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# DICA4Schools: good practices of the role of academy in education for sustainability

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**Abstract:** The paper presents DICA4Schools, an education initiative of Politecnico di Milano aimed at disseminating scientific knowledge on environmental sustainability to primary and secondary schools. The program emphasizes an inclusive and engaging pedagogical approach that leverages the Kolb Cycle, Problem-Based Learning, and Inquiry-Based Learning methodologies. By incorporating peer education activities, the program also fosters critical thinking and collaborative skills. DICA4Schools promotes sustainability and resilience through interactive and hands-on learning experiences (i.e., lab experiments, games, and technological tools). These activities are planned and tailored to students' ages and their prior knowledge and aligned with the SDGs identified as relevant by the school teachers. Preliminary impact assessment indicates that DICA4Schools has been successful in enhancing students' knowledge and awareness of environmental sustainability. The program has also stimulated interest in STEM disciplines among both female and male students, demonstrating the potential of academic institutions to play a vital role in education for sustainable development starting from early years education.

***Keywords:*** *Education, environmental sustainability, schools, public engagement, scientific dissemination, teaching approach.*

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## 1. Introduction

Sustainable development is nowadays recognized as one of the main goals and challenges of modern society. To achieve this aim, a profound change in the way people think and act is needed, and this change has to be organized starting from the individual level at an early age, in order to equip everyone with the knowledge, values and skills of "sustainability citizens", which can spread from individuals to communities and then society. This is the reason why the youngest students play a crucial role in raising environmental awareness and fostering sustainable behaviour. Recognizing the importance of sustainability, young students and pupils will be motivated in implementing sustainable development goals in their personal lifestyle, influencing their proximal environment (e.g., family) and afterwards their professional context.

This paper shares an education experience of Politecnico di Milano, in which effective strategies and actions for disseminating scientific issues on environmental sustainability to primary and secondary schools have been explored. In 2017, the Department of Civil and Environmental Engineering (DICA) introduced DICA4Schools, a program dedicated to promoting sustainability and resilience in schools, reaching the dual objective of Education for Sustainable Development (ESD) in the framework of SDG 4 on inclusive, equitable and quality education. Interactive and hands-on teaching methods, such as experiments, games, and technological tools are employed enhancing student engagement and understanding. This initiative has grown significantly, now offering around 25 free activities aligned with various Sustainable Development Goals, including responsible resources management, sustainable cities, climate change impacts, and the role of engineering in addressing global challenges.

ESD plays a vital role in reshaping unsustainable values and mindsets, fostering the questioning, innovation, and creativity necessary to devise improved solutions for the global challenges. This is particularly significant given that younger generations are often overlooked in discussions on environmental issues, including risk management policies, despite their critical role in addressing climate change scenarios [1]. Recent research has analyzed the training, knowledge, and perceptions of natural hazards and disaster prevention [2], revealing the presence of social stereotypes that can lead to misconceptions about environmental processes. On the other hand, studies indicate that enhancing education on environmental issues can improve socio-territorial resilience to natural risks [3] and foster greater awareness of resource management [4].

For this reason, over the last decades, there have been efforts across the world to embed ESD into the curriculum ([5] and reference therein). In the European Union (EU), some higher education institutions strived to align education strategies with international and national ESD frameworks, embedding ESD directly into their curricula. For instance [6], explored the competencies in ESD from the perspective of students' teachers, specifically focusing on their understanding and attitudes.. Conversely, studies from other regions, such as Latin America, have reported only sporadic initiatives focused on ESD integration. Hernandez et al. [7] reveal varying levels of ESD implementation and underscore a gap between the theoretical understanding of ESD and its practical application.

In Italy a variety of initiatives and approaches have been promoted and implemented, particularly within higher education institutions and regional planning frameworks. Notably, Italian universities have been actively integrating Sustainable Development Goals (SDGs) into their curricula [8], predominantly with a top-down approach. In 2021 the Italian Ministry of Education reintroduced Civic Education as a compulsory subject in the institutional curricula of primary and secondary schools, including three thematic sections, namely the Italian Constitution, sustainable development, and digital citizenship. Embedding environmental education was recognized as an essential element for nurturing a generation of environmentally conscious individuals, capable of understanding and addressing future environmental challenges.

Schools, as key agents of scientific knowledge dissemination, play a critical role in promoting sustainable practices among students. Emphasis has been placed on enhancing teachers' knowledge and attitudes towards sustainability, recognizing their pivotal role in training future generations [9]. However, the integration of sustainability into educational curricula remains both limited and challenging. Translating sustainability concepts into effective educational practices remains a significant challenge, and this issue is currently affecting the way sustainability is perceived among children and teachers [10]. Barriers to a proper ESD integration include resistance to change, insufficient funding, competing priorities, and a lack of awareness and expertise [12]. Despite increased global attention, these barriers collectively hinder the adoption of ESD across various educational levels and contexts, as recently discussed also in [11].

DICA4Schools is proposed as a tool to overcome such barriers. The following sections provide a detailed overview of the program, emphasizing the learning approach and public engagement strategies implemented by Politecnico di Milano to promote a proactive attitude of the future generations towards sustainable development.

## 2. Methods: approach, context and setting

The Dica4schools program (Figure 1) was born from the convergence of two distinct yet complementary elements: the high-level education DICA can offer on sustainability issues and the demand for innovative teaching contents and approaches from schoolteachers on the same topics. In fact, while sustainability issues have recently been introduced into the teaching programmes of Italian schools, teachers typically lack specific expertise in these areas. DICA4schools embraces principles and methodologies of experiential and active learning, in which the learner's experience is made central to the teaching-learning process. The main impact of the program is twofold: i) to raise awareness among students, and ii) to improve the capacity of schoolteachers in relation to the SDGs. The effectiveness of the program is evaluated through a questionnaire, the feedback from which allows for continuous improvement of the educational offering. The indirect impact on the program is related to the role that students and schoolteachers can play in disseminating acquired knowledge to parents, relatives, friends and, more generally, the wider society. In this regard, increased efforts are being made to activate peer education mechanisms among students, with the aim

of further enhancing the capability of schools in educating on SDGs. The next sub-sections provide detailed description of the program.

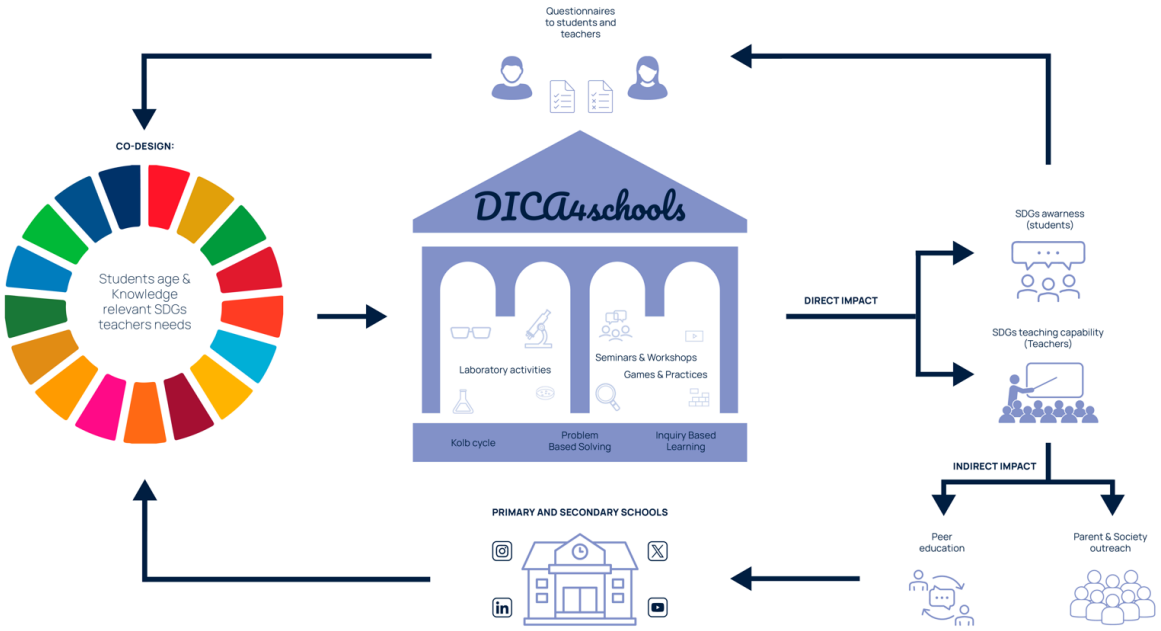


**Figure 1.** Graphical abstract of the DICA4Schools approach.

## 2.1. Teaching-Learning Approach

DICA4schools activities are based on engaging teaching methods and experience-based learning which can effectively enhance sustainable education.

A traditional conception of learning is merely transmissive and passive. The experiential perspective learning is instead comprehended as "the process whereby knowledge is created through the transformation of experience" [13]. Such transformation produces effects on the whole individual, encompassing the cognitive as well as the emotional and behavioural domains [14]. In these terms, experiential and active methodologies stand as a valuable tool for developing both knowledge and skills in ESD as well as critical thinking and proactive attitudes towards sustainability [15]. A complete list of activities proposed by the DICA4schools program can be found in Appendix A. We will discuss here key principles and teaching-learning strategies applied in this initiative.

A first reference point for the introduction of ESD lies in the many possible applications of the Kolb cycle, in which new knowledge arises from the reframing and conceptualization of a concrete experience [13]: the learning process is thus dynamic and adaptive, both in relation to the individual's prior knowledge and to contextual demands. The activities proposed by the DICA4schools program (see Table 1) are often aligned with Kolb's cycle principles. For instance, the activity entitled "Dr. House: Diagnostics and analysis of the built environment"

leverages the analogy between the work of medical doctors and that of engineers and architects to introduce concepts and techniques of structural and material diagnostic . This, in turn, raises participants' awareness of issues related to deterioration and disruption in buildings. Following the steps listed by the pedagogical model, the training begins with hands-on experience in the laboratory, which is followed by participatory analysis and reflection, led by the facilitating researchers, that deepen and consolidate the learning and empirical evidence of the students involved.

These elements can also be complemented by applications of Problem Based Learning (PBL) [16], in which knowledge is developed from solving complex problems through which content and methods can be explored, and Inquiry Based Learning (IBL) [17], in which instead the starting point of learning is the formulation of research questions. For example, in the “Flood laboratory” delivered within Dica4Schools participants are invited to explore key questions about the flood phenomenon (“How does rain create a flood?”, “Why are cities flooded and what can we do to prevent and protect ourselves?”). This encourages curiosity and critical thinking, prompting participants to analyse causes, consequences and possible prevention strategies, while connecting scientific and practical concepts to everyday experience.

Research on these methodologies highlights how integrating principles and techniques of scientific inquiry into active learning processes is more effective in enhancing conceptual understanding than strategies that rely on more traditional, passive approaches [18]. In fact, directly experiencing the formulation of research questions, hands-on inquiry, and critical reflection helps students develop more flexible knowledge and improve their abilities for autonomous and self-directed learning [19]. Furthermore, all these pedagogical approaches anchor theoretical knowledge to practical exploration and the real-world context to which the same knowledge is relevant: students are led to actively construct their own understanding through experimentation and interaction, integrating theory and practice. Constant reference to real-world situations also establishes a learning environment in which to question and disrupt ideas and preconceptions, while bringing the younger generation closer to the STEM and STEAM disciplines. Often Dica4Schools promote these ideas by employing physical demonstrators that can visualize and materialize the processes and challenges at play in an immediate and accessible way.

## 2.2. Context

The activities proposed by DICA4Schools are thought to stimulate students to find answers to key questions in the field of sustainability, such as "What seismic and flood risks really are?"; "How can we use our water resources consciously?"; "How can we protect them from pollution?"; "Is the climate changing?"; "What does climate change mean?"; "Does recycling waste really work?"; "Which are materials and techniques for building and retrofitting modern infrastructure?". The aim is to bring new generations closer to a scientific approach to address fundamental challenges for the development of our society.

All topics are strictly related to some keyword pillars of the department in the field of civil and environmental engineering: sustainability, resilience, innovation, knowledge transfer, and social responsibility. Through DICA4Schools, students can get in touch with the most innovative research in the fields of water, soil, air, buildings, historical heritage, and infrastructure and experiment with advanced technology in the fields of material, metamaterials, geomaterials, micro-electrical, to mention a few examples.

Each activity can be related to some of the SDGs, in particular to: SDG 2: Zero hunger; SDG 4: Quality education; SDG 6: Clean water and sanitation; SDG 9: Industry, innovation, and infrastructure; SDG 11: Sustainable cities and communities; SDG 12: Responsible consumption and production; SDG 13: Climate action; SDG 15: Life on land; SDG 16: Peace, justice, and strong institutions (see also Table 1).

## 2.3. Setting

Contact with primary and secondary schools is facilitated through social media and developed further the webpage of the Department dedicated to DICA4Schools (https://www.dica.polimi.it/dica4schools/), providing all the information related on content, as well as organizational: the complete list of the activities, their description, the name of the responsible, the kind of activity, the duration, the location, and the range of age of students it is dedicated to, the calendar. In the webpage a link for the enrolment is also present. There are three main kinds of activities: seminars and workshops, games and practical experiences, and laboratory activities (Figure 2). The duration generally ranges from 30 to 180 minutes depending on the activities and on the age of the students involved. The activities are aimed at students at primary schools (6-11 years old), lower secondary schools (11-14 years old), and secondary schools (14-19 years old). Activities are planned and tailored to students' ages and prior knowledge and aligned with the SDGs identified as relevant by the teachers. Consequently, many of these activities can cover a wide range of ages (Table 1).

Activities are preferably carried out at Politecnico di Milano to give the students the opportunity to visit the university and its labs. Alterernatively, activities can be also carried out in the schools' facilities. Some activities are carried out at the Off Campus spaces of Politecnico di Milano (https://www.polimi.it/en/campus-and-services/spaces-and-study-areas/spaces/off-campus) in line with the university initiatives for public engagement . Off Campus spaces are locations where the university staff can conduct research close to local communities in the city of Milan, facilitating co-creation and collaborations with local associations, citizens and schools.

Seminars are frontal lessons supported by innovative teaching concepts and tools, with open discussions and students' interaction. Some practical activities are carried out in external public spaces such as parks and urban settings. During laboratory activities, students can experiment with the phenomena of interest, test some instruments directly in the field, and experience manual activities with innovative materials and tools.

**Table 1.** The DICA4school activities and related SDGs. See Appendix A for a description and visit the website for additional information (https://www.dica.polimi.it/dica4schools/).

| Title | Type | Duration | Target: school/age | SDGs |
|---|---|---|---|---|
| Meteorology and Climatology: Two Sides of the Same Coin | Seminar | 90’ | Primary/6-11 years<br>Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 11, 13, 15 |
| Soil, a resource to be protected and an important “ally” in the fight against climate change | Seminar | 30’-90’ | Primary/6-11 years<br>Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 6, 11, 13, 15 |
| The Science of Invisible Water | Seminar + game | 90’-2h | Primary/6-11 years | 2, 4, 6 |
| Waste Water: From Threat to Resource | Seminar + game | 2-3h | Primary/6-11 years<br>Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 6, 11, 12 |
| A journey to discover the secrets hidden in the stones | Seminar + game + lab | 2h | Primary/6-11 years | 4, 11, 12 |
| Dr. House: Diagnostics and analysis of the built environment | Lab | 2-3h | Primary/6-11 years<br>Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 9, 11 |
| Do you know what an earthquake is? | Lab | 90’ | Primary/6-11 years<br>Lower secondary/ 11-14 years | 4, 11 |
| Clay, bricks, masonry, and the Ziggurat | Lab | 2h | Primary/6-11 years<br>Lower secondary/ 11-14 years | 4, 9, 11 |
| Sustainable rainwater management | Lab | 2h | Primary/6-11 years<br>Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 6, 11 |
| Flood laboratory | Lab | 90’ | Primary/6-11 years<br>Lower secondary/ 11-14 years | 4, 11, 13 |
| We throw them away, but then… that’s not waste, it's a mine of resources! | Lab | 90’ | Primary/6-11 years<br>Lower secondary/ 11-14 years) | 4, 12 |
| Bacteria in a battery | Lab | 2-3h | Primary/6-11 years<br>Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 6, 12, 15 |
| Groundwater | Lab | 90’ | Primary/6-11 years<br>Lower secondary/ 11-14 years | 4, 6, 11, 13 |
| A visual path of groundwater flow through a scaled hydraulic model | Lab | 30’ | Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 11, 12 |
| Underground water resource: observe the aquifer and measure its temperature | Lab | 30’ | Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 11, 12 |
| Let's meet metamaterials: what they are and what they can be used for | Seminar + lab | 60’ | Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 9 |
| Numerical simulation in movies and video games | Game | 30’-90’ | Secondary/14-19 years | 4, 9 |
| The Collapse of the Twin Towers: Structural Engineering vs. Conspiracy Theory | Seminar | 45’ | Secondary/14-19 years | 4, 9, 16 |
| Earthquakes and historic buildings | Seminar | 90’-2h | Secondary/14-19 years | 4, 9, 11, 13 |
| Geo-Engineering Challenges: The Earth in Your Hands | Seminar + game | 2h | Secondary/14-19 years | 4, 11, 12 |
| Practical and interactive laboratory of structural engineering | Laboratory | 8h | Secondary/14-19 years | 4, 9, 12 |

| | | | | |
|---|---|---|---|---|
| Breathe the Future: Pollution and Climate Challenges | Seminar + laboratory | 2-3h | Secondary/14-19 years | 4, 11, 13 |
| The Internet of Things: What are MEMS and How Can They Be Used? | Seminar + laboratory | 100’ | Secondary/14-19 years | 4, 9 |

**Figure 2.** DICA4Schools moments.

## 3. Impact assessment

Accurate evaluation of the impact of ESD for new generations has limits and challenges [20]. As regards DICA4schools, since 2017, we estimate that around 50 schools and approximately 2,000 students have been engaged. As anticipated, to assess the program's effectiveness in meeting ESD objectives, a questionnaire was introduced at the beginning of 2024 for participants to complete at the end of each activity. Teachers complete the questionnaire on behalf of their students for primary and secondary school activities, whereas high school students respond directly. Accordingly, teachers' responses are weighted based on the number of students in each class, while each high school student's response is counted individually. The questionnaire contains about 20 questions, covering topics such as the type of activity, school level, perceived impact on curriculum enhancement, and the gender of participants. The primary goal is to evaluate how well the activities improve student knowledge on the topic and increase their awareness of its significance for sustainable development. Additionally, the questionnaire gauges whether interest in STEM disciplines has grown, with responses analysed separately by gender.

The results thus far indicate that the program is effective across all three dimensions assessed. As shown in Figure 3, none of the students reported minimal knowledge of the topic by the

end of the activity, and the percentage of students with maximum knowledge rose from 5% to 57%. Similarly, full awareness of the topic's importance for sustainable development increased from 25% to 56%. Additionally, the program boosted interest in STEM disciplines, with 91% of female participants and 82% of male participants reporting increased interest (not shown here). However, the limited number of responses to date (approximately 800) prevents us from evaluating the program's effectiveness by type of activity, main topic, or school grade.

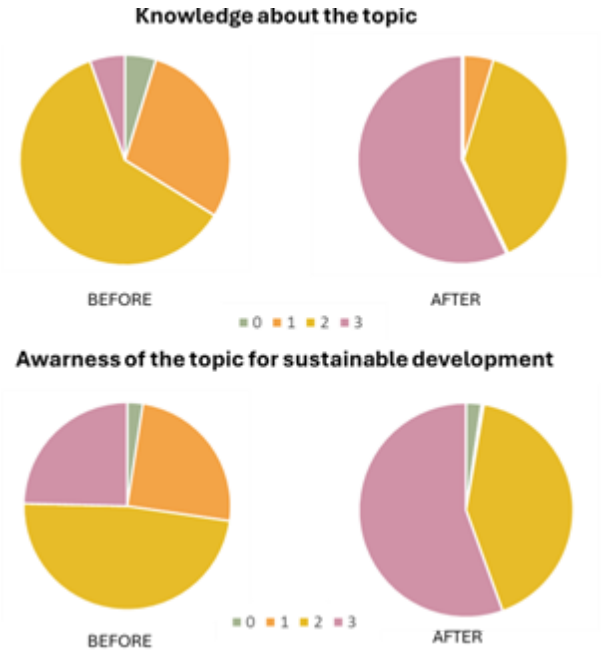


**Figure 3.** DICA4Schools impact. Comparison of knowledge and awareness levels among students participating in DICA4schools before and after their participation. Knowledge and awareness are assessed on a scale from 0 (minimum) to 3 (maximum).

## 4. Discussion

The initial feedback from the questionnaire, discussed in previous section, aligns with the researchers' perception of the program's effectiveness.

Moreover, program's effectiveness can be qualitatively evaluated by personal observations collected over the years from schoolteachers, who commonly raise three main points. First, they report high levels of enthusiasm and commitment among students during and following the activities, indicating strong student interest. Second, they acknowledge the value of the program's "innovative" teaching approach, which they find highly effective. Lastly, many teachers appreciate the program's support in teaching sustainability topics as part of Civic Education, as required by the Italian Ministry of Education. Not feeling sufficiently qualified

in this area, teachers find that the program enhances their personal knowledge and teaching confidence.

The teachers' positive perception of the program's effectiveness is evident also in the high demand for activities. The project started with prototypal activities in the academic year 2016-17 when we hosted 6 classes from a single primary school. In the following two academic years the frequency of the activities significantly increased, involving on average 550 students per year and 20 schools, mainly located in the Milan Metropolitan area. The activities of DICA4Schools stopped during the COVID-19 pandemic and re-started from the academic year 2023-24. Yet, experiences accumulated, social media promotion and positive advertising from teachers attending the activities in pre COVID-19 time meant that the project could quickly re-establish the quantitative levels achieved before the pandemic. For instance, in just one month (mid-September to mid-October 2024) of the current scholastic year (2024-25), approximately 20 activities have already been booked.

Researchers from DICA have also shown growing commitment to the program. Beginning with just a few participants in 2017, the team now includes over 90 researchers, from PhD students to full professors. The "call for new ideas" launched by the Department in July 2024 led to the development of three new activities that will be introduced in the next scholastic year.

Future efforts will aim to further enhance the effectiveness of the program, guided by insights from ongoing feedback collected through the questionnaire. Specifically, these efforts will focus on:

- Expanding the program’s reach, both geographically and demographically. To date, the program has primarily engaged schools from the Milan hinterland, with most participants from primary and lower secondary schools. Expanding the audience will require refining engagement strategies, including a stronger presence on social media to reach a broader range of schools and communities.
- Encouraging peer education initiatives among students participating in DICA4schools activities. This will empower students to become educators on SDGs, promoting sustainable development knowledge within their peer groups and fostering a collaborative learning environment.
- Facilitating knowledge transfer from students to their families and friends to amplify the program's impact. This approach leverages students as conduits of awareness, extending the program's reach into the broader community and fostering a culture of sustainability beyond the classroom.

Nonetheless, specific research efforts will be put on expanding DICA4Schools activities to teachers’ education, with two primary aims: enhancing their knowledge on SDGs and improving their ability to implement engaging teaching methods and experience-based learning in order to replicate similar activities autonomously.

## 5. Conclusion

The paper introduces the DICA4schools program, an educational initiative by Politecnico di Milano designed to disseminate scientific knowledge on environmental sustainability to students from primary, secondary and high schools. The program is grounded on inclusive and engaging pedagogical approaches tailored to students' ages and prior knowledge of the Sustainable Development Goals (SDGs). These approaches have proven effective in enhancing students' understanding and awareness of environmental sustainability while also fostering their interest in STEM disciplines. Additionally, the program has been positively received by teachers, who perceive it as a valuable support for integrating sustainability topics into their curricula.

The DICA4schools program is built on a dynamic interaction where the educational offer of the department meets the demand of the specific skills and contents focused on STEM topics by schools and schoolteachers. This aspect should be a key consideration for other organizations aiming to replicate this initiative. To further enhance the project's impact, future efforts will focus on expanding the program beyond Milan's hinterland, strengthening peer education on SDGs, fostering knowledge transfer to families and communities, and enhancing teacher training.

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## Appendix A

Description and main features of DICA4 school activities; a detailed description of the activities and reference people can be found at https://www.dica.polimi.it/dica4schools/). Addressed SDGs: (2) Zero hunger, (4) Quality education, (6) Clean water and sanitation, (9) Industry, innovation and infrastructure, (11) Sustainable cities and communities, (12) Responsible consumption and production. (13) Climate action, (15) Life on land, (16) Peace, justice, and strong institutions.

| Title | Brief description | Type | Duration | Target: school/age | SDGs |
|---|---|---|---|---|---|
| Meteorology and Climatology: Two Sides of the Same Coin | Meteorology focuses on short- and medium-term weather forecasts, while climatology studies long-term climate patterns. This seminar guides students through the history of these sciences and demonstrates how to use a meteorological station, emphasizing the importance of accurate atmospheric measurements and correct sensor positioning. | Seminar | 90’ | Primary/6-11 years Lower secondary/11-14 years Secondary/14-19 years | 4, 11, 13, 15 |
| Soil, a resource to be protected and an important “ally” in the fight against climate change | Soil plays a critical role in the water cycle by controlling rainwater infiltration through permeability, which is disrupted by urbanization. This seminar examines environmental issues from land consumption and urbanization impacts, highlighting mitigation strategies to protect soil functions in urban planning. | Seminar | 30’-90’ | Primary/6-11 years Lower secondary/11-14 years Secondary/14-19 years | 4, 6, 11, 13, 15 |
| The Science of Invisible Water | This activity introduces students to agricultural hydrology fundamentals from both scientific and practical perspectives. Key topics include plant water needs, the "water footprint" of food, and strategies for water management, with interactive discussions and a role-play on irrigation’s importance in agriculture. | Seminar + game | 90’-2h | Primary/6-11 years | 2, 4, 6 |
| Waste Water: From Threat to Resource | Our sewers carry waste water that needs to be purified to prevent pollution of natural waters, but it also carries precious resources. The acitivity explores which technologies can already be used to recover waste water and transform it into secondary raw materials and renewable energy. | Seminar + game | 2-3h | Primary/6-11 years Lower secondary/11-14 years Secondary/14-19 years | 4, 6, 11, 12 |
| A journey to discover the secrets hidden in the stones | This activity introduces geomaterials—natural materials of the lithosphere crucial for construction and resource exploration —through hands-on workshops, and interactive games. Students learn about rock and mineral identification and key properties by participating in a treasure hunt at the Petrographic Collection of Politecnico di Milano. | Seminar + game + lab | 2h | Primary/6-11 years | 4, 11, 12 |
| Dr. House: Diagnostics and analysis of the built environment | Buildings, like people, can "get sick" with visible symptoms of degradation and failure. Architects and engineers diagnose these issues using investigative techniques, much like doctors with patients. Participants build model walls and apply diagnostic methods to assess structural properties, learning to identify causes of degradation and understand building preservation methods. | Lab | 2-3h | Primary/6-11 years Lower secondary/11-14 years Secondary/14-19 years | 4, 9, 11 |
| Do you know what an earthquake is? | Through interactive activities like games and multimedia illustrations, this program teaches children and teens about earthquakes: their causes, measurement, and associated risks, with a focus on reducing risk tohistoric buildings. It also covers essential safety behaviors and basic principles of seismic emergency management. | Lab | 90’ | Primary/6-11 years Lower secondary/ 11-14 years | 4, 11 |

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| Clay, bricks, masonry, and the Ziggurat | This lab begins with a lesson on ceramic materials and clay, the sedimentary rock used in brick and ceramic production. Students learn about clay processing phases—extraction, shaping, firing—and explore historical brick types, originating with the Sumerians for waterproofing roofs. The activity concludes with scaled brick-making, wall construction, and designing a Ziggurat. | Lab | 2h | Primary/6-11 years<br>Lower secondary/ 11-14 years | 4, 9, 11 |
| Sustainable rainwater management | These lab activities focus on sustainable water management and urban water cycle restoration, using an on-site system with a rainwater collection and infiltration tank. Participants learn about monitoring instruments for hydrological and geotechnical variables, analyze real-time data, and observe scaled-down simulations of the system's processes. | Lab | 2h | Primary/6-11 years<br>Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 6, 11 |
| Flood laboratory | This activity teaches children about floods—how rain causes them, why cities flood, and how to prevent and protect against flooding. Using interactive models, children explore the causes, impacts on communities, and the role of civil protection plans, fostering awareness of individual responsibility for sustainable development and flood prevention. | Lab | 90' | Primary/6-11 years<br>Lower secondary/ 11-14 years | 4, 11, 13 |
| We throw them away, but then… that's not waste! it's a mine of resources! | This activity focuses on waste separation and recycling, encouraging participants to recognize different materials and understand the importance of sorting waste at the source. Through hands-on experiments, children learn to identify materials, read package labels, and understand the recycling process, starting from the point of purchase. | Lab | 90' | Primary/6-11 years<br>Lower secondary/ 11-14 years) | 4, 12 |
| Bacteria in a battery | This activity explores the importance of soil and the problems caused by soil pollution, highlighting its impact on humans. It introduces the role of soil bacteria, which can break down pollutants and even produce electricity, like natural "batteries." Participants will learn how these processes work and how soil can be cleaned and restored. | Lab | 2-3h | Primary/6-11 years<br>Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 6, 12, 15 |
| Groundwater | This lab offers interactive activities to explore underground water resources, which are essential but invisible. Students dig a well to discover how water is hidden beneath the surface and learn about its slow movement and impact on water quality through scale models. | Lab | 90' | Primary/6-11 years<br>Lower secondary/ 11-14 years | 4, 6, 11, 13 |
| A visual path of groundwater flow through a scaled hydraulic model | This activity uses a small-scale hydraulic model to illustrate the behavior of underground water. Students observe how water moves through different types of aquifers (free or confined) and simulate water extraction from a well, visualizing its movement inside the well and nearby areas. | Lab | 30' | Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 11, 12 |
| Underground water resource: observe the aquifer and measure its temperature | This activity involves measuring the underground water table and temperature in two piezometers located in a public park, at depths of 30 and 60 meters. Using manual and automatic tools, students independently assess the water depth and temperature at various levels. They compare results from the two piezometers and discuss their findings. | Lab | 30' | Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 11, 12 |
| Let's meet metamaterials: what they are and what they can be used for | This activity introduces metamaterials and their unique properties, such as auxetic structures, through hands-on experiments. Participants will build origami models and test 3D-printed metamaterial samples to explore the differences between regular materials and metamaterials. The session concludes with a discussion of current and potential technological applications for metamaterials. | Seminar + lab | 60' | Lower secondary/11-14 years<br>Secondary/14-19 years | 4, 9 |
| Numerical simulation in movies and video games | This seminar explores the role of numerical simulation in revolutionizing the film and video game industries. It explains how methods originally designed for engineering are used to create special effects in films—like explosions and natural disasters—and dynamic environments in video games. The seminar also connects these techniques to solving complex engineering challenges. | Game | 30'-90' | Secondary/14-19 years | 4, 9 |
| The Collapse of the Twin Towers: Structural | This seminar examines conspiracy theories surrounding the collapse of the Twin Towers on September 11th, 2001, particularly the idea that explosives were | Seminar | 45' | Secondary/14-19 years | 4, 9, 16 |

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| Engineering vs. Conspiracy Theory | pre-planted by the American Secret Services. It focuses on the structural analysis of the collapse, aiming to demonstrate that the towers fell due to the plane impacts and fires, not controlled demolition. The seminar challenges participants to critically assess the evidence and draw their own conclusions. | | | | |
| Earthquakes and historic buildings | This activity combines a seminar and practical demonstration to explore earthquakes and their impact on historic masonry structures. The seminar covers earthquake basics, seismic waves, environmental effects, and Italy's seismic history, along with mitigation strategies. The second part features a shaking table model to demonstrate how earthquakes affect buildings, exploring whether historic buildings can still be safe with proper mitigation measures | Seminar | 90'-2h | Secondary/14-19 years | 4, 9, 11, 13 |
| Geo-Engineering Challenges: The Earth in Your Hands | This activity introduces geomaterials through seminars, a visit to the Petrographic Collection at Politecnico di Milano, and hands-on workshops. Students learn about the interaction between humans and geology, focusing on slope dynamics and groundwater resources protection. | Seminar + game | 2h | Secondary/14-19 years | 4, 11, 12 |
| Practical and interactive laboratory of structural engineering | In this hands-on program, students explore structural engineering by using educational kits with magnetic rods, spheres, and bars to understand basic principles. They then visit the Nervi Laboratory at the Lecco Campus, where they examine 3D models of real structures, reinforcing classroom concepts and offering a tangible, engaging approach to the field. | Laboratory | 8h | Secondary/14-19 years | 4, 9, 12 |
| Breathe the Future: Pollution and Climate Challenges | In 2-3 seminars, students learn about air quality, pollution sources, health impacts, and control strategies. Topics include: 1) Air pollution phenomena (greenhouse effect, ozone hole, fine dust), 2) Methods for measuring pollution, and 3) Data processing and communication. Seminars may include labs on air quality data analysis. | Seminar + laboratory | 2-3h | Secondary/14-19 years | 4, 11, 13 |
| The Internet of Things: What are MEMS and How Can They Be Used? | This activity explains how Micro-Electro-Mechanical Systems (MEMS) like accelerometers and gyroscopes enable functions like screen rotation on phones and motion-sensing in gaming. Students learn about the design of these tiny sensors, found in phones, cars, and drones, and explore how MEMS allow real-time data acquisition for interactive experiments. | Seminar + laboratory | 100' | Secondary/14-19 years | 4, 9 |


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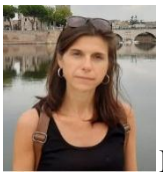
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