Shaping the Future

Greece's Innovation Centers as Hubs for Sustainable Practices in Constructionist Education

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Abstract
This article explores the transformative role of Greece's Innovation Centers (ICs) in advancing constructionist education and sustainability. By serving as collaborative hubs that connect schools, local communities, universities, and businesses, the centers foster STEM learning and promote environmental stewardship by utilizing cutting-edge technologies, such as Extended Reality (XR), Artificial Intelligence (AI), and robotics, to create immersive and engaging educational experiences. Through hands-on learning, Eco-Friendly Maker Spaces, and Sustainability-Themed STEM Modules, students develop critical thinking, creativity, and problem-solving skills while addressing real-world environmental challenges. The article also highlights the challenges of resource constraints, teacher training, and curriculum integration, proposing effective strategies such as partnerships and blended learning approaches to overcome them. Ultimately, the synergy between constructionist education and sustainability at the ICs equips future leaders to navigate complex environmental issues and fosters a culture of responsibility and innovation, preparing students to become proactive agents of change in their communities.

Keywords and Phrases: Innovation Centers, Sustainable Practices, Constructionist Education

1. Introduction
In an era marked by escalating environmental challenges and the urgent need for sustainable practices, education must evolve to equip future generations with the skills and knowledge necessary to navigate this complex landscape. Greece's Innovation Centers emerge as transformative hubs for constructionist education, where hands-on, experiential learning is at the forefront of shaping environmentally conscious and responsible citizens. Backed by a nationwide project funded through the Recovery and Resilience Fund (2022–2025), the ICs are being implemented in all 13 Regional Directorates, with pilot centers already in operation.

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Constructionist education, rooted in the principle of "learning by doing," encourages students to actively engage with their environment, fostering critical thinking and problem-solving skills essential for innovation. The ICs are designed to provide dynamic learning spaces that integrate advanced technologies, immersive experiences, and collaborative teaching practices. This holistic educational model not only enhances students' understanding of ecological principles but also instills a sense of environmental stewardship that transcends the classroom.

By incorporating innovative educational approaches such as Eco-Friendly Maker Spaces and Sustainability-Themed STEM Modules, ICs empower students to explore and develop practical solutions to pressing environmental issues. This article delves into the pivotal role of Greece's Innovation Centers in promoting sustainable practices within constructionist education, examining the challenges faced, the outcomes achieved, and the effective models and strategies that can enhance environmental awareness among students. Ultimately, this exploration highlights the significance of integrating sustainability into education as a means to cultivate a generation of proactive change-makers equipped to address the global challenges of our time.

2. Innovation Centers (ICs) of Greece

ICs serve as hubs connecting schools, local communities, universities, research institutions, and businesses, fostering STEM learning, green growth, and innovation. They combine physical spaces and virtual platforms to accommodate diverse educational needs and remote access. The Centers aim to develop a comprehensive education proposal, focusing on cutting-edge topics that promote student development. These activities include exploring the metaverse, augmented and virtual reality, robotics, digital literacy, applied science, STEM & social challenges, digital educational games, big data, and machine learning.

The metaverse provides students with creative expression, social interaction, and understanding of its impact on society. The metaverse refers to immersive virtual environments where users interact in real-time through avatars, often blending digital and physical experiences. Augmented and virtual reality enhances immersion in learning experiences, while robotics helps students develop programming and engineering skills. Digital literacy emphasizes critical information evaluation, managing information overload, and cyber ethics. Applied science encourages curiosity and problem-solving, while STEM & social challenges strengthen students' social sensitivity. Digital educational games promote learning through fun and collaboration, while big data analysis enhances IT skills. Machine learning activities introduce students to its operation and applications.

2.1 Details about Innovation Centers

ICs constitute a knowledge ecosystem that integrates and links the school community, the local community, research institutions, universities and local businesses, while connecting with similar educational ecosystems in Europe and elsewhere in the world. Innovation Centers are purpose-built, high-quality environments for STEM learning, green growth and innovation promotion in general. Each lab can be designed to support multiple topics and curriculum modules to meet the unique educational needs of each community.

The project "Development of Innovation Centres in 13 Regional Directorates" is a national initiative implemented by the Hellenic Ministry of Education and Religious Affairs, coordinated by CTI Diophantus. The project is funded by the Recovery and Resilience Fund and spans the years 2022 to 2025, currently progressing through the final stages of implementation. Each of the 13 Regional Education Directorates in Greece is establishing a fully equipped Innovation Centre (IC), aimed at supporting STEM learning, sustainability, and teacher training. Several pilot ICs – such as those in Western Greece and Central Macedonia – are already operational, serving as best-practice models for the national rollout. The initiative involves a wide array of stakeholders including public educational institutions, university partners, local businesses, and sustainability experts, ensuring both pedagogical relevance and community engagement.

Currently, the Innovation Centers are being implemented as part of a national initiative supported by Greece's Ministry of Education. Thirteen centers – one in each Regional Directorate of Education – are under development, with some already operational as pilot facilities. The centers are equipped with advanced technologies and serve as hubs for teacher training and educational innovation. They aim to have both a virtual format to support remote schools and districts, and a physical presence at a specific site to be visited by stakeholders. At the same time, one Innovation Lab will be developed in the premises of the implementing institution for the needs of designing the educational material and the training of the teachers who will staff the Innovation Centers.

Main pillars of the project: In detail, the scope of the project includes the following five (5) main pillars:

a. Educational Programs: For all educational programs, detailed scenarios and educational material is being developed, covering the teaching of each subject, while at the same time manuals are being compiled for students and teachers.
b. Supply and installation of technological/network equipment (hardware/software) to enable the implementation of these specific educational programs.
c. Architectural design of ICs' premises: The supply and installation of office-hall equipment and other interior design works is being carried out to serve the single identity among all ICs, with a pleasant and playful environment that attracts visitors. The exterior premises of each IC can also be used for the implementation of educational scenarios.
d. Training of teachers and, in general, of the personnel that will staff Innovation Centers, so that they acquire the necessary knowledge and skills to carry out the task of disseminating knowledge to both the teachers who will visit the ICs and their students.
e. Services: Production of educational modules, piloting & technical support services, project coordination and management.

2.2 Cutting – Edge Labs and Pedagogical Added Value

ICs in Greece are transforming education through the integration of advanced technologies and collaborative teaching practices. Spread across the 13 Regional Education Directorates, these centers provide dynamic learning environments that connect academia with local industries, research institutions, and universities. They aim to cultivate future-ready skills and ethical technology use while fostering student-centered education. As of 2025, several of these Innovation Centers have already begun pilot operations, offering teacher training programs and launching early STEM education modules across select regions.

Each center boasts cutting-edge laboratories, each adding unique pedagogical value to the educational landscape. The *Extended Reality (XR) Lab* employs VR and AR technologies to create immersive learning experiences, helping students visualize complex concepts through simulations and virtual collaborations. The *AI and IoT Lab* introduces students to artificial intelligence, machine learning, and smart devices, enabling hands-on exploration of advanced technologies and promoting critical thinking and interdisciplinary learning.

In the *STEM and Robotics Lab,* students engage in project-based learning, experimenting with robotics and engineering concepts to connect theory with real-world applications. The *Fabrication Lab*, inspired by MIT's FabLabs, allows students to transform digital designs into physical objects, blending creativity with engineering and craftsmanship. Additionally, the *Meeting and Presentation Space* enhances communication and collaboration skills, providing a flexible venue for discussions, project showcases, and remote learning.

ICs contribute significantly to fostering *immersive learning,* with XR technologies enhancing engagement and understanding through realistic simulations. They promote *collaboration and accessibility* by connecting remote schools, enabling equal access to resources, and preparing students for teamwork in modern workplaces.

Personalized education thrives in these environments, with AI tools enabling tailored learning experiences that address individual needs. Moreover, ICs focus on developing *future-ready skills* like problem-solving, creativity, and technological fluency, essential for today's workforce.

Importantly, ICs emphasize *ethical and sustainable technology use,* integrating discussions on data ethics and sustainability into the curriculum. By fostering responsibility and critical thinking, they prepare students to navigate the complexities of a technology-driven world.

Through their multifaceted approach, ICs are not just hubs of technology but catalysts for transformative education, equipping students with the skills, knowledge, and values to lead as innovators and ethical digital citizens in an interconnected future.

3. Innovation CENTERS and Sustainable Practices in Constructionist Education

The integration of ICs within educational frameworks, particularly in the context of constructionist education, is pivotal for fostering sustainable practices and innovation in the constructionist approach to learning. The Centers serve as incubators for STEM education, emphasizing experiential learning and environmental stewardship, which are essential for addressing contemporary global challenges.

Greece's ICs are designed to promote STEM learning through hands-on experiences, aligning with the principles of constructionist education that advocate for "learning by doing" (Ng & Tsang, 2021). This pedagogical approach encourages students to engage actively with their environment, fostering critical thinking and problem-solving skills necessary for innovation (Jha, 2012). The emphasis on practical engagement is supported by research indicating that such active learning strategies lead to deeper understanding and retention of knowledge, particularly in STEM disciplines (Martins & Oliveira, 2016).

Furthermore, the integration of technology ICs enhances the learning experience, allowing students to explore complex concepts through interactive and collaborative projects (Ostashewski et al., 2011). Sustainability is a core component of the educational model promoted by ICs. Research indicates that education plays a crucial role in fostering pro-environmental behaviors and green growth (Deshuai et al., 2022). By equipping students with knowledge about renewable energy and sustainable practices, the Centers contribute to the development of human capital that is aware of and committed to environmental stewardship (Li, 2022).

Moreover, the incorporation of green initiatives within educational settings has been shown to enhance students' environmental literacy and their adoption of sustainable practices (Goldman et al., 2018). This aligns with the broader goal of integrating environmental considerations into economic growth strategies, as highlighted in recent studies (Huda, 2024). The role of higher education in promoting sustainable practices is further emphasized by findings that link educational attainment with increased awareness and implementation of energy-efficient technologies (Li, 2022; Ribeiro et al., 2021). This holistic approach is essential for preparing future leaders who can navigate the complexities of environmental challenges and contribute to sustainable development (Revilla et al., 2020).

Based on the above, ICs embody a transformative educational model that integrates constructionist principles with a focus on sustainability and innovation. By fostering an environment where students can engage in hands-on learning and collaborative problem-solving, the Centers are instrumental in preparing individuals who are equipped to tackle the pressing challenges of our time. The synergy between education, sustainability, and innovation is crucial for building a resilient future.

3.1 Innovative Approaches in Sustainable Education

The integration of innovative approaches in sustainable education, particularly through the establishment of Eco-Friendly Maker Spaces, Sustainability-Themed STEM Modules, Outdoor Learning Opportunities, and Community Engagement Projects, is essential for fostering a culture of sustainability among students. These initiatives not only enhance learning experiences but also empower students to become active participants in addressing environmental challenges. The main innovative approaches of ICs are depicted in the following table (Table 1).

Innovative Approaches via Innovation Centers of Greece		
	Innovative Approaches	**Description**
Eco Friendly Maker Space	Each Innovation Centre is equipped with green maker spaces where students use sustainable materials	Create projects such as renewable energy models, upcycled products, or water conservation systems
Sustainability – Themed STEM Modules	Teaching concepts of energy efficiency, waste reduction, and ecological balance through hands-on activities	Using technologies like solar kits, Arduino boards, and robotics to explore environmental solutions
Outdoor Learning Opporunities	Leveraging outdoor spaces to study ecosystems, biodiversity, and sustainable agriculture.	Projects include creating green roofs, rain gardens, and solar installations.
Community Engagement Projects	Involving local communities in sustainability efforts, such as recycling drives, energy audits, or urban greening campaigns	Students present solutions to real-world problems, fostering a sense of accomplishment and impact.

Table 1: Innovative Approaches of ICs in Sustainable Education.

Eco-Friendly Maker Spaces are pivotal in promoting hands-on learning experiences that utilize sustainable materials. Research indicates that such spaces encourage creativity and innovation while instilling a sense of environmental responsibility in students (Bascopé et al., 2019). By engaging in projects that involve renewable energy models and upcycled products, students develop practical skills and an understanding of sustainability principles (Rogers et al., 2015). The maker space concept aligns with the pedagogical approaches advocated in education for sustainable development (ESD), which emphasizes experiential learning as a means to cultivate change agents for sustainability (Bano & Hina, 2021).

Sustainability-Themed STEM Modules further enhance the educational experience by integrating concepts of energy efficiency, waste reduction, and ecological balance into the curriculum. These modules often employ technologies such as solar kits and Arduino boards, which allow students to explore environmental solutions through hands-on activities (Jeong et al., 2020). Studies have shown that project-based learning in STEM education significantly enhances students' creativity and critical thinking skills, which are crucial for developing innovative solutions to sustainability challenges (Hanif et al., 2019). Moreover, the multidisciplinary approach to teaching sustainability within STEM frameworks has been recognized as a means to deepen students' understanding and engagement with sustainability issues (Rogers et al., 2015).

Outdoor Learning Opportunities leverage natural environments to study ecosystems, biodiversity, and sustainable agriculture. Projects such as creating green roofs and rain gardens not only provide practical applications of sustainability concepts but also foster a connection between students and their environment (Yoon & Joung, 2019). Research supports the notion that outdoor learning enhances students' environmental literacy and promotes a sense of stewardship towards nature (Tank, 2017). By engaging in real-world projects, students can apply their knowledge in meaningful ways, reinforcing the importance of sustainability in their daily lives.

Community Engagement Projects are instrumental in bridging the gap between education and real-world application. Involving local communities in sustainability efforts, such as recycling drives and urban greening campaigns, allows students to present solutions to tangible problems, fostering a sense of accomplishment and impact (Alonso-Yanez et al., 2019). This engagement not only enhances students' learning experiences but also cultivates a sense of social responsibility and community awareness (Lathifah, 2024). Studies indicate that such collaborative efforts can lead to increased motivation and positive attitudes towards sustainability among students (Lorek et al., 2023).

The innovative approaches in sustainable education through Eco-Friendly Maker Spaces, Sustainability-Themed STEM Modules, Outdoor Learning Opportunities, and Community Engagement Projects create a comprehensive framework for developing environmentally conscious individuals. By integrating hands-on learning experiences with community involvement, these initiatives empower students to become proactive agents of change in addressing sustainability challenges.

3.2 Challenges in Implementation

The integration of sustainability into constructionist education is essential for fostering environmental awareness and responsibility among students. However, implementing sustainable practices within this educational framework presents several challenges. This part of the article explores these challenges, including resource constraints, the need for teacher training, curriculum integration, and student engagement, while also highlighting innovative strategies to overcome them.

Resource Constraints pose a significant barrier to establishing sustainable practices in constructionist education. The costs associated with setting up green maker spaces and acquiring sustainable materials can be prohibitively high for many educational institutions (Disterheft et al., 2015). To address these financial challenges, partnerships with eco-friendly organizations and the utilization of recycled resources are essential strategies. Collaborative efforts can provide schools with the necessary materials and expertise to create sustainable learning environments (Rudyshyn et al., 2020). Research indicates that successful sustainability initiatives often rely on community engagement and resource sharing, which can alleviate financial burdens while enhancing educational outcomes (Disterheft et al., 2015).

Teacher Training is another critical challenge in integrating sustainability into constructionist education. Educators require specialized training to effectively incorporate sustainability concepts into their teaching practices (Kabadayı, 2016). Professional development programs focused on sustainability education are essential for building the capacity of teachers to engage students in meaningful, hands-on projects that promote environmental awareness (LeVasseur & Ciarcia, 2019). Studies have shown that when teachers are adequately prepared, they are more likely to implement innovative pedagogical approaches that align with sustainability goals, thereby enhancing student learning experiences (Nketsia et al., 2020). Teacher training and mentoring are complementary strategies for supporting educators in integrating sustainability into constructionist education. While training offers structured, short-term instruction, mentoring provides ongoing, personalized guidance. Mentors help teachers adapt to evolving challenges and refine their practices over time. This dual approach ensures both skill development and long-term support. The IC project has already introduced mentoring in pilot regions, encouraging peer collaboration and continuous professional growth.

Curriculum Integration presents a further challenge, as aligning sustainability-focused projects with existing curricula requires careful planning and coordination. Educators must balance standard educational goals with innovative practices that promote sustainability (Morton et al., 2016). This necessitates a collaborative approach among educators, curriculum developers, and administrators to ensure that sustainability is woven into the fabric of educational programs. Research suggests that interdisciplinary approaches can facilitate this integration, allowing students to explore sustainability from multiple perspectives and disciplines (Zhang, 2022). Curriculum integration is challenging, as educators must align sustainability-focused projects with existing goals while maintaining educational standards. Assessment adds another layer of complexity – traditional tools often fail to capture the depth of learning in constructionist, project-based settings. More authentic, performance-based evaluations are needed to reflect the inquiry, collaboration, and real-world problem-solving central to sustainability education.

Student Engagement is crucial for the success of sustainability initiatives in constructionist education. Engaging students with diverse interests in sustainability topics can be challenging, but strategies such as gamification and real-world problem-solving have proven effective in increasing participation (Hsu, 2023). By incorporating elements of play and competition into sustainability projects, educators can foster a sense of excitement and motivation among students. Additionally, research indicates that experiential learning opportunities, such as community-based projects, can enhance student engagement and foster a deeper understanding of sustainability issues (Dahl, 2019).

While the integration of sustainability into constructionist education presents several challenges, innovative strategies can facilitate its successful implementation. By addressing resource constraints through partnerships, providing targeted teacher training, carefully integrating sustainability into curricula, and employing engaging pedagogical approaches, educators can create impactful learning experiences that foster environmental awareness and responsibility among students. The outcomes of such educational practices not only benefit individual learners but also contribute to the broader goal of sustainable development. These challenges – particularly resource allocation, staff readiness, and curriculum alignment – have emerged directly from early-phase observations and stakeholder feedback across several IC pilot sites.

3.3 Outcomes and Impact

The sustainability into constructionist education has yielded a range of positive outcomes that significantly enhance the educational experience for students. Exploring the outcomes and impacts of implementing sustainable practices within this educational framework, highlighting enhanced environmental literacy, skill development, behavioral change, and community engagement.

Enhanced Environmental Literacy is one of the most significant outcomes of integrating sustainability into constructionist education. Research indicates that students who engage in sustainability-focused projects develop a deeper understanding of environmental issues and potential solutions. This enhanced literacy not only equips students with knowledge about ecological principles but also empowers them to critically assess the impact of human activities on the environment. Studies have shown that experiential learning approaches, such as those found in constructionist education, are particularly effective in fostering environmental awareness and understanding among students (Hsu, 2020).

Skill Development is another critical outcome associated with hands-on, sustainability-oriented projects. Engaging in practical activities enhances students' creativity, critical thinking, and collaboration skills. Research has demonstrated that project-based learning, a hallmark of constructionist education, encourages students to work together to solve complex problems, thereby fostering teamwork and communication skills. Furthermore, the integration of technology and innovative practices within sustainability projects allows students to develop technical skills that are increasingly relevant in today's job market (Kollmuss & Agyeman, 2002).

Behavioral Change is also a notable impact of sustainable practices in constructionist education. Students who participate in sustainability initiatives often adopt eco-friendly habits and become advocates for sustainability within their communities. Research suggests that experiential learning experiences can lead to lasting changes in attitudes and behaviors related to environmental stewardship. By engaging in projects that require them to consider the environmental impact of their actions, students are more likely to internalize sustainable practices and promote these values among their peers and families (Roth & Lee, 2004).

Community Engagement is a vital aspect of sustainability-focused constructionist education. Many projects extend beyond the classroom, addressing local environmental issues and fostering stronger community ties (Wals, 2011). Research indicates that when students collaborate with community members on sustainability initiatives, they not only contribute to meaningful change but also develop a sense of belonging and responsibility towards their communities. This engagement enhances students' social skills and reinforces the importance of civic responsibility, preparing them to be active participants in their communities (Simons, 2004).

The implementation of sustainable practices in constructionist education has demonstrated numerous positive outcomes, including enhanced environmental literacy, skill development, behavioral change, and community engagement. These outcomes not only enrich the educational experience for students but also contribute to the broader goal of fostering a more sustainable future.

3.4 Effective Models and Strategies

The integration of sustainability into constructionist education is not only timely but essential for cultivating environmental awareness and responsibility among students. This approach emphasizes hands-on, experiential learning, allowing students to engage with real-world problems while developing practical solutions. Below we present effective models and strategies for implementing sustainable practices in constructionist education, highlighting partnerships, blended learning, celebration of successes, and scaling impact through networks.

Partnerships with Sustainability Leaders are a cornerstone of effective sustainable education. Collaborating with environmental organizations and green businesses can provide essential resources, mentorship, and real-world context for students

(García-González et al., 2022). Such partnerships enhance the educational experience by connecting students with professionals in the field, thereby enriching their understanding of sustainability challenges and solutions. Research indicates that these collaborations can lead to more impactful learning experiences, as students gain insights into practical applications of sustainability concepts (Wolff & Ehrström, 2020). Furthermore, partnerships can facilitate access to materials and funding, which are often significant barriers in implementing sustainability initiatives in educational settings (Debrah et al., 2021).

Blended Learning Approaches represent another effective strategy for integrating sustainability into constructionist education. By combining virtual tools with physical projects, educators can enhance accessibility and allow remote schools to participate in sustainability-focused initiatives (Shephard et al., 2014). This approach not only broadens the reach of sustainability education but also accommodates diverse learning styles and environments. Studies have shown that blended learning can increase student engagement and motivation, particularly when students are given opportunities to collaborate on projects that address local environmental issues (Ali et al., 2023). The flexibility of blended learning also allows for the incorporation of various technologies that can enhance the learning experience, making sustainability education more dynamic and interactive.

Celebrating Success is crucial for motivating students and showcasing their achievements. Exhibitions or competitions that highlight student projects can serve as powerful motivators, encouraging peers to participate and engage with sustainability topics (Konst & Friman, 2021). Research has demonstrated that recognition of student efforts can foster a sense of accomplishment and pride, which in turn promotes further engagement in sustainability initiatives (Janhonen-Abruquah et al., 2018). Celebrating successes not only reinforces the importance of sustainability but also builds a community of learners who are committed to environmental stewardship.

Scaling Impact Through Networks is an essential strategy for amplifying the effects of sustainability initiatives. Establishing global connections between Innovation Centers allows for the exchange of ideas and best practices, thereby enhancing the overall impact of sustainability education (Jing et al., 2022). Networks can facilitate collaboration among educators, researchers, and practitioners, creating a platform for sharing resources, experiences, and innovative strategies. Studies have shown that such collaborative networks can lead to the development of comprehensive sustainability programs that benefit a wider audience and promote systemic change within educational institutions (Yan, 2021).

Overall, the integration of sustainability into constructionist education through effective models and strategies such as partnerships with sustainability leaders, blended learning approaches, celebrating success, and scaling impact through networks can significantly enhance environmental awareness and responsibility among students. These strategies not only enrich the educational experience but also empower students to become active participants in addressing the pressing environmental challenges of our time. These approaches – particularly the success of blended learning methods, public-private partnerships, and regional teacher training hubs – have been actively tested and refined through pilot implementations of the IC initiative.

4. Conclusion

In conclusion, the integration of sustainability into constructionist education through Greece's Innovation Centers represents a transformative shift towards a more engaged and environmentally conscious approach to learning. By emphasizing hands-on, experiential education, ICs cultivate a generation of learners equipped not only with technical skills but also with the critical thinking and problem-solving abilities necessary for addressing complex global challenges. The focus on sustainability within this educational framework not only enhances students' understanding of ecological principles but also fosters a culture of environmental stewardship that extends beyond the classroom.

Besides, the ICs serve as vital hubs for collaboration, connecting students with local communities, universities, industries, and environmental organizations. These partnerships enrich the educational experience by providing real-world context, resources, and mentorship, thus allowing students to engage meaningfully with sustainability issues. Research highlights the importance of such collaborations in creating impactful learning experiences that resonate with students and inspire them to take action in their communities. By working alongside sustainability leaders, students gain insights into practical applications of their learning, reinforcing the relevance of their education to contemporary societal challenges.

However, the journey toward integrating sustainability into constructionist education is not without challenges. Resource constraints, the need for comprehensive teacher training, and curriculum integration require ongoing attention and strategic planning. By leveraging partnerships, adopting blended learning approaches, and celebrating student successes, educators can effectively navigate these challenges and create engaging and impactful learning experiences. Furthermore, scaling impact through networks allows for the exchange of best practices and resources, contributing to a broader movement toward sustainability in education.

Ultimately, the synergy between constructionist education and sustainability is crucial for preparing future leaders capable of navigating the complexities of environmental challenges. By fostering a culture of innovation, collaboration, and responsibility, Greece's Innovation Centers are paving the way for a resilient future, where students are empowered to be proactive agents of change in their communities and beyond. Through this holistic approach, education can play a pivotal role in shaping a sustainable world, ensuring that the next generation is not only prepared to face challenges but is also committed to creating a more equitable and environmentally responsible society.

References

Akhmetshin, E., Barmuta, K., Vasilev, V., Okagbue, H., & Ijezie, O. (2020). Principal directions of digital transformation of higher education system in sustainable education. *E3s Web of Conferences, 208*, 09042. https://doi.org/10.1051/e3sconf/202020809042

Almond, K. and Power, J. (2018). Breaking the rules in pattern cutting: an interdisciplinary approach to promote creativity in pedagogy. *Art Design & Communication in Higher Education, 17*(1), 33-50. https://doi.org/10.1386/adch.17.1.33_1

Alonso-Yanez, G., Thumlert, K., Castell, S., & Jenson, J. (2019). Pathways to sustainable futures: a "production pedagogy" model for stem education. *Futures, 108,* 27-36. https://doi.org/10.1016/j.futures.2019.02.021

Bano, N. and Hina, K. (2021). Inclusion of global citizenship education and sustainable development in pre-service curriculum: a perspective study. *International Journal of Innovation in Teaching and Learning (Ijitl), 6*(2), 95-112. https://doi.org/10.35993/ijitl.v6i2.855

Bascopé, M., Perasso, P., & Reiss, K. (2019). Systematic review of education for sustainable development at an early stage: cornerstones and pedagogical approaches for teacher professional development. *Sustainability, 11*(3), 719. https://doi.org/10.3390/su11030719

Charina, A., Kurnia, G., Mulyana, A., & Mizuno, K. (2022). Sustainable education and open innovation for small industry sustainability post covid-19 pandemic in indonesia. *Journal of Open Innovation Technology Market and Complexity, 8*(4), 215. https://doi.org/10.3390/joitmc8040215

Dahl, T. (2019). Prepared to teach for sustainable development? student teachers' beliefs in their ability to teach for sustainable development. *Sustainability, 11*(7), 1993. https://doi.org/10.3390/su11071993

Deshuai, M., Hui, L., & Ullah, S. (2022). Pro-environmental behavior–renewable energy transitions nexus: exploring the role of higher education and information and communications technology diffusion. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.1010627

Disterheft, A., Caeiro, S., Azeiteiro, U., & Filho, W. (2015). Sustainable universities – a study of critical success factors for participatory approaches. *Journal of Cleaner Production, 106,* 11-21. https://doi.org/10.1016/j.jclepro.2014.01.030

Dryjanska, L., Košťálová, J., & Vidović, D. (2022). Higher education practices for social innovation and sustainable development., 107-128. https://doi.org/10.1007/978-3-030-84044-0_6

Goldman, D., Ayalon, O., Baum, D., & Weiss, B. (2018). Influence of 'green school certification' on students' environmental literacy and adoption of sustainable practice by schools. *Journal of Cleaner Production, 183,* 1300-1313. https://doi.org/10.1016/j.jclepro.2018.02.176

Hanif, S., Wijaya, A., & Winarno, N. (2019). Enhancing students' creativity through stem project-based learning. *Journal of Science Learning, 2*(2), 50. https://doi.org/10.17509/jsl.v2i2.13271

Hsu, C. (2023). Applications of business simulation games in flipped classrooms to facilitate student engagement and higher-order thinking skills for sustainable learning practices. https://doi.org/10.20944/preprints202311.0082.v1

Huda, N. (2024). Increasing green economic growth through education and income levels. Bisman (Bisnis Dan Manajemen) the *Journal of Business and Management, 7*(1), 213-222. https://doi.org/10.36815/bisman.v7i1.3188

Jeong, J., González-Gómez, D., & Yllana-Prieto, F. (2020). Sustainable and flipped stem education: formative assessment online interface for observing pre-service teachers' performance and motivation. *Education Sciences, 10*(10), 283. https://doi.org/10.3390/educsci10100283

Jha, A. (2012). Epistemological and pedagogical concerns of constructionism: relating to the educational practices. *Creative Education, 03*(02), 171-178. https://doi.org/10.4236/ce.2012.32027

Kabadayı, A. (2016). A suggested in-service training model based on turkish preschool teachersí conceptions for sustainable development. *Journal of Teacher Education for Sustainability, 18*(1), 5-15. https://doi.org/10.1515/jtes-2016-0001

Lathifah, S. (2024). Research progress, trends, and updates on stem learning-esd: a bibliometric analysis. *Jurnal Penelitian Pendidikan Ipa, 10*(5), 214-222. https://doi.org/10.29303/jppipa.v10i5.6513

LeVasseur, T. and Ciarcia, C. (2019). Sustainability literacy in a time of socio-ecological crisis: using reaccreditation as a leverage point for innovation in higher education. *Sustainability, 11*(18), 5104. https://doi.org/10.3390/su11185104

Li, X. (2022). Exploring the transmission channels between financial inclusion and green growth: a potential role of ict diffusion and higher education in china.. https://doi.org/10.21203/rs.3.rs-1442880/v1

Lorek, A., Lorek, E., & Koczur, W. (2023). Education for sustainable development in polish institutions of higher education – present and future. *Economics and Environment, 84*(1), 116-132. https://doi.org/10.34659/eis.2023.84.1.513

Mahgoub, Y. (2020). Innovation learning at king faisal university for achieving unesco sustainable development goals. *International Design Journal, 10(2)*, 209-213. https://doi.org/10.21608/idj.2020.81096

Martins, A. and Oliveira, L. (2016). Teaching fractions to primary school students with videogames – a comparison between instructivist and constructionist approaches. https://doi.org/10.21125/inted.2016.1358

Morton, C., Saleh, S., Smith, S., Hemani, A., Ameen, A., Bennie, T., ... & Toro-Troconis, M. (2016). Blended learning: how can we optimise undergraduate student engagement? *BMC Medical Education, 16*(1). https://doi.org/10.1186/s12909-016-0716-z

Ng, O. and Tsang, W. (2021). Constructionist learning in school mathematics: implications for education in the fourth industrial revolution. *Ecnu Review of Education, 6*(2), 328-339. https://doi.org/10.1177/2096531120978414

Nketsia, W., Opoku, M., Saloviita, T., & Tracey, D. (2020). Teacher educators' and teacher trainees' perspective on teacher training for sustainable development. *Journal of Teacher Education for Sustainability, 22*(1), 49-65. https://doi.org/10.2478/jtes-2020-0005

Ostashewski, N., Reid, D., & Moisey, S. (2011). Applying constructionist principles to online teacher professional development. *The International Review of Research in Open and Distributed Learning, 12*(6), 143. https://doi.org/10.19173/irrodl.v12i6.976

Revilla, J., Adúriz–Bravo, A., & Greca, I. (2020). A framework for epistemological discussion on integrated stem education. *Science & Education, 29*(4), 857-880. https://doi.org/10.1007/s11191-020-00131-9

Ribeiro, J., Hoeckesfeld, L., Magro, C., Favretto, J., Barichello, R., Lenzi, F., ... & Guerra, J. (2021). Green campus initiatives as sustainable development dissemination at higher education institutions: students' perceptions. *Journal of Cleaner Production, 312*, 127671. https://doi.org/10.1016/j.jclepro.2021.127671

Rogers, M., Pfaff, T., Hamilton, J., & Erkan, A. (2015). Using sustainability themes and multidisciplinary approaches to enhance stem education. *International Journal of Sustainability in Higher Education, 16*(4), 523-536. https://doi.org/10.1108/ijshe-02-2013-0018

Rudyshyn, S., Kravets, V., Samilyk, V., Sereda, T., & Havrylin, V. (2020). Features of the fundamentalization of education in higher educational institutions of ukraine in the context of sustainable development. *Journal of Educational and Social Research, 10*(6), 149. https://doi.org/10.36941/jesr-2020-0116

Samuel, S. (2023). A blended institutional learning approach for the higher education sustainability. *SHS Web of Conferences, 156*, 09002. https://doi.org/10.1051/shsconf/202315609002

Smyrnaiou, Z., Liapakis, A., & Bougia, A. (2023). Ethical use of artificial intelligence and new technologies in education 5.0. *J Artif Intell Mach Learn & Data Sci, 1*(4), 119-124.

Smyrnaiou, Z., Liapakis, A., & Bougia, A. (2023). Artificial Intelligence and New Technologies in Education 5.0: The Case of Development Thirteen Innovation Centres in all Greek Regional Directorates for Primary and Secondary Schools. In *ICERI2023 Proceedings* (pp. 5501-5501). IATED.

Smyrnaiou, Z., Georgakopoulou, E., Sotiriou, M., & Sotiriou, S. (2021). Constructing scientific notions: Students' and teachers' conceptual change through a responsible research and innovation initiative. In *Co-creating in Schools Through Art and Science: Lessons Learned in Community Engagement Within the Responsible Research and Innovation Framework* (pp. 39-47). Cham: Springer International Publishing.

Tank, K. (2017). Supporting integrated stem in the elementary classroom: a professional development approach centered on an engineering design challenge. *International Journal of Stem Education, 4*(1). https://doi.org/10.1186/s40594-017-0058-3

Wu, Y. and Shen, J. (2016). Higher education for sustainable development: a systematic review. *International Journal of Sustainability in Higher Education, 17*(5), 633-651. https://doi.org/10.1108/ijshe-01-2015-0004

Yoon, J. and Joung, S. (2019). Examining purchase intention of eco-friendly products: a comparative study. Journal of System and Management Sciences. https://doi.org/10.33168/jsms.2019.0308

Zhang, J. (2022). Sustainable engagement and academic achievement under impact of academic self-efficacy through mediation of learning agility – evidence from music education students. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.899706

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