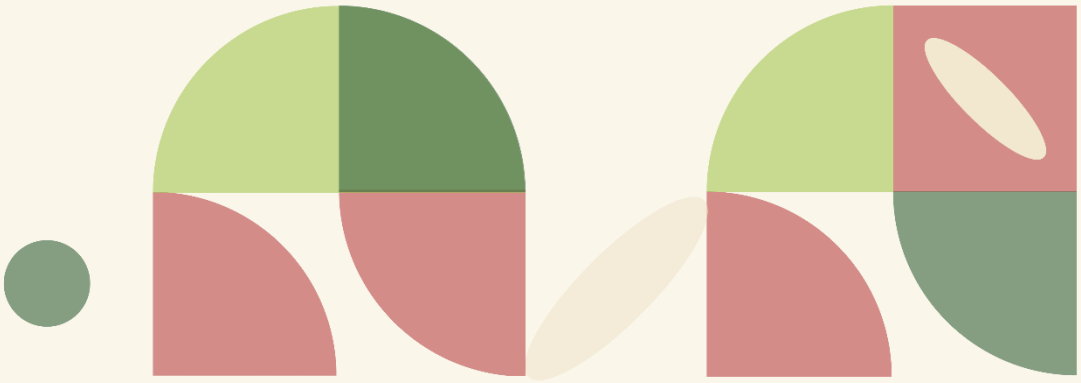
Case study: Liceo Keplero Roma (Keplero secondary school)

Rome, Italy

Institutional initiative



Key findings

For several years now, the Keplero high school in Rome has been part of the Green School initiative, a national network of schools committed to environmental sustainability. The school provides an excellent example of integrating the whole-school approach into its daily activities, embedding learning in and with learning environments for sustainability. Being the only school in Rome with a green roof symbolises its commitment to sustainability.

- **The school's Green School group is central to the success of the initiative.** The Green School group has a stable place within the school, and cultivates a sense of belonging. The Green School group works on a voluntary basis and provides an opportunity to move beyond the traditional closed classroom setting, encouraging active participation and engagement, driving the enthusiasm of those teachers and students who are involved in the group.
- **Active use of innovative pedagogies in and with the learning spaces for sustainability.** Teachers at the school actively use various spaces (green roof, Dome or Zome) to employ innovative sets of pedagogical approaches such as learning by doing, enquiry-based learning, problem-based learning and collaboration. On the green roof, students engage in hands-on learning by weeding, planting and monitoring the health of the plants and checking for invasive species. This allows the development of sustainability competences among students that are needed for a more sustainable world.
- **Whole-school approach.** The school is a brilliant example of how the whole-school approach has been successfully integrated into daily practice. Environmental sustainability initiatives are one of the cornerstones of the school's operations, with a strong emphasis on student agency within the learning spaces. The school has forged strong community partnerships with local associations and schools, as well as schools from other countries.
- **Long-term commitment to sustainability by the school and support from the leadership.** The school has committed to a series of sustainability pillars and has been very active in topics related to mobility, food waste, water waste and more. Its Green School activities are integrated into a Three-Year Educational Offer Plan (PTOF) and into a teaching system that reflects the school's commitment to sustainability and the implementation of sustainability projects on the ground. Support from the school's headteacher has been instrumental, and the initiative has been very well received by the whole school community.

1. Introduction

Keplero secondary school (*Liceo Keplero di Roma* in Italian) is a scientific lyceum[54] located in the south of Rome. The school has 922 students and 92 teachers, and is divided into two campuses (Via Gherardi and Via delle Vigne), about 6.5 km apart. Since 2016, a series of initiatives on learning environments for sustainability have been implemented at the school. These initiatives have aimed to improve the environment of the Keplero school and the well-being of its students by creating structures that increase the amount of available green space and encourage reflection on environmental issues, particularly those caused by climate change.

For the past three years, the Keplero school has been part of the Green School initiative, a national network of schools committed to environmental sustainability. Under this

[54] The scientific lyceum is a type of high school (general secondary education) in Italy specialising in scientific studies, with the option of an applied science programme with a greater focus on mathematics, physics, chemistry, biology or earth sciences, as well as a traditional focus on Italian, art history or philosophy. Liceo Keplero follows a general education curriculum and does not offer optional or elective subjects. It prepares students for university studies in any field.

initiative, the school's Green School group – a voluntary group of active students who play a key role in carrying out activities, supported by teachers – volunteer to promote sustainability through the process of participation and active citizenship. Most of the learning environments for sustainability at Keplero have been implemented at its main campus, Via Gherardi, an older campus built in the 1970s.

The Green School initiative integrates together students from different classes and age groups, creating a diverse and dynamic environment that offers a fresh alternative to the conventional teaching approach at Liceo Keplero. Under the conventional approach, teachers focus primarily on subject-based teaching in alignment with the national curriculum. Such teaching is largely theoretical, assessments are individualised, and group work is rare and often undervalued. Pupils typically learn in the same classrooms with the same teachers throughout the year.

2. Whole-school approach

For several years, environmental sustainability initiatives have been one of the cornerstones of the school's operations, with the green roof being the most unique. The Keplero school is the only school in Rome that possesses a green roof – and the school has used this feature to support the development of both the school and its neighbourhood. The green roof has become a symbol of the school's commitment to sustainability. Keplero school has various outdoor learning environments for sustainability, and these are used actively by both teachers and students for curricular and extra-curricular activities.

Keplero school's Three-Year Educational Offer Plan (PTOF) has become increasingly green. This plan is a fundamental document describing school culture, identity, and curricular, extra-curricular or other educational projects. At the same time, the school's policy is becoming more cohesive towards sustainability, with new cross-curricular sustainability projects being launched each year. Green School activities are integrated into the school's daily teaching system and plan, together with the issues of equity, accessibility and inclusion. Teachers at Keplero school are guided by Freire's critical pedagogy[55], which revolves around learning in dialogue with the students.

For the past two years, under the Green School project, the school has selected a series of sustainability pillars. Since 2023, the school has begun to implement waste sorting management in collaboration with multiple stakeholders, including the municipality and a waste collection company. The Green School group played a big part in the process, explaining to each class how to sort waste properly. The school has also been actively involved in the Erasmus+ project "Nature in Culture", which focuses on environmental sustainability. In addition, the school promotes peer education. Last y ear, as part of the aforementioned Erasmus+ project, Keplero students hosted peers from different countries and shared their knowledge about planting and growing vegetables. This experience not only allowed students to transcend the "closed" atmosphere of the classroom, but also helped them to feel more connected to a wider community. On school trips to Germany and Brussels,

Figure 29. *The Zome at Keplero secondary school.*
Source: *© PPMI, 2024. Photographers: Alessia Maso and Michela Mayer.*

[55] Freire's critical pedagogy refers to an approach in which teachers encourage learners to explore socio-political inequalities and act. This critical pedagogy adheres to the principles of co-creating knowledge, lived and personal experience, a flexible curriculum, and democracy and equality.

the school travels by train, reducing both environmental impact and the expense for families.

The school has been very active on topics relating to mobility, food waste, water waste and many more. In collaboration with other students from schools in the Green School network, students from Liceo Keplero manage social media channels to communicate with their peers through videos and creative artistic projects. Physical spaces have been built by students in collaboration with local and professional associations such a s the Synaptica Project, AK0 ("Architecture at 0 Kilometre") and Landmark APS, which offered courses on bio-construction methods and provided tools such as milling machines and electric saws. The Green School initiative at the Keplero school has attracted significant attention from other schools in the city, many of whom have already visited the school with plans to replicate its initiatives. The Keplero school itself plans to replicate the project at its other campus.

3. Spaces and teaching for sustainability

The Zome

The Zome, a complex geometric structure designed around an existing tree in the school yard, spans roughly 5 metres in diameter and reaches a maximum height of approximately 3 metres. Completed in April 2024, it is constructed from bamboo using a technique that uses the soil as a natural mortar. This method not only decorates the school courtyard but also provides seating areas inside, making the space both functional and sustainable. It was built with the help of students during a series of afternoon workshops. The Zome was funded by parents' donations to the school fund, and designed in collaboration with local and professional associations such as Synaptica Project, AK0 and Landmark APS. Inside the structure, just a few metres away from the traffic, one feels a sense of security and seclusion, separated from the garden and the street. This peaceful atmosphere encourages deep concentration and enhances the learning experience. The tree within the Zome serves as a reminder of our connection to nature and promotes a calm and positive mood. The Zome has been actively used for recreational purposes, as well as by teachers and students as a learning environment for outdoor teaching activities and for projects involving small groups of students. The Green School group meets every Tuesday afternoon in the Zome, where it begins its meetings with a discussion, followed by work in the educational garden and the monitoring of school processes (waste separation, water losses, etc.) The meeting then ends back at the Zome.

Figure 30. *The Zome at Keplero secondary school.*
Source: *© PPMI, 2024. Photographers: Alessia Maso and Michela Mayer.*

The Geodesic Dome

The Geodesic Dome, a collaborative building project, provides space for an entire class. It spans approximately 50 m^2 and stands at the heart of the school's courtyard. Constructed from a mixture of earth and organic materials, this eco-friendly structure was completed in June 2024. It serves as a unique exhibition space, showcasing various styles of housing construction and acting as a permanent display of biostructures. While the interior is currently unfurnished, plans are underway to install furniture and benches, transforming it into a versatile space for students, teachers and local associations to host cultural, musical and artistic events. Even though the Geodesic Dome is not yet finished, students at Keplero school have held the first event in the structure – a second-hand book market during the first week of September. Both the Dome and the Zome are flexible spaces that support diverse pedagogical approaches such as learning by doing, enquiry-based learning and learning by problem-solving. Teachers collaborate to bring various innovative ideas to life, such as holding reading lessons in the Dome. The structure's open layout and circular design make it an inviting space for gathering and engaging in creative activities.

Figure 31. *The Geodesic Dome at Keplero secondary school.*
Source: *© PPMI, 2024. Photographers: Alessia Maso and Michela Mayer.*

Vegetable garden

The school's vegetable garden is located in the school garden. It is a plot of about 30 m^2. Despite its small size, the vegetable garden used to grow a variety of vegetables depending on the season. At the time of the visit made for the present case study (September 2024), the aubergines were ready, and the garden was thriving. Students work in small groups, cleaning the space, planting vegetables and harvesting. Produce from the garden is sold on the school campus, and the proceeds go to organisations such as Emergency (a humanitarian NGO that provides free and high-quality care) or Doctors without Borders (*Medici Senza Frontiere*), while a small portion supports the project's upkeep.

Green wall

In 2017, this approximately 27 m^2 structure at the entrance to the school was built on a suitable base in accordance with European standards (UNI 8290-1). The green wall uses a "felt system" chosen for its reliability and results. The structure consists of a metal frame that is fixed to the wall, leaving an air gap. A PVC panel is placed on the frame and two felts are attached to it. The outer one of these is cut to create "pockets" in which the selected plants are placed, without soil, directly on site, fed by a capillary system that provides nutrients and irrigation. The various plants that cover the wall of the entrance give the space a very pleasant and lively atmosphere. The green wall serves both as an experimental project to assess how

Figure 32. *The Green Wall at Keplero secondary school.*
Source: *© PPMI, 2024. Photographers: Alessia Maso and Michela Mayer.*

vegetation can improve the energy performance of a building, and as a valuable resource for in-depth educational studies.

Green roof

The school's green roof, the first green initiative carried out at Keplero school, is installed on the first floor of the gymnasium. It covers an area of 200 m^2, and is divided into two parts. The green roof project was created in collaboration with Roma Tre University and thanks to the efforts of one active teacher. It established the conditions for the design and construction of other initiatives, especially those related to the Green School project in 2015. The green roof features a multi-layer system with a total thickness of approximately 12 cm and an anti-rooting waterproofing layer. The roof is used to carry out scientific experiments in collaboration with the University of Roma Tre to study the thermal, hydraulic and agronomic characteristics of Mediterranean vegetation planted on a roof under Mediterranean conditions. The species chosen and successive interventions and management have led to an increase in biodiversity.

Figure 33. *The Green Roof at Keplero secondary school.*
Source: *© PPMI, 2024. Photographers: Alessia Maso and Michela Mayer.*

The Green roof fosters pedagogical innovations that encourage collaboration between students from different classes. It involves them in a real-world, field-based scientific experiment on environmental sustainability, rather than a simulated laboratory study. Students are responsible for ongoing data collection and maintenance, reflecting the ethics, consistency and systematic effort required in real scientific research. This hands-on experience gives students a sense of participating in authentic research with unknown outcomes and teaches them about working collaboratively, verifying measurements and their reliability, assessing the accuracy of data and drawing conclusions. The project allows students to go beyond the classroom to grasp the real impact of climate change on their environment, adding relevance to their learning and increasing their sense of well-being and purpose at school. The green roof provides multidisciplinary opportunities for students to study agronomy, pollution, microbiology, climate, energy and sustainable urban practices. Students engage in hands-on learning by weeding, planting and monitoring the health of the plants and checking for invasive species. The roof is easily accessible through a French window on the first floor, and is visible from the classrooms and school offices.

For both the green wall and the green roof, an experiment was carried out to assess how a vegetated space can contribute to the energy performance of the building. The thermal performance of the vegetation cover was measured to assess how efficient the substrate/plant system is in providing thermal insulation. Working with the students, researchers from the University of Roma Tre observed the thermal effect of heat exchange between the green roof and the surrounding environment, gaining valuable insights into sustainable building design. The experiment has also led to an article that has just been published in a scientific journal[56], demonstrating the synergies between different species that optimise the functionality of the green roof. The students were not only involved in the experiment but also in the process of writing the paper, and experienced significant educational benefits. Many activities are carried out even during "gaps" in the school schedule, especially in the summer. During winter, these focus on related activities, such as waste separation.

Figure 34. *The Green Roof at Keplero secondary school.*
Source: *© PPMI, 2024. Photographers: Alessia Maso and Michela Mayer.*

4. Evaluation of impacts

Impact on the environment

The active Green School group at the Keplero school regularly monitors the sorting of waste. Prior to the launch of the initiative, the average total waste generated per day was 10.9 kg, of which 98.4 % was unsorted waste, 0.0 % was paper and 1.6 % was plastic. Following the introduction of the initiative, the average total waste generated per day was 9.8 kg, of which 86.5 % was unsorted waste, 7.7 % was paper, and 5.7 % was plastic and aluminium. These results show how work on sustainable environments is ongoing and involves the entire school system. Ongoing research by Roma Tre University has shown that in winter, the green roof acts as an insulator, retaining heat in the ground, while in summer it helps to cool both the area below and the surrounding environment. The system provides excellent thermal insulation, as the internal temperature of the roof slab is approximately 28°C. In similar environmental conditions, a comparable roof slab not covered by a garden reached an internal temperature of 33.4°C.

Impact on the well-being of learners

The learning spaces at Liceo Keplero were physically built by the students themselves in collaboration with teachers and local associations. This hands-on aspect brings great satisfaction to the students, as seeing results of their own work builds their self-esteem. Giving students the opportunity and responsibility to act to improve their learning environment, and doing so with students of different ages and from different classes, builds students' self-confidence and their desire to engage with both the school and the environment. As many teachers note, the green spaces that are open to all students within the school "have a positive effect on people's physical and mental well-being", while being in the Geodesic Dome or the Zome allows you to feel a "different atmosphere".

[56] The article, "Evaluation of Mediterranean perennials for extensive green roofs in water-limited regions: A two-year experiment" can be found here: https://www.sciencedirect.com/science/article/pii/S0925857424002246

Conversations with students reveal their enthusiasm, commitment, responsibility and a strong sense of belonging to their school. An example of this can be seen from their presentation at the headquarters of the Food and Agriculture Organization of the United Nations in Rome during Sustainability Days. Their knowledge and activities on composting and soil fertilisation were highly appreciated, which appeared to have a positive impact on their sense of achievement and well-being.

The use of the spaces for participatory activities – even those organised, promoted and managed by students themselves, such as book exchanges – is beneficial because it creates a sense of belonging to the school. Teachers believe that this sense of connection helps to prevent drop-out and disengagement. Italy has one of the highest drop-out rates in Europe. To respond to this, the school will focus on tackling drop-out by using education for sustainability and the green roof as key motivational factors in its new projects.

Impact on learning outcomes and sustainability competences

Students can take lessons on the green roof, in the vegetable garden, in the Dome and in the Zome, or use the green wall for educational purposes. Most of these learning activities focus on participation and active citizenship. From the teachers' observations, students who struggle in the classroom with theories and abstract thinking thrive in these hands-on workshops. Even students with social difficulties or special educational needs participate in such activities. These hands-on experiences give students a sense of participating in authentic research and teach them how to work collaboratively, which helps to develop systems thinking and exploratory and critical thinking competences.

The Erasmus project in which the school participated in 2023, "Nature in Culture", focused on sustainability issues. In particular, it involved students from the other building of the Keplero school, where there is a lot of green space but little awareness. Through project activities, teachers aim to create conditions for students to develop competence in promoting nature by cultivating flowers, and in collective action literacy by connecting with other students across Europe.

For the year 2025, the Keplero school aims to introduce a new course on environmental citizenship, as an alternative to religion. This course will further embody sustainability values in students and help them develop political agency towards the environment, contributing to acting for sustainability on an individual and collective basis.

Challenges and limitations

Despite the school's green elements and positive environmental and well-being outcomes, the Keplero school faces several limitations and challenges.

- **Maintenance challenge:** The City of Rome made a significant financial contribution to the Dome and Zome projects and is responsible for the maintenance of all secondary schools in Rome. Nevertheless, the school would greatly appreciate the City's more proactive involvement in the maintenance, which is often delayed due to bureaucratic hurdles. The initiative's full potential is limited by slow institutional responses and insufficient operational support.
- **Funding challenges:** The separation of funding sources creates another barrier to meeting different school needs. Budgets cannot be shared across offices, and this is challenging given that different offices usually split responsibility such as school maintenance and environmental initiatives. This makes it difficult to address both infrastructure and sustainability goals simultaneously. Funding should be more flexible, allowing for joint projects that cover maintenance and renovations.

- **Involvement of teachers:** Although most teachers supported the project, a few questioned its immediate value, feeling it wasn't directly tied to their teaching goals. At the same time, many teachers voluntarily dedicate their time to work without extra pay. To maintain momentum, teachers need better recognition or support, such as payment or official project integration into existing teaching responsibilities.

Strengths of the initiative and lessons learned

The Green School initiative is an integral part of the Keplero school's processes, shaping a culture of a high-level of participation, civic responsibility and engagement with green themes. The Green School group, a voluntary initiative open to all students, is a good example of this integration. Overall, the Keplero school is an excellent example of integrating the whole-school approach into daily activities. Its activities foster a commitment to ecological awareness and responsible practices among students.

- **Commitment to sustainability by the school, and support from the leadership:** the school has committed to a series of sustainability pillars and has been very active on topics related to mobility, food waste and water waste. Support from the school's headteacher has been instrumental, and the initiative has been very well received by the whole school community.
- **Positive impact on school culture:** the Green School initiative and group offer a meaningful experience that teachers and students find fulfilling. This enhances their motivation, pride and engagement, making the project a central, valued part of school life.
- **On participation:** students are highly appreciative of the Green School initiative. Furthermore, the number of teachers at the school who are involved in the initiative has grown significantly, from one at the beginning to many, and resistance has been very low.
- **On collaboration:** teachers at the school underline that collaboration with local associations, the University of Roma Tre, the 'Municipio XI' (the City District) and the Metropolitan City (the Government of the Rome Metropolitan Area) is fundamental to the initiative's success. The school's collaboration with the Green Schools network and the associations that designed some of the structures (the Zome and Geodesic Dome) has been equally successful.
- **On the community:** the project has involved the community, which will be able to use the Dome and Zome spaces for performances, events, music or other activities, making the space accessible to a larger audience outside the school.
- **Looking ahead:** the school's commitment to sustainability is evident, and a group of teachers from the other Keplero campus are eager to replicate the project there, even though this will be a volunteer activity with no additional compensation.

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