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SCHOOL LEARNING ENVIRONMENTS FOR SUSTAINABILITY IN BULGARIA

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Abstract. Development of sustainable school environments requires a collaborative, interdisciplinary approach, based on political will, long-term investment and stakeholder engagement. This article aims to analyze policies and good practices for sustainable learning environments in schools. The methods used are theoretical analysis and synthesis. The results show that Bulgarian schools still face major challenges in becoming sustainable, including policy fragmentation, weak integration of sustainability in education, and limited investments. It is recommended that a new comprehensive national program for sustainable schools be prepared. Education for Sustainable Development must be embedded across all subjects through real-world, competence-based learning. Sustainable environments should include outdoor spaces and biodiversity. Energy efficiency efforts need to expand, prioritizing renewables and smart systems. Waste management with student involvement should be adopted. Teachers require ongoing training, access to resources, and networks. Stronger school-community-local government partnerships and regular monitoring with student participation are essential for lasting impact.

Keywords: environmental education; education for sustainable development; sustainable schools

Schools and sustainability

The main available statistics, linked to sustainability in Bulgarian school environment, relate to energy efficiency and partly to waste management.

Between 2012 and 2021, Bulgaria's energy consumption grew much faster than the EU-27 average – 11.4% compared to 0.7% – with similar trends for natural gas and electricity (Simeonova-Ganeva et al., 2023). Energy costs are paid by schools themself, which is an incentive to minimize energy consumption and costs. On the other hand, school properties are public buildings owned by the municipality, which decides which investments will be made in the infrastructure.

Since 2020, a web-based energy management system has supported municipalities and schools, collecting data from 13 schools and 4 kindergartens across Bulgaria,

incl. Sofia, Burgas, Gabrovo, Samokov, Veliko Tarnovo, etc. Analysis for 2016 – 2019 shows heating accounts for about 85% of energy use, primarily from fossil fuels, with renewables under 2%. This highlights significant potential for savings in educational institutions and the need for targeted energy efficiency and renewable energy solutions (EnEffect, 2020). The project Protecting the Climate through Energy Efficiency (2018) showed that schools can save 4 – 15% of energy annually. It was followed by the Climate and Me initiative in 19 Bulgarian schools, achieving average annual savings of 7% in energy and heating costs (Gaidarova & Kotseva, 2020).

Between 2012 and 2020, Bulgaria reduced annual waste by 27.8%, compared to just 4.0% in the EU-27. Despite this, waste management practices still lag EU standards, and circular economy implementation remains limited. In 2021, the country also ranked low in eco-innovation funding, activities and results. (Simeonova-Ganeva et al., 2023). Schools are major public-sector waste generators. The Municipality project Green School for a Greener Sofia found that each school produces large amounts of paper, electronic, and organic waste, with secondary students generating an average of 22 kg of waste annually (Radeva & Baldzhieva, 2022). In 2021, 101.3 thousand students graduated in Bulgaria (NSI, 2021), which would mean an estimated 2.5 tons of school waste. While separate collection initiatives exist, there is no national school waste management program.

Sustainability in schools is promoted through Education for Sustainable Development (ESD), which fosters awareness, knowledge, and, crucially, the competencies needed for responsible lifestyle and social decisions. (UNESCO, 2012, 2017). ESD is central to school practice, preparing youth for a resilient, balanced world. It addresses environmental, social, and economic aspects, aiming to embed sustainability principles at all education levels and build competencies for a sustainable future (Boneva, 2008; Yotovska et al., 2015; Vakleva & Georgieva, 2022).

The most recent approach to ESD and sustainable learning environments in Bulgaria is the creation of STEM centers, introduced in the 2020 National Recovery and Sustainability Plan (NRSP). These are recognized as spaces for developing sustainability competences through innovating school spaces, enhancing education quality, and improving student outcomes by integrating advanced learning environments and technology.

Traditional classrooms in Bulgarian schools lack integration across subjects. New learning spaces are needed to connect curriculum with real-life problems, promote discovery-based learning, hands-on experience, and tech skills. (National STEM Center, 2023). Namely STEM centers aim to enhance student skills in science, technology, engineering, and mathematics, alongside digital transformation and Industry 4.0 competencies. Planned for over 2,200 schools, the rollout began in 2024. According to the National STEM Center (2024), most schools focus on natural sciences (41%), mathematics and informatics (36%), followed by design

and 3D prototyping (10%), green technologies (9%), and robotics (4%). Many centers also include Maker Spaces – collaborative areas that promote hands-on learning, creativity, problem-solving, and entrepreneurship.

Small-scale initiatives by civil organizations reflect growing public interest in improving learning environments. The Transformatori Association led projects promoting sustainable educational spaces and community support. Examples include A Playground for Forgotten Games and the Tebeshir project, funded by donations, voluntary work, Sofia Municipality and the America for Bulgaria Foundation (Transformatori, 2024).

Strategic documents and regulations concerning sustainability education

A key document is the Strategic Framework for the Development of Education, Training and Learning in the Republic of Bulgaria (2021 – 2030), aiming for all Bulgarian youth to complete school as functionally literate, innovative, and socially responsible citizens, committed to lifelong learning. It targets institutions, teachers, and students through specific measures.

The Framework envisions schools as safe, healthy, eco-friendly, and supportive spaces where tradition, innovation, and digitalization converge. They foster learning, interaction, and shared values among students, parents, and communities to develop capable, responsible individuals. In response to low PISA scores, the Framework emphasizes competencies and skills, with one of its nine priorities until 2030 being educational innovation, digital transformation, and sustainable development.

The National program Education 2021 – 2027, approved by the European Commission, prioritizes inclusive education, modernization and quality, and alignment with the labor market. For schools, it focuses on enhancing digital skills, providing quality e-learning content, improving educational outcomes, fostering inclusion, reducing early school leaving, supporting personal development, and strengthening teacher motivation and qualifications.

The main legal framework for school education in Bulgaria is the Preschool and School Education Act (2015). It governs the right to education and defines the structure, functions, management, and funding of the preschool and school education system. The Act outlines key education goals: developing competencies for sustainable development; fostering lifelong learning, tolerance, and respect; preparing for personal and professional growth, active citizenship, and democratic participation; promoting understanding of cultural values, global processes, and their interconnections.

Ordinance No. 5 of 30.11.2015 on General Education outlines the key competencies that should be developed throughout school education: Bulgarian and foreign language, math and basic competences in natural sciences, digital, learning, social and communication skills, citizenship, entrepreneurship, cultural

awareness, creativity, skills for a healthy lifestyle and competences for sustainable development. General subjects are directly linked to concrete key competences. The support of sustainable development principles, incl. environmental, economic and social dimensions, is carried out through various subjects and aims to build the ability to take personal responsibility for a sustainable future.

Ordinance No. 13 of 21.09.2016 for Civil, Health, Environmental and Intercultural Education aims to form students' knowledge, skills and attitudes for active civic position, healthy lifestyle, environmental protection and intercultural dialogue. Education in these areas is carried out through curricular, extracurricular activities, and projects. Civic education focuses on democratic values, rights, and obligations. Health education encourages personal and public health. Intercultural education supports tolerance between ethnic groups. Environmental education promotes awareness and eco-friendly behavior, respect for nature, sustainable development and environmental responsibility. The ordinance determines the principles, methods and mechanisms for implementation, emphasizing the role of teachers, parents, and institutions.

Latest educational efforts in Bulgaria focus on digitalization and the STEM concept, seen both as a path to integrated learning and means to modernize school environment. Direction Building a School STEM Environment under the NRSP aims to create a modern, comprehensive STEM environment in Bulgarian schools through renovation, modernization, and new spaces for labs and project-based, collaborative learning beyond traditional classrooms. Laboratories are developed and upgraded for skills acquisition and project-work through modern equipment for experimental work in all STEM fields and digital technologies, including those that allow working interdisciplinary, synchronously and asynchronously. The goal is to boost digital literacy, learning, motivation, and interest in science and engineering. Teacher training is also supported to enhance digital and innovative teaching skills using a competence-based approach.

STEM centers development follows detailed guidelines emphasizing high-tech equipment, digital tools, and connectivity, along with standards for lighting, safety, acoustics, indoor climate, and student well-being. According to the 2023 Guidelines for Physical Environments in School STEM Centers, spaces should be flexible and interconnected, using mobile barriers to create multifunctional areas. STEM centers may include Research Lab, Digital Makers Classroom, Young Researchers Center, Creative Technologies Hub, Digital Center, Natural Sciences Lab, Research and Innovation Centre. High-tech, connected classrooms are also being built. Key design elements include interior layout, furniture, flooring, walls, ceilings, doors, materials and colors, signs, lighting, acoustics, and climate control. The environment's quality is measured by its transparency, variability, flexibility, creativity, visual and acoustic comfort, and support for movement.

STEM centers support diverse learning regimes, including lectures, individual work, group activities, debates, hands-on workshops, and social interaction. Spaces and furniture should be arranged to accommodate all these modes for both curricular and extracurricular activities. Existing classrooms are upgraded with modern tech, interactive screens, and reliable internet to support interactive learning.

Regarding the regulations concerning sustainable school buildings, the national strategic documents prioritize energy efficiency. While broader aspects appear in public building bylaws, the most relevant guidance comes from the Ordinance No. 24 of 10.09.2020 on the Physical Environment and Information and Library Provision of Kindergartens, Schools and Personal Development Support Centers. The Ordinance defines safe, ergonomic, and inclusive environments and supports modern education through integrated technologies, zoning for learning and extracurricular activities, and updated infrastructure. Its Appendix – Guidelines for Modernization of the Physical Environment in Schools outlines the relevant standards. These include lighting, acoustics, green and resting spaces, energy efficiency, and technology, with health and well-being embedded in safety and design requirements. The Appendix promotes sustainability, accessibility, and flexible layouts, with features like green schoolyards, outdoor classrooms, ergonomic furniture, and energy-efficient systems.

Specific requirements for school buildings are regulated also in the Ordinance No. RD-02-20-3 of 21.12.2015 on the Design, Implementation and Maintenance of Buildings for Public Service in the Fields of Education and Science, Health Care, Culture and the Arts. It sets construction standards for educational buildings, emphasizing health, sustainability, multifunctional spaces, natural lighting, photovoltaics, green roofs, and eco-friendly waste management.

Other strategic documents related to sustainable school environment

Aligned with the EU Green Deal and UN goals, Bulgaria's policies support sustainable school environments.

The main strategic document, the National Recovery and Sustainability Plan, supports green (53.66% of its resources) and digital transformation (22.60%) across public life and the economy. It addresses science, education, innovation, decarbonization, climate change mitigation, and biodiversity conservation. The digital measures focus on enhancing digital skills and reforming the education system. The education policy goals are accelerating modernization, digitization, and improving digital skills across the workforce. Key reforms and investments include updates to pre-school, school, and higher education; lifelong learning; STEM and innovation centers; youth centers; and a national platform for adult education. The field Modernization of Educational Infrastructure aims to create inclusive, innovative, and motivating learning environments through renovations, new constructions, and energy-efficient systems, incl. alternative energy, heating,

and ventilation. Priority is given to upgrading kindergartens, schools, dormitories, and campuses. While several elements directly address sustainable learning environments, others indirectly support education through links to the labor market, technology, and digital skills development.

The following documents are also less or more related to the sustainable learning environment.

Bulgaria's Strategy and Action Plan for the Transition to a Circular Economy (2022 – 2027) focuses on a green, competitive economy, waste reduction and consumer-friendly practices. It promotes sustainable production and consumption through resource efficiency and new business models. Early measures include regulations on single-use plastics and green procurement, relevant to canteen packaging, and resource use in schools.

The National Waste Management Plan 2021 – 2028 supports sustainable waste management through efficient resource use. It includes measures to build skills and awareness for sustainable consumption and circular economy practices. Given schools' high waste generation, this plan provides a strong basis for integrating waste management and education in schools.

The Integrated National Energy and Climate Plan 2021 – 2030 outlines goals for a low-carbon economy, secure and competitive energy, and reduced imports. It calls for broad socio-economic action, incl. digital transformation and information systems. As major energy users, schools can play a key role in supporting these goals.

A specific goal in the Environment Program 2021 – 2027 is advancing the circular economy through waste prevention, reuse and repair centers, recycling, and improved waste separation. It also emphasizes awareness and sustainable consumption. Schools provide strong opportunities to implement such practices.

The Digital Transformation of Bulgaria 2020 – 2030 aims to ensure nationwide digital connectivity, improve digital skills, and boost innovation. It promotes energy-efficient, low-waste technologies across 17 sectors, including education. School modernization is closely tied to digitalization and skills development. Similarly, the Digital Bulgaria 2025 program focuses on expanding smart IT solutions, digital infrastructure, secure e-services, and raising digital competencies, making education a key area for digital progress.

Support for education personnel and schools

The Recovery and Sustainability Mechanism foresees funding of about BGN 500 million for each of the programs Building a School STEM Environment and Modernization of Educational Infrastructure. Within the Pillar Innovative Bulgaria, Component Education and Skills of the NRSP, the Ministry of Education and Science (2022) plans two types of investments. The first investment project STEM Centers and Innovations in Education includes construction of a National STEM center, creation of 3 regional and over 2240 school STEM centers throughout the

country. The second – Modernization of Educational Infrastructure includes renewed look of the institutions, incl. renovation, extension, upgrading and equipment of 57 kindergartens and 83 schools, construction of 8 new kindergartens and 8 new schools, rehabilitation of 23 dormitories and construction of 3 student campuses.

The National program Education 2021 – 2027, funded by the EU, allocates EUR 197 million. The program's priority axis Modernization of Education supports enhancing digital and STEM skills for students and teachers by providing digital content for all education levels and promoting innovation in preschool and school education. It encourages the use of digital skills and innovative teaching methods.

The Regional Development Program 2021 – 2027 supports educational infrastructure for preschool, school, and higher education in line with municipal development plans and regional territorial strategies. In rural areas educational infrastructure is also supported by the Strategic Plan for Agriculture and Rural Areas 2023 – 2027 through measures promoting employment, growth, social inclusion, and local development. Educational infrastructure investments are guided by prioritization methodologies and lists developed by the Ministry of Education and Science. To ensure effectiveness, they follow a needs assessment and are paired with training educators to fully leverage improved facilities for better educational outcomes.

Municipalities also lead local initiatives with schools and kindergartens. Sofia Municipality (2022) and the recycling company Ekopak launched a pilot program for separate waste collection in schools. Other projects include Green School for a Greener Sofia (school recycling) and My Green School, My Green Kindergarten (tree and shrub planting in 50 schools and kindergartens in 2023).

Another option for schools is the National Trust Eco-Fund, which manages targeted state budget funds, including those from debt-for-environment swaps, emissions trading, and other environmental funding agreements in Bulgaria. The Eco-Fund plays a key role in supporting sustainability in education through energy efficiency projects in schools and kindergartens, with over 100 schools and 50 kindergartens upgraded in the past eight years. These investments are paired with initiatives that engage students and staff in climate-aware behavior, such as the ongoing Climate and Me program. The Fund also supports educational projects like TICA (Toward the introduction of climate action as an element of the educational programs of Bulgarian schools) and BEACON (Bridge between climate action at the European and local level), aimed at integrating climate action into school curricula. These include teacher training and the development of manuals to promote sustainable practices in the school environment.

The recycling company Ekologika (2024) offers a school recycling program and a methodological guide for waste audits, including support for separating and recycling electronic waste. The program fosters environmental habits and civic responsibility through hands-on activities, helping students develop communication, teamwork, critical thinking, and decision-making skills.

Also, many non-governmental organizations support teachers through methodological guides, handbooks, training seminars, etc.

Since 2012, the Together – communication for support and development Foundation has created Edible Gardens in children's institutions, turning green theory into hands-on learning through nature-based play. In 2022, in partnership with the EcoCentric Foundation, they trained educators and supported eco-educational gardens in 15 schools and kindergartens across Bulgaria. These projects are funded by various sources, including the German Environmental Foundation, the EEA Grants, and the America for Bulgaria Foundation.

Teach for Bulgaria Foundation supports teachers and schools through several programs, mainly financed by the America for Bulgaria Foundation. Since 2010, A New Path in Teaching trains high-achieving graduates and professionals to become teachers, with 80% remaining in education. The Learning Together program supports sustainable school projects with scalable potential. The Exemplary Schools program promotes comprehensive learning transformation by empowering school teams to implement student-centered management and innovative teaching methods.

Another supportive initiative is the National Competition with the Teacher of the Year Award, which has been organized by the Bulgarian Teachers' Union for more than 25 years aiming to motivate teachers, boost their professional confidence, highlight their challenges, and raise the prestige of the teaching profession.

Support for architects, builders and designers

To support the construction of sustainable school buildings, there are programs for funding energy efficiency in the municipal fund.

Measures for energy efficiency and renewable energy are included in two pillars of the NRSP: Innovative Bulgaria (Education and Skills, Smart Industry) and Green Bulgaria (Low-carbon Economy). Another possibility is the Energy Efficiency and Renewable Sources Fund under the European Energy Efficiency Fund, which supports small-scale energy efficiency and renewable energy projects by municipalities, local authorities, and their partners.

Between 2016 and 2019, Razlog Municipality implemented an energy efficiency project in one primary and one secondary school. Funded by the Operational Program Regions in Growth 2014 – 2020, the project was BGN 1.75 million, with BGN 1.47 million from the EU and the rest from national co-funding (Vladov, 2019).

Between 2020 and 2024, Shumen Municipality renovated almost 90% of its kindergartens and several school buildings, mainly with European funding. In early 2024, it completed a BGN 2.23 million project to improve energy efficiency at two primary schools – in Shumen and Madara. The schools were upgraded to near-zero energy buildings with heat pumps and rooftop solar panels, replacing old heating systems and connecting to renewable energy sources (Savov, 2024).

In addition to Shumen, 15 other municipalities have been approved for funding under the Energy Efficiency of Residential Buildings procedure, financed by the EEA Financial Mechanism through the Renewable Energy, Energy Efficiency, Energy Security program.

Another example under this procedure is Dobrich Municipality, which implemented a BGN 3.27 million project. The project focused on upgrading the Sports School and the Center for Professional and Personal Development (student dormitory) into near-zero energy buildings. Measures included external wall and roof insulation, replacement of windows and doors, installation of air-to-water heat pumps, and a smart heat management system (Neichev, 2024).

STEM centers in 4 schools in the country (Karnobat, Berkovitsa, Sofia (2)) are created by a business organization of architects, designers and engineers who design educational and public buildings with different funding, e.g. America for Bulgaria Foundation, the NRSP, municipal budget, etc (Lusio Architects, 2024).

Conclusion

Creating sustainable school environments requires a systematic, interdisciplinary and collaborative approach, supported by political will, long-term investments and active participation of all stakeholders – students, teachers, parents, institutions and communities.

This study outlines significant progress in building sustainable learning environments in Bulgaria, especially in terms of energy efficiency, digitalization and the establishment of STEM centers. However, several challenges continue to limit schools' potential to become catalysts for sustainable development. Policy fragmentation, insufficient integration of environmental and social dimensions in the learning process, as well as limited investments in green technologies and resources, remain significant obstacles. Based on the analysis, the following recommendations can be done:

Establish a national program for sustainable schools that builds on existing projects and ensures a coordinated approach to the environmental, social and economic dimensions of sustainable development.

Integrate ESD into all subjects and stages of education through a cross-curricular approach oriented to real problems, practices, and competences.

Integrate outdoor spaces and consider biodiversity in shaping sustainable learning environments.

Expand energy efficiency initiatives with a focus on the use of renewable energy sources, green heating and smart systems for managing resource consumption.

Develop and implement a comprehensive waste management strategy in schools, incl. training, separate collection infrastructure, monitoring and student participation.

Support teachers and school teams through systematic training and access to resources and networks for exchange of good practices in sustainability education.

Stronger connect the school, the community and the local government, through joint projects, initiatives and participation in planning and maintenance of the school environment.

Monitor and evaluate progress through data collection, sustainability indicators, and public reporting of the results involving students.

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