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INTELLECTUAL OUTPUT 4

FINAL REPORT

COMPETENCE-BASED ASSESSMENT

urban science

Developed in the project
Urban Science
Engaging science, creating sustainable cities
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COMPETENCE-BASED ASSESSMENT

This intellectual output was developed in the Urban Science project.

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Introduction

The Urban Science project aims to develop students' competences to enable and empower them to use evidence-based arguments and science knowledge to reflect on challenges brought about by working and acting for sustainable cities. The project offers learning modules for teachers and invites them to follow their work on students' competences by choosing tools from Urban Science inventory and to monitor progress using the Urban Science rubric.

Urban Science Competences

The Urban Science framework describes two sets of competences: science and sustainability. The science competences described in the framework are very similar to what is referred to as science inquiry skills in the literature. The sustainability competences used in the framework document refer to international recommendations. Both sets refer to a wide range of competences that are to be developed through a set of activities, preferably by completing learning cycles of a selection of Urban Science modules. The two sets of competences are understood as complementary in the project as elaborated in the Framework document (see Annex 1).

Throughout the Urban Science learning journey, teachers are invited to use both formative and summative assessment tools to collect evidence about their students' learning, enabling them to make meaningful adjustments during and between the learning cycles included in the Urban Science learning modules.

Related literature offers both assessment criteria and self-assessment tools available for science and sustainability competences alike. Since the science and sustainability competences are not only complementary but overlapping in their sub-competences, the project attempts to merge competences with similar components for the assessment framework for summative assessment. Thus, the assessment rubric (suitable for summative assessment) contains fewer competences than the sum of science and sustainability competences included in the Framework. However, a selection of appropriate tools makes it possible to asses specific (or all) competences. Most tools in the Urban Science Assessment Tool Inventory are designed for formative assessment.

Urban Science competences cannot de developed by a single learning cycle. It would be a false hope to expect that any three-hour intervention profoundly changes attitude elements or motivation, nor would it result in any measurable improvement of skills. Therefore, for summative assessment (if required or needed) for single-module interventions we strongly suggest adjusting the competence rubric for the context and aims of the learning module concerned.

Aims

The aim of this intellectual output is to develop competence-based assessment tools for teaching science in the urban environment. Based on the pedagogical framework of the project, Urban Science aims to offer support for teachers' work in three ways:

(1) It provides an inventory of available tools from literature and other projects. The **Urban Science Assessment Tool Inventory** contains
   - ✓ tools that are designed for assessing specific sets of (science or sustainability) competences or competence elements;
   - ✓ tools that help students' or teachers' (self-) reflection and hence they initiate the assessment process by providing input for or feedback on the formative assessment;
   - ✓ tools that monitor progress in developing such competences.

(2) It provides a general tool designed to reflect on Urban Science competences. The **Urban Science Competence Rubric** may serve as a general tool to monitor progress through a period working with Urban Science competences. As suggested above, it can (and should) be modified if the aim is to track progress through one specific learning module. In that case, the general competence descriptions need to be adjusted to the module's content, teaching-learning aims and expected learning outcomes. As a small-scale pilot in Hungary suggests, the rubric can also be transformed to a student self-evaluation tool.

(3) It provides a separate collection of student self-evaluation tools (with brief descriptions), which offers information on students' perception on their learning. The **Urban Science Self-Assessment Tools** help to get a quick overview on the success and efficacy of a specific set of activities within the Urban Science learning journey.

There were some general assumptions and overarching principles that were considered when developing and piloting with these tools.

- Time constraints and teachers' workload are generally present in Urban Science SWOT analysis, therefore, it was important to keep the assessment process as simple as possible and to keep the time spent on assessment as short as possible.
- The Tool Inventory was expected to offer a diversity of tools including general tools that might be used project-wide (so as to provide comparable data for monitoring and evaluation purposes) as well as specific ones that allow national surveys in cases where specific national characteristics are to measure (to support the learning journey and offer evidence for progress locally).
- The tools should be user-friendly in terms of level, accessibility and language. This means that the tools selected from the Inventory should be well understood and their use should be supported by teachers in each country. For the same reasons (as not only languages, but school culture and assessment approaches show a diversity among project partners), tools available in different languages and used in different or diverse contexts were preferred. Some such

tools were developed in international collaboration (e.g. by projects supported by the European Union).

- The tools should be gender-neutral and allow members of marginalized groups to feel included. Although it was an overarching goal, not all tools in the Inventory were tested against parity, accessibility and inclusion. However, many tools (especially the ones developed in international projects) meet those criteria.
- Some tools should also focus on the affective elements of learning besides the cognitive traits as competences have strong motivational and attitude components. Learning as a process has very strong affective elements and in the case of shaping environmental attitudes (which is an integral part of learning for sustainability) the effect of these elements may even outscore the cognitive ones.
- Besides the necessary diversity of tools, the inventory shouldn't offer too many tools so that it stays coherent and easily searchable.
- The tools included in the inventory should provide feedback on the stages of the inquiry-based learning cycle and on the overall learning journey of working with Urban Science modules. Therefore, it should include tools designed for formative and for summative assessment.
- The tools in the inventory are provided with the intention that teachers critically and reflectively adapt them, tailoring them to the teaching-learning aims of the given module and to the general context of assessment (including the pedagogical scenario and the characteristics of the learning cycle stage they wish to apply to).

The general tools such as the competence rubric and the self-assessment tools were also prepared for purposeful adaptation, keeping in mind the key assumptions above.

Work process

In the following, we provide a brief overview of the work process linked to developing Urban Science competence-based assessment tools with the intention of offering an insight to the co-creative nature of the work.

The **Urban Science Assessment Tool Inventory** is a collection of tools that project partners regarded as useful in terms of working with the learning modules. After the initial collection, tools were revised and grouped (see Annex 2) according to purpose and use and links were also updated as possible. The main steps of this work included:

- Step 1: co-creating a tool universe that could be used in the project (including at least two recommendations of assessment tools per project partners);
- Step 2: overview and selection of tools to create a tool inventory;
- Step 3: country-based reflections on the Urban Science Assessment Tool Inventory;
- Step 4: piloting with tools embedded in learning modules in partner countries;
- Step 5: adjustments, modifications and finishing touches to the Tool Inventory;

- Step 6: drawing a roadmap to the tools in the Tool Inventory.

In the case of the **Urban Science Competence Rubric**, the work was initiated at the 3rd Transnational Partner Meeting linked to the revision of the Tool Inventory. After a brief workshop aiming to experiment with merging the two sets of Urban Science competences, the leading partners for Intellectual Output 4 proposed a first version of the rubric. After partners' reflection and piloting, some slight modifications were made.

The **Urban Science Self-Assessment Tools** were also proposed by Intellectual Output 4 leaders and they received general acceptance from project partners.

Urban Science Assessment Tool Inventory

As described above, the Tool Inventory consists of different tools either developed for formative or summative assessment or designed for (self-) reflection.

The Inventory collects tools for a variety of purposes and target groups that are summarized in the table bellow:

Competence		Dimensions	Type	Target group
science competence		formative	self-assessment	students
		formative	self-assessment	teachers
		summative	external assessment	students
sustainability competence		formative	self-assessment	students
		formative	self-assessment	teachers
		summative	external assessment	students
overall	affective elements	formative	self-assessment	students
	learning points	summative	self-assessment	teachers
	interview on piloting with modules	both	external	teachers

As seen from the table, the Inventory focuses on two main target groups: students and teachers, however many tools can be used for working with other educators too.

The objective of the tools are either to assess (inquiry-based) science competences (including science inquiry skills) or to assess sustainability competences. Many of the tools, and indeed these are the ones receiving the most positive reflections from teachers, are not specifically competence-based, but general tools of reflection or self-reflection or tools measuring (or estimating) affective elements of competences (motivation, self-efficacy, empowerment). Although tools in the latter group are not strictly competence-based, they might have an important role in discovering competence elements (both of inquiry-based science learning and learning for sustainability). One of the reasons why they were especially welcomed by teachers during the pilots could be that these competence elements are

often neglected during classroom teaching and teachers often feel abandoned and resourceless to shape or develope them.

The Inventory has tools that work in two different dimensions. Some of them reflect on specific steps of a learning journey: such are formative assessment tools and reflective tools for supporting teachers in the adaptation, in the development or in the process of piloting with learning modules. Others regard the overall learning process: these are summative assessment tools including a pre-post survey.

Most of the tools are self-assessment tools, but external assessment tools and interview guidelines can be also useful. The latter group can efficiently support action research (linked to the development or the adaptation of learning modules) or other forms of collaborative development of learning resources. These tools are also important as they provide a firm framework for reflection thus increasing objectivity during the process (and avoiding evaluation based on intuitive impressions of "what worked in class").

The table below is the Inventory itself. The tools within were piloted during the work with learning modules. It is suggested that teachers, before adapting a learning module, revise which tools are more appropriate or fit for purpose in their classes. This decision can be made considering school requirements, classroom culture and specific learning aims. In classes, for example, where student autonomy has not yet been developed, a formative peer-assessment too might be too early to introduce with a module, or the introduction of self-assessment tools might require more scaffolding (more elaborate description or instructions or direct support). Similarly, if the learning module applies a technique that would not be included in the school's culture (for example, gamification) using simple self-assessment tools (e.g. from the section 'Quick feedback') before introducing the new method would implicate more efficient classroom work.

Some tools included in the inventory assess teachers' competences. These tools are included here as during piloting, adaptation or training, they provide firm support and feedback on teachers' understanding of inquiry-based science teaching, and they can also be used for measuring their progress, which might be useful if adaptation is supported in schools by experts. Using them, teachers might reflect on their own professional learning too. Annex 2 includes the Inventory.

Urban Science Competence Rubric

The competence rubric represents a general tool that can be used for measuring progress in medium- or long-term processes or through the whole Urban Science learning journey. The rubric was designed as a pre and post intervention tool, with which teachers can evaluate their students' progress. However, the tool can also be transformed (or adapted) to specific sets of learning modules. This is specifically valuable if the time frame of the learning modules exceeds at least three lessons and is preferable completed over the course of two weeks or more (according to related literature, shorter interventions might not have measurable effects). Effects measured by any pre and post intervention

tool might be influenced by many other factors including school culture (e.g. level of student autonomy, democratic processes including open dialogues, support for evidence-based decisions, teachers' roles, students' involvement in and responsibility for their own learning etc.), previous experiences with teaching-learning methods, teachers' didactical repertoire and former experience with inquiry-based learning etc. Generally, the less exposed students were to open instructions and inquiry-based work, the bigger the first measured impact is and vice versa. In other cases, lack of supportive didactical (or local) learning environment, hesitation, frustration or anxiety of teachers, irregular and brief exposure to new forms of learning may hinder the successful introduction of the learning modules, or may generate frustration, lack of understanding, anxiety or refusal in students, which result in no measurable progression.

The competence rubric was prepared with a thorough examination and revision of the Urban Science Competence Framework described in Intellectual Output 2 (see Annex 1). The competence elements were studied and re-clustered (see Annex 4) resulting in a new framework (see Annex 5).

The adaptation and use of the competence rubric are recommended via the following procedure:

1. Before the adaptation, please consider the proposed intervention:

- Is it a set of modules that you are working within a specific group of students?
- Is it only one module that they will use in this specific group?
- Will students be exposed to other Urban Science activities?

2. Based on this, a decision is needed whether to keep the general rubric to cover all competences, or to modify the rubric (as in Annex 6). For this, it is recommended to examine the learning module (aims, learning outcomes) to see whether the competences are all applicable in that designed learning environment. The adaptation of the rubric is not applicable for learning modules that are being adapted or modified (in an action research cycle, for example), especially if teaching-learning aims might change during the process.

3. At this point, please revise the language.

- Does it correspond to terms in your curricula?
- Is it relevant for the student group to be assessed?

4. The teacher assesses all students in the group before they start working with the Urban Science learning module(s). It is possible to make an online questionnaire or use an online platform. If the results of the pre and post assessment are shared with external persons including researchers, special attention should be paid to the following:

- In many countries EU (or own) data protection regulations apply, therefore teachers (or researchers) may want to give codes to students and use that when processing the data from the assessment.
- It may also be necessary in case of external involvement to have an agreement with the school and to briefly notify parents that such assessment is taking place and explain in which context

the data is used and refer to the fact that it is anonymous and will not be part of the school's assessment.

- It needs to be decided and reflected on how to communicate about the assessment (if communication is needed).
- It may also be interesting to only focus on some of the competences especially if the Urban Science work is carried out in a tight time frame using only one or a few of the learning modules.

5. Design the timing of the post-intervention assessment.

6. At the end of the trial period, the teacher assesses all students in their group again using the same rubric.

7. The pre- and post-intervention results are compared. Observed changes are evaluated considering some general factors (see above).

The rubric can also be transformed to a student self-assessment tool.

Urban Science Self-Assessment Tools

A separate collection of tools (also included in the Inventory) with explanations helps teachers design student self-assessment as part of the learning cycle. This collection (see Annex 8) proved to be useful for teachers with less experience in such forms of formative assessment.

Reflections from practitioners

The Urban Science competence-based assessment framework was piloted across partners during piloting with learning modules. Additionally, a more intense piloting with the competence rubric was carried out in Hungary with the participation of 10 science teachers (involving approximately 350 students) between March 2019 and January 2020 (2 consecutive semesters). Moreover, as part of an initial teacher training seminar at the Eötvös Lóránt University of Budapest, in November 2020, pre-service teachers also reflected on the competence rubric.[1]

(1) The **Urban Science Assessment Tool Inventory** contains a diversity of tools and references. Teachers seemed to prefer reflective and self-reflective tools. A part of the Inventory was also included in the Urban Science Self-Assessment Tools collection. Teachers with richer experience in inquiry teaching adapted classroom assessment tools in various contexts also as part of Storyline and role-game approaches. Some of the quick reflection tools were also useful

[1]A valuable contribution made by Marietta Molnár compared Urban Science competences with the merged competences and reflected on the adapted rubric in the case of three learning modules developed by the teacher members of the Hungarian Research Teachers' Association. Her reflections are included in this report.

in gamificated contexts, however, setting achievable points for self-reflection is not a recommended pedagogical approach as it acts against the honesty and the relaxed manner necessary as a basis for formative assessment and support for individual development. If these tools are used in a gamificated learning environment, the assessment grids or the mere completion of a self-assessment task can be used as a basis for achieving points. Otherwise, competition among individual students or student teams and open comparison might obstruct the learning process.

(2) It provides a general tool designed to reflect on Urban Science competences. The **Urban Science Competence Rubric** may serve as a general tool to monitor progress through a period working with Urban Science competences. As suggested above, it can (and should) be modified if the aim is to track progress through one specific learning module. In that case, the general competence descriptions need to be adjusted to the module's content, teaching-learning aims and expected learning outcomes. As a small-scale pilot in Hungary suggests, the rubric can also be transformed to a student self-evaluation tool. Pre-service teachers felt that the competence areas covered in the rubric are too broad and hence difficult to link to real classroom processes, furthermore that it is challenging to adjust the rubric competences to learning modules. Pre-service teachers conceived an evidence-based tool based on this challenge that can be used to support students' self-reflection (see Annex 7). Pre-service teachers preferred to work with IO2 competences when designing the rubric as they perceived them more specific to classroom contexts. In-service teachers, however, found that the rubric was an informative tool to reflect on the learning journey, and faced no obstacles in transforming the general tool to specific, learning-module-based rubrics. Consequently, the transformed rubric (as in Annex 7) was also used to support teachers' learning during initial teacher training and pilot trainings in Hungary.

(3) The collection of **Urban Science Student Self-Assessment Tools** was highly appreciated by project partners.

Guidelines for competence-based assessment

Urban Science tools can be used for adapting learning modules, for planning classroom work or for supporting teachers in schools to prepare for such work.

In the sections above, we provided some specific guidelines on how to use the tools. Before opting for one of the three tools, it may be worth considering the following leading questions.

- ***Are you novice to inquiry-based teaching?***

If yes, please consider using the Urban Science Student Self-Assessment Tools. If you prepare to use the rubric, please consider using the version in Annex 7. Also, please consider reflecting on your own learning of inquiry teaching using assessment tools targeted to teachers from the Inventory. Such tools

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include the scientific thinking self-assessment tool or the self-assessment or interview protocol for adapting modules for example.

- ***Are you novice to education for sustainable development /teaching for sustainability?***

If yes, please consider using the rubric version in Annex 7. You may also wish to follow the process of your trialling with the learning module using a self-reflective tool from the Inventory (besides the self-assessment or interview protocol for adapting modules, some tools designed for students such as the KWL or the Blob tree may also work for you as these are simpler, yet they guide self-reflection).

- ***Do you have your own learning experience in inquiry-based learning or learning for sustainability?***

If no, you may wish to consult a more experienced colleague or one of the project partners before adapting the assessment rubric or changing the suggested assessment in the learning module you chose.

In order to learn more about your own preferences, you can take more time to complete a longer questionnaire, for example Motivated Strategies for Learning Questionnaire from the Inventory.

- ***Do you have experience in gamification?***

If no, please consult a gamification expert or a more experienced teacher (or one of the project partners) before you select new assessment tools from the Inventory to incorporate them to the learning module of your preference.

As a general experience, also very strongly represented in the pilot trainings and in the pre-service teacher training seminar in Hungary, peer support is invaluable when experimenting with new ways of teaching. Therefore, any platform for that, including social media or other real or virtual peer support groups can contribute to a delightful and efficient trialling with Urban Science materials.

Annex 1. Urban Science Competences

The Urban Science Framework document (Intellectual Output 2) lists science and sustainability competences and sketches the pedagogical framework to contextualize them. Here we copy the competence lists for reference.

A stated in that document, the two sets of competences are seen a complementary and as proposed in the session on pedagogy, continuous (formative) assessment of competences is just as important as having a sense of their development throughout working with Urban Science learning modules.

1.1 IBSE Competences

The list provides a comprehensive list of IBSE competences. These are for guidance. Each Learning Module will select only the competences appropriate for that Learning Module. However, over an annual cycle or several Learning Modules, all competences should be addressed.

IBSE Competences	
Develop knowledge and understanding of key Urban Science issues	1.a. State observable features
	1.b. State or use a classification system
	1.c. State a relationship between variables
	1.d. Show understanding of scientific theory
Learn how to	2.a. Identify equipment
	2.b. Use equipment
	2.c. Describe a standard procedure
	2.d. Carry out a standard procedure
Develop an understanding of scientific Inquiry	3.a. Propose a question
	3.b. Plan a strategy
	3.c. Evaluate risk
	3.d. Collect relevant data
	3.e. Present data effectively
	3.f. Process data
	3.g. Interpret data
	3.h. State a conclusion
	3.i. Evaluate a conclusion

1.2 Sustainability Competences

Sustainability competences need to be referenced through a deeper understanding of the sustainability challenges facing Europe; it is not the purpose of this document to assess this and further information can be found here[2]. Broadly speaking we can consider those challenges as:

- First Order: we know what the issues are, we know how to address them; the role of education is to inform society what it needs to do. An example is recycling as a solution to the issue of waste. The goals and paradigm of society remain unchanged[3].
- Second Order: we know what the issues are; addressing the issues requires radical change in how we approach solutions and the role of education becomes developing competences to explore and implement new solutions. An example is the circular economy which views 'waste' as 'food' for new processes. The goals and paradigm of society remain unchanged.
- Third Order: in this level the goals and paradigms of society itself are questioned; new forms or organising and being emerge; solutions become contextualised in a whole new way. The role of learning seen as constant experimentation, feedback, revision and iteration as learners tackle complex and inter-related issues.

Urban Science is sited as a progression from first order to second order learning and change; empowering pupils to reimagine cities in their future and teachers to grasp wider transformative learning opportunities. Sustainability competences need to be viewed in this context; competences that are characterized by the unique role they play in addressing the sustainability challenges and opportunities that are before humanity.

Sustainability Competence	Description
1. The ability to understand systems and apply systems thinking (inputs, outputs, connections, loops, feedback)[4].	1.a. Able to connect different elements within an urban environment; 1.b. Seeing how they relate to each other; 1.c. Recognising that all actions are part of a system; and 1.d. Often have multiple consequences positive or negative.
2. An understanding of how natural systems function, ecological limits and resource constraints[5].	2.a. Understanding how natural systems work within limits and use a range of strategies to adapt, optimise and flourish; 2.b. To understand how human activity that exceeds ecological limits or capacity has negative effects; and 2.c. Sustainable systems balance resource use within a fixed carrying capacity.

[2] Learning for a Change
[3] For more see http://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/
[4] See State of Washington Science Standards for more on progression in system competences.
[5] See The Donut of Social and Planetary Boundaries and Planetary Boundaries.

Sustainability Competence	Description
3. The ability to think in time - to forecast, to think ahead, and to plan.	3.a. Develop ideas for alternative futures 3.b. Understand alternative futures 3.c. Evaluate alternative futures; and 3.d. Able to predict the consequences of actions today on future choices and their ability to act.
4. The ability to think critically about value issues[6].	4.a. Identify behaviours and values that reinforce a sustainable future; and 4.b. Able to apply a values perspective to decision-making; integrating scientific knowledge with personal and societal values in making choices.
5. The ability to separate number, quantity, quality, and value.	5.a. Being able to distinguish between actions which improve or quality of life versus quantitative changes in material standards.
6. The capacity to move from awareness to knowledge to action.	6.a. Able to take responsibility to develop and implement plans; and 6.b. Evaluate their success.
7. The capacity to develop an aesthetic and compassionate response to the environment	7.a. Having a sense of connection beyond self, 7.b. See the needs of others; and 7.c. Demonstrate compassion and sympathy for others and the natural world.
8. The capacity to use these processes: knowing, inquiring, acting, judging, imagining, connecting, valuing, and choosing.	8.a. Being able to integrate a range of technical and emotional capacities; and 8.b. Know which capacities to apply to a given situation.

[6] See The Common Cause Handbook.

Annex 2. Urban Science Assessment Tool Inventory

Place in the learning cycle	Who is assessed	Tool	Purpose of assessment	Type of tool	Link
Before Stage 1 of the learning cycle	students	Motivation and self-efficacy questionnaire by Herman	to estimate the empowerment, motivation and self-efficacy of students involved in project-based science learning by their self-evaluation	self-assessment or external pre/post assessment	[1]
		KWL Grid	to find what students already know, what they would like to learn and review changes in the above	self-assessment and peer-assessment, formative	[2]
		Motivated Strategies for Learning Questionnaire	to assess motivation and use of learning strategies by students	self-assessment, formative	[3]
	teachers	Scientific thinking self-assessment tool	to support reflection on the given teaching practice by the teacher; by collecting examples or evidences	self-assessment reflective tool	[4]

[1] https://dl.acm.org/citation.cfm?id=1150071
[2] https://www.twinkl.fr/teaching-wiki/kwl-grid
[3] https://eric.ed.gov/?id=ED338122
[4] https://pure.strath.ac.uk/portal/en/publications/adding-pedagogical-process-knowledge-to-pedagogical-content-knowledge(3dadc830-bd0e-4a40-9df0-14f11238b1e2)/export.html and https://dialnet.unirioja.es/descarga/articulo/4459239.pdf

After stage 3 of the learning cycle	students and teachers	Rubric reflection and observation tool	to provide a prepared framework to focus reflection onto specific aspects of the teaching and learning process, working together with open questions.	collaborative summative assessment	[5]
	students	Formative peer assessment	to provide a detailed insight to how students assess their learning	peer assessment, formative	[6]
	students	Student self-assessment checklist	to assess written production linked to inquiry-based / design-based learning	self-assessment checklist	[7]
		IBL summative assessment tool by 5 stages	to assess students' advancement by each phase of the inquiry learning process using a 5-step model	teacher-led summative assessment	[8]
		Biomimicry rubric	to collect information about the advancement of students in a learning cycle	self-assessment summative assessment	[9]
		Teachers dialogue protocol for assessing IBL	to assess students' notions about the inquiry learning process.	dialogue, formative assessment	[10]
		Student-generated test questions	to check students' knowledge after a session / cycle	summative assessment	[11]
		Assessment Wall	to assess specific competences	self-assessment	[12]

[5] https://resources.ats2020.eu/resource-details/LITR/professional-reflection
[6] https://www.celt.iastate.edu/teaching/assessment-and-evaluation/peer-assessment/
[7] http://www.teacherstryscience.org/lp/give-me-biomimetic-shelter
[8] https://sisu.ut.ee/sites/default/files/ark/files/summative_assessement.pdf
[9] https://www.teacherstryscience.org/sites/default/files/lessonplan/resources/biomimicry_rubric.pdf
[10] https://sisu.ut.ee/sites/default/files/ark/files/dialogue_protocol.pdf
[11] https://www.prodigygame.com/blog/experiential-learning-activities/
https://schools.ednet.ns.ca/avrsb/070/tawebb/Appraisalindex/Cats/4Application/25StudentGeneratedtest.pdf
[12] https://videsizglitiba.wordpress.com/vertesanas-kriteriji/

		PISA	complex competence assessment	questionnaire, summative assessment	[13]
During piloting	students and teachers	Rubric reflection and observation tool	to provide a prepared framework to focus reflection onto specific aspects of the teaching and learning process, working together with open questions.	collaborative summative assessment	[14]
	students	Teachers dialogue protocol for assessing IBL	to assess students' notions about the inquiry learning process.	dialogue, formative assessment	[15]
	teachers	Self-assessment or interview protocol for adapting modules	to learn teachers' view about adaptation and a module's strengths and weaknesses	self-assessment, dialogue, formative assessment	[16]
Quick feedback	students	Index card summaries	to support reflection on key ideas being learnt and create questions for areas where understanding in incomplete	formative assessment	[17]
		Muddiest point	to review points that need further clarification, correction or more elaboration	formative assessment, self-reflection	[18]

[13] http://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf
[14] https://resources.ats2020.eu/resource-details/LITR/professional-reflection
[15] https://sisu.ut.ee/sites/default/files/ark/files/dialogue_protocol.pdf
[16] http://spice.eun.org/c/document_library/get_file?p_l_id=16292&folderId=16435&name=DLFE-9322.pdf
[17] http://distrategykit.weebly.com/index-card-summaries.html
[18] https://www.celt.iastate.edu/teaching/assessment-and-evaluation/classroom-assessment-techniques-quick-strategies-to-check-student-learning-in-class/

		Suggestion box	to review some points ("hazy" topics, top moments, general impressions – based on purpose and instruction)	formative assessment, self-reflection	[19]
		ABC summaries	to get quick responses of student understanding	formative assessment	[20]
		Blob Tree	to record feelings towards a topic	formative assessment	[21]
		One-Minute Paper	to identify issues/topics which are clear for the students and those which need to be revised	formative assessment	[22]
		Chain Notes strategy	to get a quick overview of students understanding of the topic	formative assessment	[23]
		Application Article	to find out if students can apply knowledge and skills in practice	formative assessment	[24]
		Online 'quiz'	to gain quick feedback responses on learning, mainly knowledge based	summative assessment	[25]

[19] https://www.celt.iastate.edu/teaching/assessment-and-evaluation/classroom-assessment-techniques-quick-strategies-to-check-student-learning-in-class/
[20] https://goalbookapp.com/toolkit/v/strategy/abc-summary
[21] https://www.blobtree.com/
[22] https://oncourseworkshop.com/self-awareness/one-minute-paper/
[23] https://www.s2temsc.org/uploads/1/8/8/7/18873120/chain_notes_strategy.pdf
[24] https://www.celt.iastate.edu/teaching/assessment-and-evaluation/classroom-assessment-techniques-quick-strategies-to-check-student-learning-in-class/
[25] https://www.socrative.com/ and https://goformative.com/

Annex 3. Examples of using the tools for trainings

Tools from the Inventory can also be used for preparing teachers to work with Urban Science learning modules. This leads to a better understanding of the tool itself while also giving genuine learning experiences to teachers. There are some examples collected in the following from Transnational Partner Meeting 3 workshop and teacher training pilots from Hungary.

3.1 Student generated test questions

Make up 3 questions for the group based on the previous session.

3.2 Motivation and self-efficacy questionnaire by Herman

Transform this questionnaire in order to discover Urban Science project participant attitudes.

Stem: "How confident are you that you can…."	1	2	3	4	N/A
Design an experiment that would test a hypothesis?					
Make a graph or chart to present science data?					
Give an oral presentation to your class about a scientific problem?					
Explain to someone how a graph you made presents important information about some science question?					
Challenge a statement made by another student or your teacher using data as your evidence?					
Work together with other students to study a scientific problem?					
Use the Internet to find data about a scientific problem you are studying?					
Use the computer to analyse data about a problem you are studying?					
Come up with a scientific question to investigate?					
Figure out the answer to a hard scientific question, without being given the answer by a teacher or finding it in a book?					
Figure out what kind of data you would need to answer a science question or problem?					
Identify a scientific question or problem that you could investigate?					
"Know how to do" scale (5 items)					
I know what to do when we write science papers and reports in this class.					
I know what to do when we make presentations in this class.					
I understand the assignments in this class as well as the other students.					
I know how to analyse data in this class.					

I know how to use data to support what I say about a science question or problem.					
"Confused/Negative Affect" scale (4 items) (Reverse scored)					
I'm not sure I have the skills to do well in this class.					
I don't understand what I need to do to be successful in this class.					
Sometimes I'm confused about what my teacher wants me to do in this class.					
My teacher pushes me too hard.					

3.3 Scientific thinking self-assessment tool

This is a tool to reflect on your own teaching practice. Can also be used when observing a lesson and providing feedback.

Aspects of scientific thinking	**Analysis**	
	Supported/ Partly supported/ Not supported	**Evidence (example)**
I observe with any or all my senses as required.	supported	Vision: observing light, materials and animals. Touching: touching surfaces.
I categorise what I observe as things and events.	supported	Materials and light characteristics as well as observed species became categories.
I recognise patterns in the categories of things and events.	supported	Linking polarized light parameters to occurrence of species.
I form and test hypotheses.	not supported	Students were passive. They waited for the teacher to come up with ideas.
I think about cause and effect.	partly supported	Students worked on causality when the teacher encouraged them.
I effectively support theory with evidence.	supported	Using literature resources, linking observations to data and causal thinking.
I visualise.	supported	Making diagrams.
I am aware of my thinking and control it.	supported	During groupwork discussions: „I can't support this" / „Your notion contradicts what is written here on the link".
I use metaphor and analogy	not supported	

I use the 'confirm early-disconfirm late' heuristic	not supported	
I collaborate in thinking	supported	Measuring light in pairs, groupwork through elaboration phase, evaluation through argumentation.

3.4 KWL grid

Fill in the table thinking about this session.

What I KNOW	What I WANT TO KNOW	What I LEARNT

3.5 Rubric reflection and observation tool

Example of Specific Action Plan – puzzle. Match the plan and comment cells in the table below. Then formulate 3 questions and 1 suggestion or comment for the teacher who wrote this.

Plan	Comment
Completed reflection after having done self-assessment over five lessons. Realized how few opportunities I provide for students to engage in self-assessment. Will develop a reflective question for each lesson for this week.	my instruction more during the lesson. Trying think-pair-share in several lessons...students write what they are unsure about and then talk with peers to clarify their understanding.
This week I am revising my goal – still focusing on student self-assessment but want to incorporate that thinking into	That's helped. Really learning about what students are thinking–more sophisticated than I expected–but with some holes there too. Helping me with my planning.
The think-pair-share seemed more effective during the lesson rather than a self-assessment	Students completed a "check in" at the end of each lesson to identify one thing they were

during the end of the lesson rush. I will try to do "check ins" at the end of lessons where I know I have enough time for students to be thoughtful.	confused about. Sorted index cards into groups and used them to plan next lesson. Realized more variety needed so that students are asked to think about what they do and do not understand using slightly different approaches each day.
Continuing with the routine of regular self-assessment, but now bringing in more of the peer component. Looking for opportunities for students to exchange alternative strategies so that they can hear other ways of approaching problems and articulate their own thinking.	Struggling more with engaging peers to talk to each other about their own work. Going to peer observe a colleague since
my chair said he has been very successful in supporting his students' articulation of their mathematical reasoning and I think I can learn from that.	I will continue to use think-pair-share during lessons where there is new content or ideas with which students can grapple.
Getting good discussion questions is really hard, but I've been partnering with a colleague teaching the same class as me.	Based on peer observation, I really saw a different approach to classroom discussions. Realized I need to demonstrate more clearly that I value student contributions. I plan to pose a problem to be solved in each lesson this week to really get students talking to each other and to me, and to do some modelling.

Annex 4. Merging competences – overview

The following table shows how the competences in the rubric are linked to the IO2 Framework Urban Science competences. Inquiry-based science (IBSE) competences are shown in white, sustainability competences are displayed in green and new competence areas are demonstrated in grey cells.

Competence area in rubric	Competences (elements from IO2 Urban Science key competences)					
Develop knowledge and understanding of key Urban Science issues (including understanding basic characteristics of scientific thinking and urban environment and understanding scientific theory)	1.a. Able to connect different elements within an urban environment;	1.b. Seeing how they relate to each other;	1.a. State observable features	1.b. State or use a classification system	1.c. State a relationship between variables	

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Competence area in rubric	Competences (elements from IO2 Urban Science key competences)								
Able to use scientific methods for inquiry in urban science	2.a. Identify equipment	2.b. Use equipment	2.c. Describe a standard procedure	2.d. Carry out a standard procedure					
Carry out inquiry science activities (including posing a question, developing a strategy, proposing a method, collecting and interpreting data, drawing a conclusion) in urban context	3.a. Propose a question	3.b. Plan a strategy	3.c. Evaluate risk	3.d. Collect relevant data	3.e. Present data effectively	3.f. Process data	3.g. Interpret data	3.h. State a conclusion	3.i. Evaluate a conclusion

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Competence area in rubric	Competences (elements from IO2 Urban Science key competences)					
Apply systems thinking to evaluate consequences of human activities in urban environments	1.c. Recognising that all actions are part of a system; and	1.d. Often have multiple consequences positive or negative.	2.b. To understand how human activity that exceeds ecological limits or capacity has negative effects; and	1.d. Show understanding of scientific theory		
Understand natural systems in the context of a city, using science knowledge	2.a. Understanding how natural systems work within limits and use a range of strategies to adapt, optimise and flourish;	1.d. Show understanding of scientific theory	1.a. State observable features	1.b. State or use a classification system	1.c. State a relationship between variables	
Understand the basic features of sustainable urban systems, using science knowledge	2.c. Sustainable systems balance resource use within a fixed carrying capacity.	2.b. To understand how human activity that exceeds ecological limits or capacity has negative effects	1.d. Show understanding of scientific theory	1.a. State observable features	1.b. State or use a classification system	1.c. State a relationship between variables

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Competence area in rubric	Competences (elements from IO2 Urban Science key competences)							
Understand alternative futures in urban environments, using science knowledge	3.a. Develop ideas for alternative futures	3.b. Understand alternative futures	3.c. Evaluate alternative futures	3.c. Evaluate risk	1.d. Show understanding of scientific theory	1.a. State observable features	1.b. State or use a classification system	1.c. State a relationship between variables
Identify behaviours and values that reinforce a sustainable future	4.a. Identify behaviours and values that reinforce a sustainable future; and	1.d. Show understanding of scientific theory	1.d. Show understanding of scientific theory	3.g. Interpret data	3.h. State a conclusion	3.i. Evaluate a conclusion		
Able to apply a values perspective to decision-making; integrating scientific knowledge with personal and societal values in making choices.	4.b. Able to apply a values perspective to decision-making; integrating scientific knowledge with personal and societal values in making choices.	1.d. Show understanding of scientific theory	1.d. Show understanding of scientific theory	3.g. Interpret data	3.h. State a conclusion	3.i. Evaluate a conclusion		

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Competence area in rubric	Competences (elements from IO2 Urban Science key competences)						
Apply scientific evidence to distinguish between sustainable and unsustainable actions in urban environments	5.a. Being able to distinguish between actions which improve or quality of life versus quantitative changes in material standards.	1.d. Show understanding of scientific theory	1.d. Show understanding of scientific theory	3.g. Interpret data	3.h. State a conclusion	3.i. Evaluate a conclusion	
Agency and responsibility supported by scientific thinking	3.d. Able to predict the consequences of actions today on future choices and their ability to act.	6.a. Able to take responsibility to develop and implement plans.	3.d. Collect relevant data	3.f. Process data	3.g. Interpret data	3.h. State a conclusion	3.i. Evaluate a conclusion
Evaluate success of (proposed) interventions in cities based on scientific thinking	6.b. Evaluate their success.	3.d. Collect relevant data	3.e. Present data effectively	3.f. Process data	3.g. Interpret data	3.h. State a conclusion	3.i. Evaluate a conclusion

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Annex 5. The Urban Science Competence Rubric

The Urban Science competences are merged to 12 competence areas and are described at four levels.

	Competence area	Novice	Beginner	Practicing	Advanced
1	***Develop knowledge and understanding of key Urban Science issues (including understanding basic characteristics of scientific thinking and urban environment)***	Need to develop understanding of scientific thinking in the context of urban environment	Able to identify elements of scientific thinking and to identify urban challenges	Apply some elements of scientific thinking to understand challenges in an urban environment	Able to apply scientific thinking to understand challenges in an urban environment
2	***Able to use scientific methods for inquiry in urban science***	Need to learn methods of science inquiry	Need to practice methods of science inquiry in urban context	With support use scientific methods in urban context	Able to use scientific methods in urban context
3	***Carry out inquiry science activities (including posing a question, developing a strategy, proposing a method, collecting and interpreting data, drawing a conclusion) in urban context***	Need to acquire inquiry activities in urban context	With scaffolding able to complete an inquiry activity in urban context	With (some) support able to use science inquiry in urban context	Able to apply science inquiry autonomously in urban context
4	***Apply systems thinking to evaluate consequences of human activities in urban environments***	Needs to know more about consequences of human activities and cities as systems	Understands consequences of human activities in urban environments also with a systems perspective	With support apply elements of systems thinking to evaluate consequences of human activities in urban environments	Able to apply systems thinking to evaluate consequences of human activities in urban environments

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	Competence area	Novice	Beginner	Practicing	Advanced
5	***Understand natural systems in the context of a city, using science knowledge***	Need to learn more about the main characteristics of natural systems	Able to recognise some system characteristics of natural systems in the context of a city, using science knowledge	Able to understand some characteristics of natural systems in the context of a city, using science knowledge	Generally, understand natural systems in the context of a city, using science knowledge
6	***Understand the basic features of sustainable urban systems, using science knowledge***	Need to know more about the basic features of sustainable urban systems	Able to identify some basic features of sustainable urban systems, using science knowledge	Able to distinguish between sustainable and unsustainable urban systems, using science knowledge	Using science knowledge, understand the basic features of sustainable urban systems
7	***Understand alternative futures in urban environments, using science knowledge***	Need to develop time-related thinking in urban context	Able to understand the basics of forecast and predict alternative scenarios using scientific thinking	Able to develop ideas about alternative futures and with support understands them using scientific thinking	Develop ideas and understand alternative futures in urban context, based on scientific thinking
8	***Identify behaviours and values that reinforce a sustainable future***	Need to learn more about values in a sustainability context	Able to identify some behaviours and values in a sustainability context	Able to identify some behaviours and values that act towards a sustainable future	Able to distinguish between behaviours and values that act towards a sustainable and an unsustainable future

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	Competence area	Novice	Beginner	Practicing	Advanced
9	***Able to apply a values perspective to decision-making; integrating scientific knowledge with personal and societal values in making choices.***	Need to understand the role of scientific knowledge and values in decision-making	Understand the role of scientific knowledge and values in decision-making	With support apply a values-perspective in decision-making	Able to apply a values-perspective in decision-making
10	***Apply scientific evidence to distinguish between sustainable and unsustainable actions in urban environments***	Needs to know more about sustainable and unsustainable actions in urban environments	Able to understand the difference between sustainable and unsustainable actions in urban environments	In some cases, or with support, able to distinguish between a sustainable and an unsustainable action using scientific evidence	Able to distinguish between a sustainable and an unsustainable action using scientific evidence
11	***Agency and responsibility supported by scientific thinking***	Need to develop responsibility and ownership for actions	Understands evidence supporting responsibility for actions in urban environment	Need to develop agency but express responsibility for actions in urban environment	Ready to practice evidence-based responsibility for actions in urban environment
12	***Evaluate success of (proposed) interventions in cities based on scientific thinking***	Need to practice how to evaluate consequences of actions in systems such as cities	Possess skills to evaluate actions in systems	Able to apply scientific thinking to evaluate success of interventions in urban environment	Able to evaluate success of (proposed) interventions in cities based on scientific thinking

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Annex 6. Examples of transforming the competence rubric

Sounds in my city rubric

	Competence area	remark	Novice	Beginner	Practicing	Advanced
1	***Develop knowledge and understanding of NOISE***	*applicable*	Need to develop understanding of scientific thinking in the context of noise in the urban environment	Able to identify elements of scientific thinking and to identify urban challenges	Apply some elements of scientific thinking to understand challenges in an urban environment	Able to apply scientific thinking to understand challenges in an urban environment
2	***Able to use scientific methods for inquiry about noise in the city***	*applicable*	Need to learn methods of measuring and mapping noise	Need to practice methods of measuring and mapping noise in urban context	With support measure and map in urban context	Able to measure and map noise in a city
3	***Carry out inquiry science activities (including posing a question, developing a strategy, proposing a method, collecting and interpreting data, drawing a conclusion) in the noise in the city context***	*applicable*	Need to acquire inquiry activities in urban context	With scaffolding able to complete an inquiry activity about noise in the city	With (some) support able to use science inquiry about noise in the city	Able to apply science inquiry autonomously about noise in the city
4	***Apply systems thinking to evaluate consequences of human influence on noise in the city***	*applicable*	Needs to know more about consequences of human activities about noise in the city	Understands some consequences of human noise in cities	With support apply elements of systems thinking to evaluate consequences of human noise pollution in cities	Able to apply systems thinking to evaluate consequences of human noise pollution in cities

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	Competence area	remark	Novice	Beginner	Practicing	Advanced
5	***Understand natural systems in the context of a city, using science knowledge***	*not applicable in this module*	Need to learn more about the main characteristics of natural systems	Able to recognise some system characteristics of natural systems in the context of a city, using science knowledge	Able to understand some characteristics of natural systems in the context of a city, using science knowledge	Generally, understand natural systems in the context of a city, using science knowledge
6	***Understand the basic features of sustainability and noise in cities, using science knowledge***	*applicable*	Need to know more about the basic features of noise in sustainable urban systems	Able to identify some basic features of noise in sustainable urban systems, using science knowledge	Able to distinguish between sustainable and unsustainable noise in urban systems, using science knowledge	Using science knowledge, understand the basic features of sustainable noise in urban systems
7	***Understand alternative futures in urban environments, using science knowledge***	*not applicable in this module*	Need to develop time-related thinking in urban context	Able to understand the basics of forecast and predict alternative scenarios using scientific thinking	Able to develop ideas about alternative futures and with support understands them using scientific thinking	Develop ideas and understand alternative futures in urban context, based on scientific thinking
8	***Identify behaviours and values that reinforce a sustainable future in the context of noise***	*applicable*	Need to learn more about values concerning noise in a sustainability context	Able to identify some behaviours and values in a sustainability context about noises	Able to identify some behaviours and values that act towards a sustainable future in the context of noise	Able to distinguish between behaviours and values that act towards a sustainable and an unsustainable future about noise in the city

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	Competence area	remark	Novice	Beginner	Practicing	Advanced
9	***Able to apply a values perspective to decision-making about noises; integrating scientific knowledge with personal and societal values in making choices.***	*applicable*	Need to understand the role of scientific knowledge and values in the context of noise pollution	Understand the role of scientific knowledge and values in decision-making about noise	With support apply a values-perspective in decision-making about noise	Able to apply a values-perspective in decision-making about noise pollution or protection
10	***Apply scientific evidence to distinguish between sustainable and unsustainable actions in the noise in the city context***	*applicable*	Needs to know more about sustainable and unsustainable actions in urban environments	Able to understand the difference between sustainable and unsustainable actions in urban environments	In some cases, or with support, able to distinguish between a sustainable and an unsustainable action in the context of noises using scientific evidence	Able to distinguish between a sustainable and an unsustainable action in the context of noises using scientific evidence
11	***Agency and responsibility about noise in the cities supported by scientific thinking***	*applicable*	Need to develop responsibility and ownership for making/preventing noises	Understands evidence supporting responsibility for noises in urban environment	Need to develop agency but express responsibility for noise-related actions in urban environment	Ready to practice evidence-based responsibility for noise-related actions in urban environment
12	***Evaluate success of noise protection in their city based on scientific thinking***	*applicable*	Need to practice how to evaluate consequences of noise-related actions in systems such as cities	Possess skills to evaluate consequences of noise pollution in cities	Able to apply scientific thinking to evaluate success of interventions about noise in urban environment	Able to evaluate success of (proposed) interventions concerning noise in cities based on scientific thinking

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Heatwaves rubric

	Competence area	remark	Novice	Beginner	Practicing	Advanced
1	***Develop knowledge and understanding of the changes in temperature in the urban environment***	*applicable*	Need to develop understanding of the heat island effect	Able to identify elements of scientific thinking and to identify urban challenges	Apply some elements of scientific thinking to understand challenges in an urban environment	Able to apply scientific thinking to understand challenges in an urban environment
2	***Able to use scientific methods for inquiry about the changes in temperature and their effects in urban context***	*applicable*	Need to learn measuring temperature, modelling, designing and carrying out a research project	Need to practice methods in urban context	With support use scientific methods in urban context	Able to use scientific methods in urban context
3	***Carry out inquiry science activities (including posing a question, developing a strategy, proposing a method, collecting and interpreting data, drawing a conclusion) in urban context***	*only partly applicable*	Need to acquire inquiry activities in urban context	With scaffolding able to complete an inquiry activity in urban context	With (some) support able to use science inquiry in urban context	Able to apply science inquiry autonomously in urban context
4	***Apply systems thinking to evaluate the consequences of human activities regarding the heat island effect in urban environments***	*applicable*	Needs to know more about consequences of human activities concerning the rise in temperature and cities as systems	Understands consequences of human activities concerning the rise in temperature in urban environments also with a systems perspective	With support apply elements of systems thinking to evaluate consequences of human activities concerning the rise in temperature in urban environments	Able to apply systems thinking to evaluate consequences of human activities concerning the rise in temperature in urban environments

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	Competence area	remark	Novice	Beginner	Practicing	Advanced
5	***Understand natural systems of cooling and heating effects in the context of a city, using science knowledge***	*applicable*	Need to learn more about the main characteristics of natural cooling and heating systems	Able to recognise some system characteristics of natural cooling and heating systems in the context of a city, using science knowledge	Able to understand some characteristics of natural cooling and heating systems in the context of a city, using science knowledge	Generally, understand natural cooling and heating systems in the context of a city, using science knowledge
6	***Understand the basic features of sustainable urban solutions concerning the changes in temperature, using science knowledge***	*applicable*	Need to know more about the basic features of sustainable urban systems	Able to identify some basic features of sustainable urban systems, using science knowledge	Able to distinguish between sustainable and unsustainable urban systems, using science knowledge	Using science knowledge, understand the basic features of sustainable urban systems
7	***Understand alternative futures in urban environments, using science knowledge***	*not applicable in this module*	Need to develop time-related thinking in urban context	Able to understand the basics of forecast and predict alternative scenarios using scientific thinking	Able to develop ideas about alternative futures and with support understands them using scientific thinking	Develop ideas and understand alternative futures in urban context, based on scientific thinking
8	***Identify behaviours and values that reinforce a sustainable future concerning climate change***	*applicable*	Need to learn more about values in a sustainability context	Able to identify some behaviours and values in a sustainability context	Able to identify some behaviours and values that act towards a sustainable future in the context of heatwaves	Able to distinguish between behaviours and values that act towards a sustainable and an unsustainable future in the context of heatwaves

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	Competence area	remark	Novice	Beginner	Practicing	Advanced
9	***Able to apply a values perspective to decision-making about sustainable redesigning solutions; integrating scientific knowledge with personal and societal values in making choices.***	*applicable*	Need to understand the role of scientific knowledge and values in decision-making	Understand the role of scientific knowledge and values in decision-making	With support apply a values-perspective in decision-making about sustainable green urban environment	Able to apply a values-perspective in decision-making about sustainable green urban environment
10	***Apply scientific evidence to distinguish between sustainable and unsustainable actions and designs in urban environments***	*applicable*	Needs to know more about sustainable and unsustainable actions and designs in urban environments	Able to understand the difference between sustainable and unsustainable actions and designs in urban environments	In some cases, or with support, able to distinguish between a sustainable and an unsustainable actions and designs using scientific evidence	Able to distinguish between a sustainable and an unsustainable actions and designs using scientific evidence
11	***Agency and responsibility about change in temperature by scientific thinking***	*applicable*	Need to develop responsibility and ownership for the rising temperature and climate change	Understands evidence supporting responsibility for the rising temperature and climate change in urban environment	Need to develop agency but express responsibility for temperature rising in urban environment	Ready to practice evidence-based responsibility for temperature rising actions in urban environment
12	***Evaluate success of redesigning districts towards sustainability in cities based on scientific thinking***	*applicable*	Need to practice how to evaluate consequences of climate stabilizing actions in systems such as cities	Possess skills to evaluate consequences of the rise in temperature in cities	Able to apply scientific thinking to evaluate success of interventions regarding the rise in temperature in urban environment	Able to evaluate success of (proposed) interventions regarding the rising temperature in cities based on scientific thinking

Annex 7. Example of transforming the rubric into self-assessment tool

Student self-assessment tool or tool supporting teachers' reflection on competences:

Competence area		Evidence from classroom work
1	*Develop knowledge and understanding of key Urban Science issues (including understanding basic characteristics of scientific thinking and urban environment)*	
2	*Able to use scientific methods for inquiry in urban science*	
3	*Carry out inquiry science activities (including posing a question, developing a strategy, proposing a method, collecting and interpreting data, drawing a conclusion) in urban context*	
4	*Apply systems thinking to evaluate consequences of human activities in urban environments*	
5	*Understand natural systems in the context of a city, using science knowledge*	
6	*Understand the basic features of sustainable urban systems, using science knowledge*	
7	*Understand alternative futures in urban environments, using science knowledge*	
8	*Identify behaviours and values that reinforce a sustainable future*	
9	*Able to apply a values perspective to decision-making; integrating scientific knowledge with personal and societal values in making choices.*	
10	*Apply scientific evidence to distinguish between sustainable and unsustainable actions in urban environments*	
11	*Agency and responsibility supported by scientific thinking*	
12	*Evaluate success of (proposed) interventions in cities based on scientific thinking*	

Note that the language may need to be reformulated if the tool is used with students.

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Annex 8. Urban Science Self-Assessment Tools

BASIS

Self-assessment is a key aspect of successful assessment. In order to internalise new knowledge and competences, students need to reflect on their learning. Self-assessment practices are important features of assessment for learning as a strategy to promote 'learning to learn' (James et al., 2007). Self-assessment leads a student to a greater awareness and understanding of himself or herself as a learner.

Student self-assessment focuses on the student's personal development and on the importance of acquiring skills for tracking this development. In self-assessment progress is measured against the student's prior performances. This process helps students stay involved and motivated and encourages self-reflection and responsibility for their learning.

The ability to self-assess effectively develops over time and with experience (Cassidy, 2007). It is important that teachers consider how they might share feedback and assessment processes with students to facilitate student learning. Thus, teachers will be helping students to develop their own skills for self-assessment especially for sustainability competences that the Urban Science project is addressing. This can be done through discussions about their ability to assess which consecutively can be altogether useful in preparing students for life-long learning.

TOOLS

The Urban Science (US) project is proposing several tools to be used towards student self-evaluation. Teachers are free to choose one or more for inviting their students for a self-evaluation experience.

Four tools are suggested below:

1. Self-reflective generic questions after different module stages.
2. Likert scale.
3. Plenary pyramid.
4. Q-K-W-L cart.

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I. SELF-REFLECTIVE GENERIC QUESTIONS AFTER DIFFERENT MODULE STAGES

Note to teacher: Students are invited to complete the following sentences.

After Stage 1 – Initiating and eliciting

1. From today's lesson my **curiosity** was awakened by … … ….
2. What I **learnt** during the activities was … … ….
3. The **question/s** I have after today's lesson is/are … … … …?

After Stage 2 – Defining and responding

4. What I mostly liked / disliked from **defining** our class's Urban Science idea was … … ….
5. From our activities' plan and future tasks I am mostly **excited** by … … ….
6. What I **learnt** during the activities was … … ….

After Stage 3 – Doing and making

7. My **engagement** in our class's enquiry included the following tasks: … … ….
8. The enquiry tasks were **meaningful** to me because … … ….
9. What I **learnt** during the enquiry activities was … … ….
10. My **answer/s** to the question/s from Stage 1 is/are … … ….
11. If so, my question/s from Stage 1 **changed** to … … ….

After Stage 4 – Communicating, presenting and evaluating

12. My most exciting / disappointing **moment** of our project was … … ….
13. My **message** to the world is … … ….

Note to teacher: Students are invited to share (should they want) their input with classmates and discuss, allowing for peer feedback to take place.

Note to teacher: Depending on the specific content of each module teachers are invited to add additional questions.

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II. LIKERT SCALE

Note to teacher: To be distributed to students pre- and post-Urban Science learning experience, not after each stage.

Levels (option 1): Not at all sure; Not sure; Neither sure nor not sure; I guess so; Sure, yes.

Levels (option 2): Definitely not; Not; Not sure; Yes; Definitely yes.

1. (Optional) Are you aware of the competencies* required for creating healthy cities and a low carbon future**?
2. Are you aware about the opportunities of science study towards your future career?
3. Are you considering studying science at a higher level?
4. Do you understand the issues related to cities sustainability and how they link to science?

*This question is allowing the teachers to introduce the concept of competences to students. A preliminary session may need to be arranged for students (depending on their age and understanding of competences).

**The teachers define low carbon (future).

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III. PLENARY PYRAMID

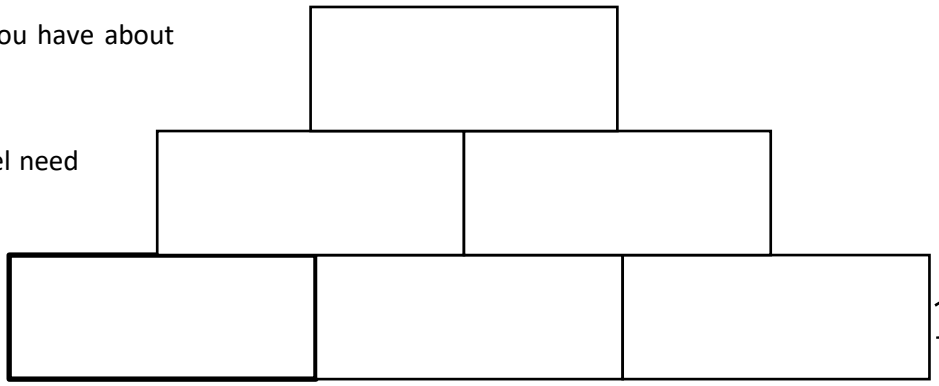
Note to teacher: The pyramid is based on the eight sustainability competences from the Urban Science framework. Pyramid is to be used as a pre- and post-learning tool, not after each stage. A preliminary session may need to be arranged for students (depending on their age and their understanding of competences). Detailed description of the competences is available in the Urban Science framework.

Note to teacher: From the list of competences below the pyramid students are asked to reflect and to put an applicable competency into a suitable row.

Write one question you have about the competences

List two competences you feel need to be developed more

List three competences you feel confident using



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1. The ability to understand systems and apply systems thinking (inputs, outputs, connections, loops, feedback).
2. An understanding of how natural systems function, ecological limits and resource constraints.
3. The ability to think in time - to forecast, to think ahead, and to plan.
4. The ability to think critically about value issues.
5. The ability to separate number, quantity, quality, and value.
6. The capacity to move from awareness to knowledge to action.
7. The capacity to develop an aesthetic and compassionate response to the environment.
8. The capacity to use these processes: knowing, inquiring, acting, judging, imagining, connecting, valuing, and choosing.

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IV. Q-K-W-L CART.

Note to teacher: Students use the chart to reflect on the content of what is being learnt and to address peers and / or the teachers with outstanding questions.

The **question** I have after today's class is: (at the end of the class)	What I **know** about that question? (as homework)	What I **want to know** about that question? (shared with peers/ teachers)	What have I **learnt** from that question? (after previous step)

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