



urban science

Monitoring and Evaluation Framework



Urban Science – Integrated Learning for Smart Cities

Over two-thirds of the European population live in cities. Enabling those cities to deliver services sustainably while keeping their citizens safe, healthy, prosperous and well-informed is amongst the most important challenges in this century. The Urban Science European project is an education response to this, to improve the teaching of scientific inquiry and investigation so that pupils develop the competences to actively contribute to creating healthy cities, gain scientific skills to enter the world of work, and meet the demand for the urban scientists of the future. Urban Science works through outdoor inquiry-based learning where urban areas become living-laboratories that help pupils explore how science can create healthier and sustainable places to live. It is solutions based; placing a strong emphasis on creativity and problem solving to ensure scientific understanding can be applied in a meaningful context. The project draws on several influences in inquiry-based learning and an understanding of how the natural world provides a systems model for sustainability. Critical to the success of the project is weaving together the needs of curriculum in the partner countries, teacher competences and learner profiles. This article provides an exploration of the development of the learning framework the project is developing, how this builds on recent work in the field, and adds value to the increasing call for and need to educate pupils in scientific literacy for a sustainable future.

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1 Introduction

This document describes the monitoring and evaluation approach. This approach is developed with the participation of the project team members.

Important characteristics of the monitoring and evaluation process are:

- The M&E approach has an emergent design in order to be able to respond to emergent issues.
- Reflection is an important part of the M&E process. Thus the process can become a pedagogical tool that enables participants to become more reflective about what they are doing, how they work and how they can improve the way they are working.
- The input of all partners is very important during the design of the process.
- We strive to optimally embed monitoring and evaluation activities into the project.
- An important ambition is to make the evaluation meaningful, both for the project team members and for the learners.

This report is a work in progress that will evolve over time.

2 Evaluation purpose

What is the purpose of monitoring and evaluation in Urban Science? How do the project team members want to use results of M&E? The main reasons for carrying out the evaluation that have been identified by the project team members are:

Accountability	<ul style="list-style-type: none"> ▪ Accountability towards the EU. A continuous check on reaching our target. Did we deliver what we promised? ▪ To see progress in each country and by partners. ▪ Ensure we deliver our plan. ▪ Accountability towards our own organisations. ▪ Justify Urban Science to other influencers.
Improving the process, learning from experiences	<ul style="list-style-type: none"> ▪ Are we doing good things? Are we doing things well? ▪ See improvement in meeting our goals: process and outputs. ▪ Improved methodological approaches. ▪ To reflect on the process and learn from our experiences. Do we communicate enough about the process? Do we communicate about what is needed? Can we avoid to overflow partners with communication? ▪ To clarify our route and results. To check whether we are going on the right direction and change when needed: re-strategize and rethink content and processes when needed. ▪ To better understand what works, how and why. ▪ To check the quality of our work.
Sharing inspiring results	<ul style="list-style-type: none"> ▪ To share results with potential new partners. ▪ To develop new projects based on results. ▪ Communicate about the process and results.

3 The intended use of the M&E results

Key stakeholders who will engage in the evaluation process are the project team members and the target groups outlined below.

<i>Primary intended users</i>	<i>Intended use of the M&E results</i>
Project team and partners	<ul style="list-style-type: none"> ▪ In order to improve the process and learn from experiences. ▪ Project team may change the programme based on results M&E.

	<ul style="list-style-type: none"> ▪ To inspire and involve other education providers. ▪ Accountability ▪ Results will have consequences for project team and partners when looking for new projects after Urban Science. ▪ To evidence to others the benefits of outdoor science.
Educators/teachers	<ul style="list-style-type: none"> ▪ Teachers in schools. ▪ Environmental education centres. ▪ NGOs and other networks.
Decision-makers	<ul style="list-style-type: none"> ▪ To contribute to the evidence base of the effectiveness of outdoor science.
EU	<ul style="list-style-type: none"> ▪ Accountability

4 Evaluation approach

The monitoring and evaluation process will be a combination of formative evaluation (to learn and improve the process and programme) and summative evaluation (to judge the overall value). Two important points of attention will be:

- Flexibility in the evaluation process regarding the issues addressed: open mindedness, expecting the unexpected and looking for surprise and patterns.
- Making the evaluation meaningful, both for the learners and for the project team members. Our ambition is to use evaluation methods integrated into the learning process of the pupils and teachers, and at the same time offer the project team useful and inspiring results to address the evaluation purposes as formulated in section 2.

5 Evaluation matrix

The evaluation matrix summarizes the implementation of the evaluation process. It is a work in progress which will develop over time.

Purpose of the evaluation	<ul style="list-style-type: none"> ▪ Accountability towards EU and own organisations ▪ Improving the process, learning from experiences ▪ Sharing inspiring results
Key evaluation areas and questions	<p>Process Project team members are enthusiastic and excited (throughput).</p> <hr/> <p>Effectiveness and Quality Criteria To what extent has the programme attained its intended objectives:</p> <p>As a result of Urban Science teachers will:</p> <p>PRIMARY CRITERIA</p> <ul style="list-style-type: none"> • Feel ownership of Urban Science. <p>SECONDARY CRITERIA</p> <ul style="list-style-type: none"> • Improve knowledge and skills in science leadership and management outdoors. • Strengthen confidence to relate lessons to everyday lives of pupils and to developing sustainable cities. • Increase confidence and competence to deliver IBSE is strengthened. • Deliver more learning outside.

As a result of Urban Science pupils will:

PRIMARY CRITERIA

- Use scientific evidence for decision-making and problem-solving.
- Be able to envision new futures for cities.
- Be able to apply interconnected and linked thinking to understand complex problems.
- Be able to relate learning to challenges related to sustainable cities.

SECONDARY CRITERIA

- Be competent to engage with inquiry-based science are increased.
- Think in new ways and from different perspectives.
- Use scientific evidence for decision-making and problem-solving.
- Be able to express passionate views about the urban communities they want.
- Be engaged and motivated to continue to study science.

The learning modules will:

PRIMARY CRITERIA

- Strongly connect science and sustainability.
- Provide activities linking urban topics to the bigger picture (systems).
- Includes values and future perspectives.
- Connects science with the work of scientists.
- Uses a clear IBSE pedagogy.
- Include out of the classroom learning.
- Focus on a low carbon economy.

SECONDARY CRITERIA

- Connect with real and accessible issues, bridging between theory and reality of the pupils.
- Be flexible, allowing for a range of approaches (single subject, inter-disciplinary, etc).
- Provide activities linking urban topics to the bigger picture (systems).
- Be progressive in competence and content provided.
- Be gender inclusive.
- Provide assessment which supports learning and delivery.
- Provides clear learning objectives, teaching methodology and assessment & evaluation tools.
- Be easily accessible and searchable from different perspectives e.g. age groups, topics, competence.
- Offer flexible delivery over a range of schedules (time).
- Support national curricula.
- Offer activities which are low cost to deliver, using easily available equipment where needed.
- Offer activities that are simple to prepare for teaching.
- Provokes questions, creativity, decision-making and engagement.
- Provide clear health and safety guidance.

Impact – results beyond the scope of, but influenced by, the project

To what extent has the programme contributed towards its longer term goal: science learning that contributes to the potential of changes in behaviour for sustainable cities?

Will there be continued positive impacts as a result of the programme once it has ended? Why or why not?

	Are students empowered to use science learning as a basis for informed decision-making and action towards liveable future cities?
Primary intended users and use	<p>Primary intended users Project team members and partners, EU</p> <hr/> <p>Intended use Project team and partners:</p> <ul style="list-style-type: none"> ▪ In order to improve the process and learn from experiences. ▪ Project team may change the programme based on results M&E. ▪ To involve teachers and education providers. ▪ Accountability towards EU. ▪ Results can influence gatekeepers. ▪ Results will have consequences for project team and partners when looking for new projects after Urban Science.
Data gathering; Methods and sources; Responsibilities	The evaluation framework below describes methods of data gathering and responsibilities. Some methods of data collection still need to be defined.

6 Evaluation framework

This framework is a summary of the monitoring and evaluation process. More elaborate descriptions of different elements of the M&E process can be found in section 9.

EVALUATION FRAMEWORK

<i>Level</i>	<i>Subjects and questions</i>	<i>Results M&E, example indicator</i>	<i>Method of verification</i>	<i>Responsibility</i>
Input Societal context and issues; the means	Science is a cornerstone for meeting the challenges of an increasingly urban Europe. If Europe's cities are to adapt, grow and meet their citizen's needs then science must be at the forefront. Over 67% of the European population live in cities. Enabling those cities to deliver services effectively, efficiently, and sustainably while keeping their citizens safe, healthy, prosperous, and well-informed is amongst the most important challenges in this century.	-	-	-
Throughput Processes	Project activities, cooperation between partners. <ul style="list-style-type: none"> ▪ Do project team members co-create a common vision? ▪ How do project team members deal with identified challenges? ▪ Are project team members inspired and challenged? 	Result: Description how project team members deal with identified challenges.	Review at Partner Meetings.	Project Coordinator
Output Deliverables: the products and direct effects of the project	Output 1 – Activity 1 State-of-the-art Report	Results: <ul style="list-style-type: none"> ▪ Completed report published. 	Completed report available online. List of contributors to research by organisation type	All partners
	Output 1 – Activity 2 Success Criteria for Schools using the Urban Environment	Result: <ul style="list-style-type: none"> ▪ Published success criteria (10-15 key criteria) 	Completed criteria available online.	All partners

<i>Level</i>	<i>Subjects and questions</i>	<i>Results M&E, example indicator</i>	<i>Method of verification</i>	<i>Responsibility</i>
	Output 2 – Activity 1 Framework for Science in the Urban Environment	Results: <ul style="list-style-type: none"> Completed and agreed framework and pedagogy. Framework and pedagogy used to develop Urban Science Learning Modules. 	Completed report available online. Review of Urban Science Learning Modules (is the framework and pedagogy used?)	All partners
	Output 3 – Activity 1 Urban Science Learning Modules	Result: <ul style="list-style-type: none"> Learning modules completed (two per country). 	Urban Science Learning Modules and resources freely available online. Feedback from end users based on effectiveness criteria (see section 5).	All partners
	Output 3 – Activity 4 Recommendations for Support to Schools	Results: <ul style="list-style-type: none"> Report on school support needs based on experience of pilot schools. 	Internal report shared and reviewed at partner meeting.	All partners
	Output 4 – Activity 3 Guidelines for Competency Based Assessment, incorporating Urban Science assessment approaches	Result: <ul style="list-style-type: none"> Completed competency based assessment guidelines. 	Guidelines and assessment tools freely available online. Feedback from end users based on effectiveness criteria (see section 5). Copies of evaluation results.	All partners
	Output 5 Activity 1 – teacher training programme Activity 2 – online teacher support	Results: <ul style="list-style-type: none"> Completed teacher training programme. Trained teachers. Online learning materials available. 	All teacher training materials freely available online. Feedback from teachers attending face-to-face training; web feedback from teachers using online resources.	All partners

<i>Level</i>	<i>Subjects and questions</i>	<i>Results M&E, example indicator</i>	<i>Method of verification</i>	<i>Responsibility</i>
	<p>Output 6</p> <p>Activity 2 – website complete and available online</p> <p>Activity 1 – good practice portfolios published and available on project website.</p>	<p>Results:</p> <ul style="list-style-type: none"> ▪ Website online. ▪ 12 good practice portfolios published (3 per partner). 	<p>Website available and user statistics.</p> <p>Portfolios published.</p> <p>Feedback by end users.</p>	All partners
<p>Objectives and Outcomes</p> <p>Short term results of the output</p>	<p>SPECIFIC OBJECTIVE 1</p> <p>Review the needs of science based businesses to identify the science skills and competencies needed for healthy cities and the low carbon economy.</p> <p>This will result in:</p> <ul style="list-style-type: none"> ▪ Increased relevance of school based science learning to the needs of business and the low carbon economy. ▪ Increased links between schools, science and the world of work. 	<p>Indicators of achievement:</p> <ul style="list-style-type: none"> ▪ Published report on criteria and competency list for schools using the urban environment (see Output 1 Activity 1 report). ▪ Peer review of identified science skills and competencies against industry and curriculum demands. ▪ Peer review of Urban Science Learning Modules against curriculum and business needs. 	<ul style="list-style-type: none"> ▪ Report available (see Output 1 Activity 1 report). ▪ Teacher survey & focus group. ▪ Teacher survey & focus group. 	All partners; lead by BVS.
	<p>SPECIFIC OBJECTIVE 2</p> <p>Enhance the support available for teachers to increase their professional competence in teaching science in the urban environment using inquiry and investigation.</p> <p>This will result in:</p> <ul style="list-style-type: none"> ▪ Improved delivery of science in schools. ▪ Better training for teachers in using urban environments for teaching science through inquiry and real world learning. 	<p>Indicators of achievement:</p> <ul style="list-style-type: none"> ▪ Availability and access to support services (face-to-face training and online support). ▪ Number of teachers accessing support services. ▪ Quality of support services to meet teacher needs. 	<ul style="list-style-type: none"> ▪ Support available online; user feedback. ▪ Website records; lists of trained teachers. ▪ Evaluation report including feedback from pilot teachers based on effectiveness criteria (see section 5). 	All partners; lead by CREDA.

<i>Level</i>	<i>Subjects and questions</i>	<i>Results M&E, example indicator</i>	<i>Method of verification</i>	<i>Responsibility</i>
	<ul style="list-style-type: none"> ▪ New pedagogical approaches to teaching science, especially focusing on blending inquiry based learning and real world learning. 			
	<p>SPECIFIC OBJECTIVE 3 Develop formative assessment models that assess science competencies rather than knowledge.</p> <p>This will result in new assessment models available and integrated with learning.</p>	<p>Indicators of achievement:</p> <ul style="list-style-type: none"> ▪ Published assessment models and guidelines. ▪ Number of models developed. ▪ Completed assessment techniques and approaches reviewed by teachers (survey and focus group). 	<ul style="list-style-type: none"> ▪ Available online. ▪ All available online. ▪ Report on teacher review based on effectiveness criteria (see section 5). 	All partners; lead by EEA and HRTA.
	<p>SPECIFIC OBJECTIVE 4 Provide learning modules for teachers to deliver science in the urban environment.</p> <p>This will result in:</p> <ul style="list-style-type: none"> ▪ Strengthened confidence of teachers to deliver inspiring science lessons that relate to the everyday lives of their pupils and to developing healthy cities. ▪ Open and flexible Open Education Resources enabling pupils to interact with their urban environment through inquiry based learning. 	<p>Indicators of achievement:</p> <ul style="list-style-type: none"> ▪ Published Urban Science Learning Modules. ▪ Number of learning modules developed. ▪ Number of users. ▪ Feedback from users (teachers/pupils) set against skills and competencies identified by SO1. 	<ul style="list-style-type: none"> ▪ Available online. ▪ In line with proposal. ▪ Survey of users. ▪ Report on feedback based on effectiveness criteria (see section 5); see assessment SO5 below. 	All partners; lead by GRID-Warsaw.
	<p>SPECIFIC OBJECTIVE 5 Science that develops the competencies of pupils to be confident learners, creative thinkers and adept at solving problems.</p> <p>Meeting this objective will result in an increased ability of pupils to link the principles of science to everyday life, and to understand the key role of science in</p>	<p>Indicators of achievement:</p> <ul style="list-style-type: none"> ▪ Pupil's level of competence measured through competency rubrics (or other suitable assessment process) and teacher assessment. ▪ Pupil's ability to apply competencies to challenges for creating healthy cities and a low carbon economy. ▪ Pupil's work related to the Urban Science Challenge 	<ul style="list-style-type: none"> ▪ Report on competency changes based on effectiveness criteria (see section 5). ▪ Feedback built into modules; evidence of pupils' work. ▪ Evidence of pupils work. 	All partners; lead by WA.

<i>Level</i>	<i>Subjects and questions</i>	<i>Results M&E, example indicator</i>	<i>Method of verification</i>	<i>Responsibility</i>
	<p>supporting the development of healthy cities.</p> <p>SPECIFIC OBJECTIVE 6 Increase the motivation of pupils to study science and connect science with careers in a low carbon economy.</p> <p>This will result in:</p> <ul style="list-style-type: none"> ▪ Pupils connecting classroom based learning with the world of work. ▪ Increased motivation amongst pupils to study science. ▪ More motivated pupils who see science as a valuable career. 	<p>Indicators of achievement:</p> <ul style="list-style-type: none"> ▪ Change in awareness levels amongst pupils towards science study and science careers. ▪ Number of pupils considering studying science at a higher level and/or considering a science related career. ▪ Number of pupils with increased understanding of urban science issues. 	<ul style="list-style-type: none"> ▪ Pupils survey before and after. ▪ Pupils survey before and after. ▪ Pupils survey before and after; examples of pupils work. 	All partners; lead by WA.
Impact Results on the long term, related to societal issue which is addressed	<ul style="list-style-type: none"> ▪ Have conditions for impact been created? ▪ Will project partners continue their cooperation? ▪ Are there indicators that the results contribute to the societal issue at stake? ▪ Are there indicators that the results contribute to a societal change 	<p>Results: Example indicators</p> <ul style="list-style-type: none"> ▪ Other teachers, countries are enthusiastic and want to teach Urban Science. ▪ To see more students outside and less in the classroom. ▪ Teachers' or students' inquiry skills or sustainability competencies improved (pre/post-tests) in some countries/schools. 	<p>Are these indicators present in pilot schools? List of interested countries and education providers.</p>	All partners.

7 Ambition Statements

At the first partner meeting we all wrote ambition statements for the project. Are these ambitions being met?

The ambition statements were:

Personal

- Pushing boundaries from cannot to can do (Lv).
- Met new people, experienced intercultural exchange and developed new networks (Hu, UK).
- Contributed to a mutual and cumulative knowledge building (Hu).
- Understood how science teaching works in the UK (UK).
- Learnt about group dynamics (Hu).
- Persuade teachers why they should do Urban Science and how easy outdoor science is (It).
- Young people recognise attractiveness of sciences (Lv, Bg).
- Practical links between curriculum and urban science (UK).
- New ideas for urban planning policy (Lv).

Our organisations

- Increased recognition for quality teaching and education development (UK).
- Involve more schools from cities in ESD (Lv).
- Deliver state-of-the-art educational content which makes others jealous (Bg).
- Improve and make our work more effective (It).
- Have a 'window' on other countries, practices and approaches (Hu).
- Improved management collaboration capacity (Hu).
- Strengthened links with business partners (PI).
- Opportunities to co-create with and learn from others (Hu).
- Institutional development involving young people (Lv).

Teachers

- Greater collaboration, inter-disciplinary delivery and teamwork (Hu, UK, PI).
- Teachers feel ownership of Urban Science (Hu).
- Teachers feel confident to step outside of their box (Lv).
- Learning modules that reduce preparation time for teachers (Bg).
- Learning modules that enable idea generation for improving healthy living (Bg).
- Teachers confident to link IBSE to their 'book' teaching (It).
- More teacher delivering learning outside (Hu, Lv).
- Teachers confident to discuss science and values (UK).
- Enjoy working with Urban Science materials (Hu).

Pupils

- Understand what responsible science is like (Hu).
- Inspired to take care of their cities and have influence on their local environment (PI).
- Become autonomous and creative individuals with responsibility (empowerment) (Hu).
- Practical experiments and take 'scientific' decision linked with everyday life of young people (It, Bg).
- Able to apply systems thinking to understand complex problems (UK).
- Express passionate views about the urban communities they want (UK).
- Tools for 'reading' the conditions for healthy living in the city (Bg).
- Pupils excited about science and find science achievable (Lv).
- To have fun (Hu).
- Pupils engaged and motivated to continue to study science.

Others

- Mainstreaming Urban Science (Hu).
- Make new links e.g. Italian Association of Science Teachers, Science Museum (It).
- Creating links between organisations e.g. ASE and SEEd (UK).

- Recognition from Association of Science Educators for Urban Science (UK).
- Influencing policy on ESD (UK).
- Municipalities/ministry integrate Urban Science into curriculum (Lv).
- Principles of circular economy integrated in to urban planning (Lv).
- Present the power of citizen’s involvement as a tool to sustain cities development (Pl).
- Have lots of practical experiments to link students to everyday life and science (Bg).

8 Dynamic learning agenda: Challenges

The dynamic learning agenda is a tool that helps to link long-term objectives to short-term concrete action perspectives by formulating the challenges that arise, recording these challenges and keeping track of them (Mierlo et al., 2010)

The dynamic learning agenda is a brief document containing the challenges that the project is facing at a certain moment. These challenges are summarised in learning questions. The agenda is a tool to support the dialogue about the challenges faced by the project. It is dynamic because it will develop over the course of the project. When a challenge is no longer relevant the associated learning question disappears from the agenda. Some question may be formulated differently over the course of the project, and new challenges will be added to the agenda.

The dynamic learning agenda will be used to stimulate reflection about the process in order to learn from experiences and to improve the process and the programme.

In our first partner meeting we identified the following challenges:

Outside our control:	We can influence but not control:	Within our control:
<ul style="list-style-type: none"> • Austerity means other stakeholders unable to join/support us (UK). • Over-crowded curriculum (UK). • Education system reform (Pl). • Lack of state institutional support (Bg). • Low level of innovative spirit amongst teachers (Bg). • Limited contact time with teachers (UK). 	<ul style="list-style-type: none"> • Lack of sustainable development understanding amongst teachers (UK). • Creating a shared vision (Hu). • Outdoor learning has ‘low’ status (UK) – evidence? • Mainstreaming and raising awareness of Urban Science (Hu). • Narrow understanding of outdoor learning – more than just sensory-based learning (Lv). • Teachers move schools to improve career (It). • Interdisciplinary learning still a new challenge (Pl). • Politicians restrict NGO access to schools – maybe outside our control? (Bg). • Active teachers more interested in personal Erasmus+ projects (Bg). • Limited number of active teachers and limited time (Bg). • Limited number of ‘active’ students (Bg). • Limited curricula time (Bg). 	<ul style="list-style-type: none"> • Keeping teachers motivate and recognising their efforts (Hu). • Not just monitoring state of urban environment, but working towards solutions too (It). • To make complex issues simple to understand without simplifying (It, Hu). • Clearly communicate what is Urban Science (It). • Provide support to enable teachers to deliver outdoor learning (It). • How to benefit from intercultural learning (Hu). • Providing clear scaffolding for teachers without over-burdening them (Hu). • Creating relevant, user-friendly and idiot proof assessment (Hu).

9 Integration of M&E activities into project activities

M&E activities will be integrated into project activities. Reflection/evaluation as part of activities thus serves a double goal: 1) personal reflection in order to deepen learning and 2) production of results for M&E.

How we achieve this will vary based on need and appropriateness, and based on the principle of evaluating what matters. Specific tools we will use include:

- Pre and post surveys with pupils and teachers.
- Most Significant Change with teachers and partners.
- Focus groups with teachers (and pupils where possible).
- Competency assessment for pupils incorporated into learning modules.

Monitoring through:

- Transnational Partner Meetings.
- Six monthly reports.
- Cooperative work on Outputs, reports, etc.
- Skype meetings.
- Progress against gantt chart.