

Urban Science – Integrated Learning for Smart Cities

O1, State-of-the-art review on urban science

Country Urban Science report - Italy

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CREDA onlus, Centro Ricerca Educazione Documentazione Ambientale

1. Summary of research done (time, methods, teachers, experts, organizations involved)

The research has been carried out through:

- Desk-based research to identify:
 - 1) Relevant education initiatives/programs about urban outdoor learning linked with science (STEAM) learning (listed in Appendix 1)
 - 2) National indications and guidelines of the Italian Ministry of Education (MIUR) about Environmental Education (EE), Education for Sustainable Development (ESD), Citizenship Education (CE), Science Education (SE) as following:
 - MIUR, MATTM (2009) Linee guida per l'educazione ambientale e allo sviluppo sostenibile
http://hubmiur.pubblica.istruzione.it/alfresco/d/d/workspace/SpacesStore/9d3e7bec-319a-439b-a8ae-73327d296c6c/all_prot3337.pdf
 - MIUR (2009), Documento d'indirizzo per la sperimentazione dell'insegnamento di "Cittadinanza e Costituzione"
http://hubmiur.pubblica.istruzione.it/alfresco/d/d/workspace/SpacesStore/2b2bc4d1-0382-4f75-a6f9-2f99f3ea85e6/documento_indirizzo_citt_cost.pdf
 - MIUR (2010) Cittadinanza e Costituzione: Attuazione dell'art. 1 della legge 30 ottobre 2008, n. 169 – Anno scolastico 2010-2011
http://hubmiur.pubblica.istruzione.it/alfresco/d/d/workspace/SpacesStore/19b60061-d624-4dbd-be97-784876cb6393/cm86_10.pdf
 - MIUR (2015) Linee guida per l'educazione ambientale
http://www.minambiente.it/sites/default/files/archivio/allegati/LINEE_GUIDA.pdf
 - MIUR (2012) Indicazioni Nazionali per il Curricolo della scuola dell'infanzia, e del primo ciclo di istruzione.
http://www.indicazioninazionali.it/documenti_Indicazioni_nazionali/DM_254_201_GU.pdf
 - MIUR (2016) Linee di indirizzo dell'educazione ambientale e della sostenibilità – per una cittadinanza ambientale.
<http://www.istruzione.lombardia.gov.it/wp-content/uploads/2015/02/lineeguida.pdf>
 - MIUR (2017) Indicazioni nazionali e nuovi scenari
<http://www.miur.gov.it/documents/20182/0/Indicazioni+nazionali+e+nuovi+scenari/3234ab16-1f1d-4f34-99a3-319d892a40f2>

- Online survey with 13 open and closed questions. 41 teachers from north and central Italy answered.
- Go in deep interviews with teachers (Capra Antonella, Maddalena Villa, Anna Pessina, Alessandra Marzorati, Monica Motta) and experts (Barbara Scapellato, Serena Dorigotti, Maria Antonietta Quadrelli)
- Visits at 2 schools (ICS Calvino MILANO and Istituto Benedetto Croce LISSONE)

2. Summary of barriers and opportunities recognized, including all investigation areas (teachers, curriculum, pedagogy used, outdoor learning, support available, understanding of concepts, ideas)

<p>Strengths</p> <p>City and urban environment can become an interactive laboratory at our fingertips.</p> <p>Urban environment teaching could facilitate the acquisition of competences of citizenship as for example to act in a responsible way.</p> <p>Pupils and teachers can feel more involved and motivated in outdoors to learn and teach about science.</p> <p>Urban environment is rich of stimuli for learning.</p> <p>US could allow easily to connect knowledge with doing, it could give the possibility to undertake tasks of reality and to gain experience with something close to the life of students.</p> <p>A pedagogy of sciences in an urban environment makes strong interconnection between the daily life experiences of students, on which too often no attention is paid (or on which one is "accustomed"), with a reflection on which to engage and anchor disciplinary knowledge.</p> <p>The possibility to give value to the environment close to school as an object of study, and as something interesting.</p> <p>The excitement and fun of learning 'a difficult subject' outside of school.</p> <p>The effectiveness to link head, hands in a real situation.</p> <p>The possibility of having a context to work on collaborative skills and class cohesion.</p>	<p>Weaknesses</p> <p>Constraints to go out of school: Permits, bureaucratic struggles to get out when you want or you need to and without having to ask permission to parents, the need of the presence of additional teachers if you want to go out and that are unavailable, or impossible to find, or to be involved.</p> <p>Increased organization in respect of a classroom lesson: authorizations; insurance; co-presence of colleagues, timetable switches, weather condition.</p> <p>Time: Chronic lack of time- If you want to work with other teachers you need to coordinate schedules which it is often an impossible mission - Dilated time for outdoor learning – Since it is often impossible to go outside it is possible to ask students to do it voluntarily in extra-school hours - the curriculum time is untouchable; school hours and rigid teachers; limited margins of work in a 30 h school time.</p> <p>Lack of human resources.</p> <p>Greater commitment and work for teachers (not recognized economically).</p> <p>Transport, difficulties in organizing medium-range trips.</p> <p>Responsibility/Security which is more in outdoors; there is a more need of supervision.</p> <p>Dangers (or fear of danger) in outdoors like traffic.</p> <p>Find an ideal space for students (with adequate security, space for work, not too noisy; interesting from the science point of view etc).</p>
<p>Opportunities</p> <p>It links schools with their territory.</p> <p>It gives the chance to contextualise the disciplines.</p>	<p>Barriers</p> <p>Possible extra costs (trip?).</p> <p>Rigidity of the school organization.</p>

<p>Chance for learning to learn.</p> <p>It develops the sense of beauty and the sense of the place where the students live.</p> <p>It improves the cohesion of the class group.</p> <p>It offers opportunities to develop the ability to explore starting from a space nearby.</p> <p>It offers the possibility to make direct observations of systems and on the relationships between systems.</p> <p>It is possible to work efficiently on respect, civil cohabitation, collaboration, environmental citizenship and sense of responsibility, acquiring self-awareness in relation to others and to the environment that belongs to everyone.</p> <p>It gives the chance to work on competences and skills for citizenship, civics, rights and duties.</p> <p>Participation is promoted.</p> <p>You can discover with new eyes the environment around us: parks, gardens, school gardens, buildings, road, energy exchanges, etc.</p> <p>Getting out of school means also promoting students physical and mental health.</p> <p>Urban environment allows to a research linked to reality and to effectively learn the disciplinary content.</p> <p>It gives the opportunity to become aware of environmental problems but also gives the opportunity to think about answers in a collaborative way.</p> <p>Laboratory didactics, in a real context and close to the students life, allow to enhance the competences of each students.</p> <p>It allows to enhance learning in a non-formal context, codifying informal learning.</p> <p>It allows to create links with the territory and to relate different urban environments, different cities.</p> <p>Students could know their territory better, can identify and give value to resources of the environment where they live.</p> <p>Possibility of understanding the relationship between human and environment.</p> <p>It is possible to work on spatial (geographic) and temporal (historical) orientation.</p> <p>It is possible to act for an environmentally sustainable management of the territory.</p>	<p>Lack of effective projects to join and participate for a dissemination of the outdoor science approach.</p> <p>The rigorous distinction of the disciplines and, on the other hand, the inability to grasp the interdisciplinary aspects of a situation like the ones of US.</p> <p>The planning phase could be very demanding, such as the production of materials, work sheets for data collection etc.</p> <p>The difficulty of planning and organizing a project in team.</p> <p>Lack of collaboration between teachers (availability, cooperation, difficulty in involving colleagues of other disciplines, lack of skills in the teaching staff, availability of additional competent personnel).</p> <p>Lack of alliance with the territory: it is difficult to find an expert, possible non-collaboration with external agencies.</p> <p>To be clear what we want to deal with (with colleagues, students, families)</p> <p>Students (large number of students in the current classes, students with behavioral problems, difficulty in managing problematic classes outside of the school, poor habit of going out and of considering the external environment of the classroom as a work environment, poor collaboration skills among the students, problem of involvement, the type of class and relationship that has been established with the class, the inability of students to move safely in an external environment with the possibility of dangerous situations for themselves and for others).</p> <p>The belief of wasting time if you go outside.</p> <p>Lack of instrumental resources and adequate tools.</p> <p>Scarcity of relevant data in the vicinity of the school.</p> <p>The need of a different/innovative teaching approach (compared to the traditional one).</p> <p>Persistence of the habit of the frontal lesson.</p> <p>The external school environment can be dispersive.</p> <p>Inadequate teacher training.</p> <p>Textbooks that do not propose anything similar that can be an incentive to experiment and try.</p>
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3. Urban science student – specific science skills and competencies needed for businesses in healthy cities and low carbon economy. Describe our “dream student”.

Before analysing the characteristics of the profile for the “Urban Science student”, it is necessary to outline how the Italian Education system works and to consider the last indications in respect to curriculum and to science, environmental, citizenship and sustainability education.

The Italian education system is organized according to the principles of subsidiarity and the autonomy of educational institutions. The State has exclusive legislative competence for the *general rules on education* and for the determination of the essential levels of benefits that must be guaranteed throughout the national territory.

This means that all the educational institutions are independent about didactics, organization, research and development. In the respect and enhancement of the autonomy of educational institutions, National Indications and Guidelines, that have been examined for this research, constitute the reference framework for the curricular design which is entrusted to each single school. The National Indications and guidelines are intended as an open text to be contextualized by each education institution that will then do specific choices regarding contents, methods, organization and evaluation that are consistent with the education goals envisaged in the national documents.

Therefore, the curriculum of an education institution is an expression of freedom of teaching and of school autonomy and, at the same time, makes explicit the choices of the scholastic community and the identity of the institute. The construction of the curriculum is the process by which educational research and innovation are developed and organized. Each school prepares the curriculum within the educational offer plan with reference to the profile of the student, to the goals for the development of skills and competencies, to the specific learning objectives for each discipline. Starting from the curriculum of the institute, each teacher identifies the most effective learning experiences, the most significant teaching choices, the most suitable strategies, with attention to the integration between the disciplines and their possible aggregation in areas, as indicated by the school autonomy, which entrusts this task to educational institutions.

Bearing in mind this general premise, we report in this research the profile of the students as it has been described by the National Indication and Guidelines and taking

in account the target age of the Urban Science project (12-16 years old, which means for the Italian system the end of the primary education and the first 2 years of the secondary education).

As stated in the 2012 National Indication at the end of the primary education for students mathematical and scientific-technological knowledge allow them to analyze data and facts of reality and to verify the reliability of quantitative and statistical analyzes proposed by others. The ability to practice rational thought allow students to face problems and situations and to be aware of limits of assertions regarding complex issues that do not lend to unambiguous explanations. Moreover students at the end of the primary education will be able to orient themselves in space and time, with a strong curiosity for the searching for meaning of the world around. They will observe and interpret environments, facts, phenomena and artistic productions. In particular, at the end of the primary education (age 14) and for the science disciplines, students will be able (pag 54):

- *to explore and experiment, in the laboratory and outdoors, the development of the most common phenomena, imagining and verifying their causes, researching solutions to problems, using the acquired knowledge.*
- *to develop simple modelling for facts and phenomena using appropriate measures and simple formalizations.*
- *to recognize structures and mode of operations in their body at macroscopic and microscopic levels*
- *to have a vision of the complexity of the living system and its evolution over time;*
- *to recognize the basic needs of animals and plants in respect of their diversity, and to identify the ways to satisfy them in each specific environmental context.*
- *to recognize the role of the human community on Earth, of the finite character of resources, as well as of the inequality of access to them, and to adopt ecologically responsible life styles.*

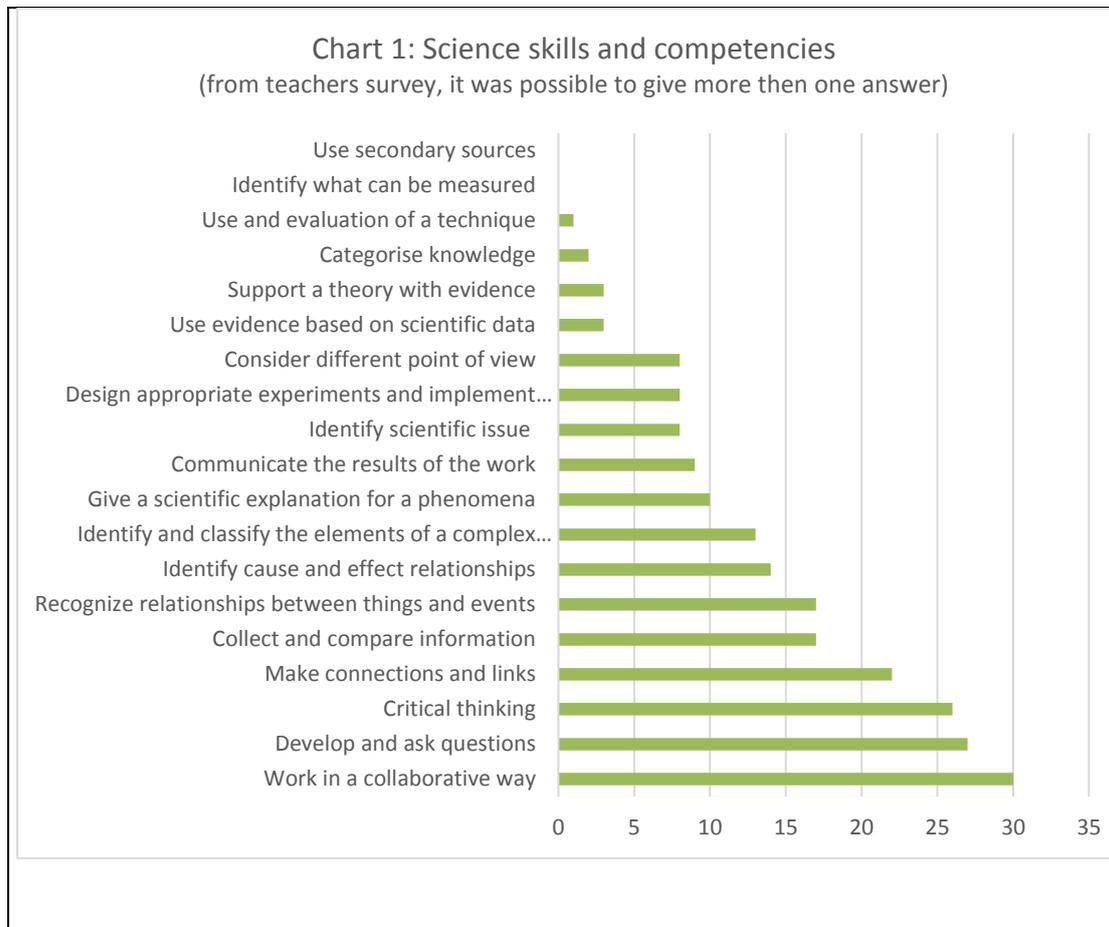
- *To link the development of the sciences to the development of human history.*
- *To develop curiosity and interest towards problems related to the use of science in the field of scientific and technological development.*

As stated in the Guided Lines for Environmental Education of the Ministry of Education, students from secondary education will be able to:

- *recognize the geographical and ecological aspects of the natural and anthropic environment, the connections with the demographic, economic, social and cultural structures and the transformations that have occurred over time;*
- *handle technological tools with particular attention to the protection of the environment and the territory.*
- *Recognize the links between science and technology, their correlation with the cultural and social context, development models and environmental protection.*
- *Recognize the interdependence between the evolution of science and technology and the related ethical, social and environmental implications.*

From teachers and experts interviewed and that answered the questionnaire on the Urban Science Students profile it emerges a person with strong critical thinking skills, able to work in a collaborative way, to develop and make relevant questions, to gather and to compare information and data, to see relationships between fact and events and finally capable to make links to tackle the complexity of the world and of the environmental issues.

In chart 1 the complete answers from the 41 teachers involved in the survey research.



4. Themes, topics and issues identified, which connect healthy city and science curriculum and could be interesting for teachers and students.

The perspective of the Urban Science project, to enhance a way of teaching science using the urban environment as a living laboratories where pupils explore how science can help create healthier and more sustainable cities, seems to be in line with the Italian Ministry of Education Indications and Guidelines examined, especially for the new proposed scenario of a school open to the territory, able to recognize the complexity of learning and to direct their teaching to the construction of knowledge starting from concrete learning needs. A school that focuses on the ability of students to recognize and select data and information, to develop methods and categories as a compass in the personal paths of life, to foster the autonomy of thinking of students.

The Ministerial Decree in 2012 on the National Indications for the curriculum for primary and secondary schools indicates as crucial:

- Learning about the principle of knowledge - the universe, the planet, nature, life, humanity, society, the body, the mind, history - in a complex perspective, overcoming the fragmentation of disciplines and integrating them into new frameworks;
- Promoting a new humanism: the abilities to grasp the essential aspects of problems and to understand the implications, to evaluate the limits and possibilities of knowledge, to live and act in a constantly changing world;
- Spreading the awareness that the great challenges (the environmental degradation, climate change, energy crises, unequal distribution of resources, health and disease, bioethical dilemmas, quality of life) can be dealt with and resolved through close collaboration not only between nations, but also between disciplines and between cultures, through participation.

Both in the Indication of 2012 and of 2017 of the Ministry of Education it is said that choices about themes and topics should go in the direction to *enhance students experience and knowledge to anchor new concepts and knowledge* and to support exploration and discovery in order to promote *students will and sense of research for new knowledge*. In this perspective, themes should be seen in their capacity to problematize and to be open to different point of views. Problematization plays an irreplaceable role, as *it urges students to identify problems, to raise questions, to questions about already developed knowledge, to find appropriate and personal investigation paths, to look for original solutions*.

In the 2017 Guidelines it is highlighted the necessity of a kind of teaching that *relates to the daily behaviour of people in every area of life, in relationships with others and with the environment through real world experiences that allows to learn, in a real manner and tangibly, how to take care of themselves, of the others and of the environment where we live and how to cooperate and to promote solidarity*.

If the nearby urban environment as laboratory could be an interesting set to support exploration and discovery in order to promote students research for new knowledge and to be an active and responsible citizen, in the same moment in order to promote

skills and competencies for a sustainable planet it is necessary to learn about sustainability, especially as outlined by experts interviewed, about **ecology, territory, ecological footprint, renewable energy, bioclimatic design, circular economy, sustainable management of mobility and water, proximity agriculture.**

Teachers who answered the questionnaire think that all disciplines can be considered and developed taking in account the urban environment as a learning laboratory and resources. Geography, biology, earth sciences, chemistry, computer science, natural science and physics, history, algebra and geometry, statistics and probability, art and technology and citizenship are reported as disciplinary areas that can be effectively developed in a teaching that starts from the city and is able to outline questions and set of problems to discovery on. Regarding topics, themes that could be easily developed in US reported by teachers mainly concern on **ecology, climate change, orientation and cartographic representation, resource energy waste management, life cycle analysis, circular economy, ecosystem services, mobility, resilience, conservation of natural resources, production of goods with low environmental impact, the creation of urban green spaces, changes in ecosystems and urban modifications, improvement of the quality of life, analysis of urban processes, urbanization, land use, soil modification, permeabilization / soil sealing, reuse, relationship between human and territory, economy of territories, fresh water cycle, analysis of the stratification of eras that coexist in urban transformations as buildings, monuments, documents and finally participation in political and social life of cities, quality of life, rights and duties.**

In the 2015 Guidelines for Environmental Education we read: "*Education for sustainable development implies skills, competences, knowledge which before being specific, are transversal and therefore not strictly related to the natural environmental* as parks, forests. Urban environment could be the perfect scenario to enhance transversal learning for sustainability. Suggested themes are:

1. Protection of fresh water and the sea
2. Protection of biodiversity: Flora and Fauna
3. Sustainable nutrition

4. Waste management
5. Protection of biodiversity: ecosystem services
6. Green economy: green jobs & green talent
7. The sustainable city: pollution, consumption of soil and waste
8. Adaptation to climate change: hydrogeological instability

5. Important concepts, interesting and actual **ideas** emerging from your research

Following the latest Indication and Guidelines from the Ministry of Education that describe a new scenario for the Italian school system already described above, we are seeing many pilot projects and experimentation, but still barriers for a complete change of prospective. Some of the most reported threats regard the possibility to embrace new teaching methods, from the transmissive ones to approaches that enable students to develop new knowledge in an investigative way and that open the doors toward the world around. Especially it seems only sporadic or linked to special programs the practice of “learning outside of the classroom” as an approach that focuses on real world situation to link and anchors knowledge, skills and competences and to create links with society and the environment.

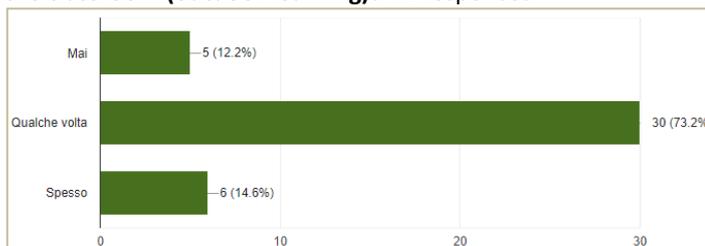
At the moment the Italian school system is living a complex process where pilot projects, research, evaluation, and training can drive and catalyse the new proposed scenario. In this perspective US project could be a field of research and experimentation especially of new methods and approaches. Moreover, as many teachers answered in the survey and said during the interviews, US project should outline learning modules and teachers training near to the real situation of schools and that remember the weakness and the barriers reported above in this report and give guidance and help to inspire a new way to teach science. Therefore, the wish is that US project could not only focus on extraordinary but impossible to realize activities, to avoid more discouragement and the fact to be just occasional experiments too difficult to constitute the ordinary day teaching lesson.

6. Other important information

Following some suggestions from the teachers' survey. Important information to consider are:

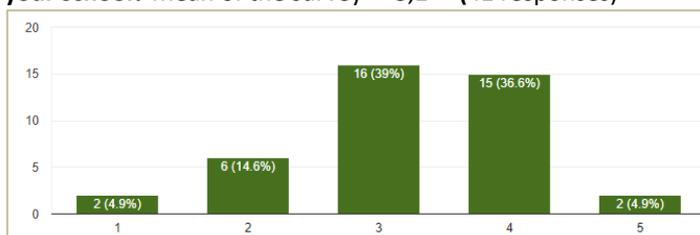
1. The majority of the teachers who have answered the survey have experience on outdoor learning and on urban environment as a "living laboratory" for their lessons - > outdoor science is possible;
2. They evaluate positively the possibility of interdisciplinary work in their school -> work with colleagues of other disciplines is possible;
3. Teachers think that science education is essential in order to have a society able to live in a sustainable way on the planet;
4. Even though they think that the organization of a urban science lesson could be more challenging, they evaluate positively the possibility in the future to teach science using the urban environment as an educational resource pointing out for facilitating this transition: training, possibility to involve other colleagues, more time in their teaching schedule for it, simplification of the organization issue and more knowledge about what are the resources in the environment near the school.

Have you ever tried to organize a lesson for your classes outside of the classroom (outdoor learning)? 41 responses



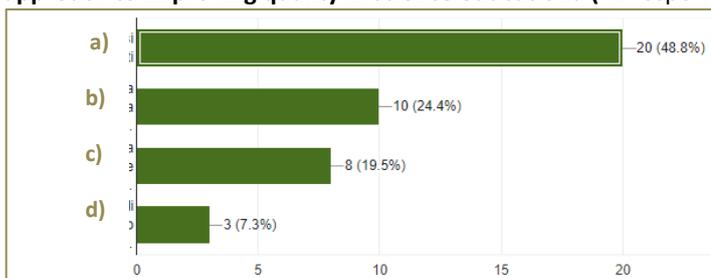
Mai=Never; Qualche volta= Sometimes; Spesso=Often

How do you evaluate the possibility to work interdisciplinary in your school? Mean of the survey = 3,1 (41 responses)



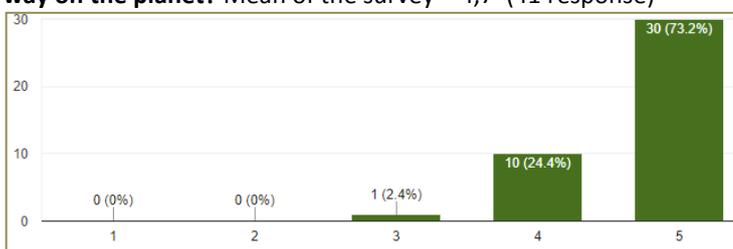
1= very difficult 5=feasible

Have you ever used Inquiry Based Science Education (IBSE) as an approach to improving quality in science education? (41 responses)

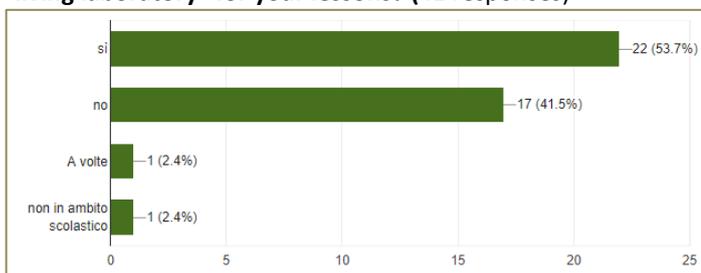


- a) I don't know what it is
- b) I know this approach, but I have never applied it
- c) I have experience with this approach with my classes
- d) It's an approach I use regularly

In your opinion how important is science education (from 1 to 5) for the development of a society able of living in a more sustainable way on the planet? Mean of the survey = 4,7 (41 response)



Have you ever used urban environment as a resource and as a "living laboratory" for your lessons? (41 responses)



Si=yes A volte=Sometimes Non in ambito scolastico=Not during regular school time

What would you need in your school to facilitate didactics that consider the urban environment as an educational resource in science teaching?

1 = not necessary 2 = so and so necessary 3 = necessary (41 answers)

	Mean
Training	2,7
Educational resources on which to base lessons and get inspired	2,5
Suitable textbooks	1,9
Involvement of other teachers	2,7
Parental involvement	2,1
Tutoring	2,4
A project in which to be involved	2,5
Communication and visibility of the results of the experience	2,5
Economic resources	2,5
Simplification of organizational issues	2,6
Knowledge of the territory and its potential	2,6
Good practices from other schools to draw inspiration from	2,2
More time	2,6

How do you evaluate from 1 to 5 the possibility in the future to teach science using the urban environment as an educational resource?

(41 answers)

	Mean
I will not try (1) / I would try (5)	4,0
Useless (1) / Effective (5)	4,2
Dispersive (1) / Engaging (5)	4,3
Boring (1) / Stimulating (5)	4,5
Challenging (1) / Simple to organize (5)	2,0