental conscience and climate change awareness, their creativity, their digital competence, and communication skills.

All teachers praised the schedule outlined in the LS, as it is easy to follow and put into practice. Some of the resources are in languages other than English, which may be an issue if the teachers are not familiar with it, but the LS comes with enough resources to be able to discard those that can't be used. The worksheets proposed in the LS are easily adaptable to different age groups and levels, and they can be expanded to include further information on the plans, vegetables, and fruits the students must examine and analyse. Students came across new terms such as climate adaptation or reforestation, learnt how to reduce greenhouse gases, and how to take care of their local environment.

LS11 – Green Jobs Create Economic Opportunities

This LS is better suited for students that are between 15 and 19 years of age. It is easily to adapt for both face-to-face and online delivery, and the structure is well organized. Time might be an issue, as it demands a lot of class time, but it can be easily adapted for those implementations that do not have the same scheduling availability. Also, a couple of the lessons ask to find a professional that works or knows about NBS to come to class, which was impossible to do in some cases. Nevertheless, the LS has alternative activities that can be used, and it provides enough material for students.

Subjects in which this LS was implemented varied between science, English, information and communication technology, and social sciences. This LS seems to be of great interest to students and is easily adaptable to their needs and interests. The LS highlights how the transition to green economy involves a suitable concern based on knowledge, research, and innovation leading to a long-term sustainable development. Its objectives are clearly stated and realized, with an emphasis on the awareness and reflection over the problems our environments face and encourages students to consider the impact generated by economic growth on human lives and the environment.

This LS was rich in information, and used a variety of digital instruments (Zeempas, QR codes, Padlet, Zoom…) and both traditional and non-traditional methodologies (like games, six thinking hats, reflections…). It also incorporates current learning trends like collaborative learning, the flipped classroom model, and gamification. It encourages dialogue and cooperation, teamwork and time management skills, interpretation and analysis of information, and critical thinking and flexibility skills, amongst others.

LS12 – School Garden, Street Garden

Although this LS is designed for students that are over 14 years of age, it is very easily adaptable to any age. The tasks can be simplified or made more challenging according to the age group, and the LS can be based around the schools the students go to in order to create a space for the local community to enjoy. The timescale of eight hours to complete the LS is well thought out and planned, and it has activities that allows students to work both in groups and as a whole class.

As the students are asked to rate the elements around their schools that help the environment, they are able to put into practice what is discussed in the classroom, and then see the impact that their intervention has in their environments. It also engages students to think about their schools not just as a green space for themselves, but for all the people within their communities, encouraging them to be considerate and make designs that are suitable for all. In this way, students learn about cultural and civic literacy, problem solving, creativity, and communication skills, alongside the more scientific and analytical aspects of NBS.

The implementation showed how NBS is important to be taught at all ages, and how even kindergarten students should be introduced to these concepts. In this way, students are accustomed to thinking about nature and taking it into consideration when solving problems from a very young age. NBS offers a totally different way of thinking about preserving the Earth and achieving sustainable development goals, and this LS offers enough materials for students to do investigative and research work before putting into action what they have learnt, and bring to life their environmentally friendly ideas.

LS13 – Nature-Based Solutions to Prevent Forest Fires and Reduce Risk Disasters Caused by Deforestation

This is a well-organized and full of resources LS that is suitable for students that are 14 years old or older. In one case, students that were around 12 years of age found the project slightly challenging, but nevertheless the LS can be adapted with some minor changes to younger audiences. The implementation worked best in courses like physics, chemistry, biology, ITC, or mathematics, and with groups of about 24-40 students on average. Students worked in groups, and the project is based on inquiry-based learning, where students are faced with real-world problems and must be creative and inventive to suggest different NBS.

The overall quality of the resources and the support from the lesson plans were very useful, and the project allows teachers to be more aware of the wealth of digital resources that can be used in the classroom. This LS was perceived as easily adaptable to the different scenarios that different countries are experiencing regarding reducing risks disasters caused by deforestation. It also allows for comparative analyses of the different actions taken by different countries about this issue. Students recognized that they now possess better knowledge about environmental issues that urgently need everyone's attention, and they have found different NBS to these problems.

In addition to the materials, some recommendations from the implementations would be to organize day trips for the students to go to forests and burned areas, to experience what they discuss in class. Also, student presentations organized at the end of the project can be recorded and linked to the schools' social media.

LS14 – Waste Management of the Food Industry – Hazards, Risks, and Solutions

Teachers praised the reaching nature of this LS, where starting from one subject, it can introduce important topics from other fields, showing its relation to content in subjects like mathematics, economics, mechatronics, or biology, amongst others. This ability to combine seemingly distant topics within one project was very appreciated by both teachers and students alike. The scenario is very broad and complex, but contents are made accessible to students. Some teachers wonder if this LS would be best suited to vocational schools or subjects.

The implementation had students aged between 14 and 19, and one test was done with pre-service teachers. Students investigated the factors affecting composting, and they discussed topics like ecoenergy, biomass, or waste storage. Students are asked to design and/or build a prototype of a recycling plant, with the compost from organic waste, and to see if they can produce enough gas/energy. The LS encourages a visit to a waste management plant as part of the activities, but as teachers had to move online due to Covid19, this was not possible. Instead they looked at waste management plants online. Overall, the LS proposes a very rich plan, and it is full of contents and resources. Teachers highlighted how the LS encourages active learning and engages students to the subject via an array of different videos, exercises, discussions, and activities.

LS15 – Participatory Planning and Governance in NBS: An Example of a Small Eco-Transport

This LS was best suited for students with ages around 14 and 18. The implementation happened both online and face-to-face, but no major changes to the LS were needed for either. Teachers highlighted how teaching through NBS was very different than traditional methods, and how this type of LS encourages creativity and innovation, critical thinking and problem solving, communication and collaboration, and ICT literacy. With this LS students practiced their second language and enriched their STEM knowledge. Furthermore, students learnt the topic of entrepreneurship, as they were introduced to of managing finances related to the project at hand.

As one of the teachers mentioned, this type of scenario greatly facilitates the way that teachers can present topics on sustainable development. Furthermore, NBS scenarios can contribute to the teachers' personal development in their areas of expertise. The feedback from students was very positive overall, and as one of the students stated: "I hope that such projects become more widespread and that they exist in many places, because this helps children to acquire, from an early age, qualities for a more economical and healthier lifestyle. Thus, from an early age, they will not only be able to use vehicles that are not harmful to the environment, but also this will teach them not to dispose of waste, not to pollute, to do everything possible to protect the environment, so our world will be an even better place to live."

Overall qualitative results

Overall, most LS were taught online due to Covid19 restrictions, through different online platforms like Zoom, Google Meets, MS Teams, etc. Some teachers, however, were able to meet face-to-face either because social distancing had been lifted in their countries at the time of implementing the learning scenario, or because they were able to create smaller groups during the implementation and have kids coming to school in particular timeslots.

Overall, students were enthusiastic about the LS and praised all the activities, even asking for more classes and topics like the ones explored. Students highlighted the importance of finding research tasks that were both of regional and global importance, and they enjoyed being able to engage with their schools' environments to find nature-based solutions to the problems they encounter. Students found the methodology proposed to be very different from the traditional classroom, which meant students were move involved and motivated to learn and discuss the topics presented.

There were, primarily, two common problems that some teachers encountered, apart from the rush to move things online due to the Covid19 situation. Firstly, having most materials in English was perceived as a shortcoming. Nevertheless, they felt this was a great way of practicing second-language skills with their students and encouraged both teachers and students to find alternative sources in their own languages and countries, therefore enriching the experience as a whole. Secondly, although most of the learning scenarios were well organized and planned, scheduling all the class hours necessary to complete the whole LS was at times challenging. However, teachers found the materials very easily adaptable to whatever time-constrains their schedules had. Some teachers decided to expand the allotted times, adding more creative exercises or classroom discussions, while others cut out some activities that they felt were superfluous, or too difficult for their students.

Overall, teachers were excited to learn and implement NBS in the classroom and felt that this type of learning scenarios should be included in their curriculum. Some of them decided to continue working with the LS after the summer recess, as the activities were so well perceived by their students. The implementation showed how important is to teach NBS at all ages, and how all students should be introduced to these concepts, even at an early age. Furthermore, teachers highlighted the overall high quality of the resources and the support from the lesson plans available in the learning scenarios. The different projects allowed teachers to be more aware of the wealth of resources that can be used in the classroom. Lastly, they also praised how these LS were easily adaptable to the different age-groups and contexts that their countries are experiencing, allowing for comparative analyses of the different actions taken by different countries about these issues. Students recognized that they now possess better knowledge about environmental issues that urgently need everyone's attention and were able to identify different NBS to these problems.

Quantitative results

In the feedback questionnaire we asked teachers to provide us information on the classes they tested the LS with, the impact the testing had both on themselves and their students, and what were the main adaptations they had to make to the LS to be able to use them.

Type of classes

Over 1,000 students participated in the implementation of the LS, with some teachers testing the LS with more than one class. The range of ages of the students that participated was rather wide, the youngest being 6-year-old, and oldest being 19-year-old (see Figure 2).

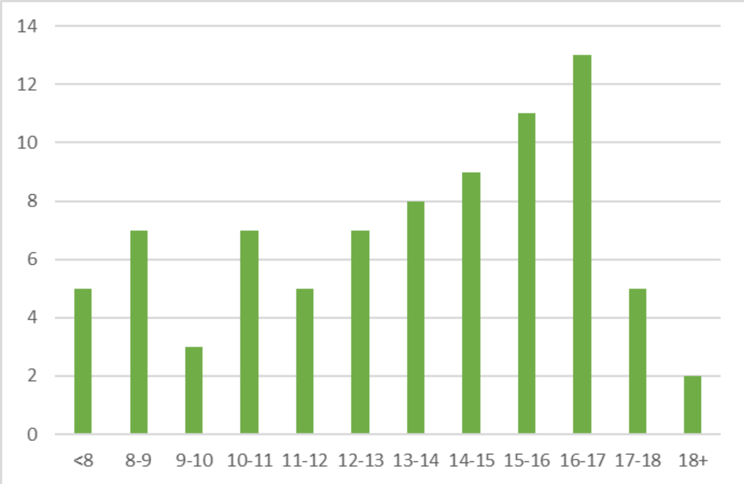

Figure 2: Ages of the students that participated in the testing of the NBS LS. Some classes covered several age groups

The LS were mostly tested in Biology and Chemistry classes in secondary (followed by Physics and English classes), as well as Science, for primary education (see Figure 3).

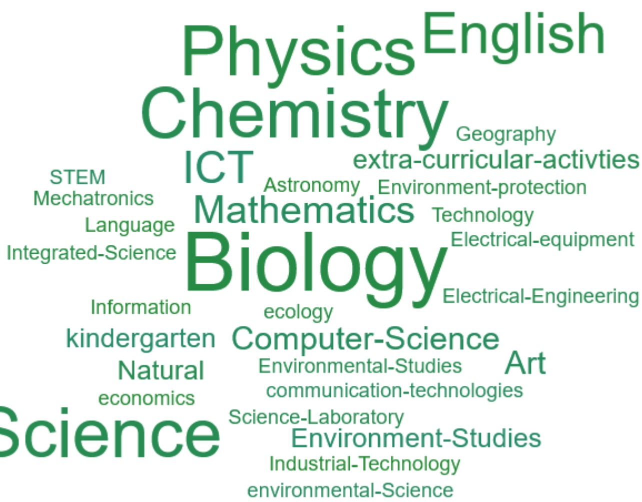

Figure 3: Word cloud showing the subjects in which the LS were tested. The more frequently a word is found, the larger it becomes in the word cloud.

Impact on students and teachers

Three questions in the feedback questionnaire were focused on teachers' perception of the impact on themselves and their students of using the NBS LS.

The first one was directly connected to the use of the developed LS in their classes. The results can be seen in Figure 4.

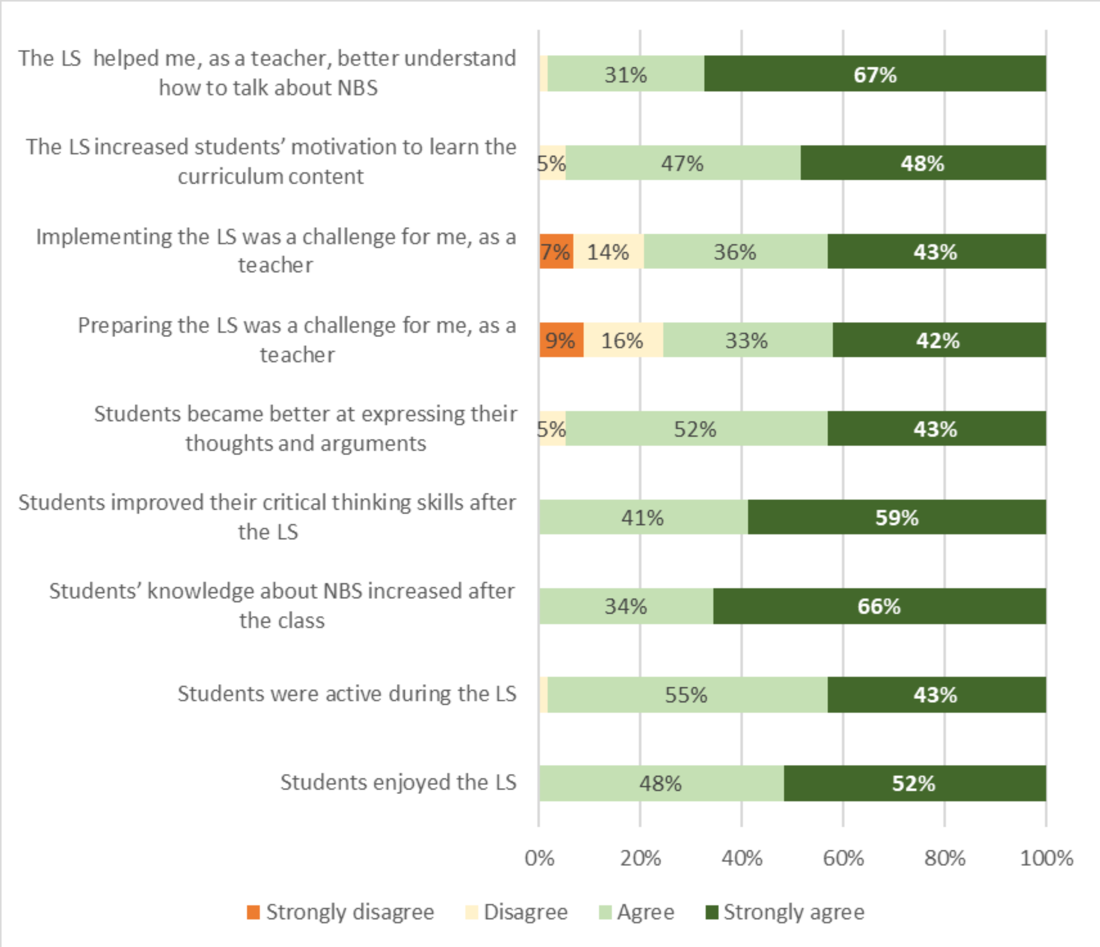

Figure 4: Perception of teachers on impact to themselves and their students of the specific LS used. Teachers had to reply from Strongly Disagree to Strongly Agree to "How much do you agree or disagree with the following statements".

Teachers were unanimous in thinking that, thanks to the LS:

- Students enjoyed the classes in which the LS were implemented
- Students' knowledge about NBS increased after these implementations
- Students improved their critical thinking skills thanks to the LS

Regarding the teachers that disagreed with the statements on:

- Students were active during the LS (1 teacher)
- Students became better at expressing their thoughts and arguments (3 teachers)

In the first case, they suggested to improve the LS by starting with a discussion instead of going straightaway to presenting videos. This recommendation was taken onboard in the final update of the LS.

Regarding the second issue, upon more detailed analysis of the open questions, we concluded that this is related to the way in which the implementation carried out, where remote teaching did not permit live discussions between students.

95% of the teachers agreed or strongly agreed that the LS increased students' motivation to learn the curriculum content (the three teachers of 58 disagreeing added that the students really enjoyed the content but not necessarily the connection with the curriculum as they were "special" classes, e.g. mixed groups due to adaptation of the schedule due to Covid19 or implementing the LS during extracurricular activities).

The statements that showed the largest disparity of answers were:

- Preparing the LS was a challenge for me, as a teacher >> 75% of the testers agreed or strongly agreed
- Implementing the LS was a challenge for me, as a teacher >> 79% of the teachers agreed or strongly agreed

From the review of the comments of the teachers in the open questions, these results turned out to be not about the LS themselves but linked to:

1. Time constraints: the testing took place at the end of the school year and was very tight (which we were already aware of when planning the project, but could not be avoided)
2. Remote teaching in most schools: because of Covid19 (which was unforeseen).

The second question was about the impact of implementing the NBS LS with their students (see Figure 5).

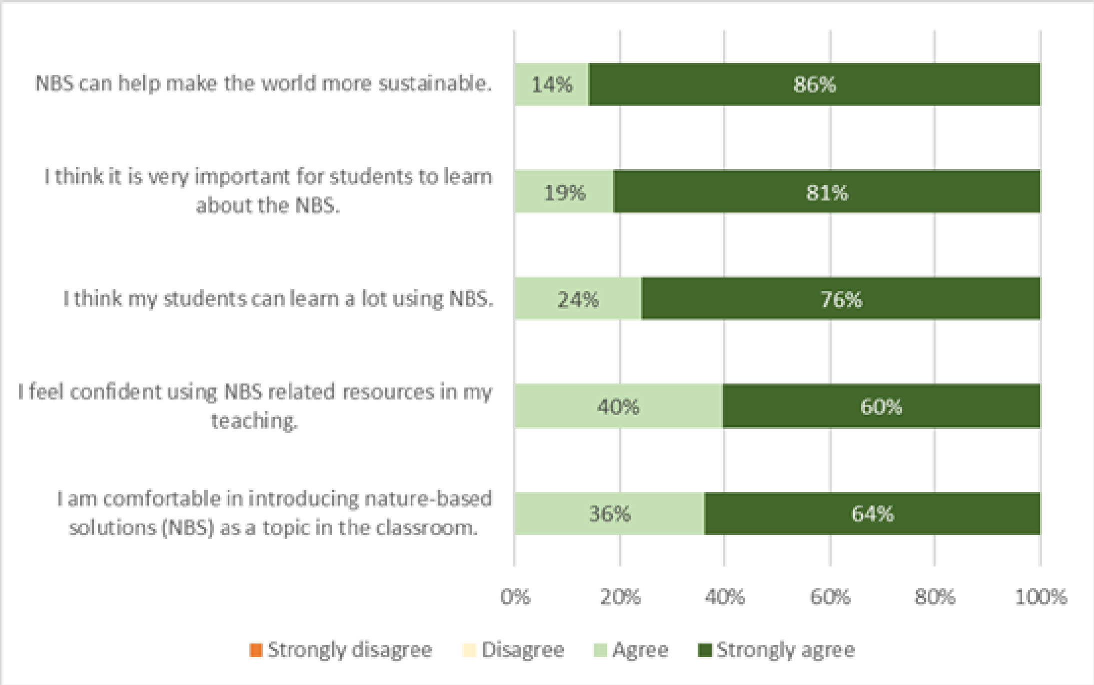

Figure 5: Teachers' perceptions on the impact on themselves and their students on using NBS LS in general.

All teachers agreed or strongly agreed that thanks to the LS:

- They are now more comfortable introducing nature-based solutions (NBS) as a topic in the classroom.
- They are now more confident using NBS related resources in their teaching.
- Their students can learn a lot using NBS.
- They think it is very important for students to learn about the NBS.
- NBS can help make the world more sustainable.

With 86% of the teachers strongly agreeing with this last statement on NBS being able to make the world more sustainable, it would be interesting to do a large-scale pilot in the future including pre- and post-questionnaires on how many teachers (and students) see the benefits of NBS towards sustainability better, as a result of having used NBS LS in their classes.

The third question on impact was on the skills and engagement (students) and development (teachers), of using NBS LS in education (see Figure 6).

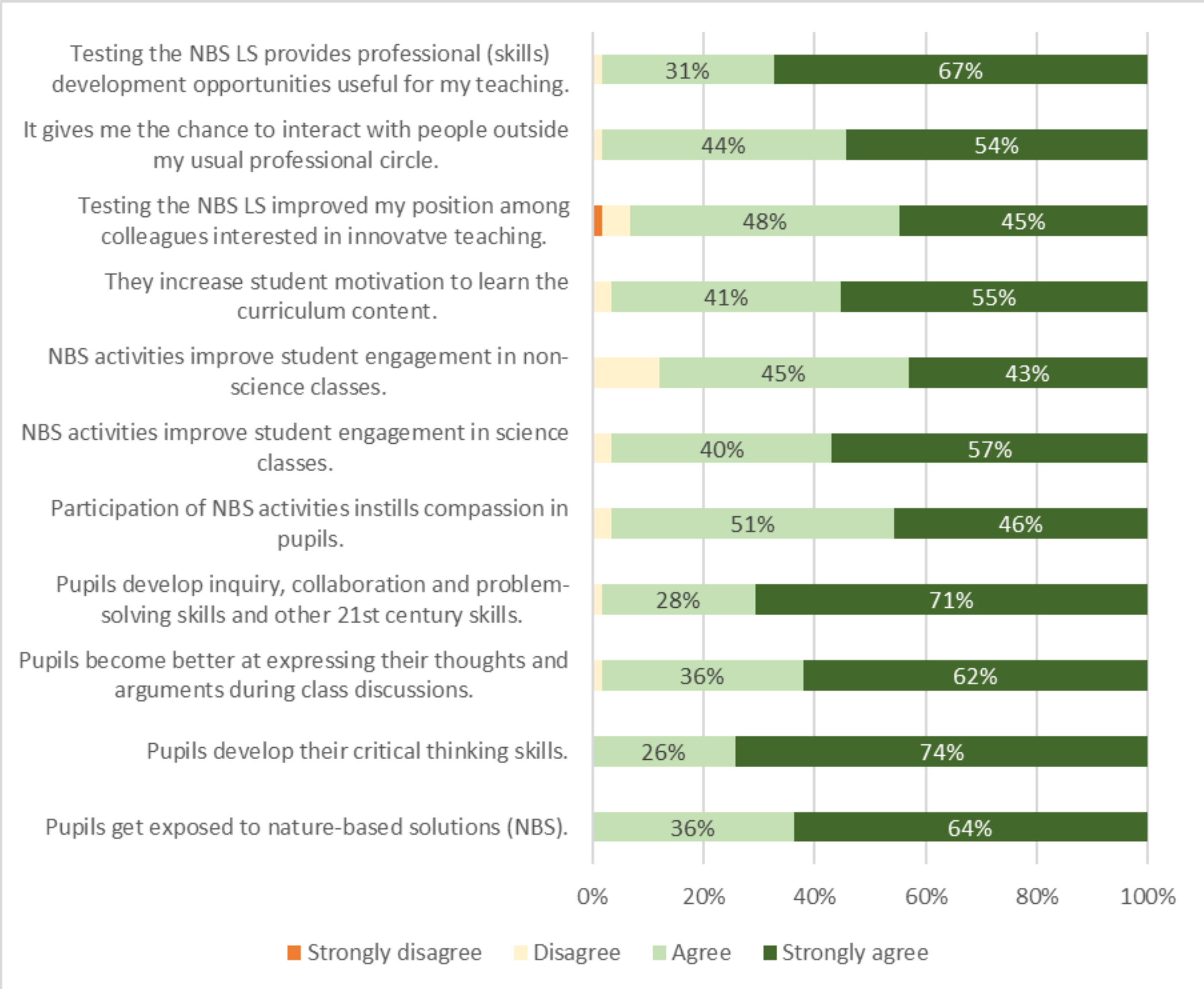

Figure 6: Teacher's perception on the impact of integrating NBS in their classes on the skills and engagement (students) and development (teachers).

Once more, 96% to 100% of the teachers agreed or strongly agreed with the importance of teaching NBS in primary / secondary as a way for:

- Pupils to get more exposed to nature-based solutions (NBS).
- Pupils to develop their critical thinking skills.
- Pupils to become better at expressing their thoughts and arguments during class discussions.
- Pupils to develop inquiry, collaboration, and problem-solving skills and other 21st century skills.
- To instil compassion in pupils.
- Improve student engagement in science classes.

12% (7 teachers) of the teachers disagreed with the NBS LS improving the engagement in non-science classes. But these teachers tested LS designed specifically for secondary education STEM classes, which would be consistent with not seeing the LS having the same effect in non-science classes.

Finally, 7% of the teachers disagreed (3) or strongly disagreed (1) with "Testing the NBS learning scenario improving their position among colleagues who are interested in innovating their classroom teaching". No additional information was provided on why this would be the case, but it would be safe to assume it was due to the lack of time to exchange and share with other teachers their experience.

Main adaptations

We asked teachers to report the type of changes they had to make to the learning scenario they used to adapt it to their own context (see Figure 7; multiple selections were possible).

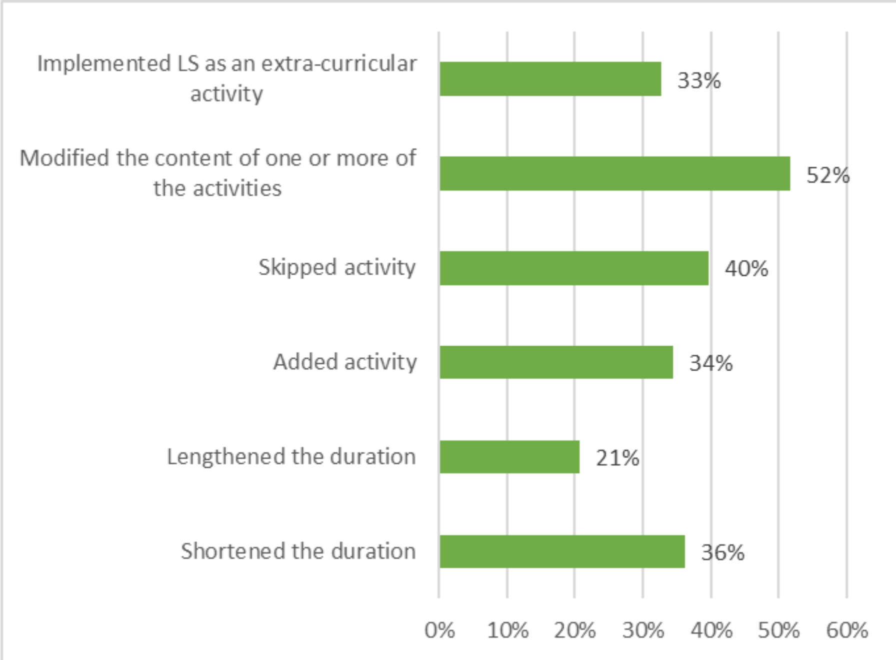

Figure 7: The type of adaptations that teachers had to make to the learning scenarios to use them in class.

Slightly more than 50% of the teachers stated they modified the content of one or more of the activities. This is less than we would have expected, which means the LS were already modular and adaptable enough not to need major modifications.

The most frequent types of adaptations were to "skip an activity" and "shorten the duration", consistent with having to integrate the LS during the end of the academic year and through remote teaching, and also as the length of classes and number of sessions per subject changes depending on the country or even region.

12 teachers (21%) needed more time for some of the activities. On the other hand, 20 teachers (34%) added at least one new activity to better fit the LS with the subject or age group they were teaching. Where indicated in the open comments and the story of implementation, this information was then passed on to the LS authors who integrated the possible extra time needed and suggested additional activities.

Finally, as mentioned, 19 teachers (33%) implemented the LS as an extracurricular activity, indicating that they could not fit it in their own classes at the time, due to the limited time provided for the validation or because they were organising already summer camps (in this latter case, showing that the LS are not only suitable to formal education but also to non-formal education).

CONCLUSIONS AND RECOMMENDATIONS

In spite of the short timeframe for the validation of the LS as well as the move to remote teaching that took education systems by surprise, according to the feedback obtained from the 57 teachers from 19 countries, the learning scenarios were a positive and beneficial experience both for teachers and students, helping both to better understand the importance of NBS.

The authors received personalised reports on improvements to their LS to make them modular, adaptable to different settings and easy to understand and implement. These improvements were added to the final versions of the LS.

All teachers agreed that thanks to using NBS LS in class, the students' enjoyed their classes, increased their knowledge about NBS and improved their critical thinking skills. Furthermore, thanks to the LS developed, teachers felt more confident using NBS related resources in their teaching.

There were, primarily, two common problems encountered when using the LS in classes, other than the move to remote teaching, which goes beyond the LS themselves.

- Having materials mostly in English. The testers are teachers that already have experience with teaching using LS and materials in English. When aiming to have the wider community of teachers use the LS, though, translation is a must. This will be partially addressed when the LS are translated to 12 additional languages and published on the Scientix portal.

- The second issue is having the time to prepare a new topic like NBS and schedule it in the programme for the subjects. Once more, the testers are experienced teachers used to integrating new topics and resources, but even they had issues with this. For most teachers, it is even more important to offer training (e.g. through an online course) and time (teachers usually plan the schedule for their classes months in advance, with smaller adaptations in terms of the resources to be used closer to the days of the lessons).

Finally, teachers shared their enthusiasm about continuing to use the LS developed and consider involving additional teachers. Example quotes from teachers included:

"All the NBS learning scenarios are interesting. In the next school year, I will implement all the scenarios suitable for primary students and I will involve my colleagues in testing and adapting these scenarios in their classes."

"Really glad I participated in this scenario. It opened my students to the outside world, rather than staying on the syllabus. They saw the relevance of Science to help with improving the sustainability of this world. The also saw how science is interconnected, which again is hardly talked about when sticking with the syllabus."

"I really liked the script and I plan to realize it next year […], together with a colleague who works with students aged 9-11."

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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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Education plays a fundamental role in fostering sustainability literacy, and Nature-based solutions (NBS) are an excellent way to address the topic. For this reason, the European Commission worked on Learning Scenarios to address NBS within various educational contexts. Considering the era of unprecedented global changes our societies are experiencing, among which climate change is one of the most notable examples, the urgency of raising awareness and sparking action is ever more prominent. In this context, education plays a fundamental role in fostering sustainability literacy, that is, knowledge about the interplay between nature and society and the exploration of how to develop resilient and inclusive communities. Among other tools, Nature-Based Solutions have emerged as a way to address these needs. Considering the above, the European Commission Directorate-General for Research and Innovation initiated and funded an NBS pilot project coordinated by PPMI, in collaboration with European Schoolnet (EUN), to create Learning Scenarios for teachers to address and include the topic of NBS in different levels of primary and secondary education. The Learning Scenarios were designed by leading teachers from seven countries and tested with over 1,000 students thanks to Scientix. In this validation report we explain the process followed to design and test the Learning Scenarios and share the results obtained. Apart from introducing NBS in class, these Learning Scenarios use innovative pedagogies – such as inquiry-based science education, place-based learning, and eco-pedagogies. As a result, they are exemplary for STE(A)M teaching, that is the interdisciplinary integration of STEM and non-STEM subjects in class. Combining various subjects, from sciences and ICT to languages and politics, provides students with a holistic view on ecological, social and economic issues, and so fosters informed and empowered young citizens.

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