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Case studies on learning environments for sustainability

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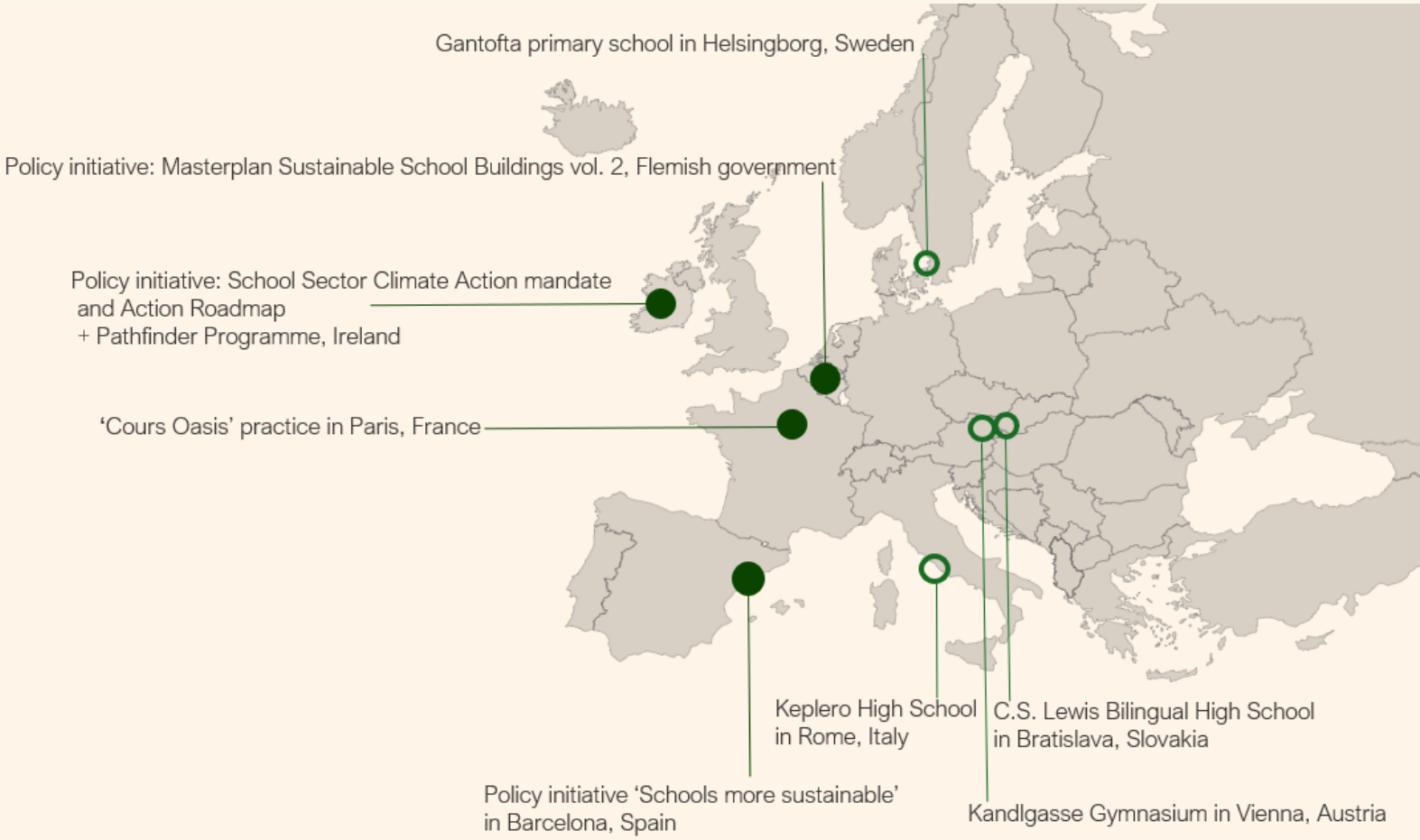
Table of contents

Your map of inspiring case studies on learning environments for sustainability



Case study: Masterplan School Buildings

Flanders

Policy initiative

Key findings

- The Masterplan School Buildings is a policy initiative in Flanders (Belgium) aimed at modernising and renovating outdated school infrastructure. It prioritises **sustainability, inclusivity and local needs** in modernising and renovating outdated school spaces.
- The initiative involves a **participatory co-design process involving architects, educators, students and local communities.** Through collaborative workshops, contributors explore the best pathways to integrate each school into its broader social and environmental contexts.
- **Environmental sustainability is at the centre of the initiative**, with schools adopting near-zero energy standards, advanced insulation and elements such as green roofs, permeable surfaces and rainwater harvesting systems. These measures align with the Flemish Climate Strategy 2050 to reduce carbon footprints and strengthen the climate resilience of schools.
- Redesigned facilities strengthen accessibility, inclusion and multifunctionality. The integration of green spaces, improved air quality and natural light have **improved well-being and satisfaction among students and teachers** (AGION, 2019).
- The Masterplan **strengthens ties with local communities** by opening school courtyards for public use and repurposing historic buildings. This approach preserves local cultural heritage and transforms schools into community spaces.
- **Administrative complexity and rigid public-private partnership (PPP) contracts create inefficiencies.** Some schools report delays in repairs, lack of flexibility in modifying construction plans, and difficulties managing long-term maintenance.
- Some schools have successfully used outdoor spaces and green infrastructure in learning for sustainability initiatives. However, these efforts are **isolated and do not represent a generalised, structured approach within the Masterplan**. There is a lack of evidence on the extent to which learning on sustainable school campuses has improved students' sustainability competencies and environmental literacy.
- Still, the initiative has modernised **182 schools**, and evaluations indicate improvements in student and teacher satisfaction and well-being, as well as reduced absenteeism (AGION, 2019).

1. Introduction

This case study explores the policy framework "**Masterplan School Buildings**" (hereafter "Masterplan") in Flanders, Belgium, by drawing on a combination of desk research, analysis contained in AGION[1] and Flemish Ministry of Education reports, and interviews with project coordinators from Team Vlaams Bouwmeester. The research included contacting schools to understand their learning for sustainability (LfS) initiatives, along with insights from the national expert on schools recognised on the Milieuzorg Op School [2](MOS) website for their sustainability projects.

The Masterplan was introduced by the Flemish Government Architect (Team Vlaams Bouwmeester) to address systemic challenges in school infrastructure. These challenges,

[1] AGION, the Flemish Agency for Infrastructure in Education, is responsible for coordinating and subsidising school infrastructure projects. Through sample-based evaluations and periodic reviews, AGION monitors project performance and verifies that schools meet established standards. Evaluations combine technical reviews, financial data and project outcomes.
[2] MOS (Milieuzorg Op School) is a Flemish initiative that supports schools in integrating environmental care and sustainability into their daily operations, teaching practices and school culture. For more information, see: https://www.mosvlaanderen.be/

identified in a study by Ghent University (Châtel et al., 2006) include **outdated, inefficient and unevenly distributed schools that fail to meet modern educational, environmental and community needs**. The Masterplan aims to overcome these issues by **integrating architectural quality, sustainability and community engagement into educational spaces.**

Multiple interconnected initiatives have been launched under the umbrella term "Masterplan School Buildings". These include the "**Scholen van Morgen**" (Schools of Tomorrow) programme and various **Design-Build-Finance-Maintain (DBFM)** calls. The Masterplan School Buildings initiative was divided into two major phases:

- **Masterplan 1.0 (2014-2019)** laid the groundwork for transforming school infrastructure across Flanders. Its main objectives were to address regional disparities in educational infrastructure, to increase school capacity to meet growing demand, and to integrate energy efficiency standards.
- **Masterplan 2.0 (2020-2024)** built on these past efforts and incorporated a stronger emphasis on sustainability, multifunctional design and long-term resilience. Approved in 2020, Masterplan 2.0 allocated a total of EUR 3 billion to modernise existing facilities, expand capacity in high-demand areas, and create schools that serve as community hubs. In addition, this phase prioritised the retrofitting of older buildings to meet energy performance standards in order to align with the Flemish Climate Strategy 2050.

The present case study examines both phases, exploring how the Masterplan strategy and its related activities balanced the goals of sustainability, inclusivity and long-term resilience while navigating challenges related to funding, stakeholder alignment and evolving policy priorities. In addition, it reviews the design and implementation processes and analyses the impact of the Masterplan on educational and community outcomes. In doing so, it aims to provide insights into how re-thinking infrastructure design can address broader societal challenges across the European context.

2. Core principles, activities and interventions in schools

Core principles

The Masterplan employs a participatory design process in which educators, students and community members work with architects to create schools that meet local needs and future educational goals. Due to the participatory nature of the design process, the outcomes and priorities of the renovation process vary from school to school. For instance, the school **BubaO Sint-Gregorius** developed a low-stimulus environment for children with special needs, while **Spectrum College** transformed its playground into a community meeting point.

The Masterplan aims to create schools that are not only places of instruction, but also **spaces of social and sustainable innovation**. To this end, the initiative is guided by the following set of core principles (AGION, 2019):

Environmental sustainability: the initiative prioritises reducing the environmental impact of school buildings by improving energy efficiency, using renewable materials, and promoting circular construction practices. These efforts aim to create climate-resilient learning environments that can support long-term educational needs.

Well-being and inclusivity: renovation projects consider diverse communities' needs to guarantee that all students benefit from high-quality learning environments. These efforts prioritise accessible, adaptive environments that foster well-being and support varied learning styles.

Collaboration: policymakers, architects, educators and local communities engage in co-design processes, which enables ownership and alignment with local needs. In addition, public private partnerships (PPPs) are employed during the financing, execution and maintenance phases.

Architectural quality: through an innovative and contextually sensitive design, these schools address the social and sustainability needs of their local communities, with a focus on functionality, adaptability and community integration.

Participation process and main actors

The **Schools of Tomorrow** initiative is part of the broader Masterplan framework, and operates as a public private partnership. Its focus is on addressing the need for modern and sustainable school infrastructure. This initiative is managed under the **DBFM** model, wherein private partners are responsible for the design, construction, financing and 30-year maintenance of school buildings. After this period, ownership is transferred to the school boards at no additional cost. Schools of Tomorrow is the large-scale application of the DBFM approach and has delivered 182 projects. Key participants include:

- **AGION:** the Flemish Agency for School Infrastructure oversees approvals, payments and cost subsidisation, based on school type.
- **Flemish government:** provides strategic oversight and policy direction.
- **DBFM Scholen van Morgen Company:** a public-private entity managing the delivery and maintenance of school projects.
- **Private partners:** including AG Real Estate and BNP Paribas Fortis, are responsible for project financing and long-term maintenance.
- **Flemish government architect:** supervises the quality of architectural designs.
- **Educational networks:** including VSKO and DIKO, which represent and support schools during implementation.

Participation in initiatives related to the Masterplan School Building follows a specific process, as outlined below:

1. Participation begins with a selection process to identify schools with **urgent infrastructure needs**. Schools are chosen on the basis of specific criteria. These include the feasibility of their proposed projects, its anticipated community and educational impacts, and alignment with sustainability objectives. A selection committee, comprising AGION representatives and educational network

members, evaluates applications. **Priority is given to schools requiring new construction or substantial renovations, particularly where infrastructure is outdated or there are acute capacity shortages.**

2. Once schools are selected, the design process involves **co-design workshops**. These sessions bring together architects, educators, students and community members to collaboratively shape the project's outcomes.
3. Inputs from the co-design workshops are refined during the **integration phase**, during which technical teams verify that proposals meet all regulatory and sustainability standards. Following an iterative approach, the resulting plans are presented to the broader community for feedback.
4. **The construction phase is executed in stages to minimise disruptions**, and the DBFM model assigns maintenance responsibilities to private partners for 30 years.

Educational integration

The Masterplan states that a carbon-neutral or energy-neutral building is not a synonym for a sustainable building. Instead, sustainability under the Masterplan adopts a **whole-school approach** (AGION, 2012), as it considers much more beyond energy consumption, and prioritises the sustainable use of space, sustainable mobility, sustainable waste management and social sustainability. One of the main pillars of the Masterplan is to ensure that new infrastructure **provides effective learning environments that support modern pedagogical needs**.

Rather than viewing schools solely as places of instruction, the Masterplan's vision is that they should become **dynamic hubs for learning, community engagement and sustainable living** (AGION, 2019). To achieve this, the implementation of the Masterplan varies between schools by adapting its overarching principles to meet the specific needs of local contexts and schools.

Sustainable and inclusive educational infrastructure

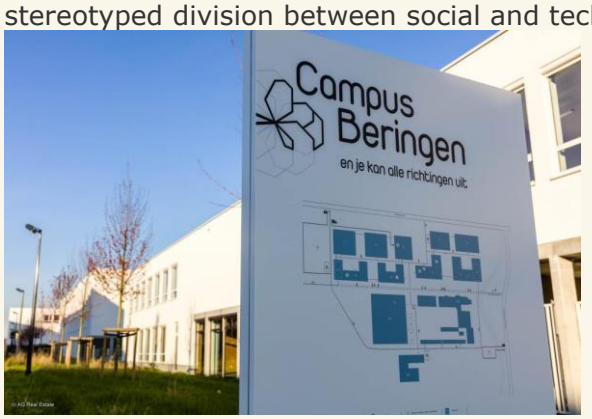
The Masterplan School Buildings initiative demonstrates its focus on inclusivity through projects such as the **BuBaO Sint-Gregorius school in Gentbrugge**, which is designed to support children with autism, behavioural challenges and speech or learning disorders (AGION 2019). The architectural approach of the project creates low-stimulus environments to reduce sensory overload. The provision of quiet outdoor spaces allows for moments of stress relief and self-regulation. In addition, designated safe zones provide areas to which students can retreat when they feel overwhelmed. The development of **BuBaO Sint-Gregorius** involved **consultations with educators and specialists** in order to guarantee that the infrastructure addressed the specific requirements of its students.

Similarly, at **Koekelberg School Campus in Brussels**, school accessibility has been improved with ramps, elevators and ergonomically designed classrooms that accommodate students with mobility issues. Flexible learning spaces are equipped with adjustable furniture and technology, which make them accessible to students with a variety of learning styles and differing physical mobility needs (AGION, 2019).

At **Spectrum College in Beringen**, the school prioritised shared public spaces and community engagement through workshops and stakeholder consultations. As a result of the consultation process, vacant sites were transformed into **publicly accessible courtyards**. These places were designed to serve dual purposes, both as recreational areas for students during school hours and as open community spaces outside of school hours (AGION, 2019).

Box 1. Spectrum College in Beringen

The renovation integrated three upper-secondary schools: TSO (Technical Secondary Education), BSO (Vocational Education), and ASO (General Secondary Education) into what is now called Spectrum College. This unified architecture prioritises equality across different educational tracks. Multiple shared spaces, such as the sports hall, cafeteria and an open learning centre, aim to facilitate **student interaction**. In the long term, this is expected to help break down barriers between tracks and eliminate the gender-stereotyped division between social and technical fields in secondary schools.



Entry to Beringen Campus Zone.
Source: *© Scholen van Morgen.*

Adaptive reuse of historical buildings

A distinctive aspect of the Masterplan is its focus on adaptive reuse by balancing **heritage preservation with the needs of contemporary schools**. AGION (2019) understands contemporary schools as centres designed to support modern teaching practices, such as collaborative, technology-driven and interdisciplinary learning. Through the repurposing process, historically significant buildings are equipped to meet modern schooling requirements while maintaining **their cultural and architectural identity**. In addition,

Box 2. Sint Franciscus College in Heusden-Zolder

Sint-Franciscus is a monastery complex with historic roots which, after being repurposed, can accommodate 600 additional students. The repurposing process consisted of a mix of renovation, expansion and retrofitting. Heritage buildings were complemented by new structures to maintain their historical character while incorporating science laboratories, collaborative working spaces and sports facilities.

Left: mosaic glass art inside the Sint Franciscus College on a black wall. Right: smaller mosaic glass art pieces on a white wall.
Source: *© Scholen van Morgen.*

this approach **minimises construction waste and the carbon footprint** associated with new materials and construction.

Sint Franciscus College in Heusden-Zolder is an example of an adaptive reuse construction. The Friars Minor monastery was transformed into a future-proof campus. This project specifically presents itself as a **"digital school",** with new classrooms being equipped with digital boards and touchscreens, as well as an open learning centre in which students are encouraged to work with all kinds of ICT tools (AGION, 2019).

However, adaptive reuse projects often face challenges due to strict compliance laws associated with heritage preservation and modern building codes. For this reason, **co-design processes** involving heritage agencies, architects and educational stakeholders are necessary to guarantee that these projects meet both regulatory and functional requirements (AGION, 2019).

Green spaces and outdoor education

Research has demonstrated that **green spaces** in schools positively impact students' physical and mental health (Fuller et al., 2007). Similarly, **outdoor education** has been proven to increase students' **sustainability awareness and competences** by encouraging contact with nature (Amicone et al., 2018). While the Masterplan School Buildings initiative does not explicitly prioritise outdoor education as a core design principle, its emphasis on **sustainability, multifunctional spaces and green infrastructure** creates opportunities for schools to incorporate **outdoor learning environments and biodiversity initiatives**. For instance, many schools' playgrounds

Box 3. Koninklijk Atheneum UNESCO in Koekelberg

Within the EcoTeam, students have planted an herb garden and 300 indigenous hedge plants at the edge of the campus, and every winter they plant one or two new trees. Using a fallen tree, they created a seating area that is used during playtime. One of the EcoTeam's first actions was to reduce mowing in designated areas, allowing natural meadows to form. This **increased biodiversity and lowered maintenance costs.** Other initiatives include an herb and vegetable garden, tree planting and insect hotels. Beyond reducing environmental impact, the EcoTeam's work has been integrated into **cross-curricular learning**, with teachers incorporating the outdoor space into science, geography and sustainability education. In English classes, students researched and made presentations on water conservation; during French classes, students gave guided biodiversity tours of the campus.

Left: students investigate a fallen tree. Right: results of fallen trees made into seating area.
Source: *© MOS.*

contain elements such as ponds, native plantings and vegetable gardens, which can promote autonomous learning and experimentation (Edubuild Yearbook, 2023).

At **Koninklijk Atheneum Koekelberg**, outdoor education is driven by the student-led EcoTeam, which emerged from a collaborative decision-making process. Initially, the school's green zone was a managed landscape, but teachers and students saw the potential for ecological improvement. The idea for this transformation originated with a small group of teachers who noticed that the school's green areas were dominated by invasive plant species and proposed a shift toward a more ecologically responsible approach. A poll was conducted among students to allow them to express their preferences for potential outdoor projects. Based on the results, the EcoTeam was formed (MOS Vlaanderen, 2021).

Similarly, **Talent School in Turnhout** has integrated outdoor classrooms into the learning environment. The school has four dedicated outdoor classrooms, designed to accommodate lessons from subjects ranging from science to literature. These spaces are equipped with seating areas, shade structures and lesson boards. Educators at Turnhout report that outdoor lessons require **little additional preparation, and students are more engaged and motivated when learning outdoors** (MOS Vlaanderen, 2023).

Box 4. Talent School in Turnhout

Students at Talent School have been taking lessons outside regularly since 2020. In addition, the teachers often take their classes to the pond or the lawn on the school grounds, and the students sometimes learn while walking.


Left: outdoor learning in the green area outside the Talent School in Turnhout. Right: a pond next to the lawn on the school grounds the Talent School in Turnhout.
Source: *© MOS.*

According to teachers, outdoor lessons offer **benefits for everyone involved**. Students find it **motivating to learn in a different environment**, and teachers enjoy the **challenge of using new teaching methods**. Parents have also noticed that **their children come home more relaxed** after spending time learning outside. Teachers agree that **fresh air helps students to stay focused**, and **that unexpected distractions**, such as a passing bee or the sound of lawn maintenance, can become **spontaneous learning opportunities** (MOS Vlaanderen, 2023).

Using sustainable infrastructure to support learning for sustainability activities

A key aspect of the Masterplan is its alignment with the **Flemish Climate Strategy 2050**, which requires all schools to be designed to **minimise environmental footprints and strengthen their resilience to climate change**. As a result, renovated schools have features such as advanced insulation, solar panels, green roofs, permeable surfaces and rainwater harvesting systems (Flemish Ministry of Education, 2019). Even though these school facilities were designed for energy efficiency reasons, **they can also allow students to observe and learn about sustainability in practice.**

For instance, the **Gemeentelijk Technisch Instituut Londerzeel** offers an example of how sustainable infrastructure can be leveraged for pedagogical purposes. Students in the 7th and 8th grades work on projects related to solar panels and other renewable energy sources, giving them the chance to explore **how these technologies function and how they contribute to reducing carbon emissions**. In the 10th grade, students engage in more advanced sustainability projects, such as designing and constructing instruments to measure air quality, and comparing air quality between old and new sections of the school. Similarly, at the school **Brede Het Ooievaarsnest in Assenede,** the wooded park has become a part of the learning environment. During science classes, this outdoor space is used for experiential learning, during which students explore the ecosystems and learn about local flora and fauna (Schooldomein, 2021).

Box 5. Klim Op School in Zandbergen

At this school, the entire campus is treated as a **"learning landscape"**, including outdoor spaces such as a vegetable garden, composting areas, a chicken coop and play areas, which serve as extensions of the classroom (Edubuild Yearbook, 2023). These features are used to support teaching about natural cycles, sustainable agriculture and environmental responsibility.

Left and right: architecture model photos of the school grounds at Klim Op School in Zandenbergen.
Source: *© GO! basisschool klim op.*

The above projects demonstrate the educational potential of sustainable features and green spaces for educational purposes. These features are recognised in national evaluation reports (AGION, 2019; AGION, 2022; Schooldomein, 2021; Flemish Government, 2016) as offering significant capacity for hands-on learning about sustainability, since they provide students with opportunities to engage with environmental concepts that are present in their schools. However, it **is not clear whether most schools are actively leveraging these features for educational purposes** and, if so, in what specific ways they are doing so. National evaluation reports lack detailed

documentation of such practices, which indicates both a gap and an opportunity for more systematic integration and tracking of these initiatives (Edubuild Yearbook, 2023).

Programme and school funding

The Masterplan School Buildings initiative operates under a complex funding scheme that includes both public and private financing mechanisms. A key element of this funding structure is the **DBFM model**, first introduced through the **Schools of Tomorrow pilot programme** in 2006. This programme was conceived as a pilot project and marked the first step in addressing the slowdown in school infrastructure construction by building 182 schools through a public-private partnership. The programme's funding model covers construction, maintenance and operational costs for 30 years, after which point the government owns the school premises outright and is fully responsible for all further maintenance and operational costs. The Flemish government and participating private entities, such as AG Real Estate and BNP Paribas Fortis, guarantee quality in the delivery while transferring most of the financial burden to the private sector (AGION, 2012). The success of this pilot project led to further funding for future iterations under the Masterplan 1.0 and Masterplan 2.0.

The **Masterplan 1.0** (2014-2019) introduced a project-specific DBFM programme to address regional deficiencies and promote energy efficiency in school buildings. **Masterplan 2.0** (2020–2024) continued these efforts while prioritising multifunctional and sustainable infrastructure. Under the initiative, the Flemish Government committed EUR 1 billion in 2006, EUR 550 million in 2016, and EUR 3 billion under Masterplan 2.0, which concluded in 2024.

3. Evaluation of impacts

Impact on the environment

Overall, the Masterplan School Buildings initiative has had a positive influence on environmental sustainability in educational infrastructure by reducing energy consumption in schools. This was achieved through the installation of renewable energy systems such as solar panels. As of 2022, schools have installed 3,829 m² of solar panels, providing a total capacity of 954.47 kW. In addition, **more than 60 % of participating schools utilise rainwater harvesting systems, collectively saving over 100,000 cubic meters of water annually** (AGION, 2019). Furthermore, the initiative's phased implementation has included energy efficiency upgrades such as advanced insulation and renewable energy solutions. These features have contributed to **reducing the energy demands of schools and supporting the transition to more climate-resilient infrastructure.**

However, due to **regional disparities, schools in disadvantaged areas tend to have lower capacities to manage emerging challenges.** For instance, the installation of permeable surfaces, energy-efficient systems or green spaces requires upfront funding, ongoing maintenance and technical expertise. An evaluations by AGION (2019) noted that the complexity of public-private partnership (PPP) frameworks can exacerbate these challenges. Schools in underfunded regions frequently lack dedicated staff or the administrative support needed to navigate funding mechanisms such as DBFM contracts, which involve complex requirements for compliance and performance monitoring.

Impact on the well-being of learners

The Masterplan School Buildings initiative has contributed to fostering inclusion and well-being within school environments. A central aspect of the redesign and construction is to

increase accessibility, thermal comfort and noise reduction, which leads to more inclusive spaces.

The AGION (2019) report showcases this, with over **77 % of stakeholders reporting satisfaction with acoustic comfort, while 90 % praised the improved lighting systems** in renovated schools. The integration of green spaces and biodiverse gardens is associated with a reduction in stress and an increase in focus among students. Surveys reveal a **76 % improvement in student satisfaction related to the overall learning environment**, accompanied by a decline in absenteeism that the report attributes to increased comfort in school (AGION, 2019). Accessibility improvements have also promoted inclusivity, with **over 80 % of the schools meeting or exceeding accessibility standards** (AGION, 2019).

Impact of sustainable infrastructure on education

The Masterplan has delivered improvements in school infrastructure and energy efficiency. Across national reports (AGION, 2012; 2019; 2022), these features are highlighted for their potential to support learning for sustainability. However, there is little evidence that the existence of sustainable features or green spaces has translated into increased awareness of sustainability among students or teachers, as this was not systematically assessed in these national reports. Thus, it **remains unclear** whether the Masterplan's reforms have **influenced educational content or pedagogy to align with sustainability goals.**

Some of the schools highlighted in this case study have successfully integrated the sustainable features from the Masterplan into their curriculum and daily school life. This demonstrates how green infrastructure can strengthen environmental literacy when supported by intentional, localised efforts. **However, such initiatives remain isolated rather than part of a systematic, national implementation** (Edubuild Yearbook, 2023). Although the Masterplan 2.0 emphasises the importance of creating **effective learning environments**, evaluations so far do not adequately monitor how infrastructure investments translate into tangible educational outcomes. This gap highlights the need for increased support, guidelines, and resources to ensure that all schools across the Masterplan network can fully leverage existing sustainable features and green spaces to strengthen students' environmental literacy and sustainability competencies.

There is a lack of national-level data on how the infrastructures impacts students learning, teaching practices, and the development of sustainability competencies. A more intentional effort to connect sustainable features and green infrastructure with pedagogical practices would guarantee that the Masterplan's investments contribute to prepare students for the environmental and social challenges of the future.

Limitations and challenges

The challenges identified in the Masterplan School Buildings initiative stem from evaluations conducted by AGION (2012; 2019; 2022) and the Flemish Government (2016; 2023). These assessments report issues related to the complexity of public-private partnerships, funding disparities, and the balance between innovation and functionality.

- **Complexities of public-private-partnerships**: national reports (AGION, 2012; 2019) recognise that, in certain instances, private partners prioritise profitability over shared social objectives. For instance, there were challenges regarding the rigidity of contracts, which prevented schools from adapting construction plans to their emerging needs. For example, a vocational school was required to build a workshop for a discontinued course because the rigid DBFM contracts did not allow

mid-project adjustments. This led to a significant misalignment between the design and actual educational needs (AGION, 2012; 2019).

- **Pedagogical integration:** the schools' sustainability achievements are evident, with success in improving energy efficiency being well documented across national reports (AGION, 2012; 2019; 2022). However, there is a **lack of data on whether these sustainable spaces are being leveraged to support pedagogical innovation and learning for sustainability activities**. This represents a missed opportunity to understand and strengthen the educational impact of these spaces.
- **Administrative inefficiencies:** the maintenance requirements for advanced systems such as energy-efficient HVAC and solar panels have strained the capacities of some schools. Nearly 30 % of stakeholders highlighted challenges in meeting maintenance standards (AGION, 2019). Furthermore, the Axxerion maintenance tool, used for reporting and tracking issues, was criticised for its **administrative burden**. Schools found the system bureaucratic, particularly for small repairs, which led to inefficiencies and frustrations among staff. For instance, 25 % of schools reported delays in resolving claims due to unclear distinctions between construction defects and maintenance responsibilities during the provisional acceptance phase (AGION, 2019).
- **Quality vs. functionality trade-offs:** while the architectural quality of the new buildings is generally rated positively, some schools expressed dissatisfaction with trade-offs between functionality and aesthetic priorities. In some cases, the use of cost-effective materials has led to increased maintenance demands. Schools noted that while these materials reduced upfront costs, they often resulted in long-term durability challenges and costs (AGION, 2019).

Strengths of the initiative and lessons learned

Overall, the Masterplan School Building initiative exemplifies a novel approach to educational infrastructure, combining sustainability, inclusivity and innovation to meet the needs of 21st-century learners. Key strengths of the project include:

- **Commitment to inclusion:** the initiative has created accessible and inclusive spaces that adapt to the diverse needs of students. An example of this is BubaO Sint-Gregorius school in Gentbrugge, which incorporates low-stimulus environments for children with autism. Meanwhile, Koekelberg School Campus has integrated ramps, elevators and adaptable furniture to support students with mobility challenges. This illustrates the Masterplan's efforts towards building inclusive environments for all students.
- **Strengthened energy efficiency**: the programme's commitment to energy efficiency has resulted in significant cost savings and reduced carbon emissions. More than 90 % of participating schools exceed EU energy efficiency benchmarks (AGION, 2019).
- **Improved learning environments and well-being**: improvements in lighting, acoustics and air quality have made schools more conducive to learning. Stakeholder feedback indicates an 85 % improvement in teachers' job satisfaction and a 76 % increase in student satisfaction (AGION, 2019).
- **Community integration**: schools have been transformed into public hubs by incorporating multifunctional spaces such as shared sports halls and public courtyards. These spaces foster community engagement and allow their broader utilisation outside school hours.
- **Participatory design:** through the co-creation process, the initiative actively involves educators, students and local communities and allows them to shape

school designs. This approach guarantees that the infrastructure will respond to users' needs, and allows the community to develop a sense of ownership.

Across the reports and evaluations of the Masterplan, some areas for improvement emerge:

- **Maximising its educational potential:** there are many opportunities to integrate sustainability into the school curriculum, as schools are equipped with solar panels, biodiversity gardens and rainwater systems through Masterplan redesigns. However, the decision to do so is made independently at the school level, and lacks systemic support from the Masterplan. Future efforts should focus on collecting data on the educational use of sustainable infrastructure and, based on the findings, develop toolkits to guide schools on how to integrate these features into their curricula. In this way, capacity-building initiatives or training could support schools in making full use of these features.
- **Balancing innovation with practicality:** architectural innovation is a strength of the Masterplan; however, some projects have faced issues with functionality and durability, such as maintenance challenges due to the use of certain materials, or spaces that do not adapt well to evolving needs. Highly specialised designs might fail to provide the flexibility needed for long-term educational use. To address this, future projects should prioritise adaptability, ease of maintenance and the ability to accommodate diverse learning activities over time.
- **Addressing funding disparities:** schools in under-served regions often face barriers in accessing and utilising DBFM resources due to limited administrative capacity and insufficient funding flexibility. Simplifying existing funding mechanisms and offering support to these schools would prevent disparities from widening.

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Case study: Cours Oasis (Oasis courtyard)

Paris, France
Local policy initiative

Key findings

- ***Cours Oasis* (Oasis Courtyard) is a policy initiative in the city of Paris** that transforms traditional school courtyards into multifunctional, sustainable spaces. Central to *Cours Oasis* is its participatory approach, which involves students, educators and families in both the design and implementation of the courtyards. This can foster a sense of ownership and shared responsibility among the school community.
- **The transformed courtyards serve as outdoor classrooms**, enabling experiential learning and the development of sustainability competences. Through hands-on activities (e.g. gardening workshops or creative projects), students engage directly with sustainability topics.
- **The courtyards have contributed to improved well-being and inclusivity** among learners. They provide shaded, calm spaces that reduce heat stress and accommodate children with differing needs. Evaluations indicate a reduction in student conflicts, increased mixed-gender interactions, and more frequent positive engagement with nature.
- *Cours Oasis* extends the use of courtyards beyond school hours **by opening them to the neighbourhood at weekends**, thereby fostering stronger community ties and offering additional green spaces in dense urban areas.
- While the courtyards feature improved local thermal comfort and have introduced sustainable features such as rainwater harvesting, permeable surfaces and increased biodiversity**, their broader impact on mitigating urban heat islands has been modest.** Nevertheless, they contribute to urban sustainability by promoting ecological practices and raising environmental awareness among students and the community.
- **The initiative faces challenges** such as resistance from some stakeholders, reliance on key individuals for its success, as well as logistical and maintenance issues and funding concerns. Ensuring sustained financial investment, broader stakeholder buy-in and integrating sustainability into school curricula are critical for the programme's long-term success.

1. Introduction

The *Cours Oasis*[3] (Oasis Courtyard) programme in Paris was initiated in 2017 within the framework of the City of Paris Resilience Strategy[4], which provides broad orientations to strengthen the city's capacity to face current climate and social challenges. The Strategy lays down various priorities and objectives linked to climate change, territorial inequalities (social, economic, etc.) and governance. Originally designed to mitigate urban heat islands and manage rainwater effectively, the *Cours Oasis* programme has evolved to consider broader goals linked to education, well-being and community engagement. By transforming traditional school courtyards into multifunctional, sustainable spaces, *Cours Oasis* offers a great example of how urban infrastructure can address environmental challenges while also promoting inclusivity and learning.

The initiative is led by Paris City Council in collaboration with various departments and external partners such as the CAUE (Paris Council for Architecture, Urbanism and the Environment[5]). By 2024, the programme had **successfully transformed 162**

[3] Cours Oasis stands for Ouverture, Adaptation, Sensibilisation, Innovation, Solidarité (Openness, Adaptation, Awareness, Innovation, Solidarity)
[4] Stratégie de Résilience de Paris – Fluctuat Nec Mergitur (2017) : https://cdn.paris.fr/paris/2019/07/24/ebc807dec56112639d506469b3b67421.pdf
[5] The CAUE is a departmental association that promotes architectural and urban quality while ensuring respect of the environment.

courtyards across primary and secondary schools in Paris[6], with further expansion to other cities (among them Bordeaux, Toulouse and Tours[7]). The *Cours Oasis* policy initiative has inspired similar initiatives throughout France[8].

This case study explores how *Cours Oasis* works towards redefining the role of school courtyards in Paris. It also examines the programme's ability to balance multiple objectives, including environmental benefits (e.g. cooling urban areas) alongside pedagogical outcomes (e.g. outdoor learning and sustainability awareness). The study also investigates the programme's social and well-being impacts. The case study will delve into the design and implementation processes of the *Cours Oasis* through a detailed analysis, highlighting its participatory approach, which involves educators, students and other stakeholders. It will assess the initiative's achievements and challenges, and the broader implications for replicating such practices beyond Paris. By doing so, the study aims to provide insights into the role of sustainable learning environments in addressing urban and educational challenges within the European context.

2. Core principles, activities and interventions in schools

Core principles

Cours Oasis are revitalised school courtyards designed to address environmental, educational and social challenges in urban spaces. They follow a series of core principles described below:

Environmental sustainability: in practical terms, implementing a *Cours Oasis* courtyard requires the reshaping of part of the courtyard using sustainable techniques and a well-thought-out design to combat urban heat islands and improve rainwater management.

Pedagogical value: the courtyards are used for educational purposes, including hands-on learning (e.g. gardening), environmental education and creative projects.

Well-being and inclusivity: *Cours Oasis* provide shaded, calm spaces to reduce heat stress and noise pollution. They promote inclusive play by creating areas that balance gender participation and accommodate children with differing needs.

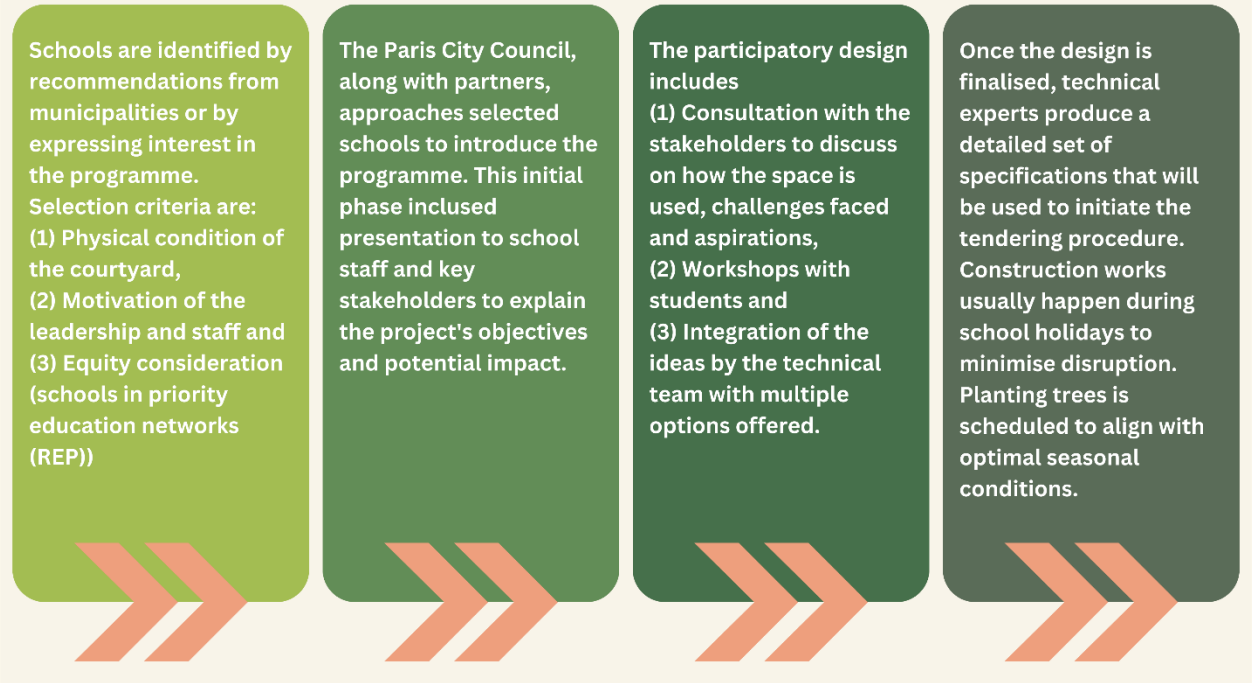
Community engagement: the courtyards are open to the neighbourhood on weekends, fostering stronger community ties and offering additional green spaces. This also offers extracurricular activities for the neighbourhood.

[6] The list of participating schools can be found on Paris City's website: https://dashboard.paris/pages/cours-oasis/?flg=fr.
[7] See the "Observatoire des cours Oasis" for a full cartography: https://www.observatoire-oasis.fr/cartographie/
[8] As showcased on the website "Observatoire des cours Oasis", https://www.observatoire-oasis.fr/projets/

Participation: *Cours Oasis* involve students, educators and families in the design and implementation. They empower school communities to take collective responsibility for sustaining and protecting these shared spaces.

Participation process

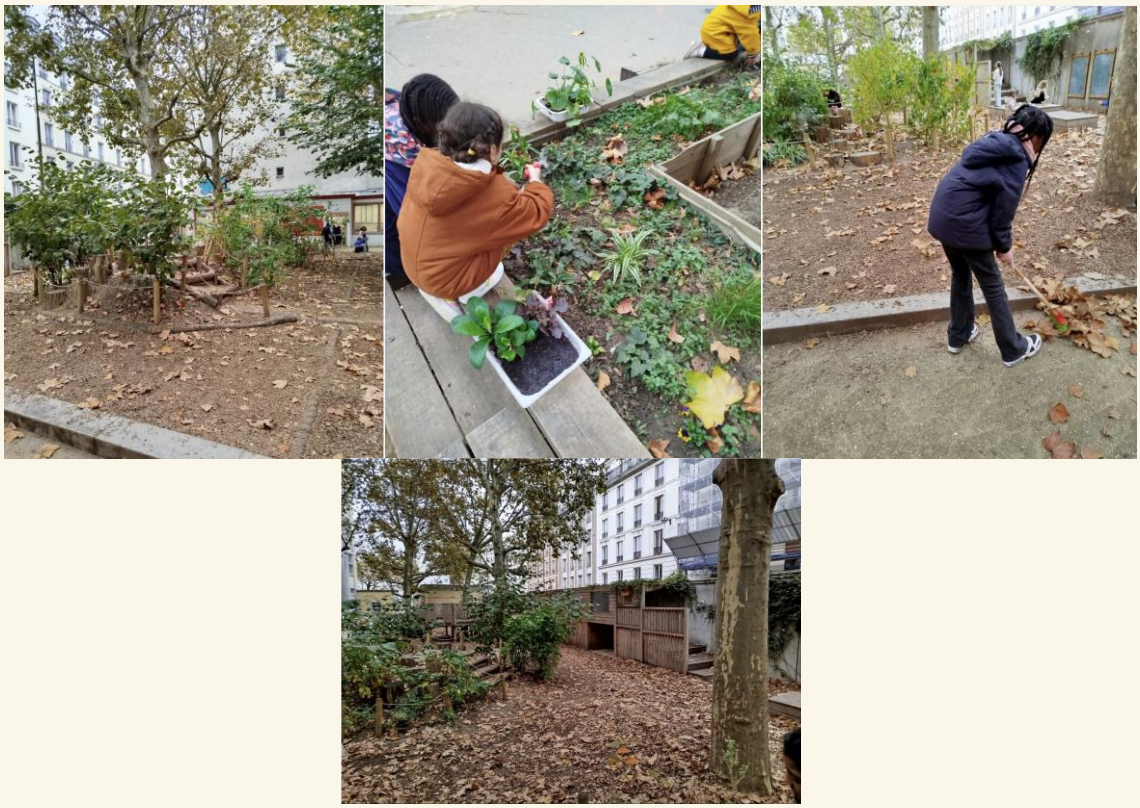
Cours Oasis are revitalised school courtyards designed to address environmental, educational and social challenges in urban spaces. They follow a series of core principles described below. Participation in the *Cours Oasis* programme follows a specific and inclusive process. The steps are:



Box 6. Example of the Keller Elementary School's Oasis courtyard[9]

The Keller Elementary School's courtyard redesign began in the summer of 2020[10], following a participatory process that engaged the entire school community. The initiative was driven by a 5th- and 6th-grade teacher with a background in architecture, who guided her students in reflecting on the design of the new courtyard. A dedicated group of nine students from various grades was also formed to contribute ideas, manage updates and communicate progress to their peers. The collective input from the students laid the foundation for subsequent design phases. Three collaborative workshops brought together the school's educational community, parents and Paris City technical services to align pedagogical goals, community feedback and technical feasibility. These workshops informed the tendering process and the specifications for the courtyard's transformation. Remarkably, the courtyard was previously an empty space – a fact that underlines the significance of the changes brought about by the Oasis programme. Today, the courtyard at Keller Elementary School is a dynamic, multifunctional space. Activities include occasional gardening sessions during school hours, regular extracurricular workshops, and

[9] For more information on the construction process and activities, please follow this link (in French): https://sites.google.com/caue75.fr/cours-oasis-keller/accueil
[10] The construction site lasted eight weeks, and participative construction activities took place throughout 2021.



Photos of the Keller Elementary School courtyard.
***Source:** © PPMI, 2024. Photographer: Alexandre Rutigliano.*

the opening of the courtyard on Saturdays to welcome students, parents and residents. Extracurricular use, in particular, has become the most active time for the space.

Specificities/activities

Co-design

Co-design is one of the cornerstones of the *Cours Oasis* programme, ensuring that **each courtyard transformation is tailored to the needs of users while fostering a sense of shared ownership and collaboration**. The process actively involves students, teachers, school administrators and parents at every stage. Each project begins with the presentation of its goals and challenges to the school community. Students are central to this process, engaging in workshops to explore sustainability, describe the current use of the courtyard (see picture below) and brainstorm ideas for the courtyard. These sessions result in a wish list in which participants articulate their aspirations for the space to be developed. A pedagogical toolkit[11] is also provided to schools, supporting educators in integrating these discussions into the school programme.

[11] Available here: https://www.caue75.fr/oasis/mallette-pedagogique

Figure 1. *Diagnostic plan of the children's use of the courtyard.*
Source: *CAUE, Livret de restitution du projet de transformation de l'école élémentaire Keller.*[12]

Student ambassadors play a pivotal role in representing their peers throughout the process. They gather input, provide feedback on proposals and act as liaisons between the design teams and the wider student body. Extracurricular sessions further extend this dialogue by involving students in hands-on activities, such as creating preliminary models or understanding the ecological and social implications of their ideas. Once input is gathered, the technical teams present multiple design options to the community, fostering debate and discussions among all users of the courtyard. The implementation phase can also incorporate participatory construction workshops[13] at which students and adults can contribute to specific tasks.

Educational integration

Cours Oasis are designed to serve as outdoor classrooms, enabling students to engage in experimental learning. In addition, gardening workshops foster hands-on learning among students as they transform school courtyards into green, sustainable places. These workshops link theoretical concepts to hands-on practice, and therefore occupy a central place in the *Cours Oasis* programme. The integration of these workshops into the programme often begins with participatory construction activities (see subsection "Community engagement and extracurricular activities" below) to build planters, install soil beds, and prepare the courtyard for planting.

Beyond gardening, educational integration extends to creative and collaborative projects. Students craft designs for floor markings, build insect houses and participate in workshops linked to sustainability. The participatory aspect of these projects ensures that the students are actively involved and not passive. Research[14] shows that this can contribute to a deeper

[12] Available at the following link: https://www.caue75.fr/media/download/11165. This booklet follows the various co-design activities organised at Keller Elementary School.
[13] More information on the participatory construction workshop available at: https://www.caue75.fr/content/les-chantiers-participatifs-des-cours-oasis and in the following video (in French): https://www.youtube.com/watch?v=eFAiRTqoZY0&list=PLH7IUBZHcOUaWqJmKZQTD5S-BibhfdK1O&index=14
[14] See, for example, Guardino, C., Hall, K.W., Largo-Wight, E. et al. (2019). Teacher and student perceptions of an outdoor classroom. *Journal of Outdoor and Environmental Education*, 22, 113-126. https://doi.org/10.1007/s42322-019-00033-7; or Takkouch, M. (2022). Informal Environmental Education:

understanding of knowledge on areas such as biodiversity and sustainability, while also developing soft skills such as collaboration and critical thinking.

Box 7. Case study: Gardening workshop at the Keller Elementary School's Oasis courtyard

At Keller Elementary, gardening workshops in the "small Oasis courtyard" provide students with practical experience in sustainability and environmental care. These sessions, led by facilitators and experts, focus on collaborative activities such as filling planters and learning essential plant care techniques. The workshops are tailored to different age groups, with 1st- to 3rd-graders participating on Thursdays, and older students engaging on Fridays. Each session lasts approximately one hour. Through these activities, students not only develop technical gardening skills but also deepen their understanding of plant diversity and ecosystems.

Left: 4 young learners play in a Cours Oasis playground. Right: a young learner digs earth in a Cours Oasis playground.
Source: *CAUE, "Cours Oasis Emeriau", https://sites.google.com/caue75.fr/cours-oasis-emeriau/accueil (left) and "Cours Oasis Jean Dolent", https://sites.google.com/caue75.fr/coursoasisjeandolent/accueil (right).*

The integration of Oasis courtyards into school activities is supported by training programmes organised by CAUE Paris[15]. These training sessions target a wide range of stakeholders including school educators, municipal staff and construction professionals, ensuring a shared understanding of the courtyards' goals and methodologies. In collaboration with facilitators, children participate in the design process, selecting colours and geometric shapes to decorate the different areas such as the sport zones and play spaces. The courtyards are designed to stimulate the imagination, physical activity and collaboration through features such as amphitheatres, climbing structures and cabins. The courtyards are equipped with materials that encourage exploration and manipulation, such as wood chips, sand, gravel and water play areas. Features such as climbing logs, bars for acrobatics and sensory trails enhance motor skills and agility, while elements such as blackboards, mirrors and cabins provide a canvas for imaginative play. Outdoor classrooms, library corners and wooden platforms cater to relaxation and quieter activities, ensuring a balance of physical and mental engagement.

School Gardens' Affordances for Fostering Secondary Students' STEM and 21st Century Skills. *Proceedings of the 2022 AERA Annual Meeting*.
[15] CAUE, Les formations Oasis (2024). Caue75.Fr. https://www.caue75.fr/content/les-formations

Box 8. Case study: The Oasis Library at Keller Elementary School

The Oasis library was originally planned to create a seamless connection between indoor and outdoor sustainable environments. Inspired by the courtyard's transformation, the school librarian envisioned the library as a natural extension, initially planning to fill the space with green plants. However, due to restrictions on indoor plants that could be hazardous to children, she opted to craft artificial nature-like decorations with students, turning the library into a vibrant space for creativity and learning. The library houses a wide range of books on sustainability topics, such as climate change, gardening techniques, biodiversity, and environmental preservation. Activities in the Oasis library include "experiments" like seed planting workshops, reading sessions on sustainability themes during school hours, and extracurricular crafting activities to decorate the space. Students highly value the space and the activities, which have a notable impact on their attitudes and behaviours. They gain knowledge about nature, recycling, and environmental responsibility, and many take pride in protecting plants and teaching others to do the same. As the school librarian observes, "We now feel that every student feels more responsible for their environment."

Photos of the Oasis library.
Source: *© PPMI, 2024. Photographer: Alexandre Rutigliano.*

Sustainable features

Sustainability has been a core focus since the beginning of the *Cours Oasis* initiative, with the objective of creating cooling islands ("*îlots de fraîcheur*") to combat urban heat and improve comfort during hot weather. This was achieved by creating shaded areas through tree planting, the installation of pergolas, and green roofs and walls. These features are intended to not only reduce heat retention in courtyards but also to introduce natural spaces that encourage biodiversity and provide students with calming, shaded environments. Water management is another foundational element. Rainwater harvesting systems are designed to collect and recycle water for irrigating plants. Permeable surfaces are introduced to improve water infiltration, reduce runoff and support natural water cycles. For example, sloped surfaces direct rainwater toward green zones, demonstrating practical and visible examples of sustainable water management to students.

To further enhance ecological balance, the initiative prioritises the use of bio-sourced, natural and reused materials. Existing asphalt in good condition was preserved where possible (e.g. for sports areas), allowing budgets to be directed toward adding permeable

surfaces and vegetation. The addition of pedagogical gardens, orchards and plant-covered structures expanded green areas, fostering student interaction with nature while contributing to urban cooling and climate resilience.

Community engagement and extracurricular activities

Extracurricular activities[16] are a vital component of the *Cours Oasis*, transforming school courtyards into dynamic spaces for learning, creativity and community engagement. These activities are designed to foster environmental awareness, inclusivity and a sense of shared ownership among students, educators and local communities. Courtyards often double as community gardens, where parents and local residents can join in participatory workshops or recreational activities on Saturdays[17]. These prove especially useful during heat waves. This openness enables a broader use of the space for activities such as participatory workshops, recreational play and even social gatherings. Such initiatives strengthen the connection between schools and their surrounding communities – an often-challenging task in urban areas[18]. Partnerships with local organisations further enhance the ability to offer extracurricular activities. These partnerships not only diversify learning opportunities, but also deepen community ties and engagement.

Box 9. Community Activities at Keller Elementary

At Keller Elementary, the Oasis courtyard doubles as a community garden, open every Saturday to the entire neighbourhood. This accessibility allows residents to enjoy the space in order to cool off, observe plants, or for recreational play. Families frequently use the courtyard to host children's birthdays or casual picnics, making it a hub for social interaction. In a dense urban area such as the 11th arrondissement, which lacks green spaces, the courtyard provides a much-needed place for relaxation and connection with nature. The school has also partnered with organisations to enhance its extracurricular offerings. For instance, the Paris European House of Photography collaborates with Keller to conduct workshops on "land art", combining artistic creativity with environmental themes. Gardening workshops, led by associations, teach practical skills such as planting and the use of edible plants, offering both educational and recreational benefits.

Programme and school funding

The *Cours Oasis* programme benefits from a diverse funding scheme that combines European, national and local resources to support its transformative goals. A major component of the funding comes from the European Regional Development Fund (ERDF) through the Urban Innovative Action (UIA) programme[19], which provided up to 80 % of

[16] In France, extracurricular activities are divided into two categories: *périscolaires* and *extrascolaires*. *Périscolaires* refer to out-of-school times during the week, such as Wednesday afternoons, lunchtimes, the hours immediately after school and, in the case of the City of Paris, after 3 p.m. on Thursdays and Fridays. These periods are considered a continuity of school time and follow specific policy orientations. Conversely, *extrascolaires* refer to broader out-of-school times, including Saturdays, with objectives that are less tied to school continuity. In this study, all workshops and activities mentioned, including those organised by the Maison Européenne de la Photographie, fall under *périscolaires* times. Activities conducted on Saturdays typically involve different actors and are categorised as *extrascolaires*.

[17] More information on the extracurricular activities is available at: https://sites.google.com/caue75.fr/cours-oasis-keller/accueil

[18] This aligns closely with Paris's vision of the "*Ville du Quart d'Heure*" (15-Minute City) in which essential services and spaces are accessible within a short walk or bike ride. By transforming school courtyards into multifunctional areas that serve as both educational hubs and community spaces, the programme reflects the broader goals of proximity and inclusivity. For more information, visit: https://www.paris.fr/dossiers/paris-ville-du-quart-d-heure-ou-le-pari-de-la-proximite-37

[19] The ERDF played a structural role in shaping the initiative, particularly in its early stages. Beyond funding, the ERDF-supported programme facilitated significant strategic developments. For instance, a study trip to Belgium

programme costs between 2019 and 2021, capped at EUR 5 million[20]. This funding enabled the transformation of 10 pilot courtyards in Paris and supported the creation of the Oasis courtyard observatory, managed by CAUE, to monitor progress and share best practices. The remaining 20 % of programme costs were covered by contributions from partners[21].

Over time, the programme's funding has transitioned from European to more locally driven sources, reflecting the evolution of the initiative. Initially, ERDF funding played a central role in shaping the programme's infrastructure and methodology. However, as these funds ceased, the responsibility shifted to local budgets, including investments of local interest (IIL), localised investments (IL), and participatory budgets[22].

Additional financial support comes from external grants, such as contributions from water agencies and the Green Funds (*Fonds Verts*[23]) of the French government, which support ecological transformations. The programme's success is amplified by partnerships with organisations such as Météo-France (providing environmental data), Sciences Po LIEPP (conducting policy evaluations), and Paris Diderot's LIED (researching energy and sustainability).

3. Evaluation of impacts

Impact on the environment

The environmental impact of the *Cours Oasis* programme overall is multifaceted, with notable achievements and limitations. The initiative aligns strongly with Paris's 2017 Resilience Strategy, aiming to create *îlots de fraîcheur* (cooling islands) to address urban heat islands that are exacerbated by asphalted surfaces covering 73 hectares of schoolyards. By introducing vegetation, shaded areas and permeable surfaces, the courtyards improve daytime thermal comfort for their users, who include students, educators and families. Features such as shade from trees and structures, along with the use of evaporative cooling from plants, contribute to reducing thermal stress during heatwaves. Yet, evidence on the programme's ability to mitigate the broader urban heat island effect is less conclusive[24]. Evaluations conducted by the LIED laboratory and Météo-France show modest reductions in air temperature, such as a 0.3°C decrease at the Maryse Hilsz schoolyard[25]. While these temperature drops are relatively minor, the courtyards remain valuable for their ability to provide immediate relief to users during the day.

was organised in late 2019, allowing project stakeholders to observe best practices in similar initiatives. This experience highlighted an additional objective for the courtyards: to serve as attractive and inclusive spaces that prioritise children's well-being while promoting non-gendered, multifunctional uses. Inspired by these insights, the programme pivoted in 2020 to focus more on creating zones of full soil, whether planted or unplanted, and incorporating features such as wood chips, play areas, rest zones and physical activity spaces. Biodiversity-rich areas and natural materials, particularly wood, became central to the courtyards' design, fostering connections between children and nature.

[20] CAUE,« Le FEDER Urban Innovative Actions cours d'école Oasis. Un projet soutenu par l'Union européenne » https://www.caue75.fr/content/le-feder-urban-innovative-actions-cours-d-ecoles-oasis

[21] The project brings together a consortium of six partners: the City of Paris, Météo France, the Ligue de l'Enseignement – Fédération de Paris, the LIED (Laboratoire Interdisciplinaire des Energies de Demain) Paris Diderot, the LIEPP (Laboratoire Interdisciplinaire d'Evaluation des Politiques Publiques) Sciences Po, and the CAUE de Paris.

[22] Inspection Générale (2023). Mission d'étude sur les cours « OASIS »: Rapport N°22-08. City of Paris, https://cdn.paris.fr/paris/2024/04/08/roc-22-08-etude-cours-oasis-avril-2023-efET.pdf, p. 35-37.

[23] See https://www.ecologie.gouv.fr/fonds-vert

[24] A climatic analysis was carried out to assess the reduction in the urban heat island effect and summer comfort, by analysing and comparing measurements before and after the works. Two weather stations have been installed to measure summer temperatures. The methodology was based on analysing the difference between two stations, one undergoing an environmental change (located in the courtyard) and the other not (located in the nearby public space).

[25] Inspection Générale (2023). Mission d'étude sur les cours « OASIS »: Rapport N°22-08. City of Paris, pp. 63-66.

In addition, the programme incorporates innovative materials such as wood chips, light-coloured asphalt, and cork-based solutions to improve comfort and reduce heat absorption. However, these materials have occasionally presented challenges. For instance, reflective surfaces such as pale-coloured asphalt can increase radiant heat exposure, counteracting some of the cooling benefits. Despite these issues, the courtyards prioritise sustainable ground surfaces, replacing traditional asphalt with permeable options to support rainwater infiltration, reduce runoff and enhance water management. Schools such as Jeanne d'Arc and Maryse Hilsz have achieved notable results, with nearly 38 % of their courtyards being converted to natural or permeable surfaces[26].

Impact on the inclusion and well-being of learners

Evaluations conducted between 2019 and 2021 by the LIEPP and LIED laboratories[27] reveal clear improvements as a result of these settings, including a reduction in conflicts, an increase in mixed-gender interactions, and more frequent positive interactions with nature. Spaces previously dominated by a single type of competitive activities, such as football, have been replaced with facilities such as wooden cabins, slides and cooperative play zones, fostering collaborative and inclusive play. Shaded and sheltered areas, essential during both rain and heat, are highly valued across all age groups, offering comfort and promoting well-being. Even so, according to these studies, the impact on middle schools has been less pronounced. In these settings, the redesign has not significantly altered the composition of student groups or their interactions with natural elements.

Our own fieldwork corroborates these results, highlighting notable changes in student behaviour and inclusion as reported by facilitators at the school. At Keller Elementary School, staff and facilitators observed a marked reduction in gender segregation in play, with boys and girls now engaging in mixed activities,[28] as well as less tension among students in general, as noted by the chief facilitator at Keller elementary school: "When they play in green space, there is no tension". Green spaces are especially beloved by students, who often prioritise "observing the living world", while wooden structures are less favoured. According to facilitators, students use natural elements creatively, building small structures and inventing games, which fosters collaboration and imaginative play.

Impact on learning outcomes and sustainability competences

The *Cours Oasis* programme has demonstrated the potential to enhance students' learning outcomes and sustainability competences, although the results vary between educational levels and institutions. According to a study on the evaluation of climate change awareness conducted by LIEPP[29] between 2019 and 2021, many students initially lacked a clear understanding of climate change and its implications. Similarly, many were unaware of the dangers of climate change or how their actions could mitigate its effects, with only 64 % believing in their ability to contribute positively[30]. However, the introduction of pedagogical tools and the workshops incorporated into the Oasis programme provided opportunities to clarify these misconceptions. Teachers, particularly in elementary schools and middle schools, used these tools to guide students in understanding key concepts such as temperature dynamics, climate change and sustainability. For younger students, activities revolved around engaging themes such as weather patterns and practical experiments.

[26] *Ibid,* p. 25.
[27] Reports available at: https://www.sciencespo.fr/liepp/fr/recherche/projet/cours-decoles-oasis/
[28] One of the elements most frequently reported during our field visit.
[29] Available at: https://www.sciencespo.fr/liepp/fr/recherche/projet/cours-decoles-oasis/
[30] Laboratoire Interdisciplinaire d'Évaluation Des Politiques Publiques, Evaluation de la sensibilisation au changement climatique, https://www.sciencespo.fr/liepp/sites/sciencespo.fr.liepp/files/OASIS_WP7_07.3.1_Sensibilisation%20au%20changement%20climatique_0.pdf, p. 4.

Fieldwork at the Keller Elementary School further supports these findings. Students demonstrated an increased interest in and awareness of nature through hands-on activities in the courtyards. For example, younger children enthusiastically showcased their contributions, such as planting seeds or building insect habitats. One student proudly pointed out where they had planted a seed for an orange tree, while others highlighted structures they had created to protect insects. These activities helped students to connect with nature in a tangible way, fostering both cognitive and emotional engagement. One child was reported as saying: "Before, I thought that plants were just here, but now I understand that nature is precious".

The courtyards also instilled a sense of responsibility and care towards shared spaces. Older students often took the lead in teaching younger peers how to protect plants and maintain the courtyards, developing a deeper understanding of the importance of biodiversity and, as one student noted, they learn "to be careful with common goods". Educators and facilitators noted behavioural changes, with students becoming more respectful of nature and demonstrating improved focus and teamwork during activities.

In addition, the courtyards inspired students to apply their learning at home, with some sharing stories of a newfound interest in plants and sustainable practices. One student recounted how they had convinced their parents to incorporate greenery into their home, transforming their living space into a "jungle". Another expressed increased attention to recycling and dietary choices.

Limitations and challenges

Despite its innovative approach and positive outcomes, the *Cours Oasis* programme faces several limitations, both practical and social.

- **Resistance from stakeholders:** one significant initial challenge was the resistance from teachers and parents. Many parents expressed concerns about the safety of new features, questioning the risks of children falling from wooden structures or consuming inedible plants[31]. Teachers were also hesitant, citing scepticism about the pedagogical value of the courtyards and opposing the idea of opening them to the public on weekends. This reluctance persisted in some schools, with teachers reporting a lack of time, insufficient training on how to use the courtyards for educational activities and competing priorities with other pedagogical projects.
- **Reliance on key individuals:** in addition, the success of courtyards often relies on the dedication of key individuals such as school directors, teachers or facilitators. For example, the Oasis Library at Keller relies entirely on the passion and initiative of a single librarian. If such an individual were to leave or be replaced by less enthusiastic staff, the continued use and integration of the relevant resources into school activities might be put at risk. This risk is further heightened by the fact that for many schools, sustainability is not part of the official curriculum, leading to a mismatch between the courtyards' potential and the school's priorities. While some teachers and facilitators have effectively integrated the courtyards into educational activities, others view them as secondary to their primary teaching responsibilities.
- **Logistical challenges:** the courtyards require specific and ongoing maintenance, which poses logistical and budgetary issues. For example, wood chips used as

[31] Regarding this aspect, the Belgian study trip underlined the importance of integrating risk into children's educational experiences. They delegation observed how Belgian schools embraced the concept of "as safe as necessary", encouraging children to engage with their environment while learning to navigate measured risks. This approach challenged the Parisian delegation to reconsider traditional attitudes towards risk, particularly in addressing parental and teacher concerns about safety in redesigned courtyards.

ground cover need annual replenishment due to compaction and dispersal. Similarly, permeable surfaces such as porous concrete demand regular high-pressure cleaning to maintain their functionality. Wooden features such as climbing structures and benches require regular upkeep to prevent deterioration. Maintenance tasks such as unclogging drains and addressing water pooling add to the workload of school staff, who are often unprepared or untrained for these responsibilities[32]. An additional challenge arises during summer holidays, when schools are closed. In Paris, the high temperatures during this period often lead to plant die-off and extremely dry areas in the courtyards. While the city may provide some maintenance during the holidays, it is often insufficient, resulting in degraded conditions when children return to school.

- **Administrative inefficiencies and funding concerns:** the study mission from the Inspection générale[33] highlighted administrative inefficiencies, including slow procurement processes for materials and plants, which have hindered the smooth operation of the programme. Moreover, the relatively high cost of courtyard renovations compared with traditional garden projects raises concerns about the sustainability of these projects, specifically as funding becomes more local.

Strengths of the initiative, and lessons learned

The *Cours Oasis* programme showcases a holistic approach to integrating sustainability, inclusivity and community engagement into the school environment.

- **Addressing urban challenges:** the programme has initially been committed to several sustainability-focused objectives, such as addressing urban heat islands, promoting biodiversity and improving rainwater management. By transforming traditional schoolyards into *îlots de fraîcheur* (cooling islands), it tackles pressing environmental challenges while creating multifunctional spaces.
- **Co-design aspect:** the programme emphasises a process of co-design, engaging students, teachers, parents and community members in shaping the courtyards. This participatory model fosters a sense of ownership and shared responsibility among all stakeholders, while also helping to develop a sense of belonging to the school. Children often express pride at their role in creating and maintaining these spaces, which enhances their connection to the school community. The involvement of student ambassadors ensures that children's voices are central, thereby encouraging active participation and strengthening collaboration skills.
- **Living classrooms:** Oasis courtyards serve as living classrooms, supporting hands-on learning through gardening workshops, biodiversity projects and creative activities. For example, the Oasis Library at Keller Elementary School seamlessly integrates sustainability themes into literacy and crafting activities.
- **Promoting well-being and inclusivity:** the courtyards contribute to reducing student conflicts and increasing gender inclusivity by diversifying play areas and activities. Mixed-gender and cooperative play have become more frequent in elementary schools, fostering a more inclusive environment. By providing shaded and natural areas, the courtyards improve thermal comfort, offering essential spaces to cool off during heatwaves for both school communities and local residents. The courtyards are open at weekends, transforming into community hubs where families and residents gather for recreational and social activities. This feature might contribute to strengthening community ties, especially in urban areas with limited green spaces.

[32] Inspection Générale (2023). Mission d'étude sur les cours « OASIS »: Rapport N°22-08. City of Paris, https://cdn.paris.fr/paris/2024/04/08/roc-22-08-etude-cours-oasis-avril-2023-efET.pdf, p. 56.
[33] *Ibid.*

- **Knowledge-sharing:** the creation of the Oasis Observatory and the publication of resources (e.g. pedagogical toolkits, recommendations booklets) support the dissemination of best practices and facilitate replication in other cities, such as Bordeaux and Toulouse.
- **Collaborative governance:** the success of the programme is closely tied to collaboration between municipal departments, such as urban planning, environmental services and education. Technical and financial support from the City of Paris has been instrumental in providing diagnostics, design expertise and construction resources. However, decentralising decision-making to arrondissement municipalities could create challenges in maintaining coherence and consistency between implementations.
- **Monitoring:** rigorous monitoring through partnerships with research institutions such as Sciences Po Paris has provided insights into the programme's impacts on microclimates and social behaviour. Expanding this evidence base helps to refine and adapt the programme to new contexts, ensuring its ongoing relevance and effectiveness.

Key lessons and recommendations

Alongside the strengths of the programme, several lessons and recommendations have emerged:

- **Stakeholder engagement:** securing buy-in from stakeholders, including educators, parents and administrators, is essential. The early stages of the programme faced resistance due to safety concerns and scepticism regarding the pedagogical value of courtyards. Ensuring proper awareness and targeted support through workshops and resources can mitigate these challenges. More structured professional development could enhance the impact and sustainability of these efforts. Such training should ideally be integrated into teachers' working hours, rather than conducted during their free time.
- **Integrating sustainability in the curricula**: a key area for growth in the programme is the integration of sustainability as a more central element in school curricula. Integrating sustainability education into school policies and school values, as well as fostering a shared understanding of its importance, could amplify the courtyards' long-term impact.
- **Sustainable funding:** the future of the programme depends heavily on sustained financial investment. Maintenance costs, including the replenishment of materials, the upkeep of vegetation and the cleaning of permeable surfaces, are significant and often unanticipated in school budgets. Moreover, opening courtyards to the wider community at weekends has demonstrated social benefits but also introduces additional wear and tear on infrastructure. Strengthened partnerships with local stakeholders, such as neighbourhood associations or environmental NGOs, could support both the maintenance and the provision of community-focused activities.
- **Capacity to adapt:** the ability of *Cours Oasis* to adapt to evolving goals has been a key factor of their success. Initially focused on environmental objectives, such as mitigating urban heat islands and improving rainwater management (which has been shown not to achieve the expected results), the programme expanded under the ERDF funding framework to incorporate broader dimensions such as education, well-being and community engagement. Flexibility allows the programme to respond to diverse needs and priorities, ensuring its relevance in different schools.

- **Leveraging broader policy alignment:** the programme benefits from alignment with broader initiatives such as *Paris Ville du quart d'heure* (the "15-minute city" concept), which supports decentralised access to green spaces and services. This integration enhances the sustainability of the courtyards and their role in achieving wider urban resilience goals.

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Case study: Escoles + Sostenibles (More sustainable schools)

Barcelona, Spain
Policy initiative

Key findings

Escoles + Sostenibles (More Sustainable Schools) is a policy initiative in Barcelona, Spain, operating at the sub-national level to guide and support schools in addressing the challenges of becoming more sustainable. After 24 years, it has grown into a network of more than 400 schools across different education levels and modalities. The initiative is **widely recognised as a trusted resource, providing essential support to schools seeking to transform and innovate their spaces and pedagogies for sustainability.**

- Guided by the **whole school approach, and the principles of inclusion and sustainability**, the programme supports member schools with regular training and ongoing guidance on projects to transform learning spaces and practices, among other activities. ***Escoles + Sostenibles* serves as a central hub for all school-based sustainability actions** and is considered a key resource in the city's sustainability landscape.
- **Evidence of impact** on *Escoles + Sostenibles* was collected, primarily through visits to two schools actively participating in the programme. While it is difficult to attribute impacts solely to the programme, the interviews conducted during the field visits to schools indicated that the support provided had played a crucial role in improving students' well-being and health (e.g. improvement of the school environment, increased diversity of playing opportunities), learning outcomes (e.g. in mathematics and natural science), competences in sustainability (e.g. autonomy, self-regulation and adaptation), on the environment (e.g. playground renovations resulted in biodiversity hotspots and increased plant diversity), and on the community (e.g. closeness to neighbours and family involvement).
- **Limitations and challenges** to the programme mainly stem from economic constraints and occasionally insufficient funding for larger infrastructure innovations. There are also cultural barriers within the community, as well as political tensions regarding the use of public spaces. At school level, challenges were highlighted due to teacher turnover and retirements.

The strengths of the programme that were highlighted are twofold: on the one hand, its **active support and promotion of substantial transformations that go beyond infrastructure improvements;** on the other hand, the **programme's flexibility allows it to work with schools at varying levels of engagement**, ensuring no school is left behind.

1. Introduction

The policy initiative *Escoles + Sostenibles* (More Sustainable Schools), operating in Barcelona, Spain, has been identified as a **relevant policy initiative at the sub-national level**, designed to guide and support schools in addressing the challenges of becoming more sustainable. The programme's sustained and continuous growth over the years makes it an interesting case study for examining the result of its work on schools and their communities.

This case study explores **how and why this programme has become a strong support element for schools**. In addition, it identifies the challenges and opportunities that have been encountered in the implementation of projects for the greening of schools and learning environments for LfS.

Context and political framework

Escoles + Sostenibles operates within the Climate Change and Sustainability Office of the Department of Urban Planning, Ecological Transition, Urban Services and Housing

(*Ajuntament de Barcelona* – Barcelona City Council). The team, made up of six permanent members, guides and supports several educational centres.

Guided by the whole-school approach and the principles of inclusion and sustainability (explained in section 2.1), the programme supports member schools with regular training and ongoing guidance on projects to transform learning spaces and practices, among other activities. Today, ***Escoles + Sostenibles* serves as a central hub for all school-based sustainability actions**, and is considered a key resource in the city's sustainability landscape.

All of the schools involved in *Escoles + Sostenibles* are members of a wider network called the *Xarxa Barcelona + Sostenible* (the More Sustainable Barcelona Network), a group of organisations and individuals committed to sustainability that have decided to work together to build a socially and environmentally responsible city. This network works with citizens' organisations, business and trade associations, schools, universities, professional associations and public administrations to transform practices and spaces to meet the challenges of sustainability and the climate emergency in the city of Barcelona.

The Citizen Agreement for a More Sustainable Barcelona 2024-2034 serves as a common working framework for the More Sustainable Barcelona Network and reflects its collective commitment. It embodies the city's ambition to address climate, social and environmental challenges in a collaborative way. The network currently includes around 2,000 organisations, of which 400 are schools across different education levels and modalities[34].

The 2024-2034 agreement is the programme's third formal commitment. The two previous commitments, each lasting 10 years, were implemented from 2002-2012 and from 2012-2022, with the latter extended to 2024. Each commitment has been developed through a participatory and highly consultative process. According to the interviews carried out for the present case study, this last commitment differs from the previous ones as the landscape of municipal, national and regional plans has evolved. Previously, commitments were proposed without the existence of regional and national frameworks such as the European Climate Plan, the National Climate Strategy or the European Green Deal. The landscape of the last 10-15 years now recognises broader agreements and more common challenges within the region. This initiative has been able to persist through different administrations and regardless of political changes[35].

By signing, participants agree to abide by jointly developed strategic actions to move the city towards sustainability. For educational institutions, signing requires the support of the school leadership, not individual teachers or parents. **The commitment process ensures that school leaders fully understand and support the responsibilities involved in committing to this collective mission.**

2. Core principles, activities and interventions in schools

Core principles: the whole-school approach and inclusion

The whole-school approach is a fundamental element of this sustainability programme. Becoming a part of *Escoles + Sostenible* entails the active participation of the educational community. The programme's conceptualisation around the *Doughnut Economic*

[34] The programme encompasses schools from early childhood education, primary and secondary education, vocational education, adult education and special education, covering all levels except university, whether public, semi-private or private.
[35] Barcelona City Council (2024) Citizen Commitment for a More Sustainable Barcelona 2024-2034, p. 9.

Framework by Raworth (2012) emphasises the need to rethink the relationship between humans and the environment, integrating the existence of limits, and acknowledging that human development is not the same as economic growth (Barcelona Escoles Sostenibles, 2020)[36]. The principles of the doughnut economy are shared below (see Figure 2).

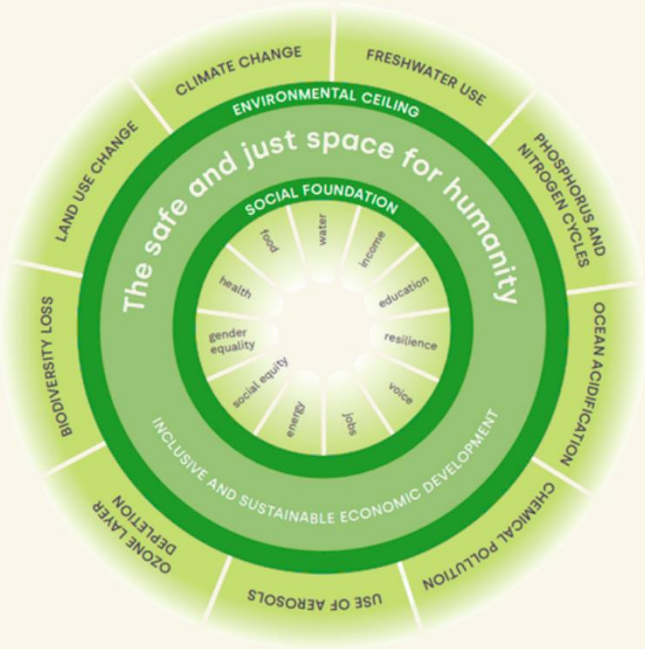


Figure 2. *The "doughnut" economy.*
Source: *Kate Raworth (2012) in Barcelona Escoles + Sostenibles (2020, 13).*

The school, under the guidance of *Escoles* + *Barcelona*, leads the transformation process, bringing together principals, students, teachers, staff and families. All members of the school community are actively involved in the process and gain a clear understanding of the expected transformation and the role each actor plays in it. The transformation process is common to all schools and comprises three key stages: 1) diagnosing the school's needs, 2) establishing an action plan following the identification of the extent of the problems and their causes, and 3) selecting feasible solutions and prioritising actions within the action plan. The solutions may require a range of changes: **infrastructure changes** such as construction, repairs, the replacement of equipment and the transformations of spaces within the school or its surrounding environment; **organisational changes** related to management of the resources and the environment, including energy consumption and the use of materials, as well as governance adjustments such as the distribution of spaces and the creation of debate spaces. In addition, **behavioural changes** are encouraged at both the individual and group levels, thereby developing competencies in social, interpersonal and personal dimensions (Barcelona Escoles Sostenibles, 2020).

The inclusion aspects of the programme are evident in the programme's collaboration with the Education Consortium in identifying schools that more urgently require infrastructure support. In addition to working with actively committed schools, the programme aims to

[36] The "doughnut" economy, proposed by British economist Kate Raworth (2012), sets out the ecological limits and requirements of human development. In 2009, the Stockholm Resilience Centre identified a number of "planetary boundaries" that would place the stability of the planet at risk should they be surpassed. Three years later, Raworth suggested including "social boundaries" into the structure of the planetary boundaries, thus generating an environmentally safe space, compatible with universal rights and the eradication of poverty (Barcelona Escoles Sostenibles, 2020)

reach those schools that are usually unable to participate due to funding or resource constraints, or a lack of access to information.

Escoles + Sostenibles has ensured access to information about sustainable education programmes and benefits over the past eight years by creating a list of over 200 free educational projects in Barcelona.

Process of participation and main actions

Schools' participation in *Escoles + Sostenibles* is voluntary. Institutions that wish to join the programme are asked to develop a strategic educational project for sustainability that involves **planning the transformation** of one or more aspects of the school. These projects should ideally be integrated into both the school curriculum and the school's educational vision, either as one- or three-year initiatives. Although all schools that sign up are accepted into the network, the programme's technical office evaluates each project. This evaluation determines the project's eligibility for funding (explained further in the section on programme and school funding).

The programme comprises a series of actions implemented on an annual basis throughout the academic year, in accordance with the annual plan. Key actions include:

- **Teacher training plans**, which have been officially recognised, are designed to facilitate professional development in the field of sustainability.
- **Organisation of student exchange events and micro-networks**, including forums, activities and annual sustainability events such as World Environment Day and the *Escoles + Sostenibles* Networking Event.
- **Provision of resources**, including the distribution of mobile school green points, compost, mulch and plants distribution to all active schools in the programme.
- **School visits** are carried out, during which technical assistance is provided. Meetings are also held with school staff, and observations are carried out to assess student engagement.
- **Dissemination of information regarding training programmes**, including key dates and environmental topics to propose new studies.
- **Provision of specialist advice on sustainable issues.** For example, if a school wants to establish a garden but lacks the necessary expertise, the *Escoles + Sostenibles* team invites specialists to guide the school throughout the process.
- **Cross-departmental collaboration**. The technical team acts as an intermediary between the City Council's sustainability plans and the schools. Furthermore, the technical team engages in collaborative efforts with other City Council departments on a range of environmental matters (e.g. collaboration with the food policies team on the development of healthy, sustainable and equitable food initiatives). This collaboration provides the expertise to develop educational materials, such as guidelines and educational kits, which can be requested by schools.

Box 10. Example of a playground transformation in Barcelona through the Escolas + Sostenibles programme

Escolas + Sostenibles is actively engaged in one of the most significant school infrastructure reforms in Barcelona – the "*Transformem els Patis/Patis Escolars*" ("Transforming Playgrounds") initiative. This initiative is part of a broader programme, "*Refugis Climatics*" ("Climate shelters in schools"). *Refugis Climatics* began as a pilot in 2018, funded by the European Commission's Urban Innovative Actions, and was implemented in 11 primary schools. Following the initiative's initial success, the Education Consortium (responsible for primary and secondary school infrastructure development) decided to expand it **to encompass 170 playground renovations in schools.**

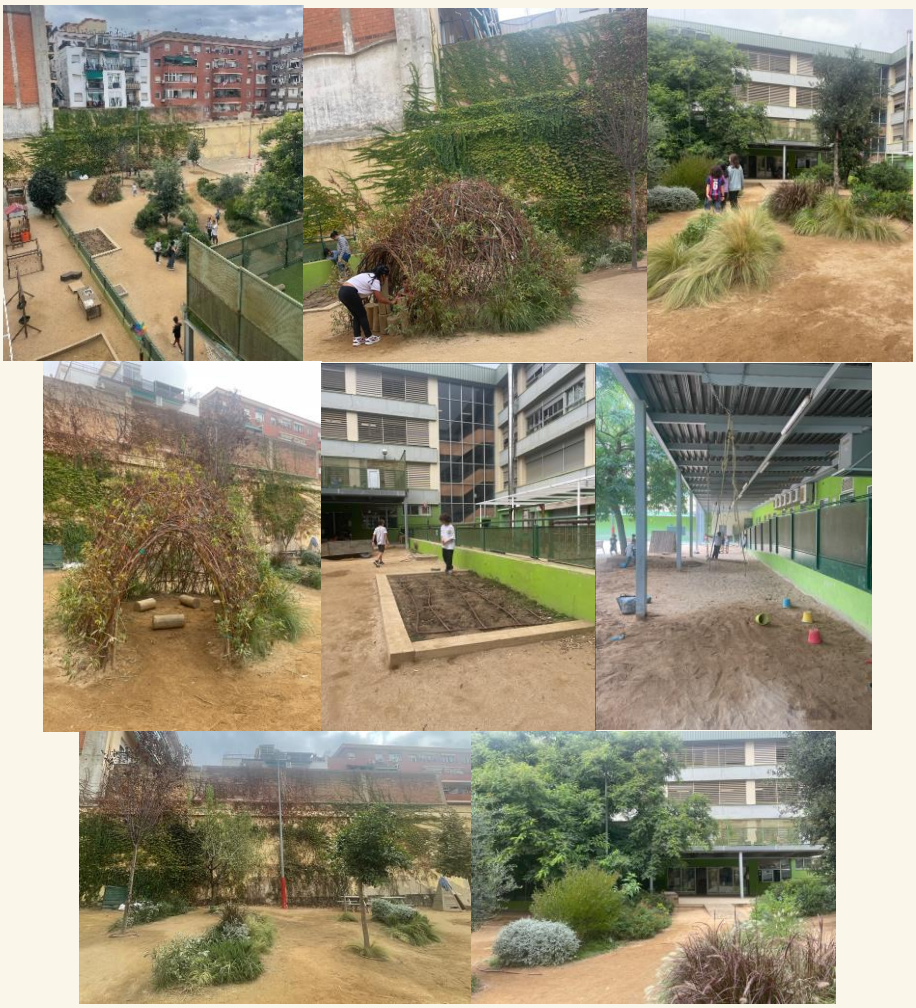
The implementation of this programme is organised into four physical transformations: 1) the introduction of elements for diverse play; 2) the planting of trees and greenery; 3) the generation of shade; and 4) the expansion of permeable and soft ground space as a garden in coexistence with sporting uses.

Escolas + Sostenibles was engaged from the inception phase of the initiative. During the pilot phase, the role of the team was to facilitate communication between the various stakeholders involved in the programme, including school principals, the wider school community and programme officers (such as architects). Following the success of the pilot programme, the Education Consortium extended the project and funding for renovations, and *Escolas + Sostenibles* became an active participant in the implementation of the initiative.

After the playground renovation has been completed, *Escoles + Sostenibles* assists educational establishments, encouraging them to pursue an integral transformation of their facilities, extending beyond the playground. **Training programmes for schools on sustainability have been incorporated into the initiative as mandatory components**. *Escoles + Sostenibles* collaborates with other departments (e.g. on gender) and offers training for teachers and parents in schools: "You can have the best playground in the world, but if you don't change how you use that space, nothing has changed. This is where we come in." (*Escoles + Sostenibles* technical team).

For the purposes of inclusion, when selecting schools for playground transformations, indicators of the levels of vulnerability[37] are considered. In this way, the programme ensures that those schools with the greatest needs are prioritised for support.

[37] For example, some indicators that are used to recognise contexts of vulnerability are (a) students receiving the Extraordinary Social Emergency Fund for children, (b) students granted the maximum meal subsidy, and (c) students under the care of the DGAIA (Department of Children, Youth and Adolescents).



The school grounds at Escola Jaume I, Sants, Barcelona.
Source: *© PPMI, 2024. Photographer: Brenda Frydman.*

Further examples of initiatives currently being implemented that are related to the innovation and transformation of school infrastructure include:

- **Air quality monitoring**: in response to increasingly stringent regulations pertaining to air quality, an initiative was launched with the objective of assessing the air quality in schools. Students are actively engaged in the project, installing sensors that allow them to gain a first-hand understanding of air quality parameters.
- **Mobility initiative**: this initiative proposes that students identify the most polluted routes when travelling to school. Students are then encouraged to develop action plans for sustainable mobility, ultimately reducing pollution around schools. The initiative has led to significant changes in how students commute, thereby promoting healthier transport options.
- **City collaborative challenges**: this initiative proposes that schools commit to reducing energy and water consumption, by actively monitoring its use and receiving tailored guidance and recommendations on how to adopt more conscious consumption

practices. The priority challenges for the 2024-2026 period are decarbonisation and saving water. This initiative is implemented in 396 schools.[38]

Programme and school funding

The funding structure for *Escoles + Sostenibles* is structured in a way that guarantees all participating schools to have access to fundamental resources and assistance (e.g. plants, compost and pedagogical resources). **The signing of the agreement provides schools with access to a range of core activities and materials free of charge, without any obligation to seek additional funding.** However, Barcelona City Council offers annual funding opportunities for schools wishing to enhance their sustainability projects, typically through small infrastructure improvements. While funding applications are optional, each school is required to develop a clear sustainability project, detailing its planned initiatives and contributions to environmental goals.

Schools can apply for either annual or triennial project funding. The maximum amount that can be awarded for annual projects is EUR 1,000, with additional sums of EUR 600, EUR 400 and EUR 200 being granted each year, depending on merit. Triennial projects can receive up to EUR 2,400 for first place and EUR 1,600 for second, with funding available each time they submit to an annual call, provided they meet criteria such as attending a six-session training seminar on sustainability project planning and whole-school approaches.

In its training seminars, the team provides guidance on how to begin a transformation with limited funding. Although schools often have a clear vision of how they want their playground and buildings to look, many lack the financial resources to implement such a vision. Nevertheless, some schools proceed, step by step, towards transformation, receiving support from parents' associations (AMPA) or other small grants. The team's message to schools that lack funding is that **funding may be a crucial aspect, but it is not the only determining factor in achieving transformation.** What truly matters is a genuine commitment to change: "With time to plan, test, make mistakes and adapt, these transformations become achievable" (*Escoles + Sostenibles* team, 2024).

In recent years, to facilitate the allocation of funding for infrastructure projects, the team has collaborated with the City Council to transition from the conventional approach of offering grants, to a new strategy of providing prize-based awards. Historically, schools were required to submit a number of bureaucratic documents to apply for funding. Since the changes have been implemented, schools are no longer required to justify their expenditure following the submission of project proposals, which has positively impacted their interest to apply.

3. Evaluation of impacts

The programme team highlighted that among the multiple initiatives it has implemented and accompanied, some show clear evidence of results while others are more difficult to monitor and assess. For example, some programmes, such as the playground transformations, have active monitoring and evaluation systems in place, which provide more robust evidence of outcomes and impact at school level. Other initiatives, such as school visits by the technical team, do not include quantitative indicators to measure improvement in schools. Instead, more qualitative data is collected to support schools in their transformation projects.

[38] More news on this action is available at: https://metropoliabierta.elespanol.com/informacion-municipal/20241108/barcelona-impulsa-un-proyecto-sobre-sostenibilidad-en-centros-educativos/899660104_0.html

Evidence of the impact of *Escoles + Sostenibles* was collected, primarily through visits to two schools actively participating in the programme. These schools have implemented significant transformations of spaces and learning approaches for sustainability with support from the programme's technical team. While it is difficult to attribute the impact of these projects solely to the programme, the interviews conducted during the field visits to the schools indicate that the support provided played a crucial role in improving students' well-being, learning outcomes and competences in sustainability and the environment.

Impact on the well-being of learners

During the visits, the school environments were observed as being calm and welcoming, fostering an atmosphere that encourages positive social and educational interactions. According to interviews with school staff, the transformation of learning spaces has helped to create a more relaxed atmosphere in which students are enthusiastic and engaged. Furthermore, **the inclusion of open, airy learning areas has had a positive impact on children's well-being and health**.

While such impacts are not actively measured during visits, educators have reported noticeable enhancements in student relationships to the *Escoles + Sostenibles* technical team. Teachers often express surprise at how **simple adjustments in the use and organisation of space can significantly change students' attitudes and behaviours**. Published evaluations have highlighted the improvement of students' knowledge of sustainable practices, the transmission of values, student participation and activism, and more responsible forms of consumption (Evaluation report, 2019).

Examples of how learning spaces are organised can be seen at *Escola Octavio Paz* (Sant Andreu, Barcelona). Classrooms are divided into distinct areas: relaxation areas, conversation areas, reading and calming spaces, and workstations. In addition, free movement throughout the school, including hallways, is encouraged. According to interviews, this has been shown to positively influence students' collaboration skills and well-being.

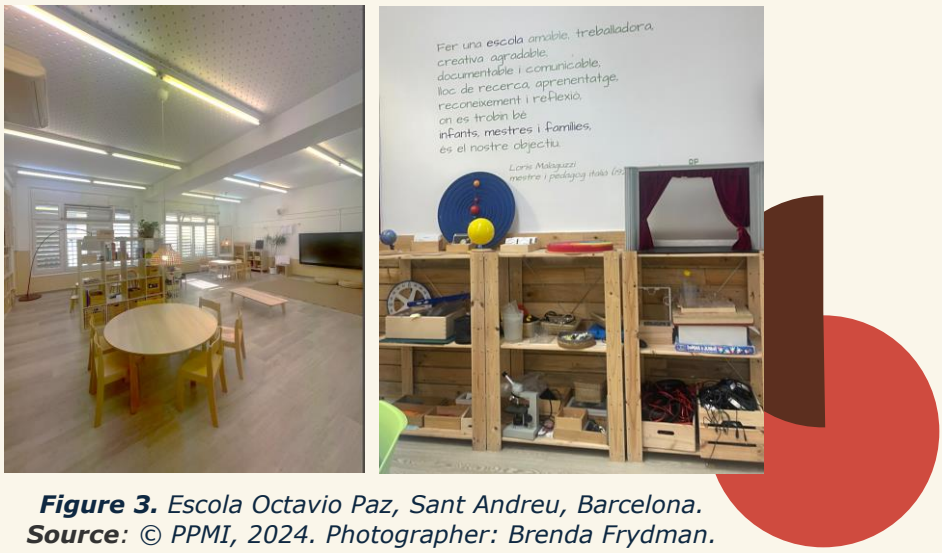


Figure 3. *Escola Octavio Paz, Sant Andreu, Barcelona.*
Source*: © PPMI, 2024. Photographer: Brenda Frydman.*
Note: *the text on the wall translates as "To create a kind, hardworking, creative, pleasant, documentable, and communicable school, a place for research, learning, recognition, and reflection, where children, teachers, and families feel at home, is our goal. — Loris Malagussi (Pedagogical Master, Italy)"*

As one of the main initiatives in which *Escoles + Sostenibles* is working, several evaluations have confirmed the impact of the initiative on school playgrounds – particularly those activities led by the *Escoles + Sostenibles* technical team. The most recent evaluation,

published in 2024, highlights the overall satisfaction of school staff and students, and describes the training schemes as being useful, dynamic and practical (Programme Evaluation, 2024).

With regard to the transformation of school playgrounds, the evaluation indicates that following their implementation, students have experienced **changes in the way they use the playground and interact**. This is mainly due to new forms of socialising through the creation of new seating and shaded areas. According to the children, these changes have reduced the emphasis on competitive sports-oriented activities (e.g. soccer) and increased the variety of play and physical opportunities in the playground. This shift has promoted more equal relationships between boys and girls (Programme Evaluation, 2024).

Another notable example presented by the programme team involves an initiative supported by *Escoles + Sostenibles*, through the creation of a strong sustainability committee of students. This committee creatively uses spaces as a medium for engagement, and the teacher involved selects students, prioritising specific dimensions of behaviour and well-being. **Feedback and observations from teachers provide valuable insights into the positive changes that occur within the school environment following the implementation of such actions**.

Figure 4. *Escola Octavio Paz, Sant Andreu, Barcelona.*
Source*: © PPMI, 2024. Photographer: Brenda Frydman.*
Note*: The image highlights the importance of shaded areas. This renovation, supported by Escoles + Sostenibles, was part of the school's project to create more sustainable learning spaces that are better equipped to resist heat.*

Impact on learning outcomes and sustainability competences

It is essential to recognise that while the programme team plays an active role in supporting schools in their sustainability projects, the improvement of academic outcomes is not a direct objective of the programme. However, the multiple projects implemented under the programme, which seek to enhance students' well-being and to promote more environmentally friendly school practices, can also lead to an indirect improvement in children's cognitive abilities and learning outcomes.

While they are not representative of all schools participating in the initiative, observations at two schools that are long-standing members of the *Escoles + Sostenibles* network reveal evidence of impact on student learning, but mostly on their sustainability competences.

At *Escola Octavio Paz*, the redesign of spaces also interacted with an institutional project that aimed to develop a comprehensive pedagogical programme on sustainable competences, with a focus on space organisation and the grouping of students according to competence level. This required the integration of new teaching methods within a supportive and adaptable environment, thereby enriching the academic experience as well

as sustainability competences such as collaborative and interpersonal skills and self-awareness. This transformation, supported by *Escoles + Sostenibles,* was highlighted by the school administration as being crucial to improving student learning. Although the school had not previously considered the children to be underachieving, **evidence shows an overall improvement in learning, particularly in mathematics and natural science (the primary focus of the project)**.

With regard to sustainability competences, school staff highlight the development of autonomy, self-regulation and adaptation. School principals highlighted that the comprehensive approach to sustainability had a direct impact on children's competences:

"The students have become highly communicative, independent, and skilled at problem-solving—qualities that stand out significantly. That is the greatest achievement: I believe it's in these areas where we've made the most progress, rather than solely in academic results" (School Principal, Octavio Paz school, 2024).

Impact on the environment

Figure 5. *Project map at the Escola Jaume I*
Source: *© PPMI, 2024. Photographer: Brenda Frydman.*

According to the team at Escola Jaume I, a study has identified that the school's playground has had the greatest impact on biodiversity in the district, making it **the largest biodiversity hotspot in its neighbourhood**. Previously, there were no green areas at this location. The central green area on the project map (see **Figure 5**), is the newly developed school playground. The study also shows a significant increase in plant diversity, with 27 different plant species, as well as a richer diversity of invertebrate fauna. The biodiversity of both invertebrates and vegetation is now comparable to that found in nearby parks.

Impact on the community

Based on interviews carried out during the school visits, education staff mentioned the impact of the projects on the surrounding community. At Escola Jaume I, the school has become an important hub for the community to gather and discuss initiatives. The school actively invites community members and organisations to learn about the institutional initiative, and encourages other schools to follow the project.

At Escola Octavio Paz, the school principal highlighted an instance when students were invited to paint a local shop's shutter to discourage graffiti. They took the opportunity to decorate it with a message promoting the protection of the Earth. In addition, it was noted that families were encouraged to become actively involved in sustainability initiatives, although levels of engagement vary.

Limitations and challenges

In discussions with the research team, the education staff highlighted a series of challenges and difficulties they encountered during the last few years of the programme's implementation.

- **Economic constraints on the team**: In 2025, 381 schools are involved in the *Escoles + Sostenibles* initiative – and an additional 28 schools are joining. While participation has increased, resources have not increased at the same pace. Due to resources being limited, the technical team can only visit around one-third of schools each year.
- **Insufficient funding for visible and engaging space reforms:** although many schools recognise the importance of implementing infrastructure reforms that enhance pedagogical and learning outcomes, the funding available is often taken up by urgent matters (e.g. leaking roofs). This leaves only limited resources left for visible improvements that could impact student behaviours. While some classroom conditions have been improved to allow the better use of space, the initial investments have not necessarily translated into learning benefits for the students, although they have helped to guarantee minimum conditions for teaching and learning.
- **Cultural barriers:** ideological and cultural barriers sometimes exist within the educational community. While teachers may be highly motivated, they must also engage with approximately 500 families from diverse backgrounds (some with more traditional perspectives), who may not fully understand or consider it a priority to invest time and funds in infrastructure transformation.
- **Political barriers:** changes in government have stalled progress, and certain measures to protect ongoing projects have hindered the initiative's momentum. Tensions that arise when political priorities come into play sometimes limit and delay improvement activities (e.g. with regard to space available for sports fields within the neighbourhood). For example, one playground transformation project initially faced resistance, and *Escoles + Sostenibles* played a crucial role in finding actionable solutions.
- **At school level**: there are challenges in relation to human resources, such as teacher turnover and retirement. Ongoing consolidation and efforts to maintain learning spaces are also a concern (e.g. where a school administration works closely with a gardener). These programmes are also highly demanding in terms of teacher training, with teachers needing to commit closely to the transformation proposals.

Strengths of the programme and lessons learned

Based on the desk-research and interviews carried out with the programme technical team and participating schools, it is evident that *Escoles + Sostenibles* is a key element in ensuring transformative change on sustainability issues in the education landscape in Barcelona. After 24 years of ongoing support and close cooperation with schools, the **principles of sustainability have been successfully embedded into school projects** – and, in some cases, this has been achieved despite time and economic constraints. The evident growth in number of participating schools has allowed the team to position itself as a relevant source of consultation and orientation for sustainable transformation.

During school visits, two significant elements where highlighted as being crucial to the programme's success. These are:

- **Real transformation extends beyond the mere provision of infrastructure for sustainability.** For *Escoles + Sostenibles,* it is evident that the process of infrastructure renovation does not necessarily equate to the transformation of schools. While infrastructure improvement is a crucial aspect of the process, **true**

transformation requires a more comprehensive approach, encompassing training, participation, cooperation and a cross-cutting strategy towards sustainability. Emphasis is placed on the fact that, for instance, playground renovations require an educational project behind them; the mere repetition of past practices or the provision of resources without complementary actions is insufficient. Another central element is the need to put students at the centre of the process, encouraging them to experience, experiment and embrace mistakes while engaging in sustainable projects with the surrounding neighbourhood. This, in turn, helps to facilitate their role as agents of change. With regard to this, the team explains: "The subject doesn't have to be environmental as long as it is approached in a participatory and experiential way. These are the values we strive to convey through highly sustainable practices*" (Escoles + Sostenibles* team, 2024).

- **"Leave no one behind".** The team indicated that schools commit to sustainability to different extent. Therefore, the team considers it crucial to monitor closely, and provide support in order to meet the needs of individual schools. For instance, following consultation with schools, the programme adjusted its eligibility criteria and reduced some of the most demanding requirements. The team explained the rationale behind this change: "Once you enter the programme, you begin to evolve and learn. You can also discover examples from other schools, including what changes they have implemented and whether it has worked or not*" (Escoles + Sostenibles* team, 2024). The director of the programme has recognised that imposing high expectations on schools from the early stages of involvement carries the risk of discouraging participation. **The gradual engagement of additional schools has been instrumental in the programme's growth and evolution.** As schools become more established in the programme, they are able to engage in more ambitious projects. Starting from a one-year project to transform a small aspect of school infrastructure can serve as the foundation for a future sustainability programme within a given school. The training provided enables schools to progress from undertaking an annual project to a three-year project, and facilitates the formulation of a more comprehensive vision of sustainability.

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Case study: C.S. Lewis Bilingual High School

Bratislava, Slovakia
Institutional initiative

Key findings

C.S. Lewis Bilingual High School in Bratislava takes an innovative approach to teaching, learning and all school activities. While it follows the national curriculum, the school's approach adapts it to create space for additional activities that support students' academic and personal growth, and the development of their sustainability competences, values and attitudes.

- **Innovative pedagogy and student well-being**: C.S. Lewis Bilingual High School prioritises innovative teaching methods such as outdoor, experiential and hands-on learning to promote sustainability skills and critical thinking. The school integrates mental health and well-being into its activities, organising events such as a Well-being Day and providing dedicated relaxation and study spaces. This holistic approach promotes both academic and personal development, creating an environment in which students can thrive.
- **Student agency and community engagement:** the school emphasises student agency by involving students in decision-making processes, co-designing spaces and leading initiatives such as running a student café as well as extracurricular and team-building activities. A compulsory charity work programme further instils a sense of civic responsibility, encouraging students to work with NGOs and engage in community service. These initiatives help students to develop leadership skills and to commit to social and environmental causes.
- **Sustainable practices in infrastructure and education**: the school integrates sustainability into both its physical spaces and its educational philosophy. The school's commitment to sustainability is evident through its use of recycled materials in the renovation of the school buildings and in the installing photovoltaic panels to reduce energy consumption (providing almost a quarter of the school's electricity needs). By designing spaces such as the Gallery (See Figure 5 and 6) and promoting practical environmental action, the school demonstrates how sustainable infrastructure can complement education and inspire students to take responsibility for their environment. While previous recycling efforts have faced challenges in maintaining commitment, the school is actively exploring ways to relaunch the initiative with greater community involvement, demonstrating its commitment to sustainable development and continuous improvement.

1. Introduction

C. S. Lewis[39] Bilingual High School in Bratislava is a church/private bilingual high school with around 500 students. It was established in 2004 following the success of "Narnia" primary schools[40] in Bratislava and Pezinok in Slovakia. C. S. Lewis High School follows a similar education model, with the same mission: "We educate and lead every student to be able to think creatively and critically, to take responsibility for themselves, others, and the world, and to have the ability to create communities in the spirit of Christian biblical values." (Bilgym, n.d.).

The school is highly supportive of diversity and, thanks to its scholarship programme, endeavours to be accessible to socio-economically or physically disadvantaged children.

[39] C.S. Lewis was a British professor and writer famous for his fantasy writing, which included a series of books, *The Chronicles of Narnia*.

[40] Narnia primary schools exist in four cities in Slovakia. They are part of the broad network of C.S. Lewis schools, including another secondary school with a technical focus, located in the same building as the gymnasium. All of the aforementioned schools are part of the same school network, created and managed by the by a local free evangelical church, *Cirkev Bratská*. These schools have a shared mission and pedagogical approach, which includes collaborating with parents and a shared approach to children with diverse needs, taking into account the school's local context, including the Christian character of schools, in an ecumenical way.

Through **innovative pedagogy and unconventional teaching**, the school aims to **inspire students to be creative and free, and to improve their well-being.**

Drawing on the desk research, as well as interviews with the school principal and school coordinator, teachers and students, and fieldwork observation, this case study aspires to showcase an inspiring example of an institution integrating a whole-school approach into its daily practices and overall vision – from supporting teachers in their professional development and formative assessment, to collaborating with NGOs.

Since 2014, the school has been working with local architects on the transformation and renewal of a communist-era school, initially constructed in 1972. The vision for the renovation initiative was to remove physical and mental barriers, to **bring in more natural light and create an open and welcoming school that respects the environment by using recycled materials derived from demolition**. The renovation has been recognised for its excellence in architectural design, winning the prestigious CE ZA AR 2019 Award[41] in the civil and industrial buildings category. The school won this award for successfully adapting its infrastructure to the needs of a modern education system.

2. Whole-school approach

Since the school's establishment in 2004, its vision has centred on **community building, relationships, student engagement and inclusion**. The school management is inspired and driven by the initiatives and energy of the students. At present, the school focuses on a wide range of topics, including **global studies and democratisation, mental health and well-being, empowerment and participation, volunteering, and the environment**. In the coming years, it aims to further promote the values of a healthy school and to enhance **digital literacy**.

The school takes an **innovative approach to teaching and learning**, using outdoor, experiential and hands-on learning while supporting the development of sustainability competences, including critical and systems thinking. Teachers are supported in attending various training programmes on outdoor learning (such as Erasmus+ abroad). In addition, the school regularly organises a development day for teachers to discuss complex issues related to teaching, such as formative assessment and feedback to students, classroom management and challenging students' behaviour.

The school has adapted its **learning spaces** to be **used for both learning and extracurricular activities**. Discussions with school management and teachers reveal that pupils spend their after-school time on school grounds.

The physical infrastructure of the school is critical in supporting learning and teaching. For example, the architects worked with more **sustainable solutions during the reconstruction**, using recycled materials or preserving the existing structures. At the beginning of the school year and prior to the heating season, the school management encourages and reminds students and teachers of small actions that can make a difference to the school's energy efficiency.

Community collaboration, including with NGOs, an environmental centre and parents, is present and widely supported in the school. Ten hours of charity work per year is a compulsory part of the school curriculum for every student. As part of this activity, various NGOs from Slovakia participate in the school's Charity Fair event, promoting their work and motivating students to choose and volunteer with their organisation. An

[41] With the CE ZA AR Awards, the Slovak Chamber of Architects awards the best in contemporary Slovak architecture.

environmental centre in a local urban forest, funded by Interreg[42] Slovakia-Austria in cooperation between the Cities of Bratislava and Vienna, as well as the environmental NGO Daphne, cooperates with the school in providing outdoor learning activities (full-day excursions to the environmental centre, observations of biodiversity or invasive species, field trips with a zoologist to explore forest ecology and the urban forest environment). Regular volunteer work (such as cleaning or painting) is also undertaken at the school and in the schoolyard with the help of parents, students and teachers. Student relationships are strengthened through various activities such as team building, community service (a week of joint charity work), field trips and special events held on school grounds.

3. Spaces and teaching for sustainability

Gallery

The central space of the school includes the Gallery, which has the capacity to seat up to 600 visitors. As part of the school's opening, vertical structures made of metal bars that separated the changing rooms were demolished, and opaque horizontal railings were replaced with lightweight structures. Barriers were removed, including the entrance itself, which is now barrier-free. The hall is an inviting space that welcomes visitors to the school. During the breaks, the Gallery becomes vibrant and lively – students are likely to meet there to play table tennis with each other or even with teachers.

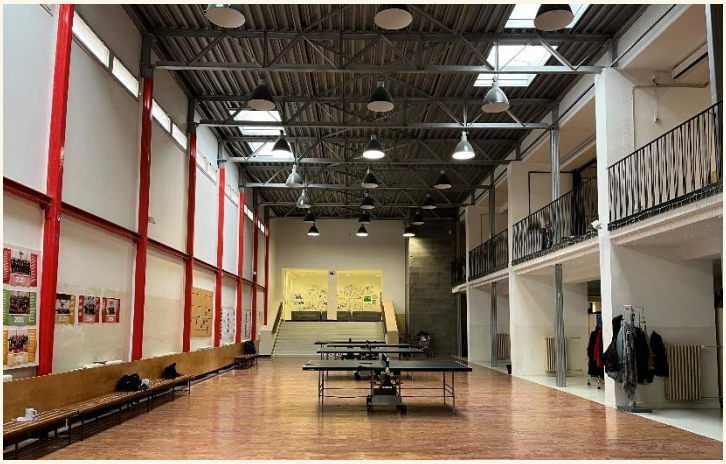

Figure 6. *Gallery at the C.S. Lewis Bilingual High School.*
Source*: © PPMI, 2024. Photographer: Bernadeta Baroková.*

The Gallery extends to the school's first floor, where a "chill-out" zone has been created for students to hang out, study or rest between classes. This is wide open and connected to the ground floor by railings. The upper Gallery space includes a wall that recalls the original structure of the building and serves as an artistic space now filled with ceramic art made by students. This space also contains a foosball table, which was bought by the students themselves using contributions they receive from the state as an individual cash grant to fund extra-curricular activities at the school.

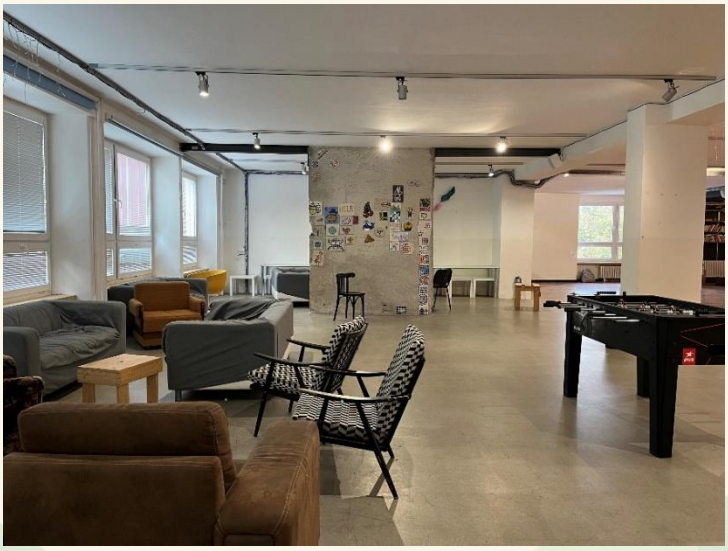

Figure 7. *Gallery on the second floor C.S. Lewis Bilingual High School.*
Source: *© PPMI, 2024. Photographer: Bernadeta Baroková.*

[42] Interreg is an EU funding programme that supports transnational cooperation and social cohesion.

While the Gallery is only a **place of rest and relaxation**, it also provides a space for the **experimental teaching** of physics. Because the Gallery can accommodate the entire school population, a popular and well-established concept called WICK (the "Weekly Inspirational Club for Kids") takes place there. Students and teachers meet regularly in the Gallery for 45 minutes instead of having a class meeting. The gathering is held with the whole school to discuss topical issues relating to broader cross-curricular aims and social or environmental problems, or to hear exceptional life stories from inspirational people.

Reading room and study room

The connection between students, parents and the school has led to the creation of two student spaces with different functions – one is **a quiet room ideal for studying; the other is intended to provide spaces for community, relaxation and dialogue**. The newly designed spaces, **co-created *by* students *for* students**, are now in use and have positively impacted the school environment and the community. This shared space has **strengthened community engagement and fostered a more inclusive and supportive school culture**, ultimately enhancing student well-being and academic focus.

An active parent of one of the pupils was involved in organising and coordinating practical activities such as the purchasing of furniture. The students actively contributed ideas and, together with the architect, created a concept that combined practicality with aesthetics. Together, they consulted and informed the school management about the process and the budget. "It was **their ideas and energy that transformed the space**, and we just paid the invoices and gratefully admired the result of their work," the principal said in an interview carried out for this case study. Many other parents, alumni and friends have helped through volunteering, 2 % donations[43] and other material and financial support. Creating the spaces provided an opportunity to strengthen parent–student–teacher relationships, as well as to have conversations, provide feedback and inspiration, and most importantly – to act, and as the school principal put it in an interview, to get up "from couches to action". These two spaces show that **active participation and engagement can lead to sustainable solutions for the school community**. They also offer an essential lesson in cooperation and responsibility towards one's environment.

***Figure 8**. Study room (left) and reading room (right) at the C.S. Lewis Bilingual High School*
***Source:** © PPMI, 2024. Photographer: Bernadeta Baroková.*

[43] Tax-paying individuals can donate between 2 % and 3 % of their income tax directly to the NGO of their choice. A person volunteering for a minimum 40 hours a year can donate 3 % of their income tax (subject to them providing confirmation of their volunteering).

Cafeteria "The Eagle and Child"

This project aims to **develop students' entrepreneurial thinking and business skills** and allows them to **engage in social entrepreneurship**. The project was started by a group of students from all year groups. They bonded over their dream of creating a welcoming space on campus with homemade treats and healthy drinks. This start-up became a reality on 5 September 2016, thanks to the financial support of Agathe Center for Entrepreneurship and the VUB banking foundation. The cafeteria is built from upcycled old blackboards and despite having irregular opening hours, it is a lively place. When the cafeteria is open (during breaks), music fills the air –played on speakers or performed live on the piano – and one can have good homemade cakes or pancakes, fresh fruit, lemonade or toast. Voluntary contributions cover the cost of production, and any "profits" are donated to a cause decided upon by the students, e.g. to a scholarship fund.

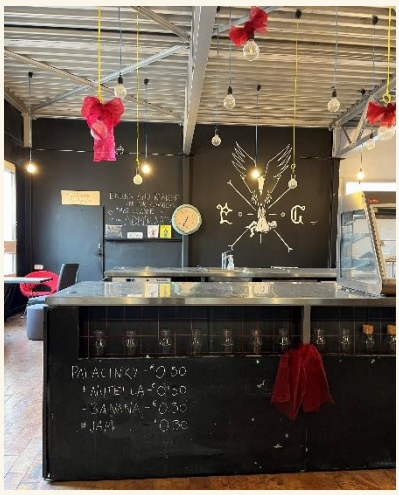

***Figure 9**. Cafeteria at the C. S. Lewis Bilingual High School*
***Source:** © PPMI, 2024. Photographer: Bernadeta Baroková.*

Community living space "BARAKA"

BARAKA is a space and a group of diverse people – students, alumni and teachers – who are united by an interest in developing themselves and the school, and are drawn to community experience. In Hebrew and Arabic, "baraka" means "blessing", which is what the community aspires to be – both for its members and for the surrounding community, through specific projects and internships at the school. It is a **residency emphasising relationships, creativity, responsibility and values**. BARAKA aims to unite people and develop communities that critically reflect on and re-imagine their context.

Being a BARAKA intern means 10 months (an academic year) of living, working and growing together through practical projects and relationships. Anyone aged 18-26 can become a community member by going through the selection process – either students, young teachers or alumni. BARAKA's overall mission is to **promote personal growth** for each individual and to encourage the development of others and of the school environment and its surrounding area. The experience aims to **foster a sense of community** that helps people become more holistic, honest and humane.

The BARAKA annexe, created as part of the school's refurbishment, aimed to provide a warm and homely environment, transforming previously uninviting areas into welcoming spaces. The redesigned space can accommodate up to 17 interns in shared rooms, as well as two teachers who have a separate room but share common areas (living room and kitchen). Central features of the space include a kitchen, lounge and study, with areas divided into quieter zones for reflection and spaces for communal activities. The design follows the principles applied throughout the rest of the building, emphasising the visibility and preservation of structural elements. In this case, original features such as the cast iron wiring have been retained, adding a distinctive charm and sense of historic character.

Figure 10. *Community kitchen at 'BARAKA' at the C. S. Lewis Bilingual High School*
Source: *© C. S. Lewis Bilingual High School.*

4. Evaluation of impacts

Impact on the environment

Discussions about **environmental issues** have taken place at the school since its establishment in 2004. They are **part of the global studies and civic studies curricula** and, on and off, a part of the broader life of the school (e.g. through environmentally oriented topics at WICK assemblies). In 2019, the topic received new momentum as the students restarted a **student-led eco-club**, supported by the teachers. This club allowed students to discuss environmental issues, as well as organising information sessions and clothing swaps. Following this initiative, a small group of students reintroduced a **waste management system** for sorting paper, plastic and other waste. Unlike the scheme in the previous building, which was managed by the school, this time it was managed by a group of lead students and other volunteers (other students or teachers) after school hours. However, frustration soon set in – users did not recycle properly, so the lead students had to sort the waste manually. This resulted in lotto great a burden of work for these students. In the end, the students decided to abandon the system. Although the waste management system is currently on hold, the school's management has been discussing how to reintroduce the system and make it more efficient and sustainable in the long term. However, the school does not wish to impose a system on the students; instead, it wants to see them take the initiative. One of the students who led the previous initiative said she would welcome a new initiative, but that it would need more support from the school management. Based on our observations, one possible solution to such a situation could be for the school administration to provide training at the beginning of the initiative and to further empower the students' enthusiasm by providing the right tools and management.

During the reconstruction in 2018-2019, **adding shading louvres to the school's façade** created a structure tailored to the school's exact requirements for shade. Parts of the façade are also covered with **"smart" climbing greenery** that produces leaves in the

spring and sheds them in the autumn, allowing in more daylight and preventing unnecessary heat gain in the summer.

The school building has an annual electricity consumption of approximately 92 to 99 MWh. In 2022, the cost of electricity increased to three times that of previous years due to Russia's invasion of Ukraine and its decision to stop gas supplies to several EU countries, in combination with inflation and the continuing economy recovery after the COVID-19 pandemic. These factors caused an energy crisis and uncertainty over future gas supplies during the cold season, pushing energy prices to record levels. It also impacted the cost of electricity, the price of which in the EU was linked to the price of fossil fuels.

To reduce energy demand and costs, the school installed a **photovoltaic system** with a peak PV generating capacity of 34.49 kW, calculated to cover 24.6 % of the school building's annual electricity consumption, with the possibility of gradually increasing to 54.6 kWp, which would cover 29.4 % of the school building's yearly electricity consumption. Real data from 2024 show that the PV system had a peak generating output of 37.6 kWp that year. Thus, while the school consumed 25 kW of electricity from the PV system, the additional 12.6 kW of electricity generated by the solar panels was "sold" to the distribution system.

The PV panels were installed on the school roof in 2023. The initial investment in the energy system was EUR 50,000, with a monthly maintenance cost of EUR 100. Based on these figures, the estimated payback period for the investment is around five years. As an example, in June 2024, the school's electricity expenditure amounted to EUR 1,500, while the PV energy production was valued at approximately EUR 1,300 (as a surplus supply to the distribution system).

However, the school encounters seasonal challenges, particularly during the summer, when PV production capacity peaks but the school's demand for energy decreases due to the holidays. Implementing a battery storage system would be especially beneficial over weekends when energy production exceeds consumption. Addressing this imbalance could involve forming partnerships with nearby businesses or residential buildings – an approach that has shown promise in other countries. C.S. Lewis school currently engages directly with its energy supplier and "sells" the excess electricity generated back to the grid. Still, the school is eager to explore solutions to optimise energy usage and mitigate losses during low consumption periods in future.

During the first year of the PV system's operation, the school has sought ways to communicate and promote the project (e.g. by displaying energy data from the PV panels on a TV screen in the reception area). Discussions with a physics teacher suggest that there is **potential to integrate PV panels as a practical approach to learning in classes.**

The school encourages and reminds students and teachers of small actions that can make a difference, such as moving furniture at least 40 centimetres away from radiators, turning off lights or lowering classroom temperature. Through such behavioural "nudging", the school supports individual action and responsibility. Students also learn to be more responsible and aware of the environment while working as interns in the school, taking on the responsibility for checking common areas or turning off lights.

Impact on the well-being of learners

The school has several **meeting and relaxation areas**: the Reading Room, Gallery and Cafeteria. These spaces allow students to have conversations, relax, play sports or play the piano. Along with the Study Room, these rooms allow students to study as well as

providing ample space for group work. The school emphasises **the importance of community**, and these spaces allow people to meet and build friendships and relationships. In one of the common areas, the school is experimenting with a "no phone zone".

To encourage individual initiative and political action, the school has made **charity work** compulsory in the curriculum. The following requirements are laid down: students must not receive any remuneration (financial or non-financial), and volunteering work must fulfil a time quota of 10 hours per school year, and be carried out within a non-profit organisation or civic association. To support this initiative, the school organises a Charity Fair.

Every year in January, the school organises a **Well-being Day**, when lessons are not based on a traditional timetable but on joint activities and workshops on the school campus. This day provides an opportunity for the school community to develop differently from classroom experiences, to get to know people from other classes, and to relax a little after the first term. Over the years, workshops have included cooking, yoga, breathing exercises, mental well-being, creativity and art therapy, stress management and resilience, and sex education. The central theme of the upcoming Well-being Day in January 2025 was "From body to soul".

The school encourages students to take responsibility for themselves, to recognise and appreciate the values of others, and to develop their own social and emotional intelligence. To support the development of these qualities, the school introduced a mentoring programme in 2012. This aims to enable more personal contact between students and teachers, who can reflect together on the student's academic and personal life. In addition to the mentoring programme, the school has a dedicated team of psychologists who provide support in specially designed rooms. These rooms offer a safe and welcoming space for all students who need support, whether regularly at challenging times or for specific needs such as sitting exams. The school is committed to creating an environment in which every student feels valued and supported, including those who are struggling with mental health issues or other personal difficulties.

A complex yet visually ordered space design can motivate the learner and maintain their attention throughout the day. To achieve this, the school worked with architects, who introduced the colour scheme as an element for organisation and orientation. Accessibility, the material solution of surfaces, exposed cables, the spatial concept of the design of common areas (changing rooms and the demolition of the gallery), as well as details such as the circular windows in doors and the wayfinding system – were all introduced during the reconstruction. Replacing some of the brick walls has helped to visually shorten the communication corridors, and natural light has made the interior more pleasant. Exposing children and staff to natural light has been demonstrated to lower absenteeism, mood and stress, and to enhance well-being and learning.

Impact on learning outcomes and sustainability competences

Education at C. S. Lewis school is allows for self-awareness and reflection. The school emphasises **responsibility, honesty and problem-solving as well as critical and creative thinking in teaching and learning.** Students study in small groups up to a maximum of 16 or 17 students. In addition to the compulsory programme of Slovak language, history and mathematics, the school offers lessons in global studies. This deals with topics such as education, poverty, human rights, environmental issues, migration and political regimes. In their first year, students take lessons in public speaking, study skills, literature and writing. Later in their studies, students choose subjects for in-depth study.

A **biology** teacher indicated that they use articles in their lectures to **develop critical thinking, integrate knowledge from mathematics and politics, and promote sustainability values**. Implemented in collaboration with a local association, outdoor learning is integral to the teaching process. For lessons such as biology or literature, students often visit a nearby forest (which is easily accessible and does not require extensive planning), thereby enriching their learning experience through direct engagement with nature. A physics teacher uses experiential and hands-on learning, making use of specialised laboratories and equipment as well as various spaces in the school, such as the gallery to carry out gravitational experiments and the stairwell for acoustic experiments. In addition to traditional topic-based teaching, this **physics** teacher has developed **lessons that focus on specific phenomena, such as climate change**. Using this approach, he links together different concepts from physics and shows how theoretical knowledge can be applied to the challenges of the real world. This approach to teaching focuses on knowledge, not grades, and he encourages students to adopt a similar philosophy. In addition, teachers often discuss **digital technology and the ethical use of AI with students**. Such an approach to teaching and learning encourages students' internal motivation to learn about specific topics and allows a greater and more practical understanding. Observations and explorations stimulate students' interest in real-world issues, and subsequent discussion encourages exploratory and critical thinking.

Each year, the school organises a BilGym Learning Week, during which the usual schedule is abandoned. Instead, students learn independently and manage their own time. At the same time, students are invited to participate in extracurricular activities such as field trips, cycling or adventurous night hikes in the Small Carpathian mountains. In this way, students learn independence, time management and responsibility.

The school's College/Future Counselling programme is designed to help students make informed decisions about their future academic lives and careers. Among other things, this includes the Alumni Future Fair, a platform of meetings with alumni who share experiences and offer valuable advice to students. Seniors participate in management training-style seminars on personal development with lecturers from a company, FBE (For Business Excellence). These initiatives help students to explore their aspirations and values, as well as developing their time management and communication skills. Through engagement with alumni and reflective exercises, such programmes encourage systems thinking and help students to navigate academic and career transitions.

Limitations and challenges

Despite positive outcomes, the C.S. Lewis Bilingual High School faces several challenges.

- **Ongoing discussions about the restarting of recycling.** Although the initiative has been put on hold, discussions on relaunching it are ongoing and lively.
- **Balancing comfort with energy-efficient practices.** The school provides regular reminders of energy-efficient practices in classrooms and hallways – at the beginning of the school year, and before the heating season starts. Such practices often involve a trade-off between personal comfort and energy efficiency, shaped by culture and habits. Still, the school encourages practices such as the wearing of extra layers and optimising heating use, encouraging collective responsibility.
- **Communicating the success of the PV panels to the students.** The PV panels were installed on the school's roof in 2023 and are therefore inaccessible and invisible to the students. However, they make a significant contribution to the school's energy efficiency. During the first year of the PV system's operation, the school has been looking for ways to better communicate better and promote this project, with the aim of raising awareness about sustainability and clean energy among students and staff (e.g. on the TV screen in the reception area). Discussions

with one physics teacher suggest that there is potential to integrate this as a practical approach to learning in his classes.

- **Passing it on.** Many of the school's initiatives are dependent on specific colleagues and students who understand their importance and lead/organise them for others – being "owned" by people rather than presented as a process. It can be challenging to find and train new people to whom these initiatives can be passed on, so that they do not dissipate when the people leading them leave the school.

Strengths of the initiative and lessons learned

C.S. Lewis Bilingual High School is an excellent **example of the integration of the whole-school approach into daily activities**. Its activities contribute to the development of students' values and attitudes, with an emphasis on community, commitment and individual responsibility.

- **Student agency.** The school actively supports students in their academic and personal development, allowing them to engage in ongoing school processes and activities or to take individual initiatives. The school also encourages students to take responsibility for shared spaces and guides them to take individual and collective action to care for their school environment sustainably and responsibly.
- **Professional development of staff.** Development days are organised to support teachers in their teaching and teachers are actively encouraged to attend training programmes, such as Erasmus+. Such events motivate teachers to use innovative teaching methods, such as outdoor learning for literature or biology lessons, or using the learning spaces within the school for physics lessons.
- **Professional support system.** The school has set up a mentoring system to improve the relationship between teachers and students and to allow students to discuss their academic and personal development in dedicated mentoring rooms. In addition, the school has a professional team of psychologists providing support in dedicated support rooms.
- **Energy efficiency efforts.** In 2023, the school installed a photovoltaic system with a PV generator, calculated to cover 24.6 % of the school building's annual electricity consumption, with the eventual possibility of this rising to cover 29.4 % of the total.

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Case study: Gantofta school

Gantofta, Sweden

Institutional initiative

Key findings

Gantofta school applies collaborative, inter-generational and interdisciplinary projects and solution-based pedagogy. The school's "new" open spaces, such as its refurbished sports hall, support these pedagogies and give students the opportunity to be creative and proactive, and to practice sustainability and circularity.

- **Gantofta school is a public school outside the city of Helsingborg** that has created multipurpose and sustainable spaces in line with the principles of circularity. Central to Gantofta's approach is collaboration in the design, usage and monitoring of the sustainability of its spaces, which involve the whole community – especially students. This fosters a sense of ownership, shared responsibility and student agency.
- **Gantofta's unique sustainability-focused science programme** makes the school a popular choice in the area. Through this programme, students develop scientific literacy, sustainability and digital competences. School improvements is a common theme for project-based work. Students usually work in teams across ages and classes, and in some cases with PhD students at Lund University.
- **The school's transformed sports hall and changing rooms serve as multifunctional and flexible classrooms**, suitable for project-based learning and group work. One dedicated room in the multifunctional space is quiet and sound-isolated, ensuring that students who want focus time can also benefit from the space. Through small-scale gardening, as well as monitoring sensors in this room that measure air quality, students get to practice sustainability.
- The interventions, which include **solar panels and thermal energy**, have saved the school **additional costs and greenhouse gas emissions** and reduced its dependency on the energy grid. During the next stage of the project, the school would like to place greater focus on sustainable eating habits, reducing food waste and improving the school's ventilation and insulation systems.
- **The school's holistic approach to sustainability and circularity has contributed to improved well-being and inclusivity** among learners. Students report that the school's culture models kindness, and is a culture in which one can be oneself. The impact of this is especially positive with regard to student agency.
- **The average grade results of students have improved** during the years in which the school has been most active in sustainability. However, it is not possible to claim direct causality between the interventions and learning outcomes. Teachers do, however, report that students' sustainability and digital competences have improved as a result of the innovative teaching methods used.
- **The initiative has previously faced challenges** such as a reliance on key individuals for its success, as well as logistical and maintenance issues and funding concerns. However, these challenges have been overcome through **strong, engaged and distributed leadership.** Ensuring sustained financial investment and expertise from the city administration have also been critical to the school's success.
- **Currently identified areas for improvement include the professional development of teachers, and stronger communication** of the rationale that underpins the school's work. This would help to ensure that learning expands beyond the school to include parents, as well as to those students who have not yet been convinced or motivated to study and practice sustainability.

1. Introduction

Gantofta is a public school outside Helsingborg in Sweden for students aged 6-16 (grades F-9). The school currently has around 400 students. Gantofta takes an active stance on sustainability and learning. Its motivated and engaged teachers are dedicated to environmental and sustainability issues, and work to collaborate with the community, school and municipality wherever possible.

This case study is an inspiring example of **distributed and engaged leadership** for sustainability and circularity that benefits the environment, the school community and the school budget – all the while supporting student agency and learning. It draws on desk research, observations from fieldwork and a focus group including the principal, administrator, municipality environmental officer, a teacher and a group of students.

In 2022, the school repurposed existing spaces using **second-hand furniture and locally sourced materials**. The school turned an old sports facility into a large classroom, paying attention to acoustics. The old changing rooms were turned into music rooms, and a garage was turned into a kitchen – eventually cutting the school's costs and carbon emissions by avoiding the need to travel to another school's kitchen.

The school has a **strong science programme** in which students can learn programming, robotics and product design. Importantly, the programme combines science lessons with sustainability practices and improvements within the school. The school is experimenting with a digital tool for climate data tracking, and teachers and learners are actively using this to track air quality, energy consumption and food waste. The students often work in teams, cutting across age groups and school classes. Thus, the school practices both **interdisciplinary and inter-generational learning for sustainability**.

2. Whole-school approach

The Swedish National Agency for Education Skolverket defines a sustainable school as "a school that works with a holistic approach to issues related to sustainable development. This involves integrating environmental, social and economic issues into teaching, involving children and young people in learning and preparing them for the future" (Skolverket, cited in Helsingborg, 2021).

Gantofta school does possess have a strategic document nor guidelines on sustainability that drive its operations. However, as noted on the municipality's webpage, the school **strives for a holistic approach** to teaching and practice: "We create a common thread throughout our operations when it comes to what we stand for and want to achieve" (Helsingborg, n.d.). **Sustainability** is one of the core values that shines through in the school's practices across its spaces, community collaborations, student involvement and teaching.

As the school's principal notes, "**circularity is our ideology**". With this statement, the principal is not simply referring to the recycling of waste but also Gantofta's **green procurement practices,** under which reusable materials are chosen whenever possible (e.g. for school materials and furniture, etc). Importantly, learners participating in the school's circularity efforts at the school learn a range of skills. For instance, in 2024, students in 5th grade (11 years-of-age) collaborated with Erikshjälpen, a Swedish aid organisation, to sew oven gloves and mitts from donated old denim clothes. The students later organised an event to sell these items to locals through Erikshjälpen. The income raised from this went to families affected by the war in Ukraine. Additionally, students at the science programme **3D-printed** new handles for broken chairs in the school canteen to avoid purchasing new ones, saving the school costs while providing practical applications for the school's 3D printers.

The school's commitment to sustainability is especially evident in its efforts to **renovate, run and improve its learning spaces** in order to enhance its **sustainability** over time. In doing so, the school brings its students along with it on this journey in order to build their sustainability competences, as well as science and digital literacy. Over the last few years, the school has renovated several of its larger learning spaces by using recycled, second-hand and locally sourced materials, while relying on local expertise (see next chapter) and student involvement. The school uses thermal heating and has installed solar panels on the roof.

The renovations are not one-off, but part of the school's continuous learning and sustainability journey. The school is participating in **Antiloop** – an Internet of Things project that helps schools in Helsingborg to visualise climate data (Internet of Things Sverige, 2024). Using digital tracking tools, students and teachers monitor environmental sustainability metrics such as indoor air quality, soil moisture levels, sound levels and food waste. They regularly brainstorm on future actions that could help to improve these indicators (as well as on small-scale and education-related solutions). Participating in this monitoring process enables students to improve their digital literacy and become more aware of how environmentally friendly school design and human behaviour positively impact one's surroundings and experiences. The teachers discuss the results of the tracking with the students, and brainstorm further solutions.

Figure 11. *Sensors in operation.* ***Source:*** *© PPMI, 2024. Photographer: Iselin Mulvik.*

Gantofta school runs a popular **science programme with a focus on sustainable development**. This programme takes a collaborative and peer-learning approach to teaching and learning. During the programme, students are grouped or paired across ages and school classes to participate in research projects. Researchers at Lund University provide the students with potential ideas for projects (e.g. relating to farming or programming), and support them with their research. Throughout the science programme, the older students (those in their teens) undertake research processes inspired by regular PhD programmes – thereby giving the school pupils a unique and in-depth learning experience. Students may spend one semester on an in-depth literature review in order to prepare for a research experiment or product design project that they carry out in the next. The goal is to give students more time to explore information, to be creative and to structure their time. In each project, the teacher acts more like an assistant to the students than a lecturer. The students themselves discover and analyse information, with the teacher there to guide them. As the teachers note, the students benefit from taking risks and responsibility in a safe and healthy environment. Such intellectual challenges contribute to developing student agency, and increases their motivation for learning.

It is not just those students who participate directly in the science programme that experience the creativity that stems from learning for sustainability at the school. The science programme's efforts often spill over and inspire students outside the programme, too. For instance, students frequently discuss sustainability in their "sloyd" classes. **Sloyd** is a system of handicraft-based education that originated in Finland in 1865 and is taught as a compulsory subject in Scandinavian schools (Wikipedia, 2024). During the 21st century, sustainability has become central to the sloyd curriculum, although it has always been a part of its pedagogy and practice (Redaktionen, 2018).

Besides **sloyd**, younger children and those outside the school's science programme can also experience Gantofta's **Climate week and Earth Day** initiatives each year. During these events, the school organises presentations and visits by researchers, local businesses and organisations to showcase what they do to work for a more sustainable future. The school uses these days to showcase interesting career opportunities in g reen sectors, and always emphasises a career perspective in the presentations. For instance, during Earth Day 2020, the school was visited by a renewable energy company, Öresundkraft; a local farmer; the city's planning administration; and the coordinator of the city's Environment and Lifestyle unit, all of whom presented their work (Sjöberg, 2023).

***Figure 12**. Solar panels on the roof at Gantofta school.*
***Source:** © PPMI, 2024. Photographer: Iselin Mulvik.*

This **collaborative way of working with local institutions** is another key feature of the school's holistic approach to sustainability. It is not only students at the school who benefit from its efforts to develop sustainable learning environments; the school also welcomes the community in to use its spaces – especially its outdoor spaces, whenever the school is closed. Gantofta collaborates with the local school administration, stakeholders and businesses to improve the school spaces and source knowledge, expertise and products locally. The school is also part of a regional network of schools that work on sustainability and often collaborate on common projects such as Antiloop.

The school approaches sustainability from the perspective of a **"School to work co-lab**" (SSA in Swedish). This means that the school makes an additional effort to prepare students for future studies and careers. At least once per semester, the whole school co-works on SSA issues in the context of the SDGs. This approach drives collaboration, whenever possible, between the school and local and sustainable organisations and businesses. This enables students to learn about sustainability and potential future jobs. The teachers involved in this effort see this approach as a way to contextualise and raise the quality of their teaching, while improving the school culture overall (Sjöberg, 2023).

In addition to sustainability, another key value – and the *modus operandi* of the school – is its focus on **building positive relationships.** This means that staff and students have fun, are seen and respected, and everyone can grow individually together (Helsingborg, n.d.). The school staff has been described as a closely knit group of employees who practice leadership that is **present** and is close to students (in Swedish, "*nära ledarskap*"). **Leadership is distributed** (as opposed to being hierarchical). The principal works closely with the assistant principal, administrator, janitor and teacher representatives to achieve their common goals of student success, happiness and school innovation. As the principal notes, this way of work is more reminiscent of a board in an association.

Indeed, students are often directly involved in improving facilities around the school, and the school **consults students on decision-making**. There is a student council, whose representatives join meetings with the school leadership once per semester. Furthermore, students in the school's science programme have been designing sustainable learning spaces around the school. For example, a 12-year-old student designed and developed a deposit-based plastic bottle recycling machine for the school as a part of a science programme. The students who worked on this project practised programming when designing the machine, and maths when calculating the income and savings it could

generate for the school. Teachers and administrators at the school supported the students in procuring the various components the students needed to build the machine from local businesses in the area.

In 2020, a group of 10-year-old students participated in **a local project** that focused on investigating and describing their local environment, and proposing architectural solutions. The students picked the worst and best places around their school and its surroundings, and presented ideas for improvements to the urban planning administration. The students wanted more green areas and less rubbish, as well as art that was made with recycled plastic. While the municipality initiated this project, the openness of the school's leadership to participating in projects that foster student involvement and reflection on their nearby spaces is yet another indication of the school's commitment to student involvement (Helsingborg, 2021).

3. Spaces and teaching for sustainability

The main school building was built in 1963, in line typical school architecture practices in Sweden in the 1960s – a period of building boom in the country. Key characteristics of this period are the use of yellow brick tiles, copper details, various levels of ceiling heights and large windows. The main building is U-shaped and is connected to two other buildings.

Sports hall and changing rooms transformed into classrooms

In 2021-2022, the school faced a **sharp increase in student intake,** and thus needed additional learning spaces. At the same time, the school was to build a new and more modern sports venue. To solve the challenge of needing more learning space, the school's leadership decided that, rather than demolishing the old sports hall and building the new sports hall in its place, it would retrofit the old sports hall into a new learning space and build the new hall in a different location on the school grounds.

Gantofta practises a range of innovative teaching approaches. These include creative, collaborative and inter-disciplinary projects, as well as solution-based pedagogy. The new open spaces, such as the refurbished sports hall, aim to support these pedagogies as well as inclusion. The school leadership therefore decided to **repurpose the old sports hall** into a new open and flexible learning space that would suit these innovative pedagogies, inspired by a trend in Danish schools over recent years (NORD Architects, 2024). Given that the Danish capital, Copenhagen, is just 42 kilometres away, it was natural for the school leadership to look to Denmark for inspiration. For instance, at Hellerup School in Copenhagen, there are no classrooms but rather a series of contiguous, **multipurpose spaces** arranged around the building's central stairs (Edge Foundation, n.d.). These spaces double as both social meeting areas and lecture seating. The arrangement makes the school's space open, flexible and trustful, with no closed doors. It encourages physical movement and activity that is suitable for project-based pedagogy.

Gantofta has sought to replicate this vision with its old sports hall. Its stairs have been used as multifunctional space and potential seats for lectures, while there is also easily movable furniture around the space. However, Gantofta has not applied Hellerup's complete vision across the school. The school leadership and students interviewed recognised the potential limitations of a fully open space, which could easily turn into unorganised chaos. While such a space is great for creativity and activity, if there is too much noise, it could disturb those students who need quiet focus time.

The school has addressed this issue by paying attention to **acoustics** during the building phase, using fabric and materials on the walls to reduce echo. Furthermore, the space is divided into several zones. There is a sound-isolated nook that students can enter for focused work, and a semi-isolated hut in the middle of the room for collaborative work. In

addition to these, one side of the sports hall also has regular desks and chairs (see picture in the introduction), while another has a lounge area (see the image below).

Figure 13. *Sports hall turned into a flexible classroom at Gantofta school.*
Source: *Left: © Ecophon Sverige, 2022. Photographer: Teddy Strandqvist, Studio e. Right: author's own – taken by the research team during the field visit.*

The students interviewed were delighted with the new space, especially the "**quiet rooms**", as they call them (see the box in the background of the picture above). The students noted that once they had got more desks and chairs and divided the room into more **dedicated zones**, it became a more usable space for everyone and for all activities. The students appreciated that so few resources were used in creating this space. All interior design elements and furniture were obtained second-hand from companies and local shops.

Several challenges were encountered during the renovations. One of these was that the sports hall's ceiling was initially too high, resulting in poor acoustics (Ecophon, 2022). The firms conducting the renovations solved this by adding another, lower ceiling together with 40 mm soundproofing plates to improve the room's acoustics. To achieve this, the school worked with several firms specialising in acoustic systems suited to the needs and challenges of public spaces' (e.g. Akustikmontage NV Skåne AB and Ecophon Sverige). Starting in 2025, Ecophon will conduct a study on sound environments at Gantofta with researchers at the university KTH. The rationale behind this study is that although the health effects of sound environments are well studied, students' perspectives on sound environments are often missing from sound research (Ecophon, 2025).

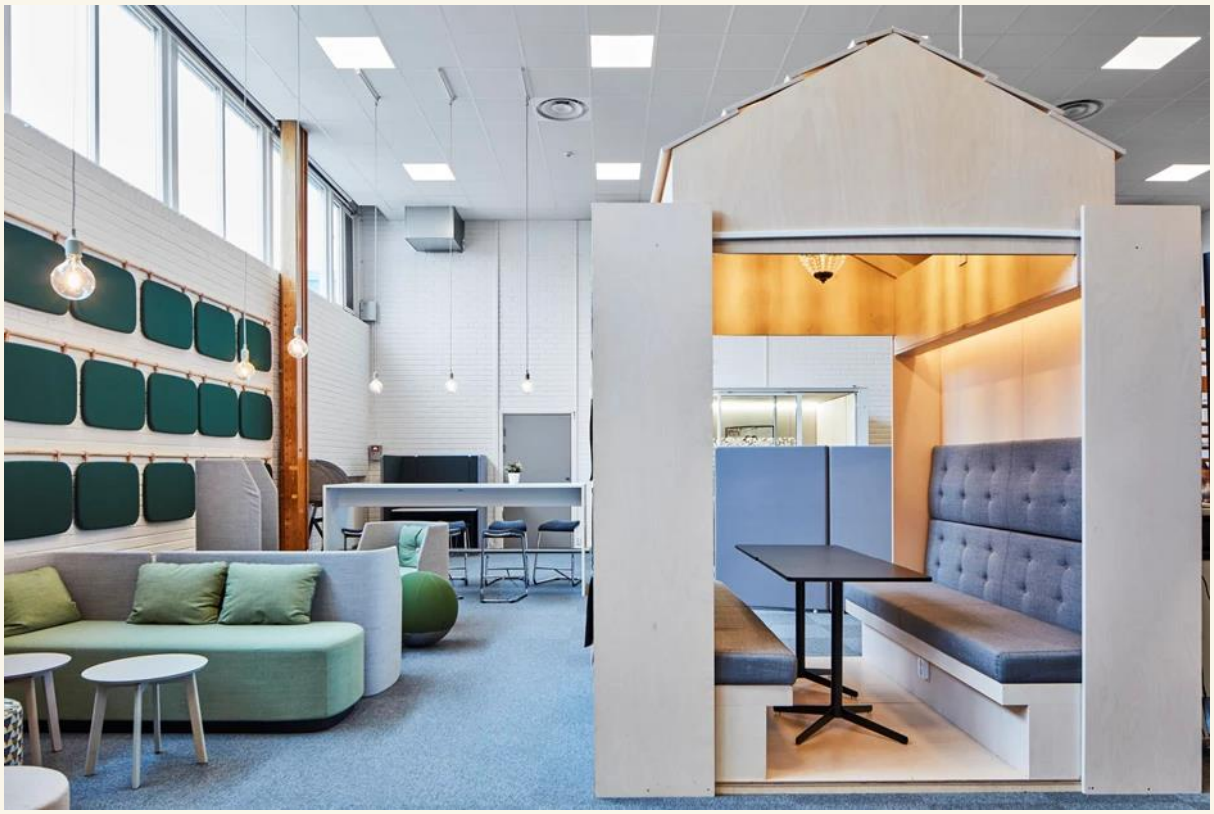
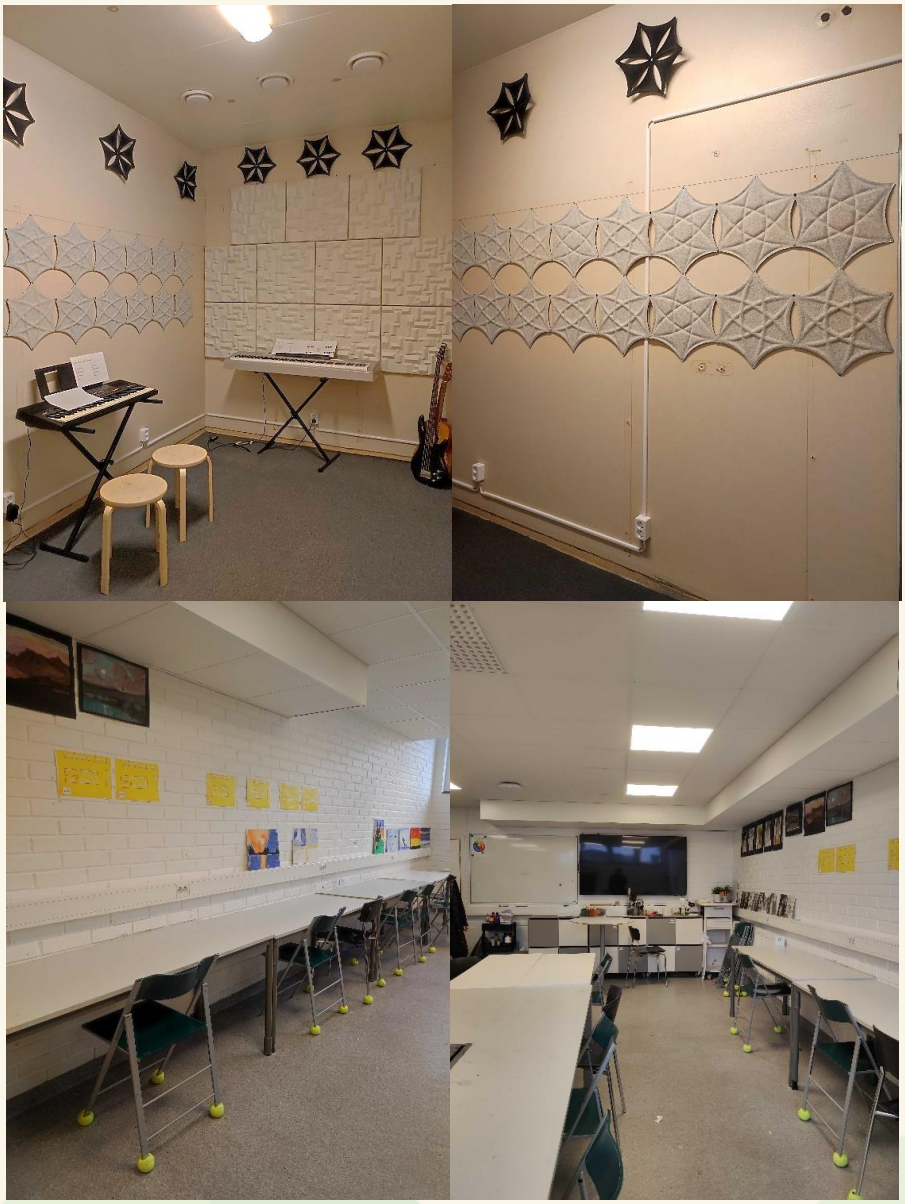


Figure 14. *Lounge area and semi-isolated collaborative hut in the transformed old sports hall.*
Source: *© Ecophon Sverige, 2022. Photographer: Teddy Strandqvist, Studio e.*

Figure 15. *Lounge area and sound-proof working space in the old sports hall at Gantofta school*
Source: *© Ecophon Sverige, 2022. Photographer: Teddy Strandqvist, Studio e.*

Box 11. Example of showers and changing rooms turned into classrooms for music and arts at Gantofta school

Not only was Gantofta's existing sports hall repurposed, but so were the changing rooms and showers. One part of the changing rooms was turned into an additional classroom for arts and photography, while another – including the showers – was turned into a classroom for music lessons. Visible marks remain on the wall from where the showers used to be, reminding visitors of the origin of the place and the creativity behind the retrofitted space. When asked about their favourite space at school, students quickly answered the music classrooms (see the dedicated piano room below) and admitted that this was probably because they enjoy their music classes.



Top, left and right: showers have been turned into a piano room.
Bottom, left and right: a changing room has been turned into a classroom for the arts. Old tennis balls have been fitted to the ends of chair legs to protect the floor and avoid noise when moving the chairs around.
Source: *© PPMI, 2024. Photographer: Iselin Mulvik.*

Garage transformed into a kitchen

Another excellent example of repurposing of space at Gantofta regards the transformation of an old garage into a school kitchen. Prior to 2024, when the new kitchen was finished, the school had regularly sent its students to a nearby school for their cooking lessons, as part of the subject course on food and cooking. Transport to the other school had costs SEK 150,000 per year (around EUR 14,000). In order to save future transport costs, the school invested SEK 150,000 to transform an old garage into a kitchen. While this meant a higher upfront investment, the new kitchen reduces the school's costs and increases the funds available for other investments. Again, the school tried to obtain as many items and machines as possible for the kitchen second-hand.

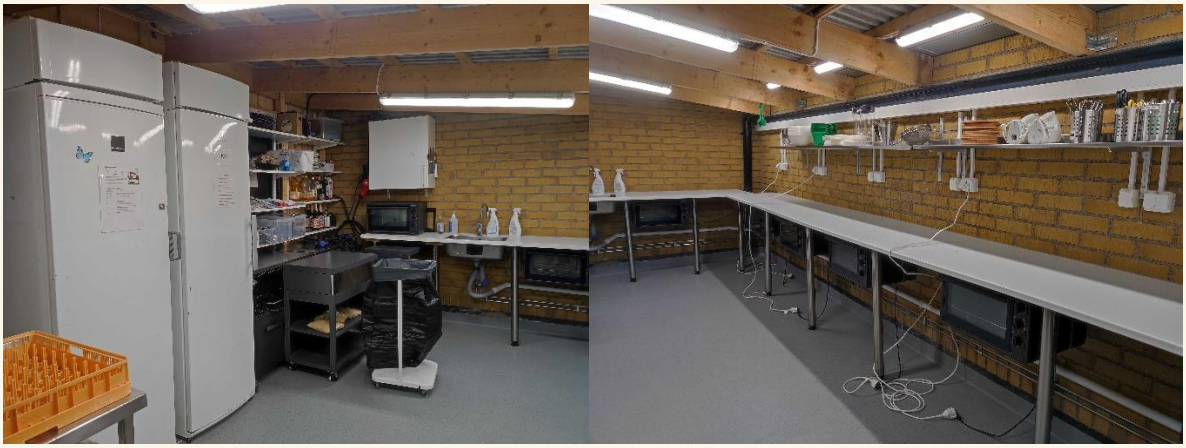


Figure 16. *New kitchen at Gantofta school.*
Source: *© PPMI, 2024. Photographer: Iselin Mulvik.*

Outdoor playground

The outdoor space at Gantofta has seen several interesting interventions that have put the principles of circularity into practice. The outdoor green and sustainable playground has a small climbing wall, a library and a large container with tools for the school's building game.

Figure 17*. Outdoor playground at Gantofta school.*
Source: *© PPMI, 2024. Photographer: Iselin Mulvik.*

The programme ″**Bygglek" (building play)** at Gantofta School in Sweden provides students with tools to create and modify huts and structures in an area called "Lilleskog" at the edge of the schoolyard. This programme began in 2023 when the Helsingborg school administration offered the school a container of building materials. The school received innovation funding for this project a part of H22 City Expo – an initiative to transform Helsingborg into one of Europe's climate-smart cities (Helsingborg, 2024).

Initially, the teachers were hesitant due to safety concerns about young children using tools such as hammers, nails and saws. To address safety, they implemented a "building license" that students must earn before they can participate. Clear rules and checklists govern the use of the area, and regular safety inspections are made of the structures built. A two-week suspension from the programme is in place for those breaking the rules. All materials come from recycled sources; most are supplied by the municipal recycling centre. The only extra costs for the school are tools and hardware. The student builders face challenges, including vandalism when school is not in session, but have adopted a resilient attitude: "They break it, we rebuild it!" (Pedagogsajten, 2023; Orre, 2024).

Finally, students at the science programme have installed a **beehive** on the roof of the new sports hall. Students maintain the beehive together with an external consultant. The purpose is for students to learn about sustainable food production and produce honey products that can be consumed at the school.

***Figure 18**. Student studying a beehive at Gantofta school.*
***Source**: © Gantofta school – shared for the purpose of this publication.*

4. Evaluation of impact

Impact on the environment

The environmental impact of the renovations at Gantofta is multifaceted. The circularity, green procurement and renewable energy practices at the school have reduced greenhouse gas emissions related to transportation, as well as materials and energy consumption. The school could improve in a few areas, such as in its food habits and energy consumption, but these would require more targeted investments in the school infrastructure and behaviours.

By introducing **solar panels and using thermal heating sources**, the school has further reduced its energy needs from the energy grid. Since a large share of Sweden's energy is already renewable, it may be that the ultimate impact of Gantofta switching to solar and thermal energy is not as significant as it might be in countries that are more reliant on fossil fuels. Nevertheless, these efforts make the school less dependent on the energy grid, and provide opportunities for the students to teach and learn about energy savings and climate change preparedness.

The environmental impact of the school renovations is often not very noticeable, since their **effect is mostly indirect**. For instance, by repurposing the old sports hall into a classroom, the school has avoided building another space for additional classrooms, thereby avoiding both further costs and construction-related impacts on the environment. Similarly, by converting a garage into the school kitchen, the school has reduced greenhouse gas emissions stemming from the previous transportation of students to other schools. As a student in the focus group noted – more spaces mean more opportunities and less time wasted on the road.

A few areas remain more challenging to improve, and will be the focus of future brainstorming between students and school staff. Food waste is one of the indicators students help to track as a part of the school's science programme, and one of the few indicators that has proved more difficult to improve. Furthermore, students noted that it is challenging to convince each other to eat vegetarian food, and thus, the canteen still serves meat most days (except on meat-free Mondays). Creating an outside kitchen and amphitheatre and focusing more on outdoor learning and sustainability in the cooking classes are already being planned.

Lastly, the principal and teachers noted that greenhouse gas emissions in schools are primarily concerned with air quality and ventilation. Although the school now relies on renewable energy sources, further reductions could be made in energy consumption. Such reductions would, however, require more costly interventions such as changing windows and improving isolation.

Impact on the wellbeing of learners

Overall, there are several positive signs of improved well-being in the school to highlight, including positive student feedback regarding the interventions and the **increased popularity** of the school. Discussions with students and teachers in the school indicate that the most significant achievements have been in **student agency**. Students learn through activities that are meaningful and relevant to them and driven by their own often self-initiated ideas supported by the school staff. In several cases, students' ideas have led to direct changes in the learning environment and school practices. Areas where there has been less clear positive impact on well-being regarding harassment and feeling of safety (especially for girls and teachers).

For the younger students engaging in the 'Bygglek' programme, the teachers reported a positive impact on well-being and learning (Orre, 2024). The programme exceeded expectations. Students show **increased responsibility, self-confidence, and independence**; conflicts have decreased while collaboration has increased, and children quickly resolve minor disputes to continue building. The activities incorporate many educational benefits that students recognise, such as **practical applications** of math, Swedish, and technology, problem-solving skills, cooperation and communication, physical activity, outdoor time and opportunities for creative expression.

The Swedish school directorate regularly evaluates schools to support quality and inclusive education. For instance, in 2024, it surveyed 3096 schools nationwide on key wellbeing and learning metrics. Skolverket (2024a) published a report on the 2024 results of Gantofta school, comparing it to other regional schools along key quality criteria. The survey found that the school's strengths are **quietness, student influence, pedagogical leadership, and support services**. The school scores a bit poorer on a few social indicators, such as harassment (for students in the 5th and 8th grades) and safety (for girls and teachers).

Response group	Education quality scores (maximum 10)
Areas where the school scored **high** or above the regional average **– students**	Quietness: 6.5 vs 5.4 (Helsingborg) and 5.6 (national) Student influence: 6.2 vs 6.0 (Helsingborg) and 5.8 (national)
Areas where the school scored **high** or above the regional average **– teachers**	Pedagogical leadership: 8.0 vs 7.2 (Helsingborg) and 7.1 (national) Follow-up on work: 8.0 vs 7.5 (Helsingborg) and 7.6 (national) Student health: 7.5 vs 6.2 (Helsingborg) and 6.7 (national) Special support: 6.5 vs 5.7 (Helsingborg) and 5.8 (national) Support: 6.8 vs 6.2 (Helsingborg) and 6.2 (national)
Areas where Gantofta scored **lower** than the regional average **– 5th graders**	Information about the education: 6.1 vs 7.0 (Helsingborg) and 6.7 (national) Preventing harassment: 5.4 vs 6.4 (Helsingborg) and 6.3 (national) Teacher treatment: 6.6 vs 7.1 (Helsingborg) and 7.3 (national)
Areas where Gantofta scored **lower** than the regional average **– 8th graders**	Critical thinking: 4.7 vs 6.1 (Helsingborg) and 5.6 (national) Student influence: 4.0 vs 4.9 (Helsingborg) and 4.5 (national) Preventing harassment: 4.7 vs 5.4 (Helsingborg/national) Safety: 7.1 vs 7.7 (Helsingborg) and 7.8 (national)
Areas where Gantofta scored **lower** than the regional average **– teachers**	Collaboration: 5.8 vs 6.5 (Helsingborg/national) Student treatment: 6.0 vs 6.1 (Helsingborg) and 6.5 (national) Safety: 5.8 vs 6.4 (Helsingborg/national) Assessment and grading: 5.8 vs 6.3 (Helsingborg) and 6.2 (national)

In addition, boys generally reported feeling significantly safer than girls (scores of 8.9 versus 6.7, respectively). Boys rated treatment by peers, stimulation, and support higher than girls, while girls rated teacher treatment (6.5) higher than boys (5.6). These findings are consistent with findings from other studies across Sweden and the EU on gendered bullying patterns and the tendency of girls to perform better than boys in school, which could explain their perceived better teacher treatment. Consequently, boys may be more in contact with support services and thus rate these higher.

Focus groups with the students also indicate that one of the most positive well-being impacts the interventions on students regards **student agency and involvement**. Students who work on product design projects often end up directly in real products used at the school to improve sustainability. In the science programme, students designed their

ideal schoolyard in Minecraft, using digital visualisation, illustrative geometry, and mathematics skills (Pedagogsajten, 2021). Some of the less complex ideas have already been put to life, while others are planned for the future, given the need for more funding.

Finally, the students participating in the focus group highlighted the impact of the work on sustainability on the **overarching school culture**. Gantofta is a school where one can be oneself, and it's **a 'kind school'**. This matters for learners. Students shared that due to the positive focus on circularity principles, it has become normalised to wear second-hand clothing. Two students who recently transferred to the school from another school commented that they noticed a big difference in students' attitudes. A student noted that while in another school, she felt much more pressure to wear fashionable and new clothes; in Gantofta, 'no one cares', and one wouldn't get bullied for wearing second-hand clothes. Gantofta was seen as overall more **inclusive, with less bullying and more healthy lifestyles**. The students noticed that energy drinks and tobacco were much less visible in the school environment.

Impact on learning outcomes and sustainability competences

Literature reviews suggest that improving the well-being of students and sustainability achievements of a school (e.g., improving indoor air quality and outdoor learning) enhances student health and concentration with potential positive butterfly effects on learning. This section looks at the school's achievements and developments across the last 5-10 years when Gantofta has been the most active in sustainable learning environments and learning for sustainability. Have these efforts positively impacted students' learning outcomes in general and concerning sustainability competences?

Overall, for 2024, the school scores are around average on national tests regarding Swedish, English and Mathematics levels in the school and slightly lower than the region average (Aftonbladet, n.d.). Yet, the first chart below show some interesting trends over time from 2015-2024 regarding the average grades. First, **the average grades across 17 subjects increased** from 200 in 2014/15 to 240 in 2023/24. Second, since 2022, the average grades are **higher than the national average**. Finally, there are **clear gender differences**: boys improved their scores more over the years (from 160 in 2014/15 to 260-270 in 2023/24), while the girls' results varied more.

Regardless of these positive results, there haven't been any experimental studies to investigate the relationship between the learning spaces and teaching on learning outcomes. Thus, one **cannot claim direct causality** between the interventions and the positive learning outcomes. Furthermore, the student mass has changed a lot over the years, and all the school's achievements may have inspired families that are more educated and concerned about sustainability to move to the area or place their kids in the school. Thus, it is possible that the socio-economic backgrounds of parents partially explain the improved scores. The second chart below indicates that the number of inhabitants with more than 3 years of education after high school (black line) is increasing in Helsingborg.

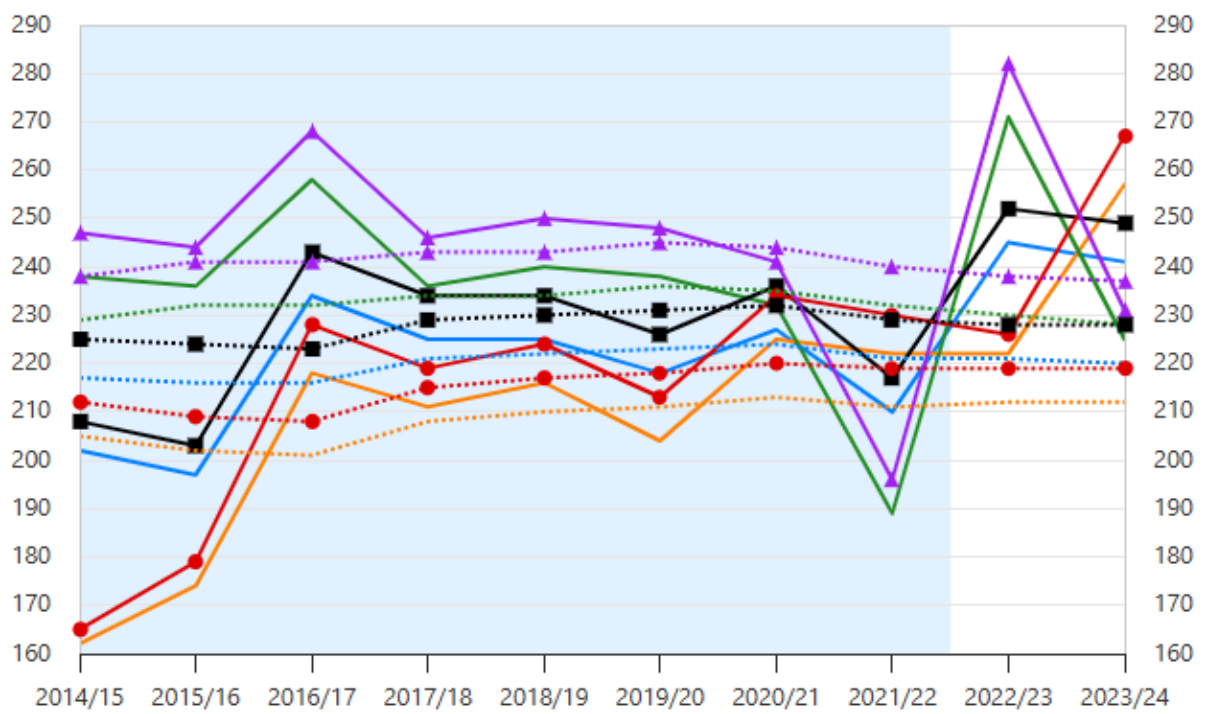


Figure 19. *Average merit score, grade 9 (15 years of age) over the last 10 years at Gantofta school.*
Note: *The blue line is the average; the purple and green lines are girls; orange and red are boys. Dotted lines are national averages.*
Source: *Skolverket, 2024b.*

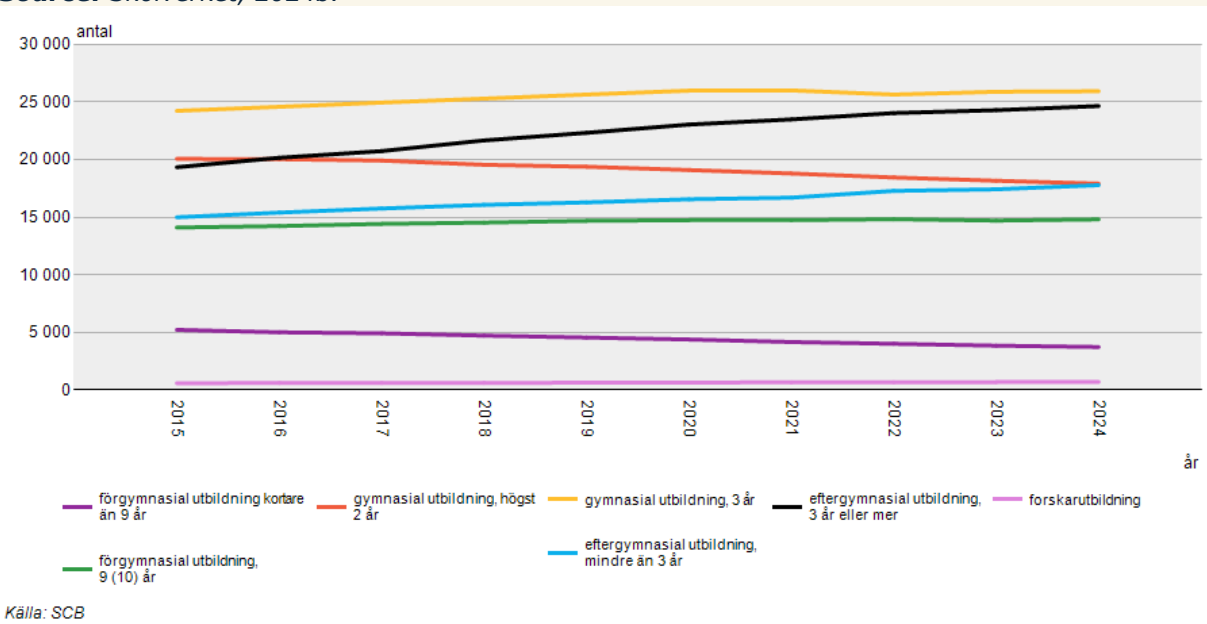


Figure 20. *Educational attainment levels and changes in population numbers by year in Helsingborg.*
Note: *Yellow represents secondary education plus 3 years; black represents secondary education plus 3 or more years; red represents secondary education plus a maximum of 2 additional years; blue represents secondary education plus fewer than 3 additional years; green represents compulsory education; purple represents less than compulsory education; and lavender represents research-level education.*
Source: *SCB, 2024.*

Sustainability competences are not assessed directly in the Swedish education system; thus, no statistics are available regarding their development. However, discussions with teachers paint a positive picture: students' sustainability has improved over the years.

Students are **more aware of and engaged in sustainability.** They are also **more digitally skilled and innovative** when engaging in sustainability at school.

A research report from 2023, based on an analysis of surveys and interviews with students, found that **the science programme at Gantofta stimulates students to pursue higher academic studies** after they finish school (Skånes Kommuner, 2023). While this study did not focus on its impact on learning outcomes *per se*, it does indicate that students **gained interest in science and sustainability as viable and exciting career paths**. Students who were motivated towards higher studies prior to participating in the science programme saw their attitudes strengthened positively by participation. Following their participation in the programme, increased interest in higher studies was also seen among those students who previously had a lower level of motivation. Motivation increased among those students who achieved higher grades at the end of the programme.

With regard to **digital competences**, improvements have been made since 2018, when innovative digital pedagogy began to be applied more comprehensively at the school. Gantofta hired a teacher specialising in digitalisation for their science programme. Now, students regularly gather and analyse data from sensors and trackers around the school, and use "**storyfication"** to communicate their findings. This relates to a two-year project in which students were given a specific challenge to solve with the help of a fictional character. During the first year, the students worked their way through a game with their character on cross-curricular assignments, using various digital tools. During the second year, students blogged and shared stories online about what lessons they had learned and what achievements they had made.

The results of this show that both **educators and students' digital competences improved.** leading to higher student engagement (Pedagogsajten, 2021b). Among students, 80 % felt they had become more used to using computers by the end of the project. According to a survey run by the school, the students had also increased their awareness of laws and regulations on the internet (e.g. the General Data Protection Regulation). They learned to source information online more critically, as well as to program, record sounds, create digital cartoons and reflect on society's structure and functions using multimodal expressions. Teachers also improved their digital skills via the experience. Along with the above increases in digital skills among students, there was a need for increasingly challenging teaching, and thus higher levels of digital competence among educators. Hence, this project had a positive spill-over effect on the development of teachers' digital competences.

Limitations and challenges

Despite its positive outcomes, Gantofta school sees room for improvement in the following:

- **Supporting teachers with time and resources for professional development.** In projects that mix sustainability with digitalisation, it is sometimes challenging for teachers to keep up with the pace of student learning, given how rapidly technology develops and what little time is available for teachers to learn. While bringing in expertise from outside can address this challenge to some extent, it is also essential to support teachers and ensure they have the time and opportunity to keep up with the most critical developments in their area of expertise. As one teacher noted, "Students have challenged us in our digital competence, and we have tried to be one step ahead of the student (…). With higher workloads during parts of the school year, the creativity of us educators has been more sparse." (Pedagogsajten, 2021b).
- **Communicating the success and rationale behind the sustainability efforts to the students and parents**:

- Interviews with school staff and students revealed that the school does not communicate enough about its achievements. Both school staff and students noted that some people perceive that the school only engages in circular practices in order to cut costs and save money. Hence, there is a need to communicate more clearly the reason for these actions, and how they benefit learning and teaching and the school surroundings.
- While school staff often communicate on Facebook, these posts focus primarily on students' work and concrete actions – not on the rationale that underpins the school's actions. The school's rationale for sustainability is also not described in any strategy or on the school's webpage. The survey by Skolverket found that information about education was perceived as being lower among 5th-graders (11 years of age) and parents than the regional average.
- Students suggested that the school could consider using additional platforms to sharing its results, given that young people no longer use Facebook. In addition, more substantial communication in and around the school, or on the platforms used by students, could motivate them to behave in more environmentally friendly ways within areas identified for sustainability improvements (e.g. informing students about carbon emissions next to the price tag on meat in the canteen).

Strengths of the initiative and lessons learnt

Gantofta school is an excellent **example of the use of circularity principles in renovating school spaces** and in **bringing students along on this learning journey**. Its activities contribute to the development of students' science, digital and sustainability competences, emphasising student agency and community collaborations.

- **Strong and distributed leadership for and with the students.** The school actively supports students in their academic, personal and professional development, allowing them to engage in ongoing school development processes and practices and to take individual sustainability initiatives. Students generally feel listened to and included, and the school's open culture and distributed and present leadership nurture inclusion and well-being. This type of leadership is crucial to the continuation of sustainability efforts at the school. School staff report that prior to this current distributed leadership, sustainability efforts were led by one highly motivated teacher – but that once she had left the school, all the work on sustainability ceased. It is therefore crucial to have in place an engaged group of staff members who can collaborate and continue these efforts, even when there is staff turnover.
- **Supportive governance structures and personnel.** The school does not operate in a vacuum. Instead, it is strongly supported by local policymakers and urban planners. The city of Helsingborg (which aims to be a climate-smart city) directly motivates the school to get involved in these efforts (e.g. funding for innovations and concrete ideas such as the Bygglek programme). In addition, the city has a dedicated environmental and leisure coordinator within its school administration. The coordinator visits schools in the city region, advises them on whom to contact, how to apply for public funding, and brainstorms sustainability solutions. The current coordinator is an ex-middle school teacher with 20 years of experience in teaching and an environmental sciences degree specialising in the intersection of pedagogy and environmental issues (Sjöberg, 2023).
- **Community collaborations.** One highlight of the school's efforts is its impressive collaboration with the local municipality, research institutes and businesses. The school's work leaves a mark on the local community and inspires other schools. Nowadays, teachers at the school's science programme visit other schools with a

sample of students to share the lessons learned in the initiative. Each year, the school also participates in conferences and events to showcase the work of the science programme. Art by students in 4th grade (10 years old), in which they conceptualise the SDGs, has been exhibited at the Habiteum Museum in Helsingborg. One of the art pieces demonstrates the work on SDGs at the school, focusing on greenery, safe playgrounds and renewables (Pedagogsajten, 2021c). Together, these efforts inspire more schools toward sustainable development and attract new collaboration partners.

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Case study: GRG7 Kandlgasse

Vienna, Austria

Institutional initiative

Key findings

- **GRG7 Kandlgasse school is known for its inclusive education approach and strong partnerships** with various organisations, including the local district, ÖKOLOG[44], academic institutions and non-governmental organisations. These collaborations enhance the educational experience for students by promoting inclusivity and equity, providing engaging activities, and fostering sustainability and environmental awareness.
- **Greening elements offer excellent potential to improve the learning environment in urban areas**. Greenery and photovoltaics make for great synergy on the school's roof, maximising the potential of its PV panels. The greening of the school's façade serves as shading and improves the thermal insulation of the wall, as well as having a cooling effect on the microclimate and the area surrounding the greenery. The combination of these three effects also positively influences the indoor climate. The outdoor green walls have a cooling effect, especially on sunny summer days, and the moisture released by the plants ensures a comfortable indoor environment in winter. The courtyard greenery has a cooling effect of up to 2°C. Newly installed measuring devices include sensors for particulate matter and CO2, as well as instruments to measure the green infrastructure's temperature and humidity data and provide readings on indoor air quality and the effects of the greening systems.
- **Although the school has several green spaces, these areas are not yet fully utilised for learning**. For example, the school garden functions primarily as place for play. If used effectively, these spaces could contribute significantly to the development of sustainability competences; students could participate in hands-on activities related to sustainability topics. However, practical and technical challenges persist, such as ensuring safe access to the roof, or instructions on who to coordinate with regarding the maintenance or use of the roof.
- **Among the remaining challenges, are limited awareness of sustainability issues** and a **lack of guidance** on sustainable learning environments. Ensuring that sustainability is integrated into school curricula, as well as that there is sustained support and instruction, will be critical for long-term success.

1. Introduction

The present case study explores the school's journey towards the adoption of a holistic approach to learning environments for sustainability, while maintaining its **core mission of providing students with support, respect and gender equality in a family atmosphere**[45]. Evidence is drawn from a combination of desk research, interviews with school administrators and educators (five interviews in total), as well as fieldwork conducted by a national expert. GRG7[46] Kandlgasse is a lower- and upper-secondary school in Vienna with 570 students and 85 teachers. It is both a classical *Gymnasium* and a *Realgymnasium*[47]. Despite space and resource constraints, the school has gained recognition for its **inclusive, innovative and flexible educational practices, enhanced**

[44] ÖKOLOG is a programme initiated by the Austrian Ministry of Education. It has been running for 25 years, currently operates in around 750 Austrian schools. ÖKOLOG implements environmental education for sustainability and deals with environmental, economic and social issues. The programme supports sustainable thinking and action in the transformation of everyday school practices.
[45] More on the values of the school can be found at: https://kandlgasse.at/infos/schulprofil/leitbild.html
[46] GRG stands for "Gymnasium und Realgymnasium", which means "secondary school and secondary school with emphasis on sciences".
[47] A *Gymnasium* is a secondary school that focuses on the liberal arts, humanities, and at least two foreign languages and prepares students for university studies. A *Realgymnasium* focuses on mathematics, natural sciences and geometry.

by its collaboration with external academic institutions. It is also driven by **motivated teachers,** committed to improving student outcomes.

The school's core values are centre around three main pillars: social, ecological and networking. The school takes a **responsible approach to nature and the environment**, teaching students through **project-based lessons and interdisciplinary work**. The school is committed to fostering critical and democratic awareness. It is also passionate about ensuring equal opportunities and promoting gender equality. In 2016, GRG7 Kandlgasse won the Austrian School Prize for Sustainability and Responsibility.

In recent years, **the school has incorporated greenery, thanks to the collaboration with the Technical University (TU) Vienna**, which led the initiative. Initially, the project focused on gathering data on air quality rather than directly improving student well-being or learning outcomes. This case study explores the benefits and impact of greenery on well-being, health and learning outcomes.

Due to a lack of curriculum integration and untapped potential in its green spaces, the school does not currently embody the vision of a fully sustainable learning environment. However, its **dedication to progressive education and inclusive practices, including flexible teaching methods**, reflects a willingness to embrace future opportunities. The planned expansions offer the hope of better aligning the school's physical spaces with its sustainability goals and values. This includes the potential creation of quiet areas – "learning islands" – and sensory-friendly environments that enhance student well-being and learning experiences. These places would serve as retreats for quiet or focused work. In this case study, we also reflect on the challenges and aspirations involved in integrating sustainable learning environments into contemporary educational settings.

2. Whole-school approach

Adopting a holistic approach to education through the whole-school approach involves integrating learning for sustainability into every aspect of the school's operations, teaching methods and relationships. While the school may not explicitly state that it adheres to the whole-school approach, our analysis demonstrates that specific dimensions of whole-school approach are particularly strong. These include governance, institutional practices, pedagogy and community collaborations. In contrast, other areas, such as capacity building and curriculum, are less well developed.

The school demonstrates strong **governance,** with **inclusion** as a core principle, significantly reinforced by the *Wiener Mittelschule (WMS)*[48] structure, which facilitates diverse educational opportunities and support systems. The school follows a series of core values, described below:

Environmental sustainability: several green spaces have been designed and implemented in collaboration with academic institutions, teachers and students. These have shown a positive influence on the environment.

[48] This model integrates students who do not meet the standard academic qualifications for an academic high school (AHS). It provides additional resources and promotes flexibility within the school, fostering a more inclusive environment.

Pedagogical value: teachers are highly motivated and interested in maximising the potential of green spaces for teaching and learning. They often introduce teaching together in teams in their lessons, as well employing hands-on or outdoor learning.

Well-being and inclusivity: the school promotes an inclusive and equitable approach to education. Its outdoor green spaces cater for play with and in nature.

Participation: the school engages academic institutions, teachers and students in the design and implementation of its learning spaces. In this way, it empowers the school community to take collective responsibility for sustaining and protecting these spaces, and promotes environmental awareness.

In terms of **pedagogy and learning**, the school encourages **sustainability initiatives and environmental awareness** through "do-it-yourself" workshops and waste reduction projects such as its Waste Action Weeks (*Müllaktionswochen*)[85], organised by the Ökolog[49] Team and the Waste Scouts project, or the campaign "Saving the Bees", which recognises the importance of bees for ecosystems. The school has a designated individual responsible for overseeing environmental education and sustainability initiatives – the ÖKOLOG-Coordinator, who is part of the teaching staff. The school's recent "Repair and Reuse" initiative, which encourages students to repair and reuse items, is an example of a sustainability activity that promotes practical environmental awareness. In a recent project, students collected plastic items from home and had them professionally photographed for a photo exhibition that explored plastic use. Future events, including upcoming Climate Days for younger students, aim to further integrate sustainability education. However, these initiatives are not linked to the school's green spaces.

The school participates in ongoing exchanges with the local district council, the University of Vienna, the Vienna University of Technology (TU Wien) and the University of Natural Resources and Applied Life Sciences (BOKU). These **partnerships** are an integral part of the school's general network. While they do not specifically focus on sustainable learning spaces, they have undoubtedly played a pivotal role in advancing a deeper understanding of this topic. TU Wien, in cooperation with BOKU and Kräftner Landschaftsarchitektur and ATB Becker eU, installed various types of greenery at the school in 2015 (as part of the GrünPlusSchule project), funded by the Austrian Research Promotion Agency (FFG).

In addition, the school has collaborated with NGOs that focus solely on the environment. The organisation Green Cool School[50] has been involved in specific initiatives at the school such as creating an insect hotel and supporting plant care on the green roof. Global 2000 regularly conducts workshops on climate-related topics, including urban climate adaptation. Although not explicitly tied to the school's green spaces, these workshops bring valuable environmental perspectives to the students. Another initiative in which the school is involved, Climate Ready School, is part of a more significant effort to prepare schools for climate challenges, with the aim of implementing improvements that align with broader climate resilience goals.

[49] Ökolog is a programme for environmental education and school development in Austrian schools. It contributes to the UN Sustainable Development Goals and is initiated and supported by the Ministry of Education.
[50] For more on this, see: https://www.grueneschulen.at/projekte/gymnasium-kandlgasse-39-wien/

Partnerships are a significant part of the school's identity, enhanced by strong **community collaborations with organisations that support inclusion**. For example, support for students on the autism spectrum is provided by the umbrella NGO for organisations caring for the needs of people with psychosocial disorders in Austria, Pro Mente. This ensures these students can access the necessary resources within the school environment. The school also has a robust partnership with the Federal Institute for Visually Impaired Students, whose goal is to provide visually impaired students with accessible learning resources and support, guaranteeing a barrier-free educational experience. Such partnerships and support systems help to guarantee an equitable, accessible educational experience for students with disabilities, enabling them to participate fully alongside their peers. Ensuring inclusion promotes high-quality learning for everyone, as well as social sustainability, and positively impacts the well-being of all learners. The commitment of **teachers** is vital to a school's social performance – and teachers at this Viennese school are highly motivated, implementing a range of projects for students. Initiatives are driven by individual teachers who recognise the significance of LfS and act on their motivation. Teachers collaborate actively with environmental organisations and conduct workshops. Some teachers have specialist training in dyslexia support, political education, ICT, museum pedagogy, Gestalt pedagogy, mediation or learning coaching.

Teachers collaborate mainly within **teaching teams** specific to their subjects, teaching together in teams within the classroom. This approach ensures shared responsibility and enhanced support in delivering the curriculum. Team teaching sessions vary in format depending on the specific lesson. Sometimes they involve the division of teaching responsibilities, or a more integrated approach to presenting the material collaboratively. Educators are encouraged to collaborate between subjects and to try out innovative teaching methods. This collaborative approach – especially prevalent, due to team teaching setups in the lower grades – allows teachers to develop more flexible and varied instructional methods. However, the focus of such practices is more on general teaching approaches than specific guidance on sustainable learning spaces.

Teachers of different subjects, including biology, geography, art and design, collaborate to develop projects that align with a selected **Sustainable Development Goal** (SDG) for the week. This initiative forms part of the *Freiarbeitsklasse* (iIndependent work class"). While not all classes will necessarily focus on SDGs, students receive weekly independent work plans under this initiative that allow them to choose which subjects to focus on, and in which order. Parents can influence whether their children are placed in the *Freiarbeitsklasse* when they begin lower-secondary school. The teaching team incorporates SDGs into their planning, each week selecting specific goals that are relevant and meaningful for the students. They then facilitate interdisciplinary learning experiences by brainstorming ideas related to the SDG and deciding which subjects best fit each concept. On the basis of the chosen SDG, each teacher then integrates the theme into their individual subject, creating interdisciplinary connections across the curriculum. These activities foster independence and personal interest on the part of students.

One example of a *Freiarbeitsklasse* is presented by a biology teacher who deliberately incorporates the green wall into their lessons. It was recently used to demonstrate plant characteristics, such as leaf structure and vein patterns. The teacher also seized the opportunity presented by the green wall's malfunctioning irrigation system to illustrate how inadequate watering harms plant health. This unplanned but invaluable and engaging teaching moment showcased the evolving learning experience with nature, providing a tangible example of plant care and environmental impact. Other teachers stated that they actively incorporate sustainability and environmental protection into their teaching of biology, geography, economics and environmental education, setting a strong example for the integration of nature-based learning.

Another example is the elective Future Lab, which integrates green features into the teaching process. In this class, students explore the urban environment, climate change and mobility. This course employs an interdisciplinary approach by integrating biological and geographical perspectives on human impacts on the Earth, with sustainability as a central theme.

Lastly, a teacher of Art, technology, design and spatial planning integrates discussions about green spaces into the curriculum. These include topics such as the design of such spaces, the use of sustainable and renewable materials, and maintenance practices. This approach encourages students to think critically about sustainability and whether particular objects or materials contribute to long-term or short-term use. As a result, sustainability becomes an everyday concept for the students. The school's green spaces provide numerous **spontaneous opportunities** during its afternoon care programme. During afternoon care, students frequently focus on outdoor plants, picking berries and asking questions about edibility and plant types or observing local wildlife, such as a pigeon nesting in the outdoor green wall.

Student engagement is essential in establishing and maintaining ownership of space and developing sustainability competences. The planned redesign of one nearby street provided an opportunity for committed 8th-grade students from GRG7 Kandlgasse. As part of the elective Future Lab, they created a concept for a safer, more attractive and climate-friendly redesign of the school forecourt. Reclaiming the school's front area as a public education space is a future aspiration. It has the potential to enhance urban space and create a more open, engaging area for the school and the wider community. This illustrates the school's broader vision of sustainability, which extends beyond its own walls to include how it interacts with its surroundings.

Another example of such engagement is the installation of indoor green walls, which were developed in collaboration with TU Wien employees, students and teachers from the school. Some students take the initiative to pluck dry leaves from the green wall or to report problems such as lighting issues. Nevertheless, these students do this independently rather than as part of a structured plan for involvement. In the courtyard, students often show interest in natural elements, such as collectively picking mulberries or checking on the fish in the pond. This interest primarily surfaces during unstructured times, such as during afternoon care sessions, rather than as part of formal classroom activities.

3. New learning settings

The school incorporates a number of diverse green spaces. However, these spaces have not yet been integrated into a structured curriculum, and the learning potential of the green spaces has not yet been fully explored, although many teachers have highlighted their interest in enabling more structured interaction and educational opportunities.

Green roof

In 2015, the gymnasium roof was renovated by sealing and the addition of insulation. Recognising an opportunity, the school also transformed it into a green roof. Since fall protection, scaffolding and the construction site lift were already on-site, these resources could be reused.

The green roof is located on the eastern side of the school and is accessible through a physics classroom on the top floor. It covers a space of approximately 50 m^2. The green roof is a sustainability feature that integrates **photovoltaic (PV) panels** together with vertical green façades, using the shading and cooling effects of the vegetation to increase solar efficiency. By positioning the greenery at varying distances from the PV panels, the façade reduces the surface temperatures of the panels, helping to maintain higher energy output, particularly in an urban environment where heat can reduce PV efficiency. This combined system aims to improve energy efficiency and indoor climate control while adding green infrastructure to the school.

Figure 21. *Photos of the green roof and solar panels.*
Source: *© PPMI, 2024. Photographer: Gabriel Kudela.*

The surface of the green roof is covered with **natural vegetation**. The roof supports biodiversity by being mown infrequently, allowing plants to grow tall enough to provide habitat for various insects and to attract pollinators. It also absorbs rainwater, which helps to manage run-off and contributes to a cooler, more energy-efficient building environment.

The green roof is also home to an **insect hotel**, built in collaboration with an external sustainability initiative and with the active involvement of students. This project promoted environmental awareness and hands-on learning. The insect hotel provides nesting and hibernation sites for insects such as solitary bees and ladybirds, which contribute to pollination and natural pest control.

Figure 22. *Insect hotel at GRG7 Kandlgasse*
Source: *© PPMI, 2024. Photographer: Gabriel Kudela.*

Teachers are interested in using the green roof as a dynamic learning environment, but have not yet been able to do so. Its potential remains untapped due to safety issues, such as the need for secure railings and controlled access. While the photovoltaic system's output is shown on screens in the assembly hall and physics room, its potential for educational use also remains unexplored. Addressing these issues could transform the space into a safe, engaging area for student activities, unlocking valuable learning opportunities. Moreover, teachers and students currently have only limited knowledge of certain features, such as the vertical green façades behind the PV panels. Although students were involved in constructing the insect hotel, it is now located

on the green roof, and therefore inaccessible. Ensuring accessibility and long-term engagement could provide an opportunity to provide more sustainable learning opportunities. Creating opportunities for regular interaction with these projects could help to reinforce their educational value and keep them fresh in students' minds, fostering a more profound and lasting connection to sustainability.

School garden

The school garden was created with the help of a teacher who has now retired. Its garden beds were constructed using old railway sleepers and are planted with various shrubs and perennials. The horticultural planning and redesign of the planting beds in the inner courtyard took place during a practical workshop lasting several days, carried out with pupils as part of the regional project *Mikroschulklima,* together with professional support and the local Office for Sustainable Competence and the Institute for Engineering Biology and Landscaping at BOKU.

The School Garden is located in the school courtyard and covers an area of approximately 50 m^2. It includes several "green islands" of trees, shrubs and other plants that create shaded areas, which are particularly valuable during the warmer months. Several trees produce edible fruit, including plums and berries. There is also a small pond with goldfish in the garden. The space is used by teachers and students for both recreational and learning purposes, allowing classes to be held outdoors when the weather permits, reducing overcrowding indoors and providing a fresh-air alternative. While the green outdoor areas are considered valuable for teaching, these spaces are close to the sports area. Thus, when physical education classes are held, it becomes a challenge to use them for quiet academic activities.

The school garden provides many benefits for learners, including social and educational ones. Students can play in shaded areas, which create a more comfortable environment that reduces heat exposure. Students are taught sustainable ways of interacting with the environment, such as using only fallen branches. The greenery stimulates student curiosity and has the potential to increase student engagement.

During our observation, the school garden stood out as the most actively used element of the sustainable spaces in the school. Students could always spend time in the garden, even despite low outside temperatures. Many students engaged with its natural elements – playing with the soil using fallen branches, sitting and chatting, or simply observing the trees and the fish pond. When asked, students said that they enjoyed being in this space, with many noting that it's their favourite place in the whole school.

Figure 23. *Courtyard at the GRG7 Kandlgasse.*
Source: *© PPMI, 2024. Photographer: Gabriel Kudela.*

One of the school's caretakers is very fond of the school garden and is committed to its upkeep and improvement. This year, the caretaker[51] attempted to introduce flowering plants, but the effort was unsuccessful as the soil appeared to be "dead" – lacking the essential nutrients needed for such plants to thrive. Addressing this issue could breathe new life into the garden and open up opportunities for its growth and success. The failed attempt highlights a lack of effort in maintaining the soil, as the caretaker noted that the last time the soil was replaced was eight years ago, when the school won the Austrian School Award and pupils were involved in renewing the school garden.

Figure 24. *Another courtyard at the GRG7 Kandlgasse.*
Source: *© PPMI, 2024. Photographer: Gabriel Kudela.*

Some biology teachers have expressed concerns about the fish pond, viewing it as a limited space for the fish – more like a "prison" than a natural habitat. While they acknowledge its educational value in allowing students to observe animals up close, it has several drawbacks. Occasionally, students try to interact with the fish by poking at the water, which can inadvertently encourage a problematic attitude toward nature. Such behaviour treats living creatures as objects of entertainment rather than beings deserving of respect and careful observation. This situation highlights the need for sustainability education, and suggests the potential for a valuable learning experience.

Outdoor green walls

Outdoor green walls are located in the school courtyard and entrance hall. The green walls on the south elevation of the building feature two different systems: a trough system and a cassette system[52]. Both are designed to provide an effective cooling and insulating layer for the building, contributing significantly to sustainability by reducing energy requirements and providing shade during the summer months while improving thermal insulation throughout the year. They also reduce the surrounding ambient temperature through evapotranspiration, helping to counteract the urban heat island effect. The design also incorporates monitoring systems to assess the impact of the green walls on nearby photovoltaic panels in order to optimise the cooling effect and maximise energy efficiency. In addition, the school's entrance hall features two vertical green walls that bring a natural, calming aesthetic to the space. These walls are planted with various species, including climbers, ferns and other resilient greenery. These plants contribute to a healthier indoor environment by improving air quality and increasing humidity in the space, which is particularly beneficial in high-traffic areas such as the entrance hall. The green walls also provide a welcoming first impression for students and visitors entering the building.

[51] *They* are used throughout the case study to keep language gender-neutral.
[52] A trough system uses long horizontal planting containers (or troughs) mounted on vertical structures. It is suitable for large-scale installations. Plants are planted directly into these troughs, thereby allowing more space for root growth. This system is therefore ideal for large plants with extensive roots. The trough system integrates simplified drip irrigation. A cassette system consists of individual panels or cassettes with pre-grown or pre-planted vegetation, smaller in size and used for vertical structures. Each cassette comes integrated with irrigation modules that can be easily replaced.

While teachers and caretakers appreciate the outdoor green walls for providing a refreshing "green island" in an otherwise grey environment, they are not yet fully integrated into the school's learning activities. Teachers recognise their value and are eager to explore ways of linking the green walls more directly to classroom practice in order to enhance their educational impact. Some teachers expressed a desire for the walls to include a greater variety of plants, particularly those that could attract more wildlife, such as pollinators. This would enhance the educational and environmental value of the installation, as students could observe and engage with the increased biodiversity up close.

A few years ago, the main green wall became a nesting site for pigeons, sparking student curiosity and informal learning opportunities led by teachers. However, the caretakers face challenges with cleanliness and hygiene due to pigeon droppings, raising concerns about health risks to students.

Figure 25. *Outdoor green walls at GRG7 Kandlgasse.*
Source: *© PPMI, 2024. Photographer: Gabriel Kudela.*

Indoor green walls

Indoor green walls are located in two of the school's classrooms, and are built as "do-it-yourself" walls by students under the guidance of the Vienna University of Technology teachers and staff. These walls are designed to be inexpensive and easy to maintain. They contain species such as *Epipremnum aureus* (Devil's Ivy), *Nephrolepis exaltata* (Sword Fern), *Chlorophytum comosum* (Spider Plant) and *Spathiphyllum sp.* (Peace Lily), which were chosen for their indoor air-cleaning properties. These walls increase humidity, filter pollutants such as small particles and CO2, and improve air quality and room acoustics, contributing to a healthier learning environment. The moisture they release also maintains a comfortable indoor climate, especially in winter. The classrooms in which the green walls are installed are dark, with little daylight during the winter, so lighting is provided by two UV light projectors.

Figure 26. *Indoor green wall at GRG7 Kandlgasse.*
Source: *© PPMI, 2024. Photographer: Gabriel Kudela.*

Figure 27. *Another indoor green wall at GRG7 Kandlgasse.*
Source: *© PPMI, 2024. Photographer: Gabriel Kudela.*

The Green Wall initiative was part of a larger project that began with the research project GreenPlusSchool (*GrünPlusSchule* in German), which ran from 2015 to 2018. The students who participated in the Green Wall initiative, learning about sustainable design and environmental impact, have since left the school. Educators noted that while these features were briefly incorporated into lessons, there was no long-term plan to integrate them into the sustainability curriculum. The green walls are now seen primarily as aesthetic features with potential environmental benefits. This pattern of installing sustainable features such as solar panels, insect hotels or green walls without consistent integration into teaching was highlighted as a missed opportunity. As several teachers recognised, some greening elements, such as mobile greenery, were removed after the research project ended.

Green corridor

The green corridor, located next to the biology classrooms, offers a pleasant, jungle-like atmosphere with medium-to-large potted plants along the windows. This inviting space is a favourite for students working on group activities, where they enjoy collaborating close to the greenery. While the corridor is currently not accessible during breaks – something that some students would like to see changed – there is an opportunity to explore ways of making this peaceful environment more widely available. A previous initiative allowed students to adopt and care for plants in their classrooms, but challenges with consistent maintenance led to the discontinuation of this scheme. With better support or a revised approach, similar projects could flourish, combining responsibility with engagement.

Figure 28. *Green corridor at GRG7 Kandlgasse.* ***Source:*** *© PPMI, 2024. Photographer: Gabriel Kudela.*

4. Evaluation of impacts

Impact on the environment

Green spaces in schools are vital for the environment. It has been demonstrated that the green spaces in the Kandlgasse are effective in reducing urban heat islands, potentially lowering the temperature of the microclimate by up to 2°C, which benefits the community's comfort. Furthermore, these spaces improve indoor air quality and foster healthier student learning environments. In addition, a positive synergy has been noted between greenery and photovoltaics, promoting sustainability and innovation.

Greening measures at the school were initially implemented as part of the research project "*GrünPlusSchule*" (2015-2018). These measures were designed to be cost-effective. A subsequent monitoring project by TU Wien (Institute for Materials Technology, Building Physics and Building Ecology, Research Department Ecological Building Technologies) and its partners measured the ongoing effects of indoor and outdoor greening[53]. All greening systems and combinations of them were evaluated for their ecological impact, and a cost-benefit analysis was conducted. The evaluation found that greening offers excellent potential to improve learning environments in urban areas, and acknowledged the synergistic effects of the greenery and photovoltaics on the roof. Further investigation revealed that the greening of the façade both serves to provide shade and improves the thermal insulation of the wall, as well as having a cooling effect on the microclimate and the area surrounding the greenery. The combination of these three effects also positively influences the indoor climate.

A second evaluation focused on the effects of wall-mounted indoor greening on hygrothermal comfort depending on the weather conditions. New measuring devices were installed, including sensors for particulate matter and CO2 as well as instruments to measure the green infrastructure's temperature and humidity data and report on indoor air quality, humidity and the effects of the greening systems. This evaluation revealed that

[53] The evidence reported in this part of the case study is mainly derived from the research study conducted by TU Wien (https://nachhaltigwirtschaften.at/resources/sdz_pdf/schriftenreihe_2021-16-gruene-waende-kandlgasse.pdf).

the greening has a cooling effect, especially on sunny summer days, and that the moisture released by the plants ensures a comfortable indoor climate in winter. In addition, the researchers noted its positive effects on energy-saving potential, noise reduction and water retention.

The influence on the microclimate produced by the courtyard greenery were investigated using a simulation. The results of this determined a cooling effect of up to 2°C, but revealed that the perceived temperature is significantly higher due to lower air speeds and reflected heat from surfaces.

The combination of photovoltaics and greening on façades demonstrates that the greening elements positively effect the temperature and performance of the PV modules. The knowledge gained from this research project is helping to understand and explain the effects of green infrastructure in and around school buildings in urban areas. Ultimately, this will become an integral part of sustainable school design, reducing the impact of urban heat islands.

Impact on the health and well-being of learners

Green spaces, often called "green islands" at Kandlgasse school, are significant in supporting physical and mental health and providing a natural aesthetic. Green areas within schools enhance the surrounding natural environment and contribute to users' overall health. Students and teachers report feeling more comfortable and relaxed in greener surroundings, positively impacting their overall health and well-being.

Students often use the outdoor green spaces during breaks to play games such as hide-and-seek among the shrubs and trees, or to interact with the natural surroundings. These "green islands" provide students with an opportunity to be active, promoting their physical movement and supporting both physical and mental health, which aligns with the concept of holistic health. Students generally enjoy spending time outside in the courtyard, and such green breaks can help them to regain attention. The school's outdoor green spaces provide shaded areas, which are especially valuable in the summer, allowing pupils to avoid sitting on the concrete in direct sunlight. In general, teachers appreciate the school having green spaces. These outdoor areas are ideal for team-building exercises, and their positive effect on pupils is noted.

The inside green walls positively affect the air quality in the classrooms and creates a healthy indoor environment. While the difference is not immediately noticeable when moving between green and non-green classrooms, various research studies indicate that good indoor air quality enhances health and productivity.

Greenery provides a subtly calming atmosphere in the classroom and enhances student comfort. The green walls contribute to a more comfortable and welcoming classroom environment and a relaxed feeling. Pupils demonstrate a mindful attitude towards greenery, treating plants as living beings and not damaging them. This mindfulness fosters a sense of responsibility and promotes a supportive classroom dynamic around sustainability values.

Although the school has several green spaces, space constraints prevent the school from providing quiet or private spaces, often referred to as "learning islands", where students can retreat and concentrate in a calm environment. Initially designed for around 500 students, the school now accommodates more than 600 students without any increase in space. This overcrowding creates the feeling of a "battery cage" that harms students' comfort and mental well-being, far more so than the presence or absence of greenery.

Additional space and designated quiet areas are critical to improving student well-being and effective learning, and are one of the school's current priorities.

Impact on learning outcomes and sustainability competences

The green spaces within the school provide an opportunity to promote and actively employ learning for sustainability. The school implements innovative teaching methods, sustainability-related projects and events to raise student awareness. While these practices do not yet constitute a continuous, integrated approach within the school's green spaces, they demonstrate an untapped potential to positively impact students' long-term understanding and practice of sustainability.

Despite the school's currently untapped potential, it has been shown that green spaces on school campuses are vital for learning for sustainability. Learning spaces for sustainability promote relaxation and mental relief, enhance focus, and serve as unique educational tools. They provide invaluable opportunities for hands-on learning, environmental exploration and ecological stewardship.

The green wall at Kandlgasse is a learning space that can illustrate plant biology concepts through observation. Students can see first-hand how plants function, including the role of vacuoles in plant cells or what happens when a plant does not get enough water. This learning experience has led to students noticing the health of other plants around the school, comparing them with the green wall, noticing drooping plants on the green wall and identifying signs of plant distress. This indicates an increased awareness among the students and a shared responsibility for plants.

The outdoor space in the courtyard is an ideal setting for teaching beyond traditional subject matter. It incorporates social and practical learning, whereby students can interact with natural materials. During activities such as shelter building, teachers emphasise the importance of being good stewards of natural resources and their environmental impact. This encourages students to respect nature and to embody sustainability values.

Some students come from homes in which sustainability practices such as sorting waste are not a priority, making it more challenging for them to adopt these habits at school. Teachers note that it often takes a sustained effort to instil these habits, as such students may not initially understand or value practices such as recycling. However, as students progress through the school, their attitudes towards sustainability tend to change positively. Teachers can see that older students better understand sustainable practices and are more committed to them. This shows that positive attitudes towards sustainability grow with age. For younger students, especially those who do not experience sustainability practices at home, initial efforts focus on basic concepts such as separating waste. Projects such as DIY days and waste separation initiatives have helped to raise students' awareness of sustainability. Through these activities, students learn the value of recycling and upcycling. Rather than throwing things away, they see if they can find new uses for them. Over time, these practices begin to take root as the students mature. As evidence of this, discussions about nature and respect for nature do occur at the school, but only occasionally.

Limitations and challenges

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

- **Limited awareness and use of sustainable elements:** while green walls are present in some classrooms, they are not widely integrated into lesson plans across subjects. These features are mainly acknowledged in biology, where teachers have

incorporated them into the curriculum. However, teachers of other subjects rarely refer to the green elements, as they lack specific resources or measurement tools to meaningfully engage with them. One rare example of such engagement is an elective Future Lab that explicitly incorporates into the teaching process green features such as the urban environment, climate change or mobility. However, interaction with other school staff on this topic appears limited, and the initiative is an isolated one.

- **Potential for maximising learning and teaching opportunities:** although students are interested in the green elements within the school and take the initiative to interact with them on their own, this interest primarily surfaces during unstructured times, such as during the afternoon care sessions, rather than as part of formal classroom activities. Moreover, it can be challenging for younger students to switch from playing to focusing in the outdoor area because they are used to seeing it as a place for fun, not learning. The potential for integrating greenery into the curriculum is under-exploited, and there is a lack of a more organised approach or collaboration with other teachers regarding the use of sustainable learning spaces for interdisciplinary or sustainability-focused activities.
- **Lack of guidance on learning spaces for sustainability:** no formal support or instructional guidance for teachers is explicitly provided with regard to the use of sustainable learning elements such as green walls or outdoor spaces. The sustainable learning space is perceived as a standard classroom with green features. Teachers do not receive structured guidelines or training to leverage these elements in their teaching or to establish meaningful collaboration. Although teachers are enthusiastic about the spaces, a few stated that teachers' energy might diminish without sustained support. They believe a thorough overview of the purpose and goals behind installing the plant wall or technical details would have been beneficial. This also relates to its unfulfilled learning and teaching potential. When teachers are unable to provide guidance to students, students are left on their own to interact with the green elements during extracurricular hours.
- **Space constraints:** current spatial limitations present a significant challenge in implementing the school's vision for ideal quiet and green spaces. Previous attempts to transform hallways and shared rooms into quieter, more pleasant environments have been unsuccessful. However, the school is optimistic that expanding via the creation of connections between buildings will result in new, diverse and less structured learning and quiet zones, encouraging students to relax, recharge or study. These could include retreat areas and well-lit, quiet corners, as well as greenery to create a calming environment. Greenery would enhance the aesthetic and functional qualities of these spaces, which could improve students' comfort and sense of security. Such zones could promote a more student-centred and flexible learning experience. The ideal vision for the school in the long term includes a greater number of retreat spaces specifically for students who require quiet or restorative environments. These spaces would feature greenery, non-standard furniture and multiple layouts to accommodate diverse student needs.
- **Limited knowledge about funding and budget allocation for sustainability:** the school administration says it has no information about whether sustainability had been integrated into the school's budget or long-term planning. Knowledge of budgetary specifics, particularly with regard to sustainability, appears to rest solely with the school's leadership. This emphasises a gap in staff awareness of financial matters relating to the initiative.
- **Maintenance challenges:** the school's green spaces require specific and regular maintenance, which poses recurrent logistical issues, with no clear responsibility regarding their upkeep. Teachers limit their involvement to essential care due to

uncertainty around who is ultimately responsible for plant maintenance. Whether this is the school caretakers or external collaborators such as TU, which previously took care of maintenance, the role now seems ambiguous. This uncertainty also creates a lack of confidence among staff members, including custodians, who are already overburdened and may not want to take on additional tasks in relation to the green spaces.

- **Technical challenges:** the automated irrigation system for the green wall, controlled externally, often activates unpredictably, causing noisy disruptions during classes and tests. Teachers cannot access or receive training on how to manage the system, which only compounds the issue. Furthermore, the wall's bright lighting cannot easily be switched off, which disrupts activities such as film screenings.

Strengths of the initiative and lessons learned

Kandlgasse School demonstrates an excellent approach to partnerships and education. This programme has several strengths, lessons and recommendations.

- **Excellent partnerships:** the school is highly regarded for its openness to innovative projects and external partnerships, including collaboration with leading institutions such as the Technical University of Vienna (TU) and the University of Natural Resources and Life Sciences, Vienna (BOKU). This openness has reinforced the school's standing as a progressive institution willing to engage with various educational initiatives, even if the integration of sustainable learning spaces remains limited. Further support from these partners would enhance the school's capabilities by helping in the design and implementation of specialised quiet or green spaces.
- **Inclusive education as a priority**: the school's focus has shifted towards inclusivity, providing comprehensive support for a wide range of learning needs, including students with autism and others who require individual attention. The school has fostered a powerful sense of teamwork among staff and students, which has become a fundamental element of the school's functioning. This inclusive focus has inevitably deprioritised the school's sustainable learning spaces, as resources are now directed towards ensuring a barrier-free educational environment. Hence, a sensible approach and balance that integrates both inclusion and sustainability is needed to secure the school's environmental and social sustainability.
- **Integration of green elements:** the school demonstrates a strong commitment to sustainable initiatives such as green walls. While these are not fully integrated into the curriculum or classroom management strategies, there is potential to do so. Embracing the benefits of motivated teachers, trusted partnerships and engaged students could help to enhance and promote a more meaningful integration of the school's green elements into daily practices and curriculum. In addition, assigning a dedicated teacher as a formal coordinator would significantly enhance the benefits of these resources for the community. This role could involve coordinating with external experts, facilitating communication and fostering awareness among students and staff about green spaces and sustainable initiatives, particularly at the start of the school year.
- **Value of outdoor green spaces for learning and play:** outdoor green spaces are particularly beneficial in warm weather, allowing students to escape stuffy classrooms. Acknowledging and promoting the environmental and social benefits of outdoor green spaces and their contribution to users' well-being and health, could enhance awareness and foster shared responsibility for these spaces, and advocate for collective action.

- **Addressing practical challenges:** minor maintenance and operational challenges could be addressed through more structured guidance and communication between staff and teachers, including the allocation of clear responsibilities. Having specific contacts or instructions on who to coordinate with (such as TU Wien or a dedicated organisation) regarding the maintenance or use of the greenery, or where to get information, would have enabled more structured interaction and maximised educational opportunities. Furthermore, engaging students in the care of green areas could enhance their sense of self-efficacy, teaching them that they can maintain and sustain the environment.
- **Addressing spatial issues:** creating more dedicated learning and quiet zones would enhance sustainability and student well-being. This expansion could alleviate overcrowding, potentially creating more space and a less cramped environment. Meeting the school's immediate spatial and educational needs would also enable a greater focus on sustainability initiatives.
- **Continued progress in sustainability awareness:** there is optimism that the school is moving in the right direction, especially with initiatives such as DIY days and recycling projects. The school's efforts are perceived to be more advanced than other institutions, fostering a positive trajectory towards sustainability and awareness.

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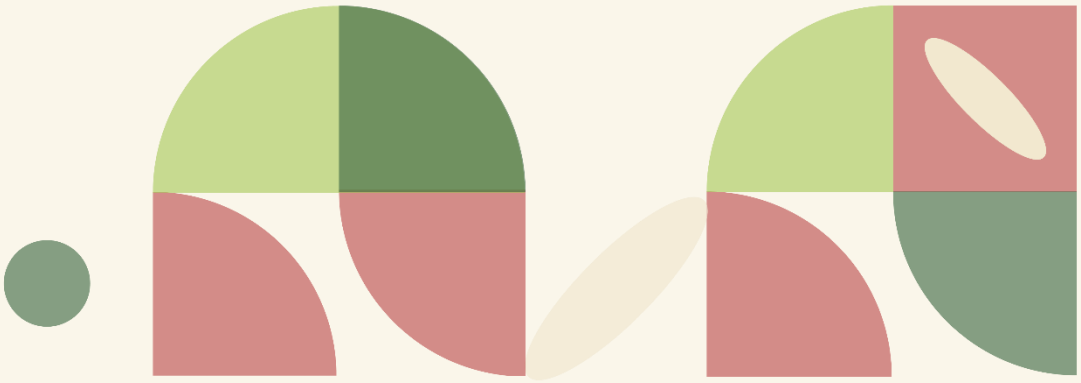
Case study: Liceo Keplero Roma (Keplero secondary school)

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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Case study: School Sector Technical Climate Action Roadmap 2023 to 2030

Ireland

National policy initiative

1. Key findings

The policy initiative "School Sector Technical Climate Action Roadmap 2023 to 2030" in Ireland sets out a transformative and holistic approach to educational infrastructure. It prioritises **decarbonisation and energy efficiency** to modernise and renovate outdated school spaces, while promoting **learning for sustainability.**

- **The roadmap offers multiple pathways for the school sector to achieve its energy efficiency goals and reduce greenhouse gas emissions**. However, there is no clear evidence of the impact the renovated learning environments have on teaching and learning, how they work and relate to each other in practice, or whether energy retrofits directly support learning for sustainability. Nevertheless, the situation on the ground remains promising. Under the funding for the National Strategy for Education for Sustainable Development (ESD) 2030 (hereafter, "ESD to 2030"), schools can choose projects that align with their specific needs, context and interests. These projects vary widely from enhancing learning environments (such as by the establishment of school gardens) to developing innovative educational initiatives. This approach underlines the reality that these projects are practical and interconnected, emphasising the relationship between learning environments, sustainability, and learning for sustainability.
- **There is a lack of explicit linkages between the programmes and initiatives which the roadmap encompasses.** In particular, the ESD to 2030 priority of "Transforming Learning Environments" – which takes a holistic approach, including infrastructure and pedagogical transformation – does not appear to be systematically referenced or integrated within other initiatives. Instead, the roadmap presents these programmes as separate efforts rather than interconnected components of a cohesive strategy. For instance, while infrastructure-related initiatives, such as the Pathfinder programme, focus on energy efficiency and decarbonisation, their connection to the educational transformation envisioned by ESD for 2030 remains unclear. This indicates a fragmented approach in which learning for sustainability is seen as a distinct goal rather than as a fundamental part of broader systemic change. **Strengthening these connections** could enhance the overall coherence and impact of the roadmap. Still, the strategy is a noteworthy attempt to bring everything together under one umbrella, and has prepared a framework to support an integrated approach.
- **Inclusion is one of the core principles** embedded into teaching and learning, the governance of educational institutions, and partnerships with local communities. Focusing on democratic citizenship and inclusion empowers both the individual and the community.
- **Environmental sustainability is at the centre of the initiative**, with schools adopting near-zero energy standards, advanced insulation, renewable energy systems and sustainable transport schemes. These measures align with the Climate Action Plan 2023, which outlines decarbonisation activities across all sectors in Ireland.
- **The introduction of the Leaving Certificate Climate Action and Sustainable Development** for fifth- and sixth-year students in September 2025 marks the Irish government's commitment to creating a more just and sustainable world, as well as supporting students' capacity to engage with sustainability challenges, including the climate crisis.

- **Each initiative typically has a pilot period during which the programme is tested**. During this pilot phase, valuable information is gathered about the testing of different technologies and retrofit approaches within a specific school context. This creates a strong evidence base that focuses on the reliability and scalability of renewable solutions in the school sector, prior to a national rollout. The programmes highlight a flexible and tailored approach.
- Although the implementation of the initiative faces technical and practical challenges as well as planning challenges and uncertainty over its funding, **progress has already been made in the modernisation of school facilities to the "A" energy rating**. Notably, 25 % of primary-level classrooms have been constructed or refurbished since 2008, and 20 % of post-primary classrooms have been built or renovated since 2008 (Department of Education, 2023). This indicates improvements in energy efficiency, student and teacher satisfaction, and improved teaching and learning.

2. Introduction

This case study explores policy initiatives and frameworks dedicated to decarbonising Ireland's school sector and learning for sustainability. It draws on a combination of desk research and two interviews with four policy officers responsible for these programmes.

Energy efficiency and **decarbonisation** are key objectives in Ireland's efforts to meet its energy and climate change targets. This translates to a cross-cutting programme of retrofitting and improving the energy efficiency of buildings, including schools. The overarching policy initiative in this sector is the **School Sector Technical Climate Action Roadmap 2023 to 2030** (hereafter referred to the as the "School Climate Roadmap"), which lays the foundations for specific programmes and trajectories, including the School Sector Climate Action Mandate and the Schools Energy Retrofit Pathfinder Programme.

Along with pursuing a transition to a climate-resilient, biodiversity-rich and climate-neutral economy, **learning for sustainability**[57] is another key focus for the Irish government. Within its learning for sustainability initiatives, priority action areas include advancing policy; transforming learning environments; building the capacities of educators; empowering and mobilising young people; and accelerating actions at local level. In addition, the policy framework promotes innovative pedagogical techniques, critical thinking and participatory learning. A related initiative is the second proposed **National Strategy for Education for Sustainable Development 2030** (hereafter, "ESD to 2030")**.** While the first strategy, introduced in 2014, mainly served to embed LfS across curricula, the current plan moves beyond this to become more action-oriented. **ESD to 2030** is an integrated part of the overarching School Climate Roadmap strategy.

This case study examines these policy frameworks, highlighting their unique approach and interconnectedness. The case study aims to provide **insights** into how their related activities balance the goals of **environmental sustainability, energy efficiency and decarbonisation, and well-being and inclusion, while navigating challenges related to funding, technical issues and planning.** It also reviews the implementation processes and analyses the impact of the policy framework on the community.

[57] Instead of learning for sustainability, the term "education for sustainability" increasingly appears in official documents in Ireland.

3. Core principles, activities and interventions in schools

Core principles

While the School Climate Roadmap outlines the trajectory for the school sector in Ireland and the delivery of its targets for energy efficiency and reducing greenhouse gas emissions, the ESD to 2030 provides a framework for making education more supportive of learning for sustainability. In collaboration with other departments and agencies, these two overarching policy initiatives consist of specific programmes and action areas that support and ensure their delivery.

The **School Climate Roadmap** is a joint initiative of collaboration between departments, including the Department of Education and the Department of Environment, Climate and Communications.

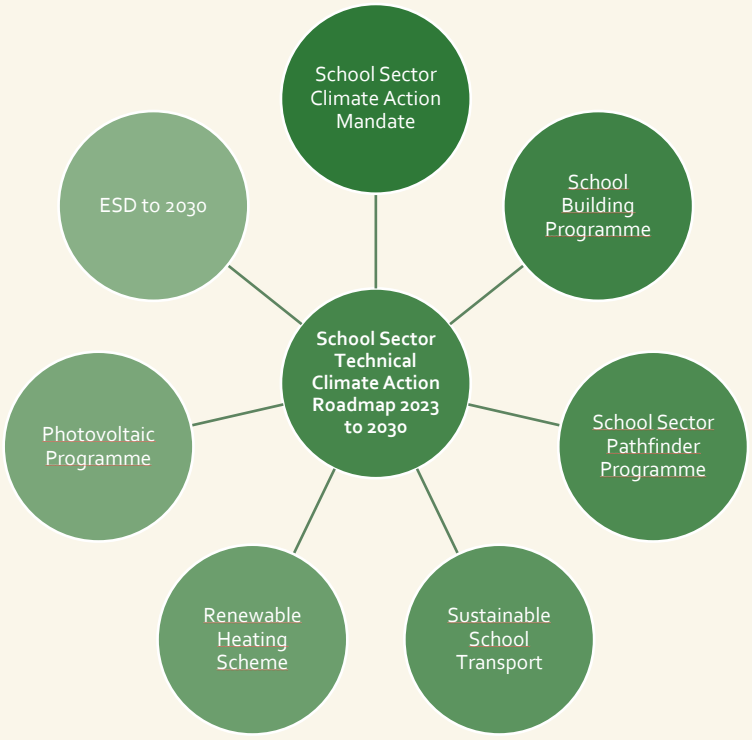

Figure 35. *Overview of the School Climate Roadmap.*
Source: *our own, adapted from the Roadmap.*

The core points of the **School Climate Roadmap** (Department of Education, 2023) include strategic policy development, programme development and delivery, focusing on decarbonisation, sustainable school transport and LfS. The roadmap is guided by the principles of minimising negative environmental impact, providing comfort and health in the teaching and learning environment, and schools ultimately becoming living demonstrations and chambers for sustainable environments. This strategy provides guidance for the school sector's trajectory towards achieving its targets for energy efficiency and reducing greenhouse gas emissions by 2030 and 2050. The strategy outlines various standalone yet connected strategies and programmes with the aim of achieving one common goal. A few examples of these initiatives are in the visualisation above. A dedicated School Sector Climate Action Mandate (Department of Education, 2024) is part of the roadmap driving the climate action agenda. This mandate outlines various principles for schools/in-school education, recognising their distinctive role in climate action, decarbonisation and learning for sustainability. These principles include learning for sustainability, school buildings, travelling to school, and overall school targets (on energy efficiency).

The ESD to 2030 employs a **whole-school approach to learning for sustainability**. The guiding principle for schools as learning environments for sustainability is to be places **"where learners learn what they live, and live what they learn"** (UNESCO, 2020). The strategy includes several sub-priorities: developing and supporting leadership for LfS,

sustainability competences and transversal skills as core to learning outcomes; promoting and supporting the use of LfS pedagogies among educators; embedding LfS into curricula and programmes at all levels to ensure that learners acquire the knowledge, skills, values and dispositions to promote, advance and take action for sustainable development; enabling access to high-quality resources for LfS; and whole-institution approaches – transforming learning environments into educational spaces for sustainability.

The initiatives within the School Climate Roadmap follow a series of core principles:

Environmental sustainability: minimising the environmental impact of school buildings by maximising decarbonisation and the use of renewables, improving energy efficiency, and supporting sustainable school travel to make school-buildings future-proof.

Well-being and inclusion: embedded in teaching and learning, the governance of educational institutions, and in partnerships with local communities, to empower the individual and the community.

Community collaboration and local engagement: policymakers, architects, contractors, schools and educators, as well as local communities, should engage in co-design processes that enable ownership and alignment with local needs.

Participation process and main actors

Part of the strategy is **the School Sector Pathfinder Programme**, which is dedicated to practical school retrofits. The usual process involves a pilot period during which the programme is tried and tested. In this way, the pilot process provides valuable information and a solid evidence base, focusing on the robustness and scalability of renewable solutions within the school sector.

For example, participation in the Pathfinder initiative typically follows the specific process outlined below:

- The Planning and Building Unit at the Department of Education, the Sustainable Energy Authority of Ireland (SEAI), and support from specific regional bodies of Ireland (e.g. Education and Training Boards) are responsible for programme administration.
- Each project involves a programme manager and a design team. Once the projects are developed and schools are selected to participate, these schools become integral to the participation process.
- Generally, two or three schools from each county are chosen for the pilot projects. A contractor is then selected to explore the potential for scalability and to enhance the contract's value, which may also attract a diverse range of contractors to the programme.
- Ultimately, as the project is implemented, students, parents, and teachers become stakeholders and end users.

ESD to 2030 was jointly developed across departments and in consultation with key stakeholders, namely:

- The Department of Education (DoE)
- The Department of Further and Higher Education, Research, Innovation and Science (DFHERIS) – a department newly developed in 2020, which provided the opportunity for a joint approach towards creating the strategy.
- The Department of Children, Equality, Disability, Integration and Youth (DCEDIY) – co-responsible for the implementation.

The public consultation with key stakeholders held during the creation of the strategy ran for a little over two months. This provided the basis for identifying the specifics of the Irish context, such as the role of culture and cultural institutions in advancing sustainable development, including research as a key element under one of the areas. The consultation process was inclusive, attracting 90 written submissions and 150 responses to the online public survey. In addition, a series of focus groups, consultation events, interviews and bilateral meetings with external stakeholders took place. Within the ESD to 2030, multiple programmes are carried out, including the participation of further actors such as teachers, early-years educators, and all stakeholders involved in early learning and care, as well as artists, parents and children. Other actors invited to participate in the initiative's development included local governments, the Department of Health, and the Department of Children, Equality, Disability, Integration and Youth.

Educational integration

The overarching School Climate Roadmap refers to the ESD to 2030 framework, which aligns with the national Climate Action Plan, the UN SDGs, UNESCO's ESD for 2030 framework and the EU Recommendation on learning for the green transition and sustainable development. This framework aims to contribute to a more just and sustainable world, and to ensure that by 2030, all learners acquire the knowledge and skills needed to promote sustainable development through ESD. The framework has three strands – environmental, socio-economic and political, and outlines five priority areas (shown in the figure on the right).

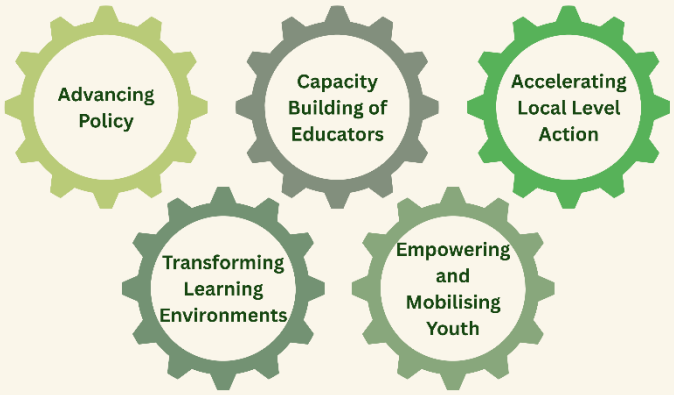

Figure 36. *Priority action areas of the School Climate Roadmap.*
Source: *our own based on Irish ESD to 2030.*

Priority action areas include advancing policy, transforming learning environments, building the capacities of educators, empowering and mobilising young people, and accelerating local-level actions. Key principles of the Irish ESD to 2030 include promoting and using "a variety of pedagogical techniques that support active and participatory learning, critical thinking and the development of key dispositions and skills" (Government of Ireland, 2022).

The strategy outlines **Priority Action Area 2: Transforming Learning Environments,** which is part of the whole-institution approach to ESD (LfS). These environments are perceived as spaces "where learners learn what they live, and live what they learn". Much has already been achieved in promoting ESD learning environments through the **efforts of educators and students, curricular and pedagogical reform, innovation, a focus**

on self-directed learning, and empowering the learner's voice. Awareness of and action for sustainability have mostly been spread through school and campus initiatives, civil society and the work of youth climate organisations.

Ireland states that this strategy will build on civil society's expertise in the design and implementation of ESD. To achieve the target of 51 % reduction in GHG emissions by 2030 and net-zero emissions by 2050, Ireland recognises that it is necessary to engage in a deep energy retrofit programme for the school sector as well as the higher and further education sectors. Significant investment will be required to upgrade learning environments. The expected outcomes of energy retrofits are reduced emissions and improved comfort and air quality in the learning environments.

Priority Action Area 2: Transforming Learning Environments includes the following sub-priorities:

- "Develop and support leadership for ESD;
- ESD competences and transversal skills as core to learning outcomes;
- Promote and support the use of ESD pedagogies among educators;
- Embed ESD in curricula and programmes at all levels to ensure learners acquire knowledge, skills, values and dispositions to promote, advance and take action for sustainable development;
- Enable access to high-quality resources for ESD;
- Whole institution approaches – transform […] environments to educational spaces for sustainability" (Government of Ireland, 2022).

More specifically, Ireland has set a strategic goal to ensure that by 2030, schools and campus environments become **"genuine places and educational spaces for sustainability"**. In practical terms, this means **supporting biodiversity** and improving the sustainability of **transport**, **energy use, educational buildings** (design and construction) and **waste management**. Although the term "learning environments for sustainability" is not used, "educational spaces for sustainability" is an effective synonym for this. Ireland recognises the critical role of leadership as a major driver in transforming learning environments. The aim is to develop and support individual and collective leadership in ESD at every level, across institutions and systems and throughout society. The strategy also fosters ESD competences and transversal skills and supports ESD pedagogies (Government of Ireland, 2022).

Overall, the aim of the strategy is to integrate sustainability as a cross-curricular theme into science, business studies, geography, home economics, music, English, history and visual art, to ensure that learners can look at sustainable development through various lenses (Department of Education and Skills, 2018; NCCA, 2018). This goes alongside action-oriented learning that combines theory and practice to ensure that learners develop their skills and knowledge about sustainable development.

To achieve these goals, the implementation of the School Climate Roadmap consists of programmes that contribute to the overall principles and trajectory of the roadmap, with the introduction of pilot projects and their subsequent rollout at national level.

Renewable energy

Multiple, smaller initiatives within the overarching policy framework focus on energy efficiency, decarbonisation and the scaling-up of renewables.

Box 12. Case study: St. Columba's Comprehensive School – energy retrofit

As part of the School Energy Retrofit Pathfinder Programme 2021, St. Columba's Comprehensive School in Glenties, Donegal, underwent a comprehensive energy refurbishment that significantly enhanced its energy efficiency and sustainability. The retrofit included zone-controlled heating, upgraded external insulation and new doors to reduce draughts, creating a more comfortable learning environment. In addition to improving comfort, the school's exterior has been transformed, boosting its aesthetics and enhancing community pride. Funded by the Department of Education and the Sustainable Energy Authority of Ireland (SEAI), the project improved the school's Building Energy Rating (BER) from C3 to B1, with a targeted carbon emissions reduction of approximately 90 % due to its transition to biomass heating. With all work managed by the Department and SEAI, this initiative demonstrates how an effective retrofit can lead to significant energy savings and school sustainability (Government of Ireland,

A crucial step toward decarbonisation is **developing pathways to achieve zero emissions** by creating modern and sustainable school infrastructure. This infrastructure should provide a safe and inspiring learning environment for all students, both now and in the future. One practical approach is to **replace traditional heating systems with renewable heating solutions such as heat pumps** or **biomass programmes**. In addition, it is essential to enhance the energy performance of older schools that were constructed when fossil fuels were more abundant and less expensive, and when technology and material options were not as advanced as they are today.

With regard to further changes on the ground, schools in Ireland are integrating photovoltaic (PV) panels into their sustainability policies through various initiatives and programmes. One such initiative is the **Solar for Schools Programme,** which aims to install solar panels on the roofs of public schools. In doing so, it aims to reduce carbon emissions and energy costs for schools, with estimated cost savings of between EUR 1,200 and EUR 1,600 per school each year (Skujins, 2023, 2024).

Another initiative is the **School Photovoltaic Programme (SPP)**, which provides funding to install up to 6 kW of solar PV panels on school roofs. Each installation includes software to monitor energy generation, and also serves as an educational tool. Schools that have solar panels fitted also serve as models for environmental responsibility, further encouraging the adoption of renewable energy sources in local homes and businesses (Solis Green Energy, n.d.). These initiatives are driven by the Sustainable Energy Authority of Ireland (SEAI), with the aim of supporting decarbonisation of schools. In 2022, prior to the national rollout of the Photovoltaic Programme, a survey established that just 10 % of post-primary schools and 5 % of primary schools had solar PV panels.

Sustainable transport

Another ambition is to reduce private car journeys to schools by 30 % and reverse the trend towards the growth of "school run" journeys. This target is supported by the Safe Routes to School (SRTS) programme and by new local initiatives such as supporting cycle buses. Overall, this programme aims to provide safe and accessible walking and cycling routes – including 500 Safe Routes to School schemes, and over 1,000 km of safe infrastructure. A new pathfinder project under the **Sustainable Mobility Policy** will support the further development of the SRTS over the next three years, and will aim to improve the safety of school surroundings. This will be complemented by the Department of Education's School Transport Scheme (STS). During the 2024/2025school year, more than 172,000 children used the school transport scheme, using approximately 7,900 vehicles on more than 10,300 daily routes (Department of Education, 2024b). A further

demand by families has been made for free school transport as an effective cost-of-living measure, demonstrating the initiative's success (Government of Ireland, 2023a). In collaboration with the Department of Transport, this initiative aims to improve infrastructure around the school to enable more sustainable means of transport, such as cycling (Department of Education, 2023).

Programme and school funding

The initiatives under the School Climate Roadmap operate under various funding schemes. The primary source of funding comes from the Department of Education. However, multiple funding sources are available, and each smaller initiative within the overarching policy framework often has a different resource.
For example, the School Sector Pathfinder Programme is jointly funded by the Department of Education and the Department of Environment, Climate and Communications. Since 2017, EUR 110 million has been spent on retrofitting 64 schools, including a budget of EUR 40 million to support the 2023 phase of the programme (Department of Education, 2023).

Initiatives relating to infrastructure include a pilot phase of the national energy profile for the school sector, completed in December 2022. This programme was funded by the European Investment Bank Advisory Hub programme. In 2023, the Climate Action Fund financed the rollout of 6 kW Photovoltaic Panels in schools. Lastly, a targeted biomass programme focusing on high thermal carbon-emitting schools and providing them with carbon-neutral biomass heating systems will be delivered via a capital-funded energy supply contracting basis (ESCO) (Department of Education, 2023).

Another area of funding comprises education for sustainable development (ESD)-related initiatives. In 2023, the Department of Education allocated EUR 555,000 funding to ESD projects in 65 primary and 64 post-primary schools nationwide. This represented a threefold increase in ESD funding compared with the EUR 167,000 allocated to 49 schools in 2022. Grants of between EUR 1,000 and EUR 5,000 were paid to successful schools that had submitted sustainability projects for 2023/2024 for funding under the second National Strategy – ESD to 2030. These projects included new school gardens and outdoor education, local air quality initiatives and projects for climate justice (Department of Education, 2023a).

At local level, another funding opportunity is provided by the National Just Transition Fund. Among other activities, this fund supports community development, research and exploratory studies as well as opportunities for education, training and reskilling, with up to EUR 22 million being committed. Other incentives for the region are provided by the EU Just Transition Fund, the Recovery and Resilience Facility, and the EU LIFE programme[58], including initiatives such as the Peatlands and People Project (Government of Ireland, 2023a).

4. Evaluation of impacts

Impact on the environment

Overall, the School Climate Roadmap and its related initiatives have positively influenced environmental sustainability in educational infrastructure by improving energy efficiency and increasing decarbonisation by reducing energy consumption in schools.

[58] The EU LIFE programme is the EU's funding mechanism for climate, environment and nature protection.

The latest SEAI-published Annual Report (2022) on Public Sector Energy Efficiency Performance notes that among those public bodies and schools that submitted complete reports for 2021, the combined improvement in energy efficiency was 31 %. This is the primary indicator for tracking the sector's performance against its energy efficiency target of a 50 % reduction by 2030. It also indicates that Schools and Educational Training Boards (ETBs) have achieved a 24 % energy improvement in the sector (SEAI, 2022).

Another significant example is the initiative to install solar panels, which has positively impacted the environment. One SEAI-registered company states that a 6 kW solar system produces an average of 15 kWh per day. Because each kWh of electricity produced by a coal-fired power plant emits 1.18 kg of CO2, a 6 kW solar system can be seen to offset around 17.4 kg of CO2 per day. The reduction in CO2 that results from such a solar system is equivalent to the amount of CO2 absorbed each year by 474 trees (Solis Green Energy, n.d.). Interviewees also see the educational potential of such initiatives beyond schools themselves. They believe initiatives such as solar panel installations in schools have a broader impact, as students share their energy-saving knowledge at home, encouraging their families to adopt similar practices and save on costs.

Further expansion of the energy retrofitting and carbon reduction programmes, as well as the implementation of renewable heat technologies and energy-efficient solutions in the school sector, will support the transition towards zero emissions and climate-proofed schools.

Impact on the inclusion and well-being of learners

Energy retrofits (carried out as part of overarching strategy and specific programmes such as the Pathfinder Decarbonisation Retrofit Programme) aim to reduce the carbon emissions of school, as well as testing energy efficiency solutions and renewable heat technologies. In doing so, these solutions also enhance comfort and aesthetics and create healthier, safer and more pleasant learning environments. Learning for sustainability initiatives (as part of initiatives under ESD to 2030) aim to collectively address climate change, poverty, inequality, sustainable consumption, health, well-being and inclusion, and to create safe and inclusive learning environments. Improving the comfort of learning environments also has positive impact on the well-being of learners.

The funding addresses equity considerations in the distribution of resources – prioritising schools deemed to be in more deprived areas or schools that have students with special educational needs. However, there is little evidence that the existence of sustainable features has, in itself, translated into any tangible impact on inclusion and well-being. Thus, it **remains unclear** whether the programmes have **influenced the inclusion and well-being among students or teachers.**

Two examples serve as illustrations of activities that target improvements in inclusion and well-being. One example is **Bremore Educate Together's Child-Friendly Policies Initiative**, supported by EUR 5,000 of **ESD to 2030** funding. This initiative empowered students to develop inclusive policies, including anti-bullying, and to deepen their understanding of children's rights. Their efforts will be shared with other schools to inspire inclusive policy development, fostering student well-being and inclusion (Government of Ireland, 2023).

Another notable example is **Natural Spaces**, a project funded by the ESD to 2030 Funding Call 2022. This initiative allowed primary school students to experience nature on their school grounds. Participating schools engaged in various activities to enhance their environments. For instance, Rathcoffey NS planted vegetable gardens, while Kilglass NS installed rainwater harvesters. Meanwhile, Knockmore JNS built bee boxes to support

pollinators, and other schools created native wildflower meadows to promote biodiversity. These projects allowed students to gain a deeper understanding of environmental sustainability through hands-on experiences, reinforcing the concepts learned in the classroom. Social sustainability was also a key theme in these projects. Inclusion was emphasised, with many schools ensuring that natural spaces accommodated **neurodiverse students by creating sensory gardens** (examples include St. Raphaela's and Lisvernane NS). Community engagement played a significant role in the project, highlighting the positive outcomes for students and their communities (Government of Ireland, 2023).

Impact on learning outcomes and sustainability competences

The infrastructure element of the School Climate Roadmap has improved both school infrastructure and energy efficiency. Based on the interviews and reports, these features are highlighted for their potential to support learning for sustainability. However, there is little evidence that the existence of sustainable features or green spaces has translated into increased awareness of sustainability among students or teachers.

The education-related initiative ESD to 2030 and its activities translated the aims of the European Sustainability Competence Framework – GreenComp - into a Sustainability Toolkit for Schools. This toolkit guides schools in adopting a Sustainability Policy Statement and explaining how schools can take part in the climate action agenda[59].

Alongside this, ESD to 2030 promotes the acquisition of skills relating to education for sustainable development and sustainable lifestyles, as well as human rights, gender equality, the promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity, and the contribution of culture to sustainable development. However, there is a lack of national-level data on how the infrastructure and education initiatives impact students' learning, as well as teaching practices and the development of sustainability competences.

The introduction of the Leaving Certificate Climate Action and Sustainable Development for fifth- and sixth-year students in September 2025 offers the potential to develop students' capacity to act more sustainably and to engage with sustainability challenges, including the climate crisis (Department of Education, 2024a; NCCA, 2025).

Limitations and challenges

Despite its innovative approach and positive outcomes, the initiatives undertaken in Ireland face several limitations.

- **Technical and practical challenges:** the nationwide rollout of electric heating to support heat pumps faces several technical challenges. These include aesthetic considerations, efficiency and maintenance. Market volatility, worsened by COVID-19, has increased material costs and disrupted supply chains, although overall capacity remains stable. Despite these difficulties, strict health and safety standards have been successfully upheld. Efforts continue to secure design teams, contractors and funding.
- **Availability of funding:** alongside technical challenges, the nationwide rollout raises concerns about the availability of funding. Although the scope of retrofits varies between schools, a deep retrofit would require a significant investment (estimated at EUR 4 million per school). This gives rise to uncertainty over long-

[59] Read more at: A Sustainability Toolkit for Schools, consisting of a sustainability self-assessment tool, a sustainability guidelines document and a sustainability policy statement template.

term funding. Another related funding challenge concerns engagement with stakeholders and other departments, and ensuring potential beneficiaries are informed about the availability of funding.

- **Planning challenges:** the effective delivery of school retrofit projects requires a phased and flexible approach to minimise disruptions. While planning requirements are generally not a significant obstacle, they can sometimes cause delays. Work is often scheduled in short phases during the summer, or strategically planned to limit disruption and avoid school closures during the academic year. However, the high cost of temporary accommodation poses a significant challenge that requires creative and cost-effective solutions, often supported by strong school leadership. Teacher engagement is also crucial, though capacity constraints can limit involvement, with only one or two staff members typically driving the agenda. In addition, project monitoring is not mandatory; it relies on stakeholder commitment, progress reports, funding conditions and school networks. Ensuring flexibility in planning and execution is essential, mainly to prevent disruption to critical school operations, including state exams.

Strengths of the programme

The initiatives in Ireland showcase a holistic approach to integrating learning for sustainability into education and the rolling out of decarbonisation infrastructure projects in the school environment.

- **Commitment to energy efficiency and decarbonisation:** schools and Educational Training Boards (ETBs) have achieved a 24 % improvement in energy efficiency in the sector. Overall data show that the combined improvement in energy efficiency in 2021 by those schools and other public bodies that submitted complete reports is equivalent to 31 % (compared with the energy efficiency target of a reduction of 50 % by 2030).
- **Schools are at the heart of the community:** based on feedback from schools, children and parents, renovated schools foster a sense of ownership and pride among residents. These improvements enhance the teaching and learning environment and create a better working atmosphere. Initiatives such as solar panel installations in schools have a broader impact, as students share their energy-saving knowledge at home, encouraging their families to adopt similar practices and save on costs. Engaging parents, students and school staff is essential to gather meaningful feedback and highlight the real-world effects of sustainability efforts.
- **Pilot period prior to the national rollout:** for each initiative, there is typically a pilot period during which the programme is tested before national rollout. During this pilot phase, valuable information is gathered, creating a strong evidence base that focuses on the reliability and scalability of renewable solutions in the school sector.
- **Flexibility and a tailored approach to implementation:** through ESD to 2030, schools given funding to develop their projects, which range from school gardens and outdoor initiatives to water quality projects, involving STEM or history classes. In addition, one of the criteria for funding is local engagement. So far, 890 schools have participated in the funding calls, with interest growing over recent years. There has been a growing interest in sustainability and climate action.
- **Monitoring ESD initiatives:** since the introduction of ESD to 2030, the Department of Education has published progress reports. The first of these was

published in November 2023, and a second one is currently in the preparatory phase. Each progress report summarises key achievements and progress.

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