# METHODOLOGIES FOR MONITORING AND EVALUATING STUDENTS' SCIENTIFIC KNOWLEDGE AND 21ST CENTURY SKILLS

Project acronym: OTTER

Project title: Outdoor Science Education for a Sustainable Future

Call: H2020-SwafS-2018-2020

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

| | |
|---|---|
| Project no. | **1010010082** |
| Project acronym: | **OTTER** |
| Project title: | **Outdoor Science Education for a Sustainable Future** |
| Call: | **H2020-SwafS-2018-2020** |
| Start date of project: | **01.09.2021** |
| Duration: | **30 months** |
| Deliverable title: | **Methodologies For Monitoring and Evaluating Students' Scientific Knowledge And 21st Century Skills** |
| Dissemination level: | |
| Due date of deliverable: | **31.05.2023** |
| Actual date of submission: | **31.05.2023** |
| Deliverable Lead Partner : | **University of Limerick** |
| Work Package: | **WP4** |
| Keywords: | **Assessment strategy, monitoring, evaluation, scientific knowledge, 21st century skills, inclusion and diversity** |

Please cite as:
O'Neill D., McCormack O., Kelly R., Azevedo N.H., (2023). D4.3. Methodologies for Monitoring and Evaluating Students' Scientific Knowledge and 21st Century Skills. Ireland. pp.49.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

| Name | Organization |
|---|---|
| Deirdre O'Neill | University of Limerick |
| Orla McCormack | University of Limerick |
| Regina Kelly | University of Limerick |
| Nathália Helena Azevedo | University of Groningen |

| History | | | |
|---|---|---|---|
| **Version** | Date | Reason | Revised by |
| 01 | 16.05.2023 | First draft of deliverable | UL |
| 02 | 25.05.2023 | Review of deliverable | RUG |
| 04 | 30.05.2023 | Final draft of deliverable | UL |

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# Table of Contents




This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## List of Acronyms

| | |
|---|---|
| EOC | Education Outside the Classroom |
| STEM | Science, Technology, Engineering and Mathematics |
| STEAM | Science, Technology, Engineering, Art and Mathematics |
| ACT21S | Assessment and Teaching of Twenty-First Century Skills |
| SDG | Sustainable Development Goal |

## List of Figures



## List of Tables




**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# OTTER project

**OTTER** is a H2020 funded project that aims to **enhance the understanding of Education Outside the Classroom** (EOC) **approaches** and how they can help **improve the acquisition of scientific knowledge and transferable skills in students**, **specifically in the field of environmental sustainability and the reduction of plastic waste**. It aims to increase interest in scientific topics among young people, while also contributing to the range of innovative educational projects and the increase of scientific citizenship within the EU.

OTTER aims to strengthen educational outside-the-classroom (EOC) **networks within Europe**, connecting experts from four different regions within the continent (**Finland, Hungary, Ireland and Spain**). The strengthening of these networks will be utilised to carry out a programme of EOC pilot schemes and an analysis of the effect they have on the performance of participating students, including their levels of sophisticated consumption and scientific citizenship, to increase understanding of the effects of education outside the classroom on EU citizens. The pilot schemes will share a common theme revolving around issues of plastic waste and recycling in order to build upon recent momentum in tackling related global educational, social, and environmental issues and due to the close relationship between reducing plastic waste and the need for more sophisticated consumers.

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# Project Consortium

Geonardo Environmental Technologies **(GEO)**

European Science Foundation **(ESF)**

University of Groningen **(RUG)**

University of Limerick **(UL)**

Learning Scoop - oppimisen osuuskunta **(LS)**

The Big Van Theory **(TBVT)**

Center for the Advancement of Research & Development in Educational Technology **(CARDET)**

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# Executive Summary

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## 1.1 About this Deliverable

This deliverable set out to develop a methodology to monitor and evaluate the project outcomes in terms of students' scientific knowledge and 21st century skills. In the first section, specific **OTTER Lab learning objectives** were established to align with:

i) the overall project outcomes,

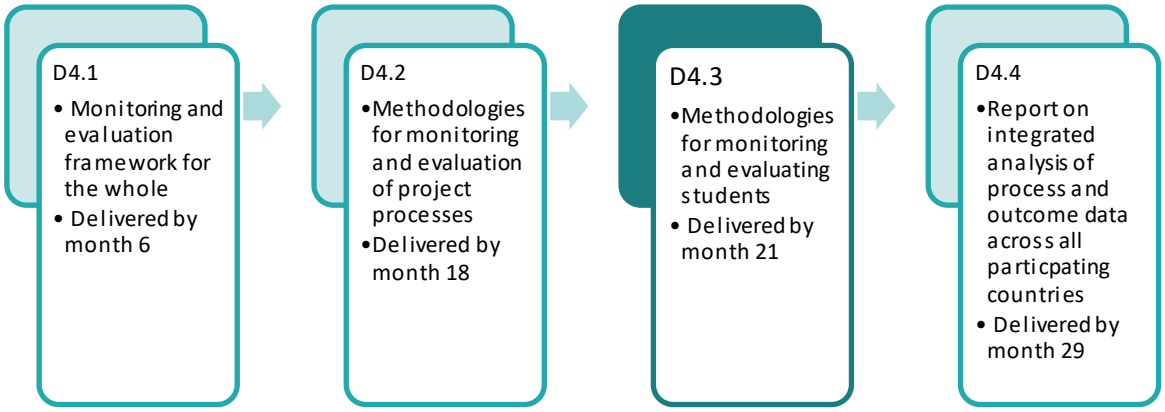
ii) research questions posed in D4.1 and

iii) findings from the literature in D2.1.

In the second section, consideration of the OTTER Lab methodology in D3.3 was essential in deciding a suitable methodology for **implementing the assessment strategy** and lend to an approach that complemented the implementation of OTTER Labs and research outputs for the project. The following sections describe each of these steps and the overall monitoring and evaluating of students' scientific knowledge and 21st century skills.

The third section outlines a range of **assessment tools** that were identified (in D4.1) to provide evidence to answer these research questions. These assessment tools were mapped onto the OTTER Learning Objectives and overall project outcomes and based on this selected to become part of the assessment strategy.

*Figure 1: Deliverables of WP4 emphasisng the third one described in tthis document*




This is the third deliverable from OTTER's Work Package 4 (D4.3 – See Figure 1). The D4.1 Monitoring and Evaluation Framework proposed an overarching monitoring and evaluation structure to conduct future OTTER activities. Deliverable 4.1 presented an integrated evaluation outline based on this premise and was designed around impact categories according to the public and professional audiences (See D4.1). It focused on a broader conceptual and methodological approach for the project. Deliverable D4.2 outlines specific tools for the evaluation of the project processes. Both of these deliverables informed this deliverable, D4.3, in designing a methodology for assessing students' scientific knowledge and 21st century skills.

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# OTTER Lab Learning Objectives

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482



Photo by Allan Mas

## 1.2 Background

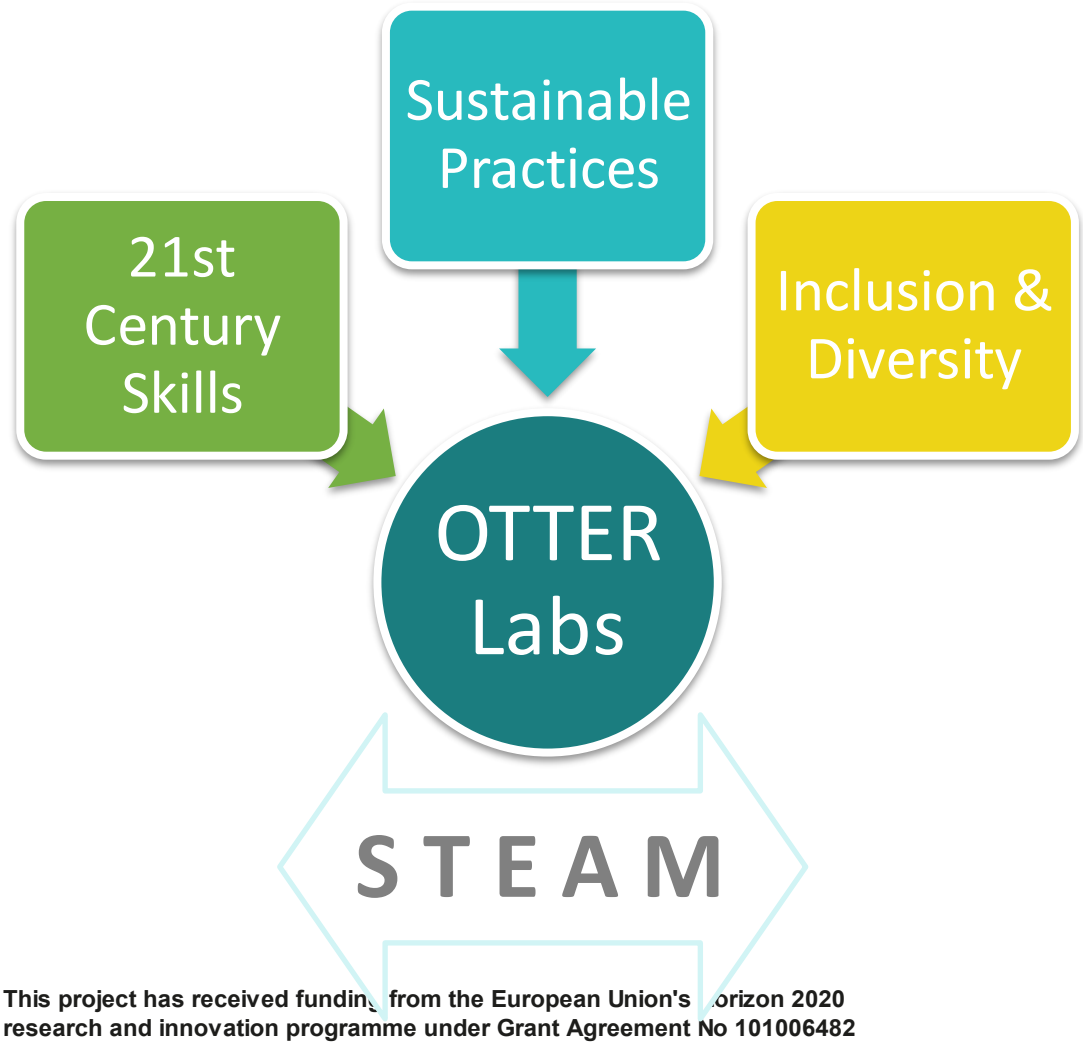
Understanding the practices and processes of science are essential to engage with many of the issues confronting contemporary society, to develop an awareness of the complex interactions among science, technology, society, education and environment, and furthermore, to prepare students to be responsible, active, moral, civic and scientifically literate citizens (Hodson, 1998; Stocklmayer et al., 2010).

OTTER Labs aim to centralise these issues by designing and planning Education Outside the Classroom practices around 3 key pillars (See Figure 2):

- Sustainable Practices,
- 21st Century Skills,
- Inclusion and Diversity.

OTTER Labs (see D3.3 and D3.4) adopts the STEAM approach as it has proven to foster innovative thinking (Colucci-Gray et al., 2017) to engage students with issues of ethics and responsibility in science and technology and to increase the general interest in science.

*Figure 2: OTTER Labs Design Principles*

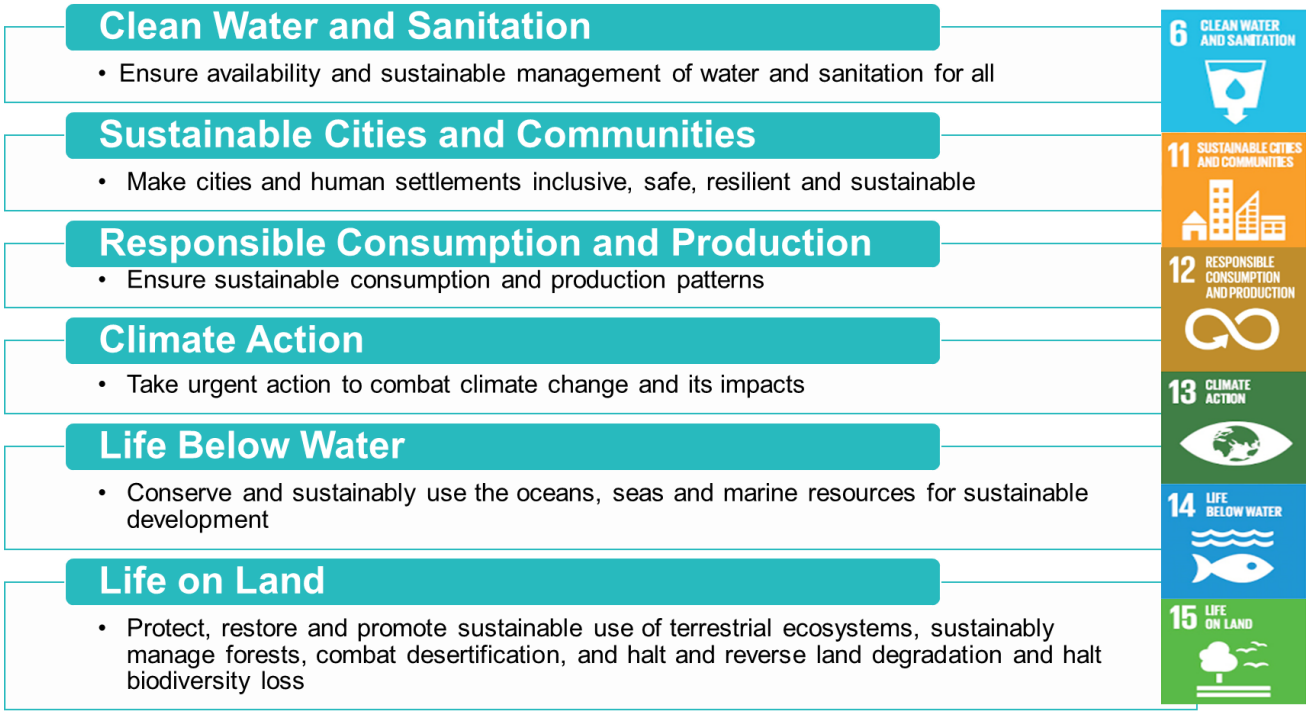



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## 1.2.1 Sustainable Practices

OTTER Labs seek to engage communities by boosting collaboration on science education through an issue that concerns us all. This approach allows us to contribute to what is currently one of the biggest environmental challenges and further pursue the implementation of actions towards the achievement of Sustainable Development Goals (SDGs 6, 11, 12, 13, 14 and 15) (United Nations, 2022). Six SDGswere focusedon in the design of OTTER Labs (See Figure 3). Although these SDGs were the focus of content creation for the labs, they were not exclusive, and teachers were encouraged to integrate connections to any of the other SDGs that were relevant.

Figure 3: Overview of OTTER Lab SDGs




## 1.2.2 Twenty First Century Skills

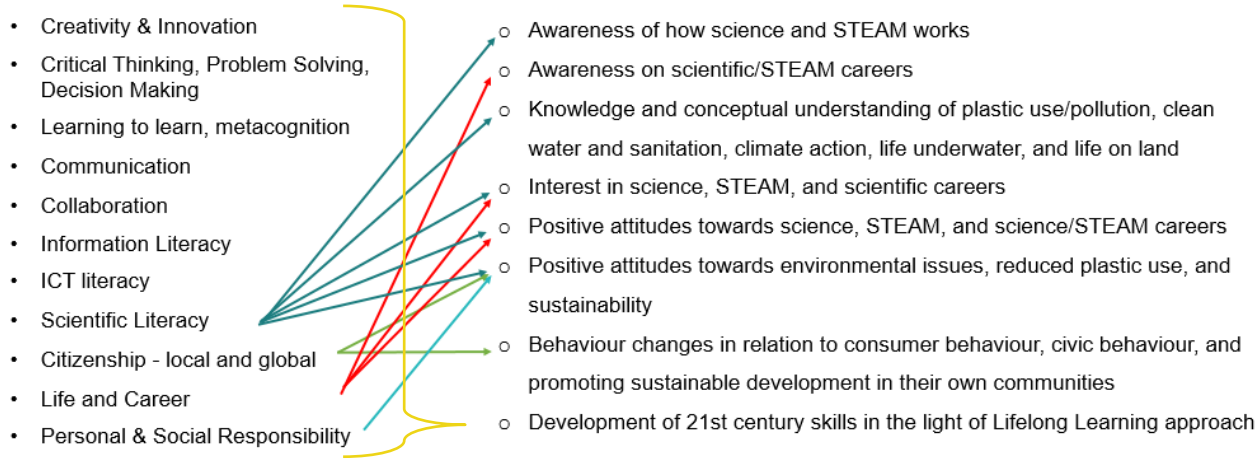
The notion of twenty-first century skills (Council Recommendation of 22 May 2018 on key competencies for lifelong learning 2018/C 189/01) was applied to develop specific measures of transferable skills developed through EOC and regular classroom instruction. We sought to foster holistic development and equip children/youth with a wide range of attributes such as problem-solving, communication, collaboration, and critical thinking. This approach acknowledges that education extends beyond the acquisition of isolated skills and emphasizes the cultivation of well-rounded individuals capable of thriving in diverse environments.

A mapping exercise, of frameworks to enhance 21st Century *Skills*, was carried out onto the OTTER project qualitative targets in order to identify the most suitable framework for this methodology (See Figure 4). It was evident from this exercise that by adapting the Assessment and Teaching of Twenty-

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

First Century Skills (ACT21S) to include Scientific Literacy, it would be an all encompassing approach to evaluating all of the targets set out in the project proposal (Griffin & Care, 2015).

*Figure 4: Mapping of 21st Century Skills to Qualitative Targets*




This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

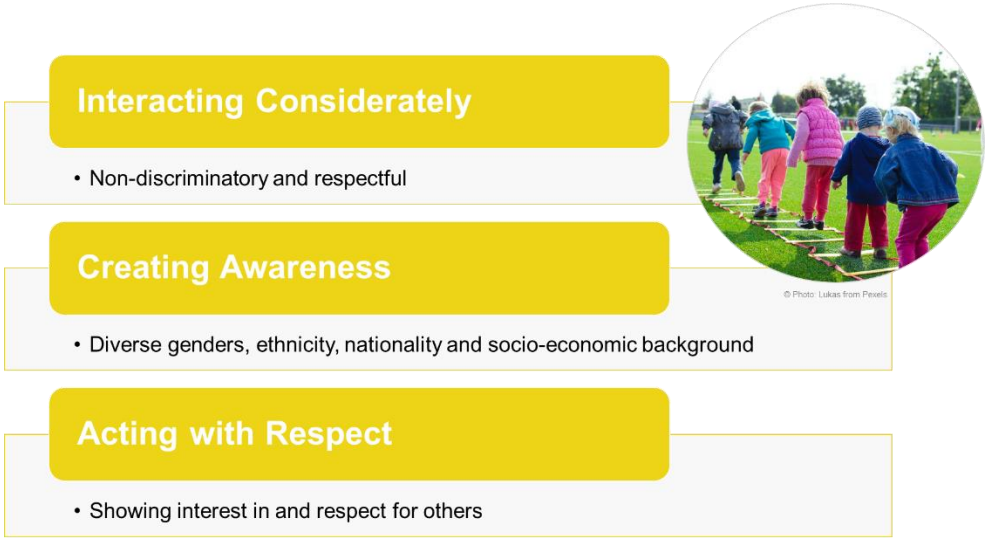
Core features identified by the Assessment and Teaching of Twenty-First Century Skills project (Griffin & Care, 2015) have been adapted to develop OTTER Labs, and include, Ways of Thinking, Ways of Working, Tools for Working and Living in the World (See Figure 5). Teachers are encouraged to choose at least one skill from each of these categories in the design of their OTTER Labs.

*Figure 5: Overview of OTTER Lab 21st Century Skills*

## 1.2.3 Inclusion & Diversity

OTTER focuses on replication of EOC experiences in different geographical and cultural contexts across Europe to include marginalised identity groups and groups with diverse backgrounds which have traditionally been excluded from science. OTTER Labs identify 3 key areas (Interacting Considerately, Creating Awareness, Acting with Respect) necessary in the development of EOC experiences for quality education (See Figure 6). This strand was designed to capture teacher efforts to embed inclusion and diversity at different levels of engagement, depending on their specific contexts and prior experience with issues related to inclusion and diversity. The first refers to students' everyday interactions and teachers' intention to promote a non-discriminatory and respectful classroom. The second level is centered around creating a deeper awareness of issues related to inclusion and diversity. The final level encourages creating opportunities for students to take action and address issues of inclusion and diversity. This approach was inspired by current documents championing the integration of inclusion and diversity such as; Gender Action Schools award (Genderaction, n.d.), EU Commission Gender Toolkit (European Commission, 2011) and Athena Swan Charter (Advance HE, 2023). The sample objectives related to this strand were derived from national wellbeing curriculum of one of the pilot countries (NCCA, 2021) and draw on examples of good practice. The objectives were also shared with the other partners for input or additions related to their particular context. This resource was familiar to teachers in one pilot country and had been tried in the classroom and so was an obvious resource to be adapted for use in the design of the OTTER Labs.

*Figure 6:Overview of OTTER Labs Inclusion and Diversity strand*

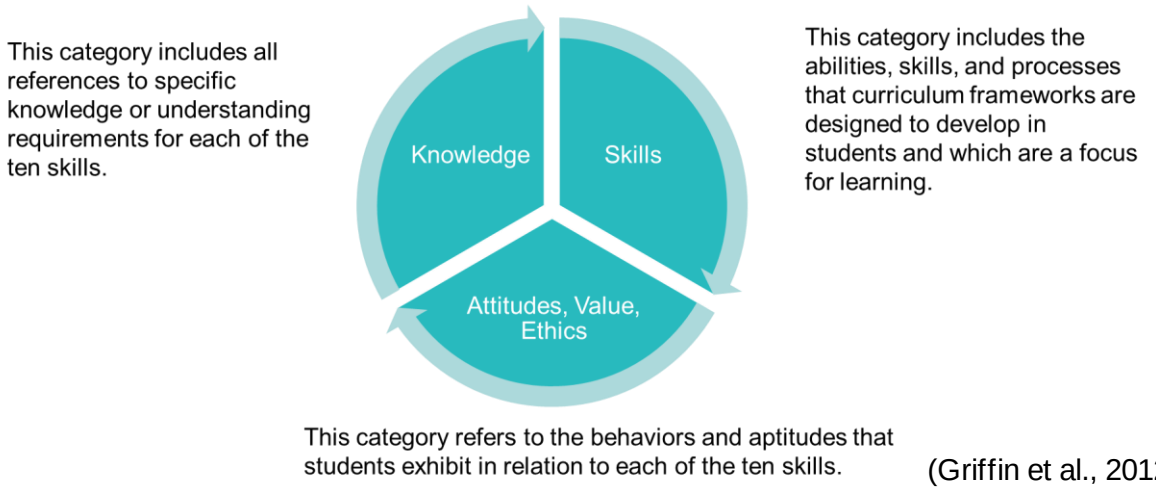



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## 1.3 Writing Learning Objectives

In line with the ATC21S framework to assess 21st century skills (Care et al., 2012), this project highlights the importance of composing learning objectives that impact student's awareness, knowledge and understanding; engagement or interest; attitudes; behavior, and skills during their EOC experience. Using the KSAVE model (Griffin et al., 2011, p.37), OTTER Labs aim to develop learning experiences that capture the holistic nature of learning (See Figure 7). Here, teachers are encouraged to think beyond objectives related to content only. By including a variety of learning objectives around knowledge, skills, attitudes, values and ethics, OTTER Labs aim to provide a more holistic student experience.

*Figure 7:The KSAVE model for writing objectives*




(Griffin et al., 2012, p.37)

### 1.3.4 The OTTER Lab Learning Objectives Tool

The final learning objectives tool (See Figure 8) proposed for OTTER Labs presents a flexible approach to developing suitable learning objectives for OTTER Labs across cognitive, affective, social/interpersonal, and physical/behavioral domains, for a variety of different age groups and align with different country curricula. Teachers are encouraged to identify learning objectives from their usual classroom practice and consider them within the 3 pillars of the OTTER Labs of sustainable practices, 21st Century Skills and Inclusion and Diversity.

This OTTER Lab learning objectives tool can also serve as an auditing tool for teachers to assess if their individual country's curricula can attend to students' acquisition of scientific knowledge (related to the SDGs), 21st century skills and inclusion and diversity. In some cases, it is expected that teachers will see the direct correlation to their own curricula objectives with the OTTER Lab learning objectives. In other cases, teachers will be able to identify gaps that they will need to develop opportunities for students to access particular objectives from the OTTER Lab learning objectives.

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

*Figure 8: OTTER Labs Learning Objectives Tool*

| Broad Pilot Aims | OTTER Lab Outcomes | | Identifying Suitable Learning Objectives from the Curriculum | | |
|---|---|---|---|---|---|
| | | | Knowledge | Skills | Attitudes, Values, Ethics |
| Sustainable Practices | Sustainable Development Goals (related to OTTER) | Clean Water and Sanitation | | | |
| | | Sustainable Cities and Communities | | | |
| | | Responsible Consumption and Production | | | |
| | | Climate Action | | | |
| | | Life Below Water | | | |
| | | Life on Land | | | |
| 21st Century Skills | 1. Ways of Thinking | Creativity and innovation | | | |
| | | Critical thinking, Problem Solving, Decision Making | | | |
| | | Learning to learn, metacognition | | | |
| | 2. Ways of Working | Communication | | | |
| | | Collaboration | | | |
| | 3. Tools for Working | Information Literacy | | | |
| | | ICT literacy | | | |
| | | Scientific Literacy | | | |
| | 4. Living in the World | Citizenship – local & global | | | |
| | | Life & Career skills | | | |
| | | Personal & Social responsibility | | | |
| Inclusion & Diversity | Providing Equal Opportunities for All | Interacting Considerately | | | |
| | | Creating Awareness | | | |
| | | Acting with Respect | | | |

A sample of how the Irish curriculum (one of the pilot countries) could be applied to the OTTER Lab learning objectives was created to aid in the population of the tool (See Table 1).

*Table 1: Mapping of OTTER Lab LOs to Irish Biology Syllabus*

| Broad Pilot Aims | OTTER Lab Outcomes | | Identifying Suitable Learning Objectives from the Curriculum | | |
|---|---|---|---|---|---|
| | | | Knowledge | Skills | Attitudes, Values, Ethics |
| Sustainable Practices | Sustainable Development Goals | Life Below Water | 1.4.9 (Bio) Human Impact on an Ecosystem<br><br>Outline of any one practice from one of the following areas: agriculture, fisheries, or forestry.<br><br>"Waste management" – problems associated with waste disposal. Importance of waste minimisation. | | to create an awareness of the application of biological knowledge to modern society in personal, social, economic, environmental, industrial, agricultural, medical, waste management and other technological contexts |
| 21st Century Skills | 1. Ways of Thinking | Critical thinking, Problem Solving, Decision Making | 1.1.2 (Bio) Process of the scientific method.<br>1.1.3 (Bio) Principles of experimentation.<br>1.5.7 (Bio) Necessity for analysis and assessment of results obtained. | | |
| | 2. Ways of Working | Collaboration | | | to encourage in students an attitude of scientific enquiry, of curiosity and self-discovery through (ii) teamwork |
| | 3. Tools for Working | Information Literacy | | to develop in students an ability to make informed evaluations about contemporary biological issues. | |
| | 4. Living in the World | Citizenship – local & global | 1.5.7 (Bio) Identification of local ecological issues related to the selected ecosystem. | | |
| Inclusion & Diversity | Providing Equal Opportunities for All | | Awareness of diverse genders, ethnicity, nationality, socio-economic background. | Communicate in a non-discriminatory way | Show interest in and respect for others |

Sample Learning Objectives were also been created to support education systems that may not have particular outcomes related to the pillars embedded in their curricula. These samples serve as guidelines for teachers, open to adaptation, for application to their own unique contexts (See Appendix J).

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# Assessment Strategy

**Methodologies for monitoring and evaluating students' scientific knowledge and 21st century skills**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482



Photo by Artem Podrez

## 1.4 Research Outcomes

### 1.4.5 Target Group

The methodologies for monitoring and evaluating students' scientific knowledge and 21st century skills deliverable focusses primarily on **teachers** and **their students** participating in the OTTER Labs. Students in the **experimental** and **control** groups will be matched as far as possible on relevant characteristics to enable valid comparisons between scientific knowledge and skills (e.g., argumentation) and other cognitive, affective (e.g., emotional engagement) social/interpersonal (e.g., collaboration and communication skills) and physical/ behavioral skills they may have acquired.

### 1.4.6 Identification of Intended Research Outcomes

This deliverable leans on the theoretical premise of Constructive Alignment (Biggs, 1996; Biggs & Tang, 2007) to design an assessment strategy for the dual purpose of:

i) facilitating quality teaching, learning and assessment opportunities through the implementation of OTTER Labs (practice) and

ii) providing research insights through the evaluation of OTTER Labs (research). Identifying Intended Research Outcomes

The research approach was designed to complement the work already being carried out by the teachers in the classroom. It was imperative to all stakeholders that assessment, for the purposes of research, could also inform the teacher of student progress and learning.

The first step in developing the assessment strategy, involved aligning key research questions, impact categories and qualitative targets (in D4.1 - Building on the Monitoring and Evaluation framework) related to the target group (See Table 2). This provided clarity and coherency between the research questions and the qualitative targets outlined in the project proposal and helped to inform the Intended (research) Outcomes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

*Table 2: Mapping of Research Questions, Impact Factors and Qualitative Targets*

| Research Questions | Impact Categories | Qualitative Targets |
|---|---|---|
| **How does young people's engagement in the project's activities increase their motivation for learning science?** | • Engagement or interest (in)<br>• Attitude (towards)<br>• Behaviour (related to)<br>• Skills (based on) | • Awareness of how science and STEAM works<br>• Interest in science, STEAM, and scientific careers<br>• Positive attitudes towards science, STEAM, and science/STEAM careers<br>• Development of 21st century skills in the light of Lifelong Learning approach |
| **How does young people's engagement in the activities influence their aspirations for scientific careers?** | • Engagement or interest (in)<br>• Awareness, knowledge and understanding (of)<br>• Attitude (towards) | • Awareness of scientific/STEAM careers<br>• Interest in science, STEAM, and scientific careers<br>• Positive attitudes towards science, STEAM, and science/STEAM careers |
| **How does out-of-school learning help build scientific citizenship?** | • Behaviour (related to)<br>• Attitude (towards)<br>• Skills (based on) | • Awareness of how science and STEAM works<br>• Positive attitudes towards environmental issues, reduced plastic use, and sustainability.<br>• Behaviour changes in relation to consumer behaviour, civic behaviour, and promoting sustainable development in their own communities |
| **How does young people's engagement in the project's activities support the development of their knowledge about clean water and sanitation, climate action, life below water, life on land, and plastic pollution?** | • Engagement or interest (in)<br>• Awareness, knowledge and understanding (of)<br>• Skills (based on) | • Knowledge and conceptual understanding of plastic use/pollution, clean water and sanitation, climate action, life underwater, and life on land |

The Qualitative Targets were then translated into Intended Research Outcomes. These were designed to give an overview of what students and teachers could work to achieve. These Intended Research Outcomes were:

IRO1. Describe and explain how science and STEAM works and related career and job opportunities.

IRO2. Analyse issues related to plastic use/pollution, clean water and sanitation, climate action, life underwater, and life on land.

IRO3. Demonstrate behaviour changes in relation to consumer behaviour, civic behaviour, and promoting sustainable development in their own communities.

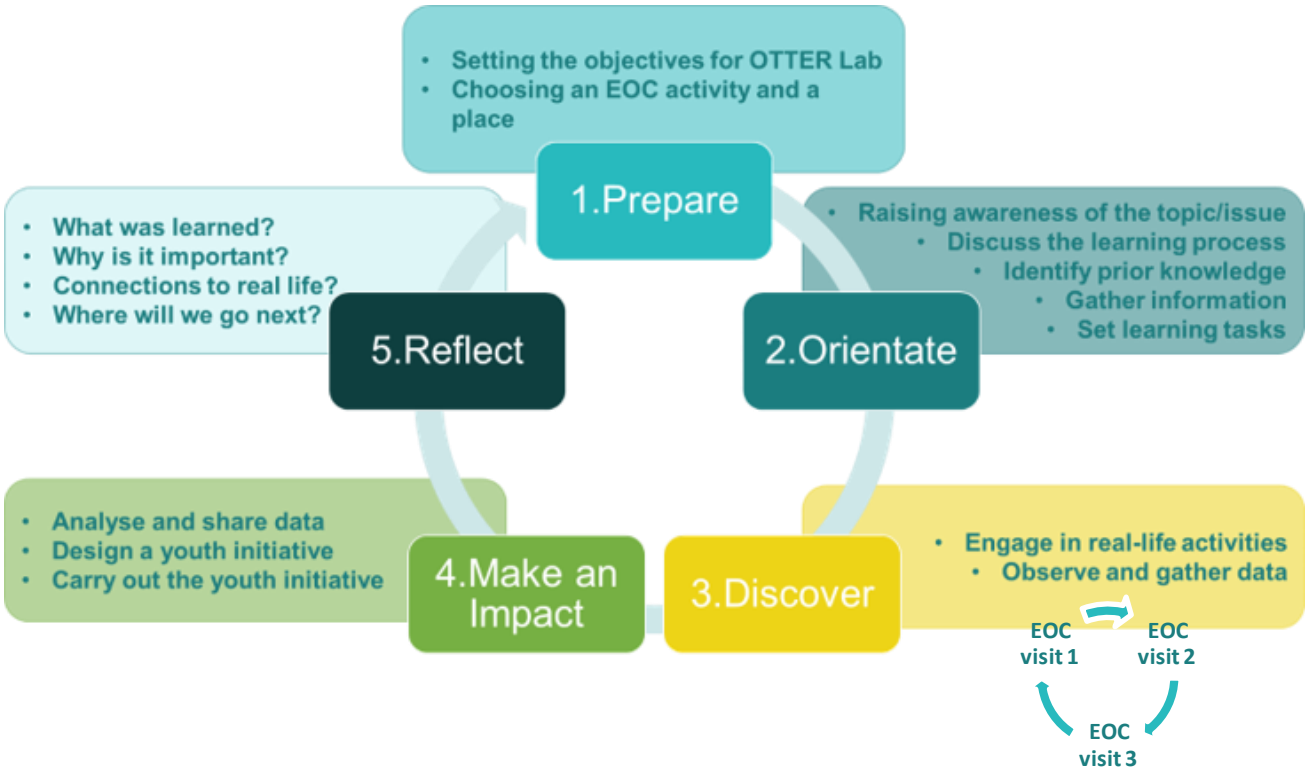
IRO4. Develop 21st Century Skills in light of the Lifelong Learning Approach.

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

## 1.5 Assessment Strategy Implementation Plan

The OTTER Lab methodology is a cycle that lends itself to multiple cycles i.e., multiple EOC visits or iterative cycles of the OTTER Lab for different concepts/cross curricular topics (See Figure 10). The design of the assessment strategy underwent several iterations. Initially conceptualised at the stage of the creation of the OTTER Lab methodology, consultation with partners and pilot teachers also fed into its development.

*Figure 9: OTTER Lab Methodology*

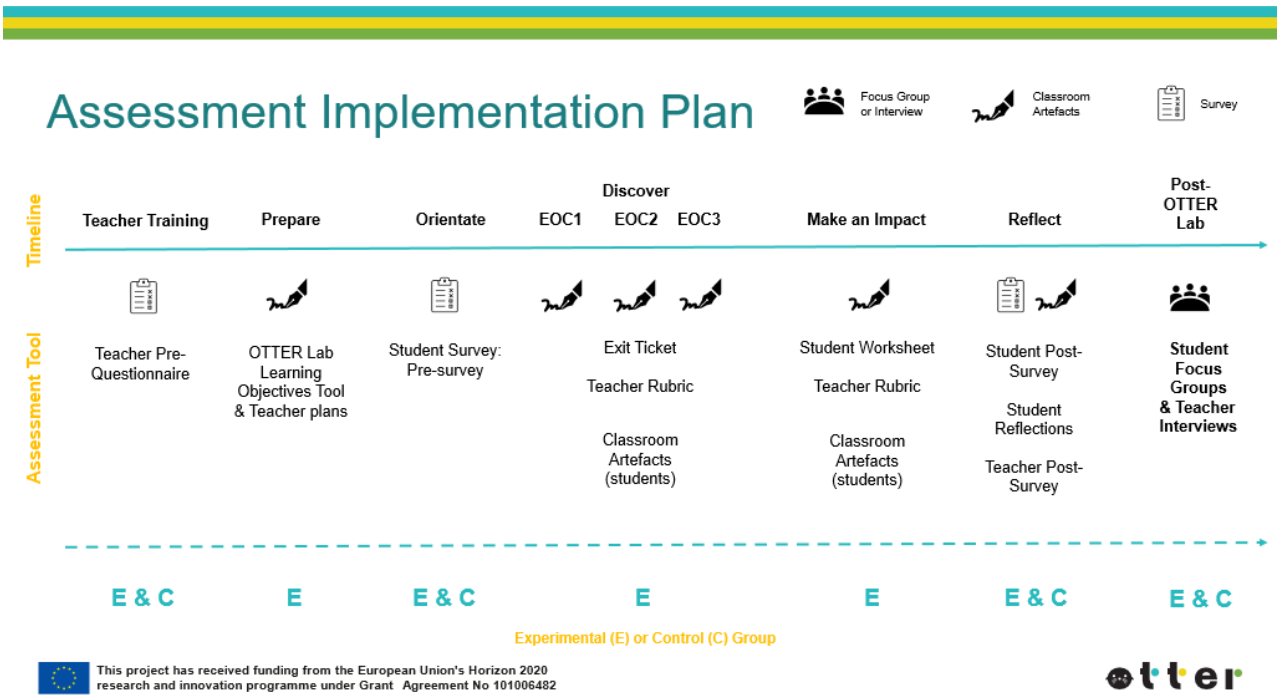



Assessment is implemented at each stage of the OTTER Lab methodology to reflect learning at that particular step. It is intended that the methodology for monitoring and evaluation is ongoing and sustainable process, rather than a one-time intervention. It was imperative that the assessment tools both informed the research outcomes as well as the student learning outcomes. In this way, teachers could see how the tools were also an asset to their own teaching approach.

Considering the broad range of ambitious research outcomes highlighted in this project, the final assessment strategy focussed on snapshot data at each of the steps (of the OTTER Lab cycle) to assess the different research outcomes and triangulate this data with a final data collection point when one full OTTER Lab had been completed by participants (See Figure 11).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

*Figure 10: OTTER Lab Assessment Implementation Plan*




The assessment implementation plan comprised of student focus groups, teacher interviews, quantitative surveys (for teachers and students) and classroom artefacts (student work carried out as part of normal classroom practice, (e.g., student worksheets, exit tickets, presentations, copy work etc.) for the experimental group. The control group participated only in student focus groups, teacher interviews, and quantitative surveys (for teachers and students).

The design of the assessment tools and the implementation plan (detailed in the next section) were developed in parallel. This was to ensure the assessment strategy met the needs of students, teachers and researchers in the process.

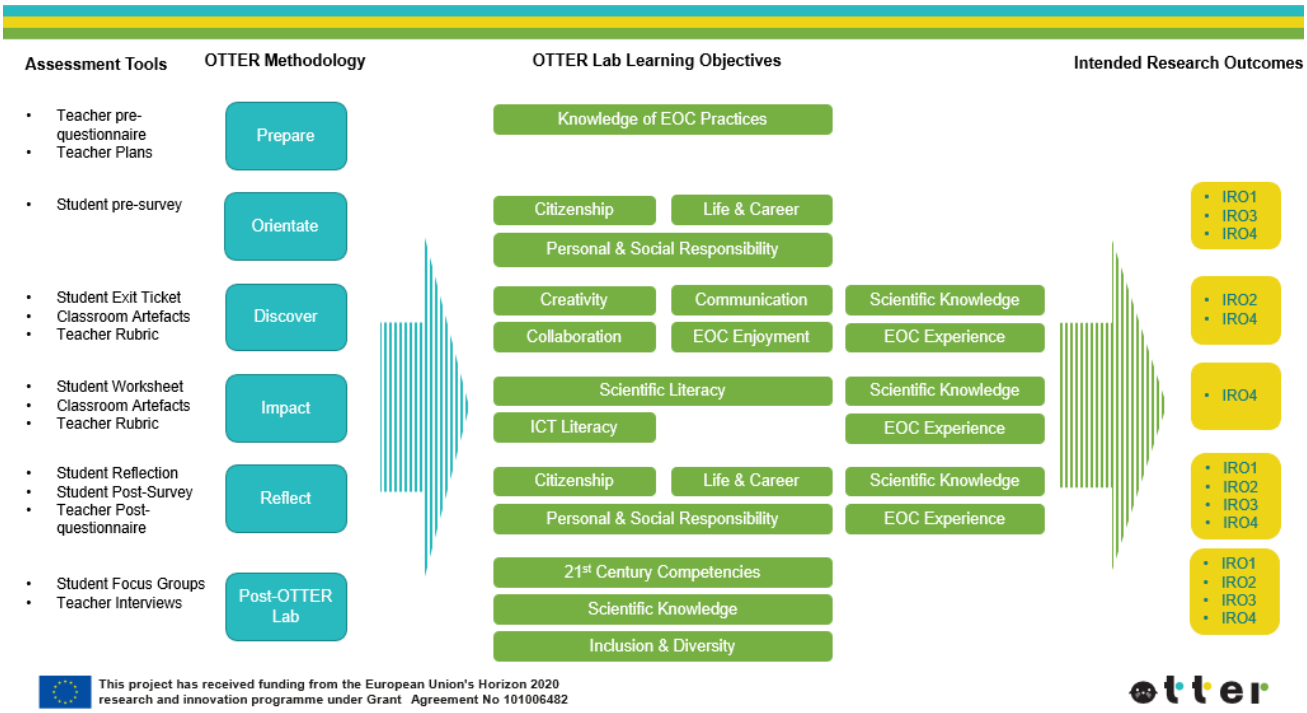
**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

## 1.6 Assessment Tools

A range of research instruments were identified from D4.1 (Table 3, p.19) that could have potential to evaluate OTTER impacts. These tools were selected according to the criteria; students' age, the alignment of the tool to the project objectives, usability, data collection and processing time, reliability of data, and validity of the objectives to be assessed. Further considerations such as translation, implementation across age groups and different country/school contexts were important in the selection and adaptation of research tools for the assessment strategy. The value that quantitative tools could add considering the changing variables across contexts, led to the decision to implement one pre/post survey, exit ticket and teacher rubrics that could be triangulated with qualitative data. The tools used to assess the Intended Research Outcomes (See Section 2.3.8) are detailed below.

The methodology for assessing students' scientific knowledge and 21st century skills proposes a holistic assessment strategy aligned with the OTTER lab learning objectives, methodology and Intended Research Outputs of the project (See Figure 12).

*Figure 11: OTTER Lab Assessment Strategy*




This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## 1.6.1 Prepare

**Teacher pre/post questionnaire**

The teacher questionnaire was designed to i) collect demographic information about the sample and the contexts from which students were positioned and ii) measure the knowledge and skills teachers have acquired throughout the project (as set out in D4.2). The tool was designed to be implemented before and after the OTTER Labs through an online submission. The first section of the questionnaire interrogated information such as the school size, location, socioeconomic background, class size and gender representation. The questions in this section were dependent on the contextual aspects of each country e.g., DEIS schools in Ireland, general, intensified and special support in Finland. Teachers were also invited to share their expectations of the programme. The second part of the questionnaire was a self-reflective piece where teachers were asked to evaluate their knowledge and skills of EOC practices (See Appendix A).

**Teacher Plans**

Teacher planning materials related to the organisation of the OTTER Labs were also collected as part of the assessment strategy. This included a completed OTTER Lab learning objectives tool and any other materials teachers used in the planning.

## 1.6.2 Orientate

**Student Pre-post Survey**

The student survey was adapted from bASES21: A Model for the Self-assessment of 21st-Century Skills in the Context of Computing Education in K-12 (Gresse von Wangenheim et al., 2021). Items from this survey were chosen as they provided the most scope for measuring the many 21st century skills outlined in the OTTER Labs. However, some issues lay in the length of the tool for the purpose of assessing OTTER Labs. As the assessment strategy was focused on assessing the research outputs throughout the implementation of the labs, a long pre-post survey was not desirable as it was seen as cumbersome on the teachers when included with other assessment tools. The decision to shorten the bASES21 assessment tool stemmed from the researcher's priority of having multiple data collection points for triangulation and validation of findings.

Three dimensions of the survey were focused on for the student survey; Citizenship, Social Responsibility and Life and Career (as defined by the bASES21 assessment tool). These parameters were selected to quantitatively measure student competencies, before and after the OTTER labs time was required for these particular aspects of the framework to evolve. Kyllonen (2012) also highlights that 21st century skills involving interpersonal skills may not be sufficiently measured using constructed response type tests and so competencies such as communication, collaboration, creativity, critical thinking were sensible omissions from the survey. Researchers acknowledged the limitations that came with adapting the tool (validity and reliability), however, given the different contexts, age groups and languages, and sample sizes of the participants creating a survey tool that provided insight and was useable by teachers as part of their normal classroom practice added value to both the research process and teaching and learning.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

The final survey tool (see Appendix B) consisted of 21 items measuring Citizenship (n=6), Life and Career (n=6) and Social Responsibility (n=8) for 9-18yr old students. The survey tool for 6-8yrs was further shortened to 6 items measuring Citizenship (n=3), Life and Career (n=2) and Social Responsibility (n=2). The tool was translated for the pilot countries and available in the languages; English, Finnish, Hungarian and Spanish. The tool was then converted into a digital tool to be implemented in the classroom.

### 1.6.3 Discover

**Exit Ticket**

Part of the innovative solution to measure 21st Century Skills (Kyllonen, 2012) was to adapt quantitative tools to useful classroom tools that could inform the teacher of student progress and provide a snapshot of student competencies at that point in time. Exit tickets were designed to be carried out at the end of an EOC visit to measure enjoyment of the visit. Adapted from the Test of Science-Related Attitudes (TOSRA), items within the Enjoyment of Science subscale (Navarro et al., 2016) were adapted to provide insight around student's enjoyment of science outside the classroom. The final tool (See Appendix C) consisted of 10 true/false items related to learning science and science outside the classroom (for 9-18yrs). One open question was also included to allow students to share any additional thoughts about learning science outside the classroom. The tool was further shortened (n=5) for the 6-8yr old students and the open question was omitted. All of the tools were available in the languages of the pilot countries.

**Rubrics**

A teacher rubric was also created from quantitative tools to assess students' collaboration (n=6), communication (n=3) and creativity (n=5) after their visit to an EOC site (See Appendix D). Adapted from Kelley et al., (2009), 14 items were selected as the most suitable items to transform into a usable tool for practitioner inquiry and research insights.

**Classroom Artefacts**

As mentioned previously, it was important to capture what was naturally happening as part of teachers' normal classroom practice. Classroom artefacts constituted any materials that students were working on as part of the OTTER Labs e.g., Voice recordings of student discussions, Essays/Long answered questions, Brainstorms/concept maps, Presentations, Diagrams, Podcasts, Post-its, Worksheets or other classroom documents. This type of data provided an opportunity to capture the unique approaches that teachers took to the OTTER Labs that might not otherwise be documented.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## 1.6.4 Make an Impact

### Classroom Artefacts

As in the Discover step, classroom artefacts constituted a large part of the data collection for Make an Impact. Here, students were creating their own unique artefacts that provide insight into many of the intended research outputs.

### Student Worksheets

Although teachers assess their students as part of normal classroom practice, researchers saw a need to further investigate competencies such as ICT literacy. Development of a worksheet stemmed from the identification of overlapping indicators of scientific literacy (OECD, 2019) and ICT literacy (Wilson et al., 2016). Those indicators of ICT that were not already being measured through scientific literacy, formed the basis of the design of the student worksheet to accompany the Make an Impact step of the OTTER Lab (see Appendix E). They include; Conducting searches suited to personal circumstances, Understanding and using architecture of social media, Selecting appropriate tools and strategies.

### Rubrics

A teacher rubric was created from adapting items in OECD (2019) Assessment and Analytical Framework related to measuring scientific literacy after the youth initiative in the Make an Impact stage of the OTTER Lab. This tool (See Appendix F) focused specifically on explaining phenomena scientifically (n=6), evaluating and designing scientific literacy (n=4) and interpreting data and evidence scientifically (n=3). Each item was assessed by teachers based on the depth of knowledge as defined by the Pisa 2018 Science Framework:

- **Low (L)** Carrying out a one-step procedure, such as recalling a fact, term, principle or concept or locating a single point of information from a graph or table.
- **Medium (M)** Using and applying conceptual knowledge to describe or explain phenomena; selecting appropriate procedures involving two or more steps; organising or displaying data; or interpreting or using simple data sets or graphs.
- **High (H)** Analysing complex information or data; synthesising or evaluating evidence; justifying; reasoning given various sources; developing a plan or sequence of steps to approach a problem.

## 1.6.5 Reflect

### Reflections

Student reflective tools were also created to provide insight into student's experience of EOC and knowledge gained through EOC (see Appendix G). Reflection is a core aspect of all teacher's practice and so this tool was already familiar to pilot practitioners and in some cases was already happening as part of normal classroom practice.

### Student Post-Survey

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

Students also completed the post survey as described in Orientate step.

**Teacher Post-Questionnaire**

Teachers competed a post questionnaire at the end of the OTTER Lab cycle as in the Prepare step.

### 1.6.6 After the OTTER Lab Cycle

**Interviews & Focus Groups**

It was important in designing assessment tools that the teacher and student perspective of learning through OTTER Labs was captured. For this reason, one-to-one interviews with pilot and control teachers were developed to assess all of the Intended Research Outcomes and triangulate with the previous data collection points. Semi-structured interviews were designed that probed teachers' reflections on the OTTER Lab process in relation to; planning, content, pedagogy, challenges, collaborations and impact of the project (See Appendix H).

Student focus groups were designed with a similar aim; to investigate student experiences of the OTTER Lab process. Semi-structured questions were developed to probe the experimental group about their youth initiative and their experiences throughout the OTTER Lab (See Appendix I). The protocol for the control group focus group was developed using similar questions but instead focusing on a topic they were learning as part of normal classroom practice during the same time period.

## 1.7 Ethics

The OTTER project endeavored to ensure that all research carried out was ethically sound and adhered to the highest standards of research integrity. OTTER project evaluations will recruit participants according to the principles of privacy and freedom. This means that we will collect only data relevant to the project, ensure confidentiality in using personal data, and that participation in research and evaluation activities will be voluntary. Participants will also be informed about the project and the implications of participating in the evaluation and research stage. Furthermore, all participants will be provided with an informed consent form in language suitable for the audience. Finally, these practices will be ensured by the internal ethics committee of the project at all stages of the evaluation of partnerships and collaborations. The project follows EU standards regarding external ethical approvals, as indicated in D7.1 and D7.2. Additionally, it has received ethics approval from the University of Groningen (CETO #85494053) and the University of Limerick (2023_01_04_EHS) and a research permit from Finland. The collection, processing, preparation, analysis, and publication of the data resulting from these evaluations will also follow the principles and actions indicated in D1.4 Data Management Plan.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## 1.8 Gender Strategy

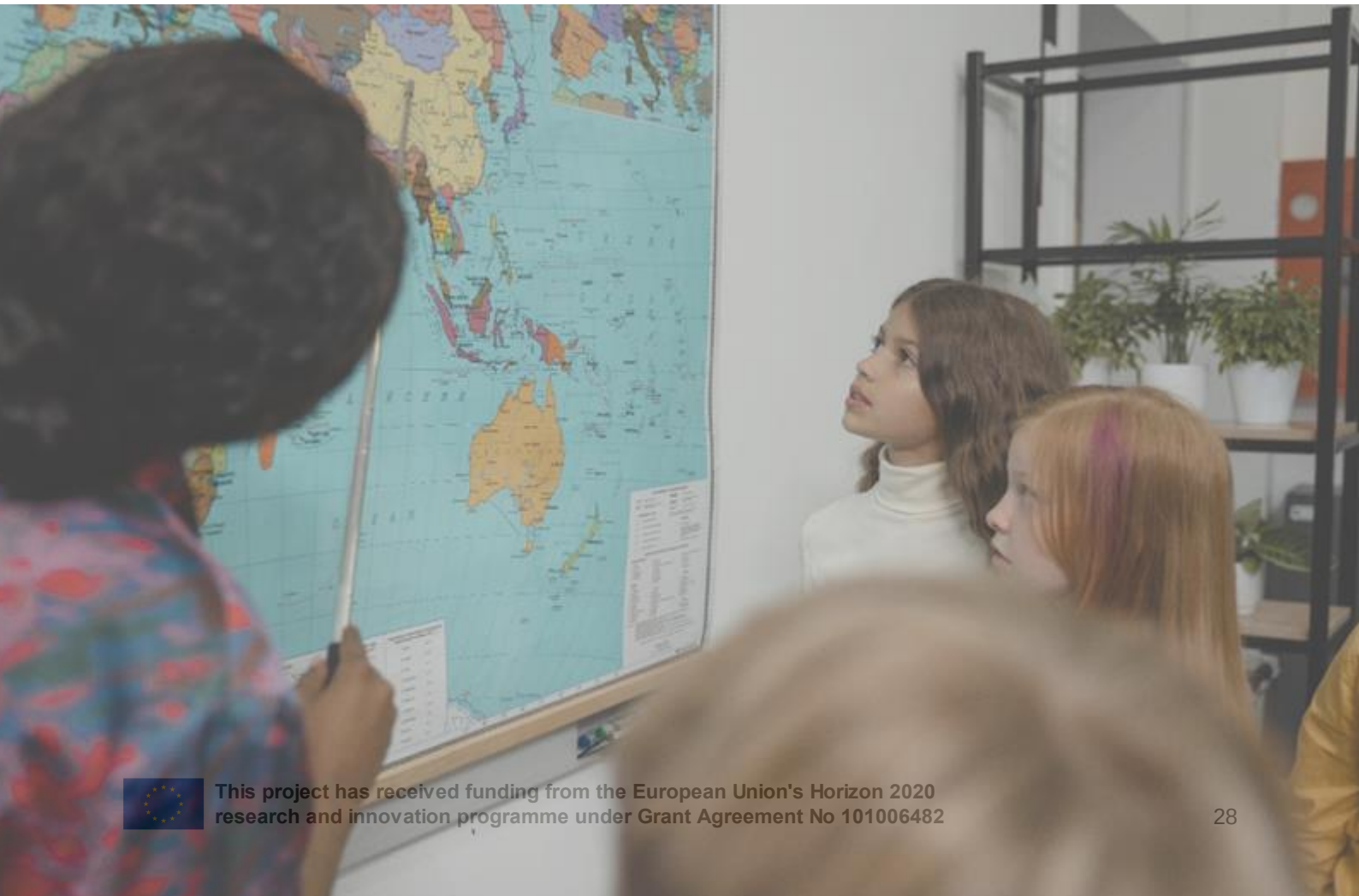
This deliverable sought to embed principles set out in **D1.3 Gender Strategy**. The following is a list of the principles and principles of practice taken into consideration in the development the assessment strategy (See Table 3).

*Table 3: Overview of Principles of Practice related to D4.3*

| Principle | Principle of practice | Evidence |
|---|---|---|
| **[1] Gender is a cross-cutting theme across all dimensions of the project** | • Participating teachers and students, are made aware of the gender strategy and are explicitly informed how this gender strategy informs the practice of all aspects of the project | Inclusion and diversity were embedded as a key objectives in the design of OTTER Labs. |
| **[3] All research conducted throughout the project is gender-sensitive…** | • The relevance of gender to the research topic is considered<br>• Literature and other sources are reviewed for gender differences in the research field | Literature was used to inform the OTTER Lab learning objectives related to inclusion and diversity. |
| | • The research methodology ensures that (possible) gender differences are investigated | Teachers are encouraged to be aware of how they might integrate objectives related to gender, gender equality and differences across genders by using the OTTER Lab learning objectives tool in their planning. |
| | • All research instruments are designed to explore potentially relevant sex and/or gender differences in the data collection<br>• Gender neutral language is used in the design of all research instruments | All research instruments consider the range of genders that may be represented by the cohort and allow participants to exhibit what gender they identify through open answer questions. All research instruments collect data related to gender. |
| **[4] Teaching, learning and assessment activities and pedagogical approaches developed and conducted throughout the project are gender-sensitive** | • Teaching, learning, and assessment activities support the inclusion of all students and teachers in the activities | Assessment activities are designed to compliment normal classroom practice and represent the teacher and student perspectives in an inclusive manner |
| | • Images and resources used within teaching, learning and assessment resources provide a balance of genders | Images used on the pre and post surveys were selected to represent student diversity |
| | • Communication and language is non-discriminatory and makes genders visible when relevant | All research instruments were designed to avoid gender biased expressions |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

# Final Considerations



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## 1.9 Challenges and Solutions

### 1.9.7 Timeline

The timing of this deliverable was an important consideration. As the assessment methodology had a later timeline than the commencement of the pilots, implementation of pilots had commenced before the assessment strategy was finalised.

This challenge was foreseen and discussions around the assessment methodology began in the early stages of the pilot design. With the cooperation of pilot partners, the implementation of the assessment strategy began as it was being finalised for this report. It must also be noted that pilot partners appreciated the research approach and valued that the assessment provide an authentic representation of the work that teachers and students were engaging in as part of the OTTER lab. For this reason, communication and collaboration between pilot partners and the research team was essential in delivering a high-quality assessment strategy. Future consideration of the alignment of pilot design and development of the assessment methodology would provide a more seamless interaction between the two processes.

### 1.9.8 Validity, Reliability and Quality of Assessment

One main concern that the researchers had in the development of the assessment methodology, was capturing the essence of the OTTER Lab process. Providing a holistic assessment strategy that reflected the nuances of how the OTTER lab was implemented in each of the different contexts (countries and age groups) as well as capture the process at each step of the OTTER lab cycle was a priority in the development of the assessment methodology.

To ensure high quality assessment of the OTTER Labs, and maintain validity and reliability of the research process, data collection and assessment was embedded at each step of the OTTER Lab cycle. The assessment strategy was aligned with the Lab teaching and learning objectives as well as the intended research outcomes. Multiple data sources were also adopted to ensure the validity, reliability, and quality of the assessment in capturing the essence of the OTTER Lab process. Alongside quantitative measures, qualitative data sources were incorporated, including project artifacts, and interviews. Triangulating data from these diverse sources will provide a comprehensive understanding of participants' engagement, learning progress, and the contextual nuances of the OTTER Lab implementation across different countries and age groups. This approach will allow for a richer analysis and interpretation of the assessment data, strengthening the overall credibility and robustness of the research findings.

### 1.9.9 Facilitating assessment

There were two main challenges associated with the implementation of the assessment methodology presented in this report, 1) Ensuring common practice and consistency with all partners and 2) Maintaining objectivity.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

The researchers were concerned that not all of the assessment tools would be implemented by experts in the field. This challenge could lead to inconsistent or missing data. To combat this, guidelines for partners and teachers were created to ensure that all pilots approached the assessment methodology in a similar way. These guidelines contained specific step-by-step instructions with embedded links to navigate the tools and in some cases sample videos to describe the data collection process e.g., conducting a focus group. The lead researchers (UL & RUG) also provided online "*question and answer*" sessions for partners to talk through their approach or concerns. The research teams also remained available by email to answer concerns of this nature. However, this approach is still open to inconsistent data collection between countries and is acknowledged as a limitation.

Maintaining objectivity was mostly associated with the data collection related to the student focus groups and the teacher interviews. This was mitigated through the assigning of pilot partners (rather than teachers) to conduct the student focus groups. Pilot partners also conducted the teacher interviews and where possible, in a team of more than one, the partner who had less communication with teachers (were not the main coordinator) conducted the interviews. This approach allowed students and teachers to give more honest answers.

## 1.10 Next Steps

The challenges (outlined previously) and the valuable insights gained from the implementation of the assessment methodology will inform adjustments for future OTTER Labs, implemented beyond the project's duration. Recognizing the importance of common practices and consistency across partners, the research team has learned the significance of providing comprehensive guidelines to ensure uniformity in the assessment approach. Moving forward, these guidelines will be refined based on the experiences shared by partners, incorporating step-by-step instructions and resources to facilitate teachers/educators' evaluation. By implementing these adjustments and incorporating the lessons learned, future OTTER Labs will benefit from an enhanced assessment methodology that promotes consistency, objectivity, and the generation of valuable data for research and improvement purposes.

The next steps following the assessment methodology will involve:

- Continuing the coordination of all assessments in each of the pilot countries and
- Conducting the analysis and synthesis of monitoring and evaluation results, including a perspective on gender and geographical differences

Data informing process assessments (D4.2) will be gathered throughout the project and outcome assessments (presented in this deliverable D4.3) will be conducted in each of the four participating countries. Students in the experimental and control groups will be matched as far as possible on relevant characteristics to enable valid comparisons between scientific knowledge and skills (e.g., argumentation) and other cognitive, affective (e.g., emotional engagement) social/interpersonal (e.g., collaboration and communication skills) and physical/behavioural skills they may have acquired.

This integration of quantitative and qualitative findings across all participating countries will then be carried out through the analysis and synthesis of monitoring and evaluation results. Analysis of similarities and differences will highlight areas where EOC might have complemented classroom activity or led to learning that did not happen in the classroom. The analysis and triangulation of data (e.g., quantitative and qualitative) will also investigate relationships between gender and geographical location in terms of students' learning outcomes and intended research outcomes.

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# Bibliography


Advance HE. (n.d.). *Athena Swan Charter | Advance HE*. Retrieved May 30, 2023, from https://www.advance-he.ac.uk/equality-charters/athena-swan-charter#diversity-monitoring-data

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, *32*(3), 347–364.

Biggs, J., & Tang, C. (2007). Teaching for quality learning at university. 3rd. *New York*.

Care, E., Griffin, P., & McGaw, B. (2012). *Assessment and teaching of 21st century skills*. Springer.

Colucci-Gray, L., Trowsdale, J., Cooke, C. F., Davies, R., Burnard, P., & Gray, D. S. (2017). *Reviewing the potential and challenges of developing STEAM education through creative pedagogies for 21st learning: How can school curricula be broadened towards a more responsive, dynamic, and inclusive form of education?*

Dept. of Education and Skills. (2015). *Junior Cycle Science Curriculum Specification*. https://www.curriculumonline.ie/getmedia/f668d804-6283-4d4a-84ab-c71e5b37d198/Specification-for-Junior-Cycle-Science.pdf

European Commission. (2011). *Toolkit Gender in EU-funded research*. https://doi.org/10.2777/62947

Genderaction. (n.d.). *Challenging stereotypes in nurseries, schools and colleges*. GENDER ACTION SCHOOLS AWARD. Retrieved May 30, 2023, from https://www.genderaction.co.uk/getting-started

Gresse von Wangenheim, C., Degering, L. P., Mioto, F., Martins-Pacheco, L. H., F Borgatto, A., & Petri, G. (2021). bASES21: A Model for the Self-assessment of 21st-Century Skills in the Context of Computing Education in K-12. *Computer Supported Education: 12th International Conference, CSEDU 2020, Virtual Event, May 2–4, 2020, Revised Selected Papers 12*, 366–391.

Griffin, P., & Care, E. (2015). The ATC21S method. In *Assessment and teaching of 21st Century Skills* (pp. 3–33). Springer.

Griffin, P., Care, E., & McGaw, B. (2011). The changing role of education and schools. In *Assessment and teaching of 21st century skills* (pp. 1–15). Springer.

Hodson, D. (1998). Science fiction: The continuing misrepresentation of science in the school curriculum. *Curriculum Studies*, *6*(2), 191–216.



**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

Kyllonen, P. C. (2012). Measurement of 21st century skills within the common core state standards. *Invitational Research Symposium on Technology Enhanced Assessments*, 7–8.

Navarro, M., Förster, C., González, C., & González-Pose, P. (2016). Attitudes toward science: Measurement and psychometric properties of the Test of Science-Related Attitudes for its use in Spanish-speaking classrooms. *International Journal of Science Education*, *38*(9), 1459–1482.

NCCA. (2021). *Junior Cycle Wellbeing Guidelines* (p. 101). National Council for Curriculum and Assessment. https://ncca.ie/media/5062/updated-guidelines-2021_en.pdf

NCCA, & DES. (2016). *Short Course—Social, Personal & Health Education—Specification for Junior Cycle*. Government of Ireland. https://www.curriculumonline.ie/getmedia/10a6e6be-40dd-425b-9463-dabfb2131fcd/NCCA-JC-Short-Course-SPHE.pdf

OECD. (2010). *PISA 2009 Results: What Students Know and Can Do*. https://doi.org/10.1787/9789264091450-en

OECD. (2019). *PISA 2018 Assessment and Analytical Framework | en | OECD* (pp. 97–119). https://www.oecd.org/education/pisa-2018-assessment-and-analytical-framework-b25efab8-en.htm

Opetushallitus. (2016). *National core curriculum for basic education 2014*. Finnish Board of Education Helsinki, Finland.

Stocklmayer, S. M., Rennie, L. J., & Gilbert, J. K. (2010). The roles of the formal and informal sectors in the provision of effective science education. *Studies in Science Education*, *46*(1), 1–44.

United Nations. (2022). *THE 17 GOALS | Sustainable Development*. https://sdgs.un.org/goals

Wilson, S., Schweingruber, H., & Nielsen, N. (2016). *Science teachers' learning: Enhancing opportunities, creating supportive contexts*. National Academies Press. DOI 10.17226/21836

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# Appendices

**Appendix A**

**Teacher Pre/post Questionnaire**

Section A (Ireland)

Demographic Information

1) Number of Students in School.
    a) Please specify by gender; Male/Female/Non-Binary/Other
2) Is your school a DEIS school? Y/N
   If Y, what band?
3) What type of school is yours?
    i) Single Sex Co-educational
4) School Denomination (if applicable) [emphasis on???]
5) School Location
    i) Urban Suburban Rural
6) Number of students in OTTER class (experimental or control)
   Please specify by gender; # of Male/Female/Nonbinary/Other
7) What do you think will be the benefits of adopting an OTTER Lab approach to STEAM subjects?
8) What do you think will be the challenges with adopting an OTTER Lab approach to STEAM subjects?

Section A (Finland)

1. Number of Students in School.
   Please specify by gender; Male/Female/Non-Binary/Other
   #M_____ #F_____ #NB_____ #O_____
2. What percent of students get general, intensified and special support in your school?
   General support _____ %
   Intensified support ____ %
   Special support ____ %
3. School type:
   a. Grades 1-9 b. Grades 1-6 c. Grades 7-9 d. Other, specify...
4. School Location
   Urban Suburban Rural
5. Number of students in OTTER class (experimental or control)
   Please specify by gender; # of Male/Female/Nonbinary/Other

   Experimental: #M_____#F_____#NB_____#O_____
Control: #M_____ #F_____#NB_____#O_____
6. What do you think will be the benefits of adopting an OTTER Lab approach to STEAM subjects?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

7. What do you think will be the challenges with adopting an OTTER Lab approach to STEAM subjects?

## Section A (Spain & Hungary)

1) Number of Students in School.
    a) Please specify by gender; Male/Female/Non-Binary/Other

2) School Denomination (if applicable)
3) School Location
    i) Urban Suburban Rural
4) Number of students in OTTER class (experimental or control)
   Please specify by gender; # of Male/Female/Nonbinary/Other
5) What do you think will be the benefits of adopting an OTTER Lab approach to STEAM subjects?
6) What do you think will be the challenges with adopting an OTTER Lab approach to STEAM subjects?

## Section B (Same for all countries)

### Teacher's prior knowledge of Education Outside the Classroom

Evaluate each of the following dimensions in a self-reflective way on a scale of 1 to 10 (1 being the lowest and 10 the highest).

1. Regarding your knowledge about education outside the classroom (EOC), please rate each statement below
    A. I believe my level of understanding of EOC goals is
        (Low) 1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 –10 (High) – Not applicable
    B. I believe my level of knowledge of EOC pedagogical approaches is
    C. I believe my level of awareness of EOC good practices
2. Regarding your skills to develop curriculum activities incorporating EOC, please rate each statement below
    A. I believe my ability to design EOC activities and lessons is
    B. I believe my understanding of curriculum alignment is
    C. I believe my understanding of curriculum integration is
    D. I believe my ability to assess and evaluate EOC activities and lessons is
3. Regarding your skills to implement EOC activities, please rate each statement below
    A. I believe my ability to implement EOC activities effectively in schools is
    B. I believe my ability to adapt EOC activities to different learning environments is
    C. I believe my ability to effectively manage resources for EOC activities is
4. Regarding your skills related to collaborations and partnerships to implement EOC activities, please rate each statement below
    A. I believe my ability to establish partnerships with schools, museums, parks, research centers, historical sites and other suitable places for EOC is
    B. I believe my ability to resolve conflicts in those partnerships is
    C. I believe my ability to communicate effectively with partners is

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Appendix B**

**Student Pre/post Survey (9-18yrs)**

1 (strongly agree) 2 (agree) 3 (neutral) 4 (disagree) 5 (strongly disagree)

| | |
|---|---|
| 1. | I have the right to give my opinion |
| 2. | I respect that people can express different cultures, religions, lifestyles, and opinions |
| 3. | I can establish a good relationship with people with personalities or interests different from my own |
| 4. | I am friendly and kind with my classmates |
| 5. | I can try to influence issues I care about together with other people. |
| 6. | I can participate in developing issues that are important to me. |
| 8. | I would dislike working in Science after I leave school |
| 9. | A job as a scientist would be interesting |
| 10. | I would dislike becoming a scientist because it needs too much education |
| 11. | A career in science would be dull and boring |
| 12. | I would like to teach science when I leave school |
| 13. | When I leave school, I would like to work with people who make discoveries in science |
| 14. | I can learn many things from other people |
| 15. | I can teach something to other people |
| 16. | I make an effort to, as much as possible, fulfill the promises that I make |
| 17. | I admit my mistakes and apologize |
| 18. | I know that government decisions can affect me in different ways |
| 19. | I think that everyone is responsible for taking care of each other. |
| 20. | I think that everyone has to consider the affects of our actions on other people. |
| 21. | I understand that my choices and actions have an impact on and other people. |

**Student Pre/post Survey (6-8yrs)**

1 (strongly agree) 2 (agree) 3 (neutral) 4 (disagree) 5 (strongly disagree)

| | |
|---|---|
| 1. | I know that my classmates can come from different places in the world |
| 2. | I can be friends with someone who is different to me |
| 3. | I am friendly and kind with my classmates |
| 4. | I would like to be a scientist when I grow up |
| 5. | I can learn many things from my classmates |
| 6. | When I am wrong, I say so |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Appendix C**

**Student Exit Ticket (9-11yrs)**

## Age 6-8yrs

| | 👍 | 👎 |
|---|---|---|
| I look forward to science lessons in the classroom | | |
| I do not like science lessons | | |
| Science lessons outside are fun | | |
| I dislike science lessons that are outdoors | | |
| School should have more outdoor science lessons each week | | |

## Age 9-18yrs

| Name/Code: Age: Gender: | 👍 | 👎 |
|---|---|---|
| Science is one of the most interesting school subjects | | |
| Science lessons are a waste of time | | |
| I really enjoy going to science lessons | | |
| The material covered in science lessons is uninteresting | | |
| I look forward to science lessons in the classroom | | |
| I would enjoy school more if there were no science lessons | | |
| Science lessons outside are fun | | |
| I dislike science lessons that are outdoors | | |
| School should have more outdoor science lessons each week | | |
| Outdoor science lessons bore me | | |
| **Have you anything else to add about science outside the classroom?**<br>*[Write your comment in this space]* | | |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Appendix D**

**Teacher Rubric**

Student Names/Codes:
Age Group:
Gender(s):

| After the EOC activity, students were able to: | To a large extent | To some extent | To little or no extent |
|---|---|---|---|
| **1.** be polite and kind to teammates | | | |
| **2.** acknowledge and respect other perspectives | | | |
| **3.** make sure all team members' ideas are equally valued | | | |
| **4.** offer assistance to others in their work when needed | | | |
| **5.** Improve their own work when given feedback | | | |
| **6.** follow rules for team decision-making | | | |
| **7.** organize information well | | | |
| **8.** complete tasks without having to be reminded | | | |
| **9.** present all information clearly, concisely, and logically | | | |
| **10.** understand how knowledge or insights might transfer to other situations or contexts | | | |
| **11.** find sources of information and inspiration when others do not | | | |
| **12.** help the team solve problems and manage conflicts | | | |
| **13.** adapt a communication style appropriate for the purpose, task, or audience | | | |
| **14.** elaborate and improve on ideas | | | |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## Appendix E

## Student Worksheet

**Student Name/code:** **Age:** **Gender:**

| Give an example of a time when: | Describe your example |
|---|---|
| 1. You used a computer/tablet/phone | What did you use the device to do? |
| 2. You used some type of digital tool to measure/collect or analyse something | What did you use the device to do? |
| 3. You had to find information online that you did not already know | What was the information about? |
| 4. You created something yourself online/using a digital tool e.g., office tools, surveys, polls, tagging on social media, blogs, websites, games, apps | What did you create? |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

## Appendix F

## Teacher Rubric

| Scientific Literacy | Students are able to: | Depth of Knowledge | | |
|---|---|---|---|---|
| | | Low | Medium | High |
| Explaining Phenomena Scientifically | Use scientifically informed language | | | |
| | Explain why the issue/concept is important | | | |
| | Predict **what** is expected to happen as a result of the Youth Initiative | | | |
| | Predict **why** they think something will happen | | | |
| | Make links with how the concept relates to society | | | |
| | Ask appropriate questions related to the issue | | | |
| Evaluating and designing scientific enquiry | Design, plan and carry out Youth Initiative | | | |
| | Consider how to ensure the information used is reliable | | | |
| | Explain how the approach is fair or ways in which better results could be achieved | | | |
| | Sort, group, graph data/evidence | | | |
| Interpreting data and evidence scientifically | Look for relationships/patterns in the data/evidence | | | |
| | Offer explanations from the data/evidence | | | |
| | Communicate findings through appropriate media | | | |
| **Any Other Comments about student learning during the Youth Initiative?** | | | | |

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Appendix G**

**Student Reflect Tool**

**Student Name/code:** **Age:** **Gender:**

Describe 3 things you liked about learning outside the classroom

- 
- 
- 

Was there anything you did not like about learning outside the classroom?

Describe 2 things you learned when you did science outside the classroom

- 
- 

Describe 1 thing you would change about learning outside the classroom

- 

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Appendix H**

**Teacher Interview**

**Experimental**

1. In your view, what was the OTTER project trying to achieve?
2. What are your reflections on the **OTTER lab process** (see prompts below)? Why?

**Prompts**

a. Planning: How were you prepared to work outside the classroom, and what were the main skills and competencies required for this?
b. Content focus: How did you feel the OTTER labs could be adapted to your country's curricular obligations?
c. Pedagogy: What type of pedagogies/teaching strategies were most commonly used when you implemented the OTTER Lab process
d. How was the effectiveness of the activities you conducted during the project evaluated, and what was the role of the different stakeholders in this evaluation?

3. What were the main **challenges** you encountered during the activities you conducted as part of the OTTER project?

4. What are your reflections on your **collaboration** with other people who participated in the project

**Prompts**

a. How did you and other project stakeholders communicate and exchange ideas during the project?
b. What were the main strategies used to ensure collaboration between you and other project stakeholders?
c. What suggestions do you have for improving the impact of collaboration between teachers/schools and out-of-school educational settings on student achievement and engagement (e.g., sharing of objectives/goals and resources, improving communication, training, etc.)?

5. What **impact,** if any, did the OTTER lab have on
   a. **You:** your knowledge, practice, attitudes….
   b. **Students:** knowledge, practice, attitudes
   c. **Other impacts:** school, parents?
   d. Were there any unexpected impacts (positive/negative)

6. What were the **lessons learned** from the project, and how can these be applied to other education projects outside the classroom?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Control**

1. What topic(s) have you been teaching over the last few weeks with your [enter name of control group class here]
2. What are your reflections on teaching this topic?

**Prompts**

a. Planning: How were you prepared teach this topic, and what were the main skills and competencies required for this?
b. Content focus: How did you identify the learning needed according to your country's curricular obligations?
c. Pedagogy: What type of pedagogies/teaching strategies were most commonly used when you taught this topic?
d. How was the effectiveness of the activities you conducted during this time evaluated, and what was the role of the different stakeholders in this evaluation?

3. What were the main **challenges** you encountered during the activities you conducted as part of this topic?

4. What are your reflections on your **collaboration** with other people when teaching this topic?

**Prompts**

a. Did you engage with other stakeholders to communicate and exchange ideas? How?
b. What were the main strategies used to ensure collaboration between you and other stakeholders?
c. What suggestions do you have for improving the impact of collaboration between teachers/schools and other stakeholders on student achievement and engagement (e.g., sharing of objectives/goals and resources, improving communication, training, etc.)?

5. What impact, if any, did teaching this topic have on
    a. **You:** your knowledge, practice, attitudes….
    b. **Students:** knowledge, practice, attitudes
    c. **Other impacts:** school, parents?

6. Do you think learning outside the classroom would be a suitable approach to teaching this topic in the future? Why? Why not?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Appendix I**

**Student Focus Groups**

**Experimental**

1. Talk to me about your **youth initiative** (have image or resource to point to).
    a. What did you do?
    b. Why did you do it?
    c. How did you decide what action to take?
    d. How does your youth initiative have an impact on other people?
2. What did the teacher do, to **help you learn** about this topic [the topic that inspired your youth initiative]?
    a. What did you learn about this topic?
    b. How do you think you learn best?
3. Tell me about your trip(s) **outside the classroom**
    a. What did you do? What did you learn about the topic?
    b. Did you collect evidence? What was it? How did you use it?
4. What did you learn about jobs or careers from your trip outside the classroom or youth initiative?
    a. Did it change your mind about any ideas you had before participating in the Youth Initiative?
5. What did you enjoy from your trip outside the classroom or youth initiative?
    a. How does this way of learning compare to learning something only in class? Why?
    b. What changes would you make to the process? Why?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Control**

1. Talk to me about when you learned about [enter topic student was studying] (have image or resource to point to).
    a. What did you do?
    b. Why did you do it?
    c. What part was most interesting and why?
    d. How does your learning about this topic have an impact on other people?
2. What did the teacher do to help you learn about this topic?
    a. What did you learn about this topic?
    b. How do you learn best?
    c. Did you collect evidence? What was it? How did you use it?
3. What other approaches would have helped you to learn about this topic?
4. What did you learn about jobs or careers from this topic?
    a. Did it change your mind about any ideas you had before learning about this topic? Explain your answer

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

**Appendix J – Sample Learning Objectives**

Sustainable Development

### Clean Water and Sanitation

- Describe the cause and effects of water pollution and water scarcity.
- Evaluate different methods of water treatment.
- Identify recycling and reuse technologies.

### Sustainable Cities and Communities

- Explain the key features of sustainable cities and communities.
- Evaluate how humans contribute to developing sustainable cities and communities
- Examine what the corporate sector can do to support environmental protection [Profit, sustainability and ethics]

### Responsible Consumption and Production

- Identify unsustainable patterns of consumption and production and describe local and global solutions to these issues
- Evaluate how humans reliance on natural resources is affecting climate change, biodiversity loss and pollution
- Describe how food is wasted in production and at the consumer level and create solutions to combat this issue

(Adapted from: Dept. of Education and Skills, 2015; United Nations, 2022)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

- **Sustainable Development (continued)**

### Climate Action

- Illustrate how earth processes and human factors influence the Earth's climate,
- Evaluate effects of climate change and initiatives that attempt to address those effects.
- Research and discuss the ethical and sustainability issues coming from our use of electricity

### Life Below Water

- Research methods that prevent and reduce marine pollution of all kinds (including plastic)
- Evaluate how humans can successfully conserve ecological biodiversity and contribute to global food production

### Life on Land

- Research the sustainable use of ecosystems, in particular forests, wetlands, mountains and drylands.
- Evaluate how humans can successfully conserve biodiversity and contribute to global food production

(Adapted from United Nations, 2022; Dept. of Education and Skills, 2015)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

- **21st Century Skills**

## Ways of Thinking

**Creativity & Innovation**
- Plan, propose and implement creative research informed solutions for a specific problem
- Learn to see alternatives and combine perspectives open-mindedly and be able to think outside of the box

**Critical thinking, Problem Solving, Decision Making**
- Evaluate and develop a research informed view on an issue/problem (as identified in sustainable practice)

…

## Ways of Working

**Communication**
- Effectively develop and share concepts and ideas with a wide range of people in different formats
- Express one's opinions constructively and acting ethically
- Express themselves in different ways, and present and perform publicly in various situations.
- Listen to others, take into account their points of view and reflect on what they have said.

…

## Tools for Working

**Information Literacy**
- Access and evaluate information efficiently (on-time) and effectively (credible sources)
- Recognize, offer and evaluate explanations for a range of natural and technological phenomena
- Describe and appraise scientific investigations and propose ways of addressing questions
- Be able to apply scientific knowledge in the context of real-life situations

**ICT Literacy**
- Ensure ICT is integrated into daily work effectively

…

## Living in the World

**Citizenship**
- Gain a sense of belonging and responsibility to one's locality, country, and (one's part of) the world.
- Be open to growth into active citizens who use their democratic rights and freedoms responsibly
- Gather methods for participation and involvement in civic society and communal work outside the school

**Life & Career Skills**
- Show an interest in and awareness of varied roles, jobs responsibilities and contexts

…

(Care et al., 2012; Dept. of Education and Skills, 2015; OECD, 2019; Opetushallitus, 2016)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

- **21st Century Skills (continued)**

## Ways of Thinking

**Critical thinking, Problem Solving, Decision Making**

- Analyse the topic being discussed critically from different viewpoints, analyse different arguments and their supporting evidence, and come to a logical conclusion

**Learning to Learn**

- Apply self-directed learning competencies in different areas of life, both independently and in cooperation with others, to achieve goals
- Develop the capacity to reflect on their own learning, how they learn, strengths and weaknesses

## Ways of Working

**Collaboration**

- Learn to work together and have opportunities to practise negotiation skills, skills to compete, arbitration and conflict resolution as well as critical examination of issues
- Effectively work with others to achieve a shared outcome/product

## Tools for Working

**ICT Literacy**

- Learn to assess the impact of ICT from the perspective of sustainable development and to be responsible consumers
- Use ICT – in an ethical and critical way - in information management and in exploratory and creative work

**Scientific Literacy**

- Broaden scientific skills for daily life, better jobs or entrepreneurship opportunities
- Act as cientific thinkers in a reflexive and creative way
- Apply scientific knowledge in the context of real-life situations.

## Living in the World

**Life & Career Skills**

- Understand the importance of work and enterprising, the potential of entrepreneurship and personal responsibility as members of community and society

**Personal & Social Responsibility**

- Understand the significance of choices, way of living and actions not only to one selves but also to local environment, society and nature
- Be aware of concepts (issues) of individual, group, society and culture and how they contribute in an effective way
- Understand the significance of protecting the environment through personal relationship with nature

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482

(Adapted from Care et al., 2012; Dept. of Education and Skills, 2015; OECD, 2019; Opetushallitus, 2016)

- **Inclusion & Diversity**

## Interacting Considerately

- Communicate in a non-discriminatory way
- Create a safe and inclusive space to form and express their views
- Appreciate and respect how diverse values, beliefs and traditions have contributed to the communities and culture in which they live
- Learn to express themselves clearly and respectfully, to ask for help, to listen to other peoples' viewpoints and discuss ideas and opinions

## Creating Awareness

- Be aware of diverse genders, ethnicity, nationality, socio-economic background
- Value what it means to be an active citizen, with rights and responsibilities in local and wider contexts
- Be aware of personal values and an understanding of the process of moral decision-making
- Develop greater empathy when learning about other peoples' perspectives

## Acting with Respect

- Show interest in and respect for others
- Take action to safeguard and promote her/his wellbeing and that of others
- Develop skills for relating effectively to others
- Learn to express themselves clearly and respectfully, to ask for help, to listen to other peoples' viewpoints and discuss ideas and opinions
- Co-create and share science knowledge with all students including those with disabilities from disadvantaged backgrounds vulnerable or from rural backgrounds.

(Adapted from; NCCA, 2021; NCCA & DES, 2016)

**This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 101006482**

# Contact

www.otter-project.eu

@otter_euproject

@OTTER_EU