ICONSUS 2025

International Conference on Sustainability

Transforming Higher Education for a Sustainable Future

EDITORS

Susana Leal, Cláudio Barradas, Ana Loureiro,
Inês Messias, Sandra Oliveira

Santarém Polytechnique University | 11-12 September 2025

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BOOK OF ABSTRACTS

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Transforming Higher Education for a Sustainable Future

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PREFACE

We are delighted to present the Book of Abstracts for the International Conference on Sustainability: Transforming Higher Education for a Sustainable Future'. This event provides a global platform for dialogue, knowledge exchange and collaboration among academics, researchers, policymakers and practitioners who are dedicated to advancing sustainability in higher education.

Taking place within the framework of the Erasmus+ project Time2Act@SD, ICONSUS2025 emphasises the vital role of higher education institutions in driving change. By embedding sustainability into teaching, research and institutional practices, universities can encourage critical thinking, interdisciplinary approaches and innovative solutions to the urgent challenges facing us today.

The abstracts collected here reflect the diversity and richness of the conference themes, ranging from curriculum development and institutional transformation to research innovation, partnerships, and community engagement. Together, they demonstrate a shared commitment to promoting knowledge, strengthening collaboration and inspiring action towards a more sustainable future.

We would like to thank all the contributors and participants for their valuable efforts, and we hope that this collection will continue to inspire dialogue and collaboration beyond the conference itself.

On behalf of the organising committee,

The organizing committee

KEYNOTE SPEAKERS

Sustainability leadership in the context of higher education institutions

João Eustachio[1]

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Abstract

Higher Education Institutions (HEIs) are central to advancing sustainable development, not only by shaping knowledge and fostering innovation, but also by cultivating leadership that integrates sustainability into teaching, research, and practice. This presentation explores the role of sustainability leadership in HEIs, drawing on a series of empirical studies that collectively assess its conceptual foundations, practical applications, and implications for responsible management education. The first study maps the research landscape of sustainability leadership through a bibliometric analysis, identifying key clusters and theoretical underpinnings. The second examines how sustainability leadership and transformational leadership interact to influence the integration of sustainability in teaching, based on a global survey of 603 academics from 102 countries. The third study investigates the leadership role of PRME signatory business schools, analysing responses from 969 educators across 104 countries and highlighting differences in sustainability-related teaching support between signatory and non-signatory institutions. The fourth study focuses on student-centric learning approaches, exploring how formal, non-formal, and informal learning environments shape sustainability competencies among management students. Together, these studies underscore the necessity of sustainability leadership as a driver of change in HEIs, demonstrating how it supports curriculum innovation, pedagogical transformation, and institutional commitments to the SDGs. The findings contribute to ongoing debates on the future of responsible management education and provide insights into how HEIs can strengthen their leadership capacity to form the responsible decision-makers of tomorrow.

Keywords: Sustainability Leadership; Higher Education Institutions; Responsible Management Education

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Transition teams as an innovative tool in higher education institution on the road to sustainability: A case study in Belgium

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Abstract

The integration of the Sustainable Development Goals (SDGs) in the Strategy Statement 2021-2026 and in the operational policy implementation lines of a Higher Education Institution (HEI) is reported. To accommodate this transition project, the HEI initiated a strategic co-creation with CIFAL Flanders, a United Nations (UNITAR)-affiliated centre of expertise on the SDGs. The rollout of this methodology in both policy and curriculum is reported. Inside the HEI, the Multi-Level Perspective (MLP) approach is implemented. The MLP is a strong tool to gain insight into transition processes. A transition team grows bottom-up via a coalition of the willing towards a coalition for change and acts as a catalyst for adopting sustainability across the organization. It is composed of internal stakeholders from diverse backgrounds and job descriptions. To become SDG proof the HEI started successfully the PCA 2030 trajectory (Pioneer, Champion, Ambassador) on these working fields: learning, organizing, formulating, implementing, evaluating and communicating. The steppingstones to get “SDG Pioneer” accredited by CIFAL Flanders | UNITAR (CIFAL Flanders) are described. This project proves to be a good benchmark for other HEIs to integrate the SDGs into strategy and policy. In addition, this approach has a multiplier effect in the broader society.

Keywords: SDG Pioneer; Higher Education Institution; Transition team; Multi-Level Perspective; Sustainability

FUTURATES Future-Forward Sustain+HE

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Abstract

The presentation starts by analysing the intertwining between sustainability, education and society. Specific aspects of this sustainability triad will be then covered like Green Campus and Buildings, Carbon Tools and Eco-Schools. Innovation hubs and Sustainable Curriculum Development will also be discussed. Other critical matters will be addressed such as, Sustainable Development Goals, Ecosystem Restoration and Sustainability Advocates. Finally, issues like Green Schools and Indigenous Knowledge will be presented.

Keywords: Sustainability, Education, Innovation

TIME2ACT@SD PROJECT

Sustainable Futures: A Gamified Virtual Reality Journey through the SDGs

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Abstract

'Sustainable Futures: A journey through the SDGs' is an educational Virtual Reality (VR) game designed to equip learners with the knowledge and competencies needed to address ongoing challenges related to the Sustainable Development Goals (SDGs). Serious games can engage students, develop their higher-order thinking, and foster retention and transfer of actionable skills (Hallinger et al., 2020). By navigating the virtual world and engaging in playful activities, learners are encouraged to rethink about their own actions and behaviours, and ultimately, improve their attitudes across the key dimensions of Sustainable Development (SD), namely Environmental, Social, and Economic. The game features visually appealing 3D graphics and utilises the playful nature of VR technology to immerse students into a unique learning experience. Upon launching the game, players enter an initial, orientation level to familiarize with the system controls and game mechanics, followed by three thematic levels dedicated to Environmental, Social, and Economic sustainability. Each level includes puzzles and challenges ranging from tree planting and recycling, to managing waste, designing a sustainable city using renewable energy, discovering secret codes, and unlocking levels. The final level aims to assess students' knowledge and energise them to take action towards a more sustainable future. Initial testing and evaluation with Higher Education students provided useful insights on the game's usability and students' degree of enjoyment (Nisiotis et al., 2024). The findings can inform further research and development highlighting the role of educational technology in fostering a sustainable mindset (Leal Filho et al., 2025) and driving positive change.

Keywords: Education for Sustainable Development (ESD) · Sustainability mindset · Game-based learning · Virtual Reality (VR) · Higher Education

Acknowledgements

This work is co-funded under the Erasmus+ Program for the project 'TIME2ACT@SD: Time to Act

through Sustainable Experiences for Higher Education Students', Grant Agreement: 2022-1-PT01-KA220-HED-000087984.

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Identifying Knowledge and Competency Gaps in Sustainable Development: Insights from Higher Education Students and Teachers in Europe

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Abstract

This research, conducted within the TIME2ACT@SD Erasmus+ project, aimed to identify knowledge and skills gaps related to sustainable development (SD) and the Sustainable Development Goals (SDGs) in higher education. Drawing on the Education for Sustainable Development (ESD) framework, two transnational studies were carried out involving 716 students and 209 teachers across European institutions. The students' study employed the validated Sustainability Consciousness Questionnaire online to measure students' knowledge, attitudes, and behaviours across environmental, social, and economic dimensions of sustainability. Findings indicate that while students exhibit moderate knowledge and generally positive attitudes toward sustainability, behavioural engagement—especially in areas such as sustainable consumption, civic action, and waste reduction—remains limited. Teachers, in an online different tailor designed survey, reported low familiarity with specific SDGs (particularly Goals 12, 13, and 15) and rare use of experiential, digital, or project-based teaching strategies. Gaps were also observed in the integration of systems of thinking, anticipatory competence, and risk awareness—particularly concerning natural disaster preparedness and long-term environmental planning. The findings highlight the urgency of embedding SDG-related content and active methodologies in higher education. Recommendations include prioritising project-based and digital learning, enhancing teacher training, and designing interventions based on students' preferred learning formats – such as videos, documentaries, and interactive

tools. Its impact spans educational innovation, institutional strategy, and policy alignment with the SDGs.

Keywords: Sustainability, Higher Education, SDGs, Educational Gaps, Pedagogical Innovation

Acknowledgements

This work was funded by the European Union Erasmus+ programme (Grant number 2022-1-PT01-KA220-HED-000087984) and by the Portuguese FCT (Grant number UID/CED/04748/2023).

Changing Attitudes Through Play: A Web and Mobile Game for Sustainability Education in Higher Education

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Abstract

TIME2ACT is a European Erasmus+ cooperation project that leverages digital game-based learning to promote sustainability awareness and behavioral change among higher education students. At its core is Time2Act: Sustainability Quest, a cross-platform 3D educational game developed using Unity and deployed for desktop, mobile, and web browsers. The game immerses students in interactive missions aligned with real-world sustainability challenges, encouraging reflection on waste reduction, ecosystem restoration, social equity, and civic action. By integrating systems thinking and sustainability literacy into engaging gameplay, the project fosters motivation, critical thinking, and agency in young adults. The learner-centered approach is reinforced through co-creation with educators and students across Europe, ensuring pedagogical relevance and cultural diversity. Testing began with a student bootcamp in Belgium in May 2025, collecting feedback to refine the experience. TIME2ACT provides scalable tools and open educational resources for educators, aiming to transform students into proactive changemakers capable of addressing global challenges through informed and responsible action.

Keywords: Sustainability, Game-Based Learning, Higher Education, Digital Tools, Student Engagement

Acknowledgements

This work is co-funded under the Erasmus+ Program for the project 'TIME2ACT@SD: Time to Act through Sustainable Experiences for Higher Education Students', Grant Agreement: 2022-1-PT01-KA220-HED-000087984.

Time2act@SD: Webinars for a Sustainable and Inclusive Europe

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Abstract

Three webinars were held on the following topics:

- The European sustainability reporting standards - ESRS;

- Gender equality and women's empowerment in Europe;

- EU directive on greenwashing.

The webinar "European Sustainability Reporting Standards - ESRS" was hosted by Paolo Bartolozzi. The European Sustainability Reporting Standards (ESRS) represent a key strategic element for guiding business decisions in the current context. Knowledge of the ESRS is important for managing and planning a business, so much so that implementing these standards in corporate financial statements has become necessary. The webinar "Gender Equality and Women's Empowerment in Europe" was hosted by Claudia Villante. The webinar, in addition to defining gender equality and exploring the concept of gender roles and stereotypes, presented statistics and data on the current state of gender equality, highlighting disparities in various areas, such as education, employment, and leadership roles. The webinar "EU Directive on Greenwashing" was hosted by Nicola Moscheni. The webinar illustrated how the new EU directive against misleading sustainability information will impact consumers' lives. It is crucial to understand what is Greewashing, what is planned obsolescence and how the new directives struggle against them.

Keywords: European Sustainability Reporting Standards, ESRS, Sustainability reporting principle, Gender equality, Gender roles, Gender gap, Stereotypes, Greenwashing, Planned obsolescence.

Acknowledgements

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Design and development of MOOC about social, environmental and economic sustainability for higher education

Catarina Gonçalves[5], Paulo Costa[5], Tito Livio Mongelli[7], Elisabetta Focaricci[7], Pierangelo Verbicaro[7], Susana Leal[2], Ana Loureiro[2], Sandra Oliveira[1], Inês Messias[2], L. Cláudio Barradas[1], Adem Tekerek[3], Alper Güzel[3], Büşra Duygu Çelik[3], Andriani Piki[4], Nicos Kasenides[4], Joke Simons[6], Veronica Gelfgren[8] and Xander Michiels[6]

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Abstract

The current global challenges of climate change, biodiversity loss, inequality, conflict, humanitarian crises, economic crises and disregard for human rights threaten the peace and prosperity of today's society. Addressing these complex issues requires knowledge, collaboration and commitment from all sectors of society, including governments, businesses, civil society and citizens. Higher education institutions play a vital role in educating citizens and future professionals about sustainability issues. In line with target 4.7 of the Sustainable Development Goals, three Massive Open Online Courses (MOOCs) on environmental, social and economic sustainability have been developed for higher education students from a range of scientific disciplines. The aim is to increase students' knowledge of sustainability by providing a flexible learning tool that democratises access to knowledge. This study aims to present the co-creation process involved in developing the MOOCs and the main content produced.

Keywords: Sustainability, MOOC, SDG, Economic, Social, Environmental

Time2Act@SD MOOC for Environmental Sustainability

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Abstract

The MOOC on environmental sustainability is structured in three main chapters:

- Change in individual behaviours;
- Better use of water;
- Circular Economy.

The importance of implementing an effective change in the behaviour of individuals is present in each chapter. Every individual, with many small efforts, can improve the environmental situation and everything is illustrated and explored through images, documents and interactive videos. Knowing the actual weight of one's role in climate change allows everyone to become aware of the problems and to start a much-needed change of direction. Saving a vital resource such as water, for example, is the path to follow. Understanding the concept of "water footprint" allows us to deal with waste and bad habits that have led us to a dangerous situation for us and for the planet we inhabit. The implementation of the circular economy is important too! Instead of buying new items we could recycle and reuse!

Keywords: Climate change, Carbon footprint, Individual behaviours, Water, Better use of water, Environmental challenges, Water footprint, Circular Economy, Circular business models.

Acknowledgements

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Time2Act@SD MOOC for Social Sustainability

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Abstract

The MOOC for Social Sustainability invites higher education students to engage in a transformative learning journey that challenges them to contribute to a sustainable future. Central to the course are the interconnected domains of well-being, gender equality, and global citizenship. By addressing these dimensions in an integrated way, the MOOC encourages students to understand the complexity of global challenges while recognizing their own role and agency in creating change.

Students are not only inspired, but also empowered to actively contribute to a world characterized by harmony, resilience, and meaningful transformation. The MOOC moves beyond traditional knowledge transfer and fosters critical reflection, dialogue, and action. Through real-world examples, instructional en learning videos and reflective activities, it seeks to serve as a catalyst for change, motivating students to question assumptions, re-examine personal choices and behaviors, and explore pathways towards social sustainability.

Keywords: Sustainability, MOOC, SDG, Social

Design and development of MOOC about economic sustainability for higher education

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Abstract

Economic sustainability is increasingly recognized as a key component of long-term prosperity, not only in terms of environmental and social sustainability, but also in relation to the well-being of individuals and societies. In this context, the Economic Sustainability Massive Open Online Courses (MOOCs) has been developed to provide an accessible and easy-to-understand educational resource, specifically targeting higher education students and young professionals. The course aims to equip participants with a solid understanding of the fundamental principles of economic sustainability through clear and practical instruction. The MOOC covers a wide range of relevant topics beyond economics alone, including equality, financial literacy, responsible consumption habits, and sustainable lifestyles. In doing so, it not only offers theoretical knowledge, but also helps learners understand how to apply these principles in their daily lives. The program encourages young people to consider environmental and social impacts when making economic decisions, promoting a more holistic and responsible approach. By doing so, it contributes to the broader goals of sustainable development. This MOOC adopts a comprehensive perspective on economic sustainability and supports individuals in making more informed and conscious decisions at both personal and societal levels.

Keywords: Economic, Sustainability, MOOC, SDG

EMBEDDING SUSTAINABILITY IN HIGHER EDUCATION INSTITUTIONS

The Role of Digital Transformation in Higher Education: Improving Smart Campuses for Sustainable Futures

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Abstract

The rapid advancement of digital technologies is reshaping the landscape of higher education, presenting unique opportunities to advance sustainability through innovation, efficiency, and inclusiveness. This paper examines the strategic role of digital transformation in enabling the development of smart campuses that contribute to sustainable futures. Drawing on socio-technical systems theory and sustainability-oriented innovation frameworks, the paper proposes a conceptual model linking digital tools, such as AI-based decision-making, online learning platforms, smart energy management systems, and data-driven campus operations, with environmental, economic, and social sustainability goals. It highlights critical enablers of digital sustainability, including institutional leadership, digital literacy among staff and students, and the formulation of green IT policies. The paper also synthesizes insights from the best international practices identified in recent institutional reports and strategic frameworks. This study provides a theoretical foundation for understanding how higher education institutions can align digital innovation with sustainable development goals. It offers a conceptual basis for future empirical research and policymaking in transitioning toward climate-conscious, equitable, and digitally integrated higher education systems.

Keywords: Digital transformation; Higher education; Smart campus; Smart classrooms; Sustainable future

Systemic Integration of the SDGs in Higher Education: Evidence from Portugal, Spain, and the UAE

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Abstract

The integration of sustainability into higher education is essential for achieving the United Nations Sustainable Development Goals and addressing global challenges such as climate change, inequality, and social justice. Higher education institutions play a vital role in preparing future leaders and promoting sustainable practices across disciplines.

This study aims to examine how sustainability is being integrated into higher education institutions in three different contexts: the United Arab Emirates, Spain, and Portugal. It focuses on the inclusion of SDGs in curricula, research agendas, campus initiatives, and institutional leadership, evaluating their relevance in transforming higher education for a sustainable future.

A systematic literature review was conducted using the PubMed database. Three recent open-access articles were selected, each representing a case study of a higher education institution. These texts were analyzed through qualitative content analysis in order to identify key strategies, enablers, and challenges in implementing sustainability.

The findings reveal diverse approaches and innovative practices, contributing notably to SDGs such as good health and well-being, quality education, and innovation. Common challenges include insufficient interdisciplinary coordination, limited faculty awareness, and uneven institutional engagement with sustainability.

While meaningful progress has been made, the study highlights the need for more consistent and systemic efforts in order to integrate sustainability into higher education. The insights presented are valuable for educators, policymakers, and academic leaders committed to advancing the 2030 Agenda.

Keywords: higher education, institutional transformation, SDGs, sustainability.

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Elevating Educational Quality: The Contribution of ISO Standards in Advancing SDG 4 within Sri Lankan Higher Education

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Abstract

This study examines the role of ISO standards in improving the management performance of higher education institutions, with a specific focus on Sri Lanka. As higher education faces growing demands for quality and accountability, the adoption of internationally recognized standards such as those set by ISO is increasingly seen as essential. ISO certifications like ISO 21001:2018 (Educational Organisations Management System), ISO 9001:2015 (Quality Management System), and ISO 45001:2018 (Occupational Health & Safety Management System) offer higher education institutions structured frameworks that drive improvements in governance, operational effectiveness, and educational outcomes. The research employs a qualitative methodology, reviewing secondary sources, literature, and expert viewpoints, to investigate the potential of these ISO standards to support educational institutions in enhancing their internal processes and quality of education. The findings indicate that adopting these standards can create an environment of continuous improvement, benefiting not only institutional governance and management practices but also the learning experiences and outcomes for students. In line with the United Nations' Sustainable Development Goal 4 (SDG 4), which advocates for equitable and high-quality education for all, the study explores how ISO standards can help Sri Lanka address ongoing challenges related to quality education, particularly in underserved areas. In conclusion, the paper presents recommendations for Sri Lankan educational policymakers and leaders to integrate ISO quality assurance standards into the national education system to foster sustainable development and educational improvement.

Keywords: Sustainable development, higher education, ISO certifications, quality assurance, educational standards, ISO 21001:2018, ISO 9001:2015, ISO 45001:2018, SDG 4, institutional Performance.

The APECHE project and the development of a Holistic Framework for Integrating Sustainability in Higher Education

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Abstract

Education has gained increasing prominence in sustainability since the 1992 Earth Summit and its subsequent meetings. Recognized as a key driver of social transformation, the education sector has taken the initiative to propose new teaching practices, identify relevant content, and establish essential competencies for students to address contemporary challenges. The project "Assessing and Promoting Environmental Culture in Higher Education (ref. 2022.03754.PTDC)" was launched as a collaborative effort, of a group of national higher education institutions, including Aveiro University, aiming at assessing the implementation of sustainability-promoting practices in education within higher education institutions (namely exploring the state of sustainability in education and students' environmental literacy). Its main objective is to characterize and understand the environmental literacy of university students in Portugal. To achieve these goals, the project follows students throughout their three-year undergraduate programs, employing surveys to track changes in their perceptions and understanding of sustainability over time. Additionally, a novel tool has been developed to assess the extent of curriculum greening, providing insights into the integration of sustainability into academic programs. Furthermore, campus greening analysis is essential for evaluating how institutional practices influence students' experiences and academic development.

Keywords: Curriculum analysis methodologies · Education for Sustainable Development ·Environmental literacy· Holistic Perspective on Sustainability in Education

Acknowledgements

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Bridging Strategy and Sustainability: The Role of Portuguese Universities

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Abstract

In the light of the growing importance of sustainability dimension in higher education, this study aims to analyse how Portuguese Higher Education Institutions (HEIs) featured in the Times Higher Education Impact Rankings (THE-IR) integrate sustainability across their various dimensions into their strategic approach.

This study applies a qualitative content analysis to the strategic plans of 15 Portuguese universities listed in the THE-IR, using a coding framework structured around four analytical dimensions: sustainability governance, environmental management, social responsibility, and integration of sustainable development in research and innovation, aligned with the United Nations (UN) Sustainable Development Goals (SDG).

Although there is a growing recognition of sustainability as a strategic priority among Portuguese HEIs, the evidence within its strategic plans reveals different stages and highlights different SDG dimensions. Some institutions demonstrate a comprehensive approach, aligning their strategic goals with the UN SDG, while others concentrate on specific sustainability initiatives. The study highlights best practices, providing valuable insights for HEIs seeking to enhance their sustainability strategies. This research contributes to the understanding of how HEIs can effectively bridge strategy and sustainability, benchmark their progress and identify areas for improvement.

Keywords: Strategic Plan; Higher Education; Sustainable Development Goals; Rankings

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Benchmarking Sustainability Practices in Higher Education Using Data Envelopment Analysis: A Study of Selected European and Turkish Universities

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Abstract

This study presents a Data Envelopment Analysis (DEA) approach for evaluating and comparing the sustainable campus management performance of selected universities from Europe and Türkiye. Sustainability initiatives implemented by higher education institutions play a pivotal role in addressing global environmental and societal challenges. To objectively assess sustainability efforts, this analysis utilises data from the UI GreenMetric World University Rankings, which measure universities' performance using indicators such as energy efficiency, climate change mitigation, waste and water management, transport systems, infrastructure, and sustainability-oriented education and research activities. In the proposed DEA framework, selected universities constitute decision-making units. Relevant indicators derived from the UI GreenMetric database are used as inputs and outputs to assess operational efficiency. This, in turn, helps identify the most efficient universities, which serve as benchmarks for sustainability performance. Although DEA provides an effective means of comparative efficiency analysis, the method's limitations—such as sensitivity to selected inputs and outputs, and reliance on relative rather than absolute efficiency measures—should be acknowledged when interpreting the results. The analysis aims to highlight best practices by distinguishing efficient universities and to suggest targeted improvement strategies for institutions performing below this efficiency frontier. The findings are anticipated to provide actionable insights that will facilitate strategic decision-making in campus sustainability management, encourage the adoption of innovative practices, and strengthen institutional contributions to broader sustainability goals.

Keywords: Sustainability · Higher Education · Data Envelopment Analysis · Campus Management · Performance Evaluation

Science-Driven Architectural Geometry Optimization of Modular Plant-based Systems

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Abstract

Integrating plant-based systems into buildings can reduce energy consumption and provide fresh air to the indoor environment. Previous studies by the authors showed the air-cleaning capacity of hydroponic plants and growing media. The present study focuses on enhancing the air purification of the plant-based system by optimizing the design of the module lids to achieve uniform and stable airflow. We perform the analysis through 120 lid types using Computational Fluid Dynamics (CFD) simulations. The height and depth of each lid corner, the diameter of the lid's internal corners, and the lid's interior and exterior edges determine the characteristics of the tested lids. The optimal design selects 34 lids from the modules that produce uniform and stable airflows.

Keywords: Computational Fluid Dynamics (CFD) · Airflow · Design · Plants · Lid

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Evaluation of HEI's preparedness for future challenges in Uzbekistan

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Abstract

The higher education in Uzbekistan has undergone rapid transformation, particularly since 2021, marked by a sharp increase in the number of private higher education institutions (HEIs). This article presents the application of a European Union (EU) self-assessment tool to a public HEI in Uzbekistan. Specifically, it evaluates the preparedness of HEIs for future challenges using the HEInnovate self-assessment framework—an initiative developed by the European Commission's Directorate-General for Education and Culture in collaboration with the OECD LEED Forum. The evaluation was conducted as part of the Erasmus+ CBHE project "Triggering Innovative Approaches, Entrepreneurial Skills and Attitudes in HEI Learners through Creating Favourable Conditions for Graduate Employability in Central Asia" (TRIGGER), 2021–2024. Four universities from Uzbekistan including NIET participated in the project. The case study focuses on the Namangan Institute of Engineering Technology (NIET), a public HEI in Uzbekistan. It presents general information about NIET, the findings and analysis of a survey conducted using the HEInnovate tool, and a comprehensive SWOT analysis. Based on these evaluations, actionable recommendations have been developed to enhance NIET's readiness for future challenges. The application of the HEInnovate methodology marked a pioneering experience for Uzbek HEIs, representing their first engagement with this EU tool. The self-assessment, conducted across eight key dimensions, development strategy but also provide a replicable model for other institutions across the country. NIET aims to institutionalize this practice and promote the HEInnovate tool as a strategic instrument for ensuring long-term sustainability and competitiveness in Uzbekistan's evolving higher education landscape.

Keywords: HEInnovate tool · Innovation · Internationalization · Entrepreneurial · SWOT.

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The role of Accounting Education 5.0 in promoting the sustainable development goals (SDGs)

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Abstract

This paper examines the transformative role of accounting education in advancing the United Nations Sustainable Development Goals (SDGs), in the context of a technology-driven Society 5.0. The main objective is to discuss how future accountants can be prepared to be proactive agents of sustainable development through innovations in education, particularly the integration of digital technologies and the development of socio-emotional skills. The study adopts a qualitative, exploratory approach based on a structured theoretical and conceptual analysis of academic literature and emerging trends in accounting education. The paper argues that Education 5.0 - with its focus on technology-enhanced, human-centred learning - provides a relevant framework for aligning accounting education with sustainability, enhancing accountants' ability to contribute to sustainability reporting and support managers in critical decision-making processes related to the SDGs. The discussion highlights the need to revise accounting curricula to embed sustainability and digital literacy as core components, thereby positioning education as a driver of both professional transformation and social impact. In practical terms, this means adopting approaches such as gamification, project-based learning and simulation technologies, which can support the development of future-ready competencies. In addition, sustainability-related skills should become standard requirements in the training and certification of accountants, with support from professional bodies and regulators. This theoretical contribution aims to encourage critical reflection on the strategic role of accounting education in the nexus of digital transformation and sustainable development, while calling for empirical research to validate the proposed recommendations and assess their applicability in different educational and institutional contexts.

Keywords: Accounting Education, Education 5.0, Sustainable development goals, SDGs

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LEAN tools and Its Impact on Sustainable Higher Education Sector

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Abstract

The Lean philosophy, originally developed in industry to eliminate non-value-added activities and optimize processes, has been successfully adapted to higher education. Applying Lean principles to curricular programs, reducing administrative inefficiencies, and increasing student satisfaction demonstrate its potential. The drive to improve academic outcomes, operational efficiency, and resource management motivates the use of Lean tools. Examples include process simplification, waste reduction, and greater engagement of staff and students, such as improved grading systems, reduced paper use in services like printing and cafeterias, and a stronger focus on student value perception. Before 2016, Lean initiatives in higher education focused mainly on services like libraries and administrative offices. Today, the approach extends to improving teaching programs and methods. This evolution highlights Lean's adaptability and innovation. Integrating Lean Education into academic courses also prepares future professionals to meet challenges posed by the fourth industrial revolution, fostering systemic thinking, sustainability awareness, and ethical behavior. However, barriers such as resistance to change, lack of leadership, and limited staff knowledge emphasize the need for holistic and adaptive approaches. Understanding the specific challenges faced by both public and private institutions is essential. In addition, comprehensive process mapping and identifying sources of waste can support the effective implementation of Lean principles, enhancing performance and efficiency in higher education. By addressing these obstacles and emphasizing continuous improvement, Lean can offer not only operational benefits but also a stronger educational experience aligned with the expectations and needs of students, the primary stakeholders.

Keywords: Lean Methodology, Higher Educational Institutes, Review

SUSTAINABILITY LEADERSHIP, ETHICS AND ORGANISATIONAL CULTURE

"When people are in the heart of business, performance follows": unveiling the impact of Sustainable Human Resource Management on workers' performance

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Abstract

Managing people through Sustainable Human Resource Management (SHRM) reflects a strategic commitment to sustainability by integrating long-term HRM practices aligned with environmental, social, and economic goals. This study investigates the impact of SHRM on workers' performance (WP), considering the mediating roles of employee engagement (EE) and organizational attractiveness (AT). A cross-sectional quantitative study was conducted using Structural Equation Modeling (SEM) with data from 247 participants across sectors such as agri-food, manufacturing, and services. Findings reveal that SHRM is positively associated with EE, WP, and AT. Furthermore, EE and AT fully mediate the relationship between SHRM and performance. The confirmatory model demonstrated adequate fit to the data ($\chi^2(165) = 964.947$, $p \leq 0.05$; RMSEA = 0.085; CFI = 0.92; TLI = 0.91; IFI = 0.92). These results underscore the strategic value of SHRM in enhancing performance by strengthening employee engagement and improving the organization's attractiveness as an employer. HR professionals are encouraged to view SHRM as a key driver in building stronger worker-organization relationships. Integrating sustainability principles into HR planning can positively influence employee attitudes and contribute to better performance outcomes.

Keywords: Sustainable Human Resources Management, Organizational Attractiveness, Engagement, Performance.

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Can green human resource management influence employees' feelings?

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Abstract

Climate change is prompting the need to include people in an urgent agenda to mitigate its effects. This study aimed to analyze whether green human resource management can influence some important feelings of employees such as pride and meaning. It also examined the mediating role of pride in this relationship. The sample involved employees of ISO 14001 certified companies that carried out their economic activities in Portugal. Cross-sectional data was collected from employees who had been working in the organizations for at least six months. SPSS software was used for regression and mediation analyses, employing PROCESS Model 4. The results show that GHRM helps to improve employees' feelings, and pride in the organization partially mediates the relationship between GHRM and meaning at work. These results demonstrate the importance of green strategies in promoting employee well-being and in helping to mitigate the effects of climate change. The study makes a strong theoretical contribution, particularly by reinforcing social identity theory, and offers practical implications to help decision-makers adopt more effective environmentally oriented strategies.

Keywords: Sustainability · Environmental Sustainability · Sustainable Practices · Climate Change Mitigation.

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The Evolution of Sustainable HRM: A Bibliometric Review of Trends and Future Directions

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Abstract

The increasing prominence of Sustainable Human Resource Management (HRM) in academic research underscores the need for a structured analysis of its evolution. This study conducts a systematic bibliometric review of sustainable HRM literature, analyzing 394 peer-reviewed articles published between 2003 and 2024, extracted from the Web of Science and Scopus databases. Using Biblioshiny and VOSviewer, we performed co-citation, keyword co-occurrence, and thematic evolution analyses to uncover the field's development patterns. Our findings reveal a marked increase in publications post-2019, with contributions from 1129 authors, 728 institutions, and 57 countries, indicating the global diffusion of the topic. The keyword analysis identified three major thematic clusters: (1) the effects of sustainable HRM on employees and organizational culture (e.g., employee engagement, job satisfaction, leadership); (2) the relationship between sustainability practices and organizational performance (e.g., green HRM, environmental management, supply chain); and (3) employee quality of life (e.g., well-being, health, stress). Despite the growing diversity of themes, represented by 1262 author keywords and 827 Keywords Plus, the review reveals gaps related to employee perceptions and behavioral outcomes of sustainable HRM. By mapping the intellectual landscape of the field, this study offers a structured overview of current trends and provides clear directions for future research.

Keywords: Sustainable HRM, Bibliometric analysis, Systematic review, Employee behavior, HRM trends.

Green human resource management, employee green creativity and green voice: the moderating role of ecological identity

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Abstract

The challenges of sustainable development require organisations to rethink their production processes and daily activities. Involving employees in identifying potential solutions to internal ecological challenges can help organisations become greener. Yet, research is still incipient in how incorporating environmental issues into human resources management can provide workers with the awareness, resources, and space they need to share their ideas on how to integrate ecological objectives into organisations' performance and strategies. In this context, the objectives of this study are threefold: (1) to characterise the perceived level of investment in green human resource management (GHRM) practices; (2) to examine if GHRM practices are related to increased employee green outcomes, namely green creativity and green voice; (3) to analyse if the effect of GHRM differs depending on individual characteristics, namely ecological identity, a well-established predicted of adopting pro-environmental behavior in the workplace. A quantitative study is ongoing, based on an anonymous and voluntary online survey of employees from different organisations (current sample n=252). Preliminary results indicate that organisations' investment in GHRM is relatively low, with two-thirds of participants indicating it as non-existent or very reduced. In addition, results provide initial support for a positive relationship between GHRM and employees' green voice through increased green creativity. GHRM's effect on creativity seems stronger for workers with higher ecological identity. We will discuss the relevance of incorporating green goals in human resources management to foster the contribution of organisational members to greener organisational processes.

Keywords: Green human resource management; Employee green creativity; Employee green voice; Ecological identity.

The mediating role of ideology-infused psychological contract on the relationship between CSR and employee behaviour

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Abstract

This study examines the interaction between corporate social responsibility (CSR) programs and employees' ideological psychological contracts, focusing on the perception of an "ideology breach." Through the mechanism of social exchange, social identity and stakeholders' theories, we propose that genuine CSR efforts diminish employees' perceptions of ideology breach, promoting voice and sustainable behaviors on the employee-employer relationship. We analyse two independent samples with Hayes PROCESS macro from different professionals' sectors, the results determined that perceived CSR initiatives help predict employee voice and sustainable workplace behavior through the decrease of employee ideology breach. When employees perceive contradictions like "greenwashing," they experience an intensified ideological gap, feeling that their employer's stated principles are hypocrite, this affects negatively employee voice and sustainable behavior. This study also highlights that employee with stronger environmental attitude in their life are less vulnerable to perceptions of ideology breaches, masking potential pitfall of a company bad behavior on CSR practice. Our research enhances the psychological contract literature by emphasizing the mediation mechanism of ideological breach in the relationship between CSR and employee behavior. This research highlights the significance of transparent and meaningful CSR actions in preserving ideological coherence within the workforce. Organizations aiming to leverage their employees' dedication to broader societal and sustainable goals should invest in authentic and transparent CSR initiatives, ensuring constant and reliable communication. By doing so, they not only mitigate ideological breaches but also enhance employee engagement in sustainable behavior and foster active voice that enhances a continuous call for changes for social and sustainable good.

Keywords: Ideology Breach, Psychological Contracts, Corporate Social Responsibility; Behaviour.

Ethics and Social Responsibility: A Contribution to the Training of Leaders for Sustainable Development

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Abstract

Training leaders who are committed to sustainability is one of the major challenges facing higher education. This paper presents a pedagogical approach to integrating Ethics and Social Responsibility (ESR) into the training of management students, promoting learning aligned with the Sustainable Development Goals (SDGs).

The experience, developed at ISCAL, combined active methodologies such as project-based learning (PBL), group work with external entities, and inter-institutional open classes. Students applied the concepts in real contexts, developing proposals with social and environmental impact, which reinforced the link between theory and practice.

The open classes promoted interdisciplinarity and contact with different organizational realities, bringing students closer to the diversity of ethical and social challenges in the world of work. At the end of the semester, an anonymous online questionnaire was administered to gather students' perceptions of the experience.

The results indicate that students associate ethics with values such as integrity, justice, and respect, recognizing its relevance in management. They understand social responsibility as a voluntary commitment by organizations to social, economic, and environmental well-being, valuing it as an integral part of organizational strategy.

The teaching and learning experience proved effective in developing skills such as teamwork, critical thinking, communication, and collective responsibility. This communication highlights the role of higher education in training more conscious leaders who are capable of contributing to more ethical, sustainable organizations that are aligned with the global challenges facing society.

Keywords: Business ethics, Social responsibility, Management education, Student perception, Sustainability

Healthcare Professionals' Perceptions of Organizational Sustainability: An Exploratory Analysis in Portugal

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Abstract

The 2030 Agenda for Sustainable Development sets forth goals aimed at fostering a more equitable and enduring future. Organizations, including healthcare institutions, are pivotal in integrating sustainability into both strategic decisions and day-to-day operations. This exploratory, descriptive, and quantitative study examines how healthcare professionals perceive the organizational sustainability practices of a Portuguese private hospital. A questionnaire was designed based on established instruments from various sectors, adapted to the hospital context, and administered online to 106 healthcare professionals. Most respondents were female (75%), nurses (65%), and worked in surgical units (62%). The collected data were analyzed across four dimensions of organizational sustainability—environmental, social, economic, and institutional—to identify strengths and potential areas for improvement. Results reveal that the social dimension achieved the highest level of agreement (55%), followed by economic (42%) and institutional (40%), while the environmental dimension scored the lowest (38%). Further analysis indicated that gender, age, and professional roles influenced perceptions of sustainability practices, whereas tenure had minimal impact. Overall, the hospital displays varying degrees of maturity in sustainability implementation, with the environmental dimension showing the greatest need for enhanced strategies. These findings underscore the importance of fostering a culture of sustainability within healthcare organizations, offering critical insights for administrators seeking to optimize resource usage and strategic planning. Future studies could expand on these results by investigating different types of healthcare institutions and assessing targeted measures to strengthen sustainability efforts in areas that demonstrate lower performance.

Keywords: Organizational sustainability, Healthcare, Private hospital, Portugal, Perceptions.

Acknowledgements

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The relationship between servant leadership and organisational identification: the mediating effect of internal social responsibility

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Abstract

This study investigates how servant leadership is related to internal social responsibility and organisational identification within Portuguese Municipalities. It is based on the premise that servant leadership, by combining the motivation to lead with the desire to serve, can foster employee well-being. Accordingly, the study aims to determine whether: (a) servant leadership predicts perceptions of internal social responsibility and organisational identification; (b) internal social responsibility contributes to organisational identification; and (c) internal social responsibility mediates the relationship between servant leadership and organisational identification. A quantitative study was conducted, using a questionnaire survey, to understand how leadership practices focused on employee well-being can strengthen their bond with the organisation and promote healthier, more productive work environments in the context of local administration. The main contribution of this investigation lies in its application to the Portuguese public sector, particularly local administration, where research on this topic remains scarce. In this way, both the leadership style adopted and the measures of internal social responsibility are assessed for their role in enhancing employees' organisational identification. In the future, the study could be replicated in other public sector bodies in Portugal, and subsequently extended to the private sector.

Keywords: Servant Leadership, Corporate Social Responsibility, Internal Social Responsibility, Organisational Identification

Acknowledgements

This research was supported by the FCT - Fundação para a Ciência e a Tecnologia through the Life Quality Research Centre [grant number: UID/CED/04748/2020].

TRANSFORMATIVE EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

Unplugged sci&math lesson: an educational experience focused on sustainability

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Abstract

Energy consumption in schools results in a considerable environmental impact (Pereira et al., 2024), which is intensified by the frequent use of digital equipment. In this context, it is essential for educational institutions, particularly in higher education, to adopt practices to reduce energy consumption, especially during teaching activities. This communication presents an educational experience focused on the planning, implementation, and evaluation of an unplugged interdisciplinary science and mathematics (sci&math) lesson. An unplugged sci&math lesson aims to promote interdisciplinary learning of science and mathematics while fostering environmental consciousness among prospective teachers. The lesson was conducted in an innovative educational environment, the CreativeLab_Sci&Math, and was developed as part of an interdisciplinary collaboration between two courses of a teacher education degree of Santarém Polytechnic University: Earth and Life Sciences and Mathematical Modelling (Cavadas & Mestrinho, 2019). Building on the notion that mathematics should extend beyond its role as merely a problem-solving tool in other disciplines (Goos et al., 2023), our approach assigns equal importance to mathematics and science (Mestrinho & Cavadas, 2018). The lesson plan, the conditions of the educational environment, and the dynamics of the lesson are described in detail. Additionally, the perceptions of the students who participated in the lesson are presented, highlighting their experiences and reflections on the dynamics they underwent. This approach aims to contribute to the education of prospective teachers to integrate sci&math (Cavadas & Branco, 2023) into their professional activities and to play an active and environmentally conscious role in promoting sustainable practices within educational institutions.

Keywords: Mathematics; Science; Sustainability; Teacher education

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Integration of the Sustainable Development Goals (SDGs) in Communication Curricular Units - Project-Based Learning in a Higher Education Institution

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Abstract

Higher Education Institutions' (HEIs) mission involves the vectors of knowledge creation, teaching and interaction with society, making them a catalyst for political, economic and social change. The integration of sustainability into this trilogy offers various benefits and can help address the social, financial, and environmental challenges outlined in the 2030 Agenda. This study aimed to understand how the 17 Sustainable Development Goals (SDGs) are being incorporated into Communication Curricular Units (UCs) of bachelor's and master's degrees using a Project-Based Learning (PBL) approach, through the establishment of collaboration protocols between a Portuguese HEI and public, private or civil society partners. A mapping exercise was carried out looking at learning concerning the five pillars (5P) of the 2030 SDGs Agenda: People (1–5), Planet (6, 12–15), Prosperity (7–11), Peace (16) and Partnerships (17). This procedure allowed us to identify 64 partners over the last fifteen years who have launched 75 briefings (P5. Partnerships). The results showed that the P's most worked on over the years by the students were P1. People, followed by P2. Planet and P3. Prosperity; P4. Peace was not very significant during the period analysed. We hope to encourage reflection on education for sustainability and the social responsibility of HEIs, bearing in mind that the SDGs may not be specified in the teaching materials for certain courses, but are addressed through project-based learning in the classroom. This approach helps to strengthen the link with stakeholders in a global context while emphasising local competencies.

Keywords: Higher Education Institution (HEI), Sustainability, Sustainable Development Goals (SDGs), Curricular Units design, Project-based learning (PBL).

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Catalyst CoVE and Circular Economy: Orchestrating Innovation Ecosystems in Higher Education

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Abstract

The transition to a circular economy is not only an environmental imperative but also a pedagogical challenge, requiring a profound transformation of skills ecosystems in Europe. Higher Education Institutions (HEIs) and Vocational Education and Training (VET) centres are increasingly recognised as key orchestrators of regional innovation systems aligned with sustainability goals. This paper adopts a regional innovation ecosystem framework and explores a single case study – the CoVE Future Skills Factory®, a flagship initiative under the Catalyst Centre of Vocational Excellence (CoVE) for Sustainable Transformation. Using a qualitative and exploratory case study methodology, the research analyses how this initiative advances circular economy capabilities in vocational and higher education. The study focuses on three dimensions: (1) curriculum co-design with industry partners to support green skills development; (2) hybrid and interdisciplinary learning models that integrate digital tools and real-world challenges; and (3) international collaboration to scale innovation and foster knowledge transfer. The CoVE Future Skills Factory® exemplifies how HEIs and VET providers can contribute to transformative sustainability through applied research, institutional cooperation, and skills anticipation mechanisms. However, persistent challenges such as fragmented governance and misalignment between VET and higher education systems are identified as barriers to systemic change. The study concludes with policy recommendations to strengthen the governance of vocational excellence initiatives and promote integrated innovation ecosystems in line with the European Green Deal and the UN Sustainable Development Goals.

Keywords: Catalyst CoVE · Future Skills Factory · Circular Economy · Vocational Excellence · Sustainability

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Sustainability in Language Education through Intercomprehension

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Abstract

Over the last decades, sustainability has gained increasing importance across many aspects of human life. In the educational field, Education for Sustainable Development (ESD) seeks to equip learners with the knowledge and skills necessary to understand environmental challenges and contribute to safeguarding the planet for future generations. Within this framework, the present contribution explores how the adoption of intercomprehension (IC) as a pluralistic and sustainable approach in language education can support the transformation of higher education for a sustainable future. IC is considered a pluralistic approach because it fosters the simultaneous use of multiple languages and it is sustainable as it promotes both the preservation and promotion of multilingualism, as well as the engagement with sustainability-related topics from an ecolinguistic and a Content and Language Integrated Learning (CLIL) perspective. The integration of sustainability into language education can be effectively achieved through the development of IC-based teaching units, which enable students to improve their receptive language skills and develop multilingual competences while deepening their knowledge and awareness of environmental issues. This is made possible through the didactic use of authentic materials, such as newspaper articles, in unfamiliar or partially known languages that share similarities at various linguistic levels with those already present in the learners' repertoire. Practical examples include IC-based teaching units on sustainable lifestyle tips, sustainable tourism, waste classification, and renewable energy sources. Through IC strategies, learners can access and understand texts on sustainability-related topics even in languages they have never formally studied, enhancing both metalinguistic and environmental awareness.

Keywords: Sustainability, Language education, Pluralistic approaches, Intercomprehension

Teachers' perspectives on the educational process of Nursing students

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Abstract

Background: Student diversity has led to implications for their motivations and expectations regarding academic training, often resulting in superficial approaches to learning. There is an urgent need to reconfigure pathways that place the student at the center of educational processes, fostering a deep approach to learning in order to facilitate the translation of knowledge into clinical practice.

Aims: To reflect on the dimensions that influence the learning process; to consider the necessary transformations in nursing education.

Materials and Methods: A qualitative study using a case study design, involving ten in-depth interviews aimed at understanding the perspectives of Nursing course lecturers regarding the educational process.

Results: Five dimensions were identified: "The Student in the Educational Process", which is managed according to personal characteristics, interest, content, and pedagogical strategies; "The Lecturer and Teaching Approaches", with the majority favoring a student-centered approach focused on conceptual change; "Class Attendance", which enhances the transferability of knowledge; "Supportive Environmental Conditions", which promote attendance and enhance learning opportunities; "Assessment Process", supported by a combination of summative and formative assessment methods, contributing to quality education.

Conclusion: To increase engagement, motivation and sustainable learning outcomes, it is recommended to: adopt teaching approaches that promote conceptual change through student-centered strategies; incorporate information and communication technologies; provide pedagogical training for lecturers; adjust the student-to-lecturer ratio; improve classroom and laboratory infrastructure and resources; prioritize formative assessment; adapt curriculum organization; and focus on the quality rather than the quantity of content.

Keywords: Students, Nursing, Educational process, Sustainability

Statistics and Critical Thinking in Sustainability Contexts

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Abstract

Studies on the teaching and learning of Statistics have highlighted persistent difficulties, errors, and misconceptions among students across educational levels. At pre-university levels, students rarely can apply statistical concepts in real contexts due to reductive approaches focused on formulas and calculations, among other reasons. In higher education, the traditional approach to teaching Statistics is not much different from the previous one, so students rarely experience the transfer of theory into practice, revealing difficulties when this is proposed. In this paper, we describe an activity designed to promote experiential learning and critical thinking, implemented in a higher education Statistics course, which integrates statistical analysis with sustainability principles. In the activity, students developed data collection and analysis skills by investigating the statistical association between plants and insects in the institution's garden, applying the Chi-square test of independence to real-world observations. The process culminated in a reflective discussion on the implications of the findings, including explanatory factors for observed associations and the potential utility of the results for sustainable garden management. Student feedback indicated increased engagement and a deeper understanding of statistical concepts through hands-on experience. Given the limited and context-specific sample, the results of this study cannot be generalized. Future research can explore how this experiential approach can be adapted and scaled to diverse educational settings.

Keywords: Contingency table, Data analysis, Experiential learning, Statistical independence, Sustainability education.

Co-regulated Learning in Digital Resource Creation for Education for Sustainable Development through ICT

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Abstract

Education for Sustainable Development plays a key role in raising awareness of responsible practices and valuing nature-based tourism, thereby contributing to more sustainable development.

In the context of training future professionals in Environmental Education and Nature Tourism, Information and Communication Technologies (ICT) emerge as useful tools for creating innovative digital educational resources. These resources, such as educational games (including immersive escape rooms) and interactive digital itineraries, enhance the learning process by stimulating creativity, collaboration, and problem-solving, and encourage the adoption of responsible, sustainable practices.

The co-regulation of learning helps develop digital skills and student autonomy, allowing them to mutually regulate and adjust their learning process, fostering a collaborative and critical mindset in the design of digital educational resources.

Within the scope of the ICT course of Environmental Education and Nature Tourism (EETN) degree at Santarém Polytechnic University, the pedagogical methodology of Project-Based Learning was adopted, challenging students, in groups, to design immersive escape rooms and educational digital tourism itineraries on topics related to Education for Sustainable Development.

This exploratory study aimed to analyse the ICT employed and their purposes within the projects, and how students implemented co-regulation learning strategies in the design of the resources. A qualitative methodology was adopted, analyzing the final projects.

The results contribute to understanding the role of ICT in environmental education and nature tourism in a sustainable manner, and to identifying best practices for co-regulated learning in the creation of digital educational resources.

Keywords: Sustainability · Education · ICT · Co-regulation of Learning · Nature Tourism

Speaking for Change: How English Oratory Skills Drive Sustainability in Higher Education

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Abstract

In today's world, where sustainability is a pressing global challenge, the power of persuasive speech is more vital than ever. This study explores how English oratory skills equip students in higher education to drive meaningful discussions, influence policies, and advocate for sustainable development. Effective speech extends beyond fluency; it requires accuracy, structure, and the ability to engage audiences with compelling rhetoric.

Drawing on Meg Flanders' poem, this research examines the relationship between speech correctness, acceptance, and the power of language in shaping change. Key elements of effective speech, including stress patterns, rhetorical techniques, and speech precision, are analyzed as essential tools for impactful communication. The study also highlights the importance of passive voice in academic discourse and the role of open-ended questions in fostering critical discussions on sustainability.

By integrating structured oratory training into English curricula, universities can cultivate articulate, confident, and socially responsible individuals. Strong language skills do more than enhance communication—they empower students to challenge norms, propose solutions, and drive sustainability efforts. Ultimately, this research argues that the ability to speak for change is not just an academic skill but a transformative force in shaping a more sustainable future.

Keywords: English Oratory Skills · Sustainability in Higher Education · Effective Speech Strategies · Rhetorical Techniques · Oral Proficiency.

Towards Green Learning: A Case Study of Universities in Jordan

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Abstract

This study looks at how universities contribute to sustainable development, focusing on institutions in the Arab world, especially in Jordan. It explores how these universities promote sustainability through curriculum, student involvement, community engagement, and eco-friendly campus practices. Survey data from five Jordanian universities shows that, despite environmental commitments, actual sustainability efforts are often inconsistent. While many programs support education, skills, research, and community service, they often lack coordination and clear planning. The study emphasizes incorporating sustainability into national quality standards and university assessments, while also underlining the need for clear objectives, strategic long-term planning, and enhanced research to empower universities in promoting sustainable development.

Keywords: Sustainablity. Higher Education. Curriculum. Environment, University

SignAI: Enhancing Inclusion through AI in Sign Language Translation

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Abstract

The SignAI: Enhancing Inclusion through AI in Sign Language Translation project aims to develop an innovative application that translates gestures from Portuguese Sign Language (Língua Gestual Portuguesa – LGP) into written text, with a particular focus on science education. Designed and implemented by students, the project combines artificial intelligence (AI) with educational practices, fostering hands-on learning about machine learning and its real-world applications in scientific contexts. Throughout the project, students researched LGP, compiled and annotated a diverse dataset of gestures, and trained an AI model using the Pictoblox software. SignAI's innovation lies in its potential to recognise not only individual letters but also, in future phases, complete words and phrases—enabling more meaningful and inclusive communication. The application is also designed to be adaptable to other sign languages, supporting global inclusion efforts. Beyond technical skills, students engaged in critical reflection on the ethical implications of AI in society—an essential component of contemporary science education. The project emphasised responsibility in technological development through usability testing and model accuracy assessments. This initiative was developed within the curricular unit Recursos Educativos Digitais II and aligns with the Sustainable Development Goals (SDG) 4 (Quality Education) and 10 (Reduced Inequalities), highlighting the role of digital tools in promoting inclusive and equitable learning opportunities.

Keywords: Sign Language Translation, Artificial Intelligence in Education, Inclusive Education, Machine Learning, Digital Educational Resources

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STRATEGIC PARTNERSHIPS FOR SUSTAINABLE DEVELOPMENT

The APECHE project and the development of a Holistic Framework for Integrating Sustainability in Higher Education

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Abstract

Education has gained increasing prominence in sustainability since the 1992 Earth Summit and its subsequent meetings. Recognized as a key driver of social transformation, the education sector has taken the initiative to propose new teaching practices, identify relevant content, and establish essential competencies for students to address contemporary challenges. The project "Assessing and Promoting Environmental Culture in Higher Education (ref. 2022.03754.PTDC)" was launched as a collaborative effort, of a group of national higher education institutions, including Aveiro University, aiming at assessing the implementation of sustainability-promoting practices in education within higher education institutions (namely exploring the state of sustainability in education and students' environmental literacy). Its main objective is to characterize and understand the environmental literacy of university students in Portugal. To achieve these goals, the project follows students throughout their three-year undergraduate programs, employing surveys to track changes in their perceptions and understanding of sustainability over time. Additionally, a novel tool has been developed to assess the extent of curriculum greening, providing insights into the integration of sustainability into academic programs. Furthermore, campus greening analysis is essential for evaluating how institutional practices influence students' experiences and academic development.

Keywords: Curriculum analysis methodologies · Education for Sustainable Development ·Environmental literacy· Holistic Perspective on Sustainability in Education

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International Cooperation for Sustainable Development in Moroccan Universities: The Case of Sidi Mohammed Ben Abdellah University in Fez

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Abstract

This research explores the engagement of Sidi Mohammed Ben Abdellah University of Fez (USMBA) in international cooperation for sustainable development. Emphasizing the crucial role of universities in achieving the Sustainable Development Goals (SDGs), it analyzes USMBA's initiatives in international partnerships, collaborative projects, and the integration of sustainable development into its academic and research programs. Through a literature review, the study examines the challenges and opportunities faced by Moroccan universities in international cooperation, including financial, institutional, and cultural barriers. It uses a qualitative methodology, including interviews with university leaders and the analysis of strategic documents, to assess the impact of these collaborations on academic capacity building and contribution to the SDGs, particularly in terms of quality education and reducing inequalities. The article also identifies gaps in current research and offers recommendations for strengthening inter-university cooperation and promoting the integration of sustainable development across academic curricula. Finally, it highlights the importance of engaging local and international stakeholders to maximize the benefits of cooperative projects and ensure their sustainability. This analysis highlights the importance of an integrated and collaborative approach to addressing sustainable development challenges in Morocco.

Keywords: International cooperation, sustainable development, international partnerships, SDGs.

ESG perceptions and practices in a hospital context – Tagus Estuary Local Health Unit and Aveiro Region Local Health Unit

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Abstract

Hospital sustainability is a critical challenge of the 21st century, requiring the reconciliation of high-quality healthcare delivery with environmental, social, and governance (ESG) responsibilities. In Portugal, hospitals are major resource consumers but also potential drivers of sustainable practices aligned with the European Green Deal and the National Roadmap for Carbon Neutrality 2050. This study analyzes ESG perceptions and practices in two public health units: the Local Health Unit of the Tagus Estuary (ULSET), located in an urban/estuarine context, and the Local Health Unit of the Aveiro Region (ULSRA), characterized by territorial dispersion and an increasing focus on social initiatives.

An exploratory mixed-methods design was adopted, grounded in ESG references such as the United Nations Sustainable Development Goals (SDGs) and the Global Green and Healthy Hospitals (GGHH) framework. The quantitative phase consists of a 10-item Likert-scale questionnaire administered to all hospital administrators and to a stratified sample of 150–200 healthcare professionals. The qualitative phase includes semi-structured interviews with ESG project coordinators and systematic document analysis of sustainability reports, policies, and ISO/NP certifications. Data triangulation will identify ESG adoption patterns, critical success factors, gaps, and improvement opportunities, with statistical analysis performed in Jamovi® and content analysis in NVivo®.

The results are expected to reveal contextual differences between the hospitals, enabling the development of practical recommendations to integrate ESG into hospital management, enhance operational efficiency, reduce environmental impacts, and strengthen community engagement. By addressing a knowledge gap on ESG in Lusophone healthcare settings, this study contributes to academic advancement and to the development of more sustainable, resilient, and ethically sound health systems.

Keywords: ESG; Hospital management; Sustainable practices; Public health; Sustainability.

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Exploring the Interconnection Between Higher Education and Society: A Scoping Review on Knowledge Transfer for Sustainable Development

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Abstract

This paper examines the role of higher education institutions (HEIs) in promoting sustainable development through the transfer of knowledge to society. Focusing on the intersection of science and societal impact, the study aims to identify the key factors influencing the knowledge transfer process, explore its current state within HEIs, and assess its contribution to sustainability at local and regional levels. To achieve these objectives, a scoping review methodology was employed to identify and synthesize the existing body of literature on the subject. The selected studies were grouped into four main themes: (1) the determinants of knowledge transfer between higher education institutions and society; (2) the current landscape of knowledge transfer in higher education; (3) the role of knowledge transfer in promoting local and regional development; and (4) the contribution of knowledge transfer to sustainability goals. The results show that while numerous factors have been identified that shape the transfer process, most studies indicate that the implementation of knowledge transfer initiatives is still in an early stage. The article concludes by emphasizing the need for stronger collaboration between science and society to increase the impact of knowledge transfer for sustainability.

Keywords: Knowledge transfer, higher education institutions, sustainable transformation to society, value co-creation, scoping review

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TOOLS AND TECHNOLOGIES FOR SUSTAINABILITY LEARNING

Botanical Walking Routes as Sustainable Outdoor Teaching Tools: The Case of Aveiro University Garden Campuses

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Abstract

There is currently a need for the renovation and revitalization of botany teaching to make the subject more appealing to students. In this context, the green areas of university campuses have recently caught the attention of educators as valuable resources for teaching, aligning with the goals for sustainability in education as outlined by the 2030 Agenda. In our study, the flora of the University of Aveiro's green spaces was used to create activity proposals to be implemented during field botany classes. For that, previous field trips were conducted, documenting the species present in various areas of the campus, by photographing and listing them. These records were then used to create six walking trails for students to follow, as well as botanical training sheets for each species, including taxonomical, morphological and ecological information. At the end, a final quiz on essential botanical concepts seeks to consolidate knowledge, using gamification strategies, to be answered individually or in work groups. These proposed walking routes are part of an Illustrated Botany Manual that will contribute to the revitalization of botany teaching from a more practical and self-learning perspective, making the study of botany more dynamic, exploratory, and hands-on, as well as more sustainable, without the need for prior collection of plant material for indoor classes. By making learning in loco (even some being urban species), another aim is to help create more engaging, sustainable, and resilient communities, raise awareness about climate and ecological issues, and promote the conservation of terrestrial ecosystems and biodiversity.

Keywords: Illustrated Botany Manual · Outdoor botanical classes · Botanical training sheets · Botanical quiz

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25 Years of Sustainable Botanical Teaching at the University of Aveiro

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Abstract

Over the past century, there has been a widespread lack of interest in plants among students, as well as insufficient inclusion of this subject in curricula from elementary school through university. This concerning phenomenon was initially termed Plant Blindness and later redefined as Plant Awareness Disparity. Essentially, it represents a lack or limitation of awareness toward plants, primarily caused by their inability to move, which results in them receiving less immediate attention from humans. Therefore, there is an urgent need to renovate and revitalize botany education and its dissemination through innovative indoor and outdoor classes that make the subject more engaging and align with the sustainability goals for education outlined by the 2030 Agenda. With this experience report, we aim to highlight the multiple teaching initiatives undertaken by the University of Aveiro over the past 25 years, in close partnership with the Herbarium of UA, and present some indicators showing how these efforts have contributed to (a) mitigating Plant Awareness Disparity and (b) the sustainable promotion of botany through various indoor and outdoor classes and events. During this period, approximately 50 botanical deliverables were completed, including Field Guides, Illustrated Identification Keys, Flyers, Photographic Exhibitions, Herbarium Guided Tours, and Field Trips in urban and natural environments, involving more than 10,000 university students in both indoor and outdoor classes.

Keywords: Botanical field guides · Herbarium guided tours ·Botanical field trips · Illustrated botanical identification keys

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Raising awareness and promoting inclusive learning using a VR-powered educational tool for teaching ASL

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Abstract

In contemporary education, there is a growing need for innovative tools to better cater to a diverse audience. Virtual Reality (VR) offers immersive visual, auditory, and haptic experiences that enhance both recreational and educational applications. This research introduces a serious game that leverages hand tracking through VR to support early-stage learning of American Sign Language (ASL). The game provides an engaging environment focused on mastering the ASL alphabet (fingerspelling) by translating user gestures into an interactive ASL sign game. While currently focused on teaching fingerspelling only, the platform's scalable architecture may enable future expansions to full-word signs and additional sign languages.

Developed in Unity with XR hand tracking plugins, the game emphasizes intuitive interaction. ASL fingerspelling was selected for its static gestures and alignment with standalone headset limitations. Interactive learning is a core aspect of gameplay, and players must sign letters to progress, enabling natural acquisition by progressive through the game. The game was evaluated through a quasi-experimental approach focusing on educational effectiveness and usability. 11 participants responded to multiple pre and post questionnaires, with results revealing positive aspects of the game, but also various usability issues that can lead to improved clarity and knowledge retention.

Beyond language acquisition, promoting sign language through emerging technologies raises awareness of inequality, improves communication skills, and advances quality education (SDG 4). This project can support both hard-of-hearing students and their hearing peers, helping bridge communication gaps, and facilitate the reduction of inequalities (SDG 10).

Keywords: Virtual reality, Hand tracking, Sign language, Serious games, Education.

Science-Driven Architectural Geometry Optimization of Modular Plant-based Systems

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Abstract

Integrating plant-based systems into buildings can reduce energy consumption and provide fresh air to the indoor environment. Previous studies by the authors showed the air-cleaning capacity of hydroponic plants and growing media. The present study focuses on enhancing the air purification of the plant-based system by optimizing the design of the module lids to achieve uniform and stable airflow. We perform the analysis through 120 lid types using Computational Fluid Dynamics (CFD) simulations. The height and depth of each lid corner, the diameter of the lid's internal corners, and the lid's interior and exterior edges determine the characteristics of the tested lids. The optimal design selects 34 lids from the modules that produce uniform and stable airflows.

Keywords: Computational Fluid Dynamics (CFD) · Airflow · Design · Plants · Lid

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Enhancing Ocean Literacy Through Digital Pedagogical Resources – SDG 14

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Abstract

This pedagogical plan was developed within the curricular unit Digital Pedagogical Resources of the TeSP in Accompanying Children and Young People at the School of Education of the Polytechnic University of Santarém. It aims to promote ocean literacy among 3rd and 4th-grade students through the integration of digital educational tools, aligning with Sustainable Development Goal 14: Life Below Water. The activity follows an interactive and multimodal methodology grounded in participatory learning and environmental education. The plan includes five main stages: (1) an initial group discussion about marine pollution based on students' prior experiences, (2) a shared reading and interpretation of the children's story "Tomás e a Missão no Mar Azul," (3) a video presentation on SDG 14, (4) a formative assessment via a gamified quiz using Kahoot, and (5) a collective reflection using Padlet, where students write about what they learned. A final guided relaxation activity helps students internalize the importance of marine conservation in a calm and imaginative setting. The plan was implemented with a duration of one hour and uses digital tools such as Canva, Kahoot, and Padlet to foster engagement, cooperation, and environmental responsibility. Although empirical data has not yet been collected, the structured implementation and targeted learning outcomes provide a replicable model for digital environmental education at the primary level.

Keywords: Ocean literacy; Environmental education; Digital pedagogy; Primary education; SDG 14

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support in developing and implementing this educational activity.

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Promoting Social Inclusion Through Digital Pedagogical Resources – SDG 10

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Abstract

This educational initiative was developed within the curricular unit Digital Pedagogical Resources of the TeSP in Accompanying Children and Young People at the School of Education of the Polytechnic University of Santarém. It promotes social inclusion and equity in education, aligning with Sustainable Development Goal 10: Reducing Inequalities. Designed for 4th-grade students within the domain of Citizenship and Development, the activity integrates accessible and age-appropriate digital pedagogical tools—such as Genially, Canva, and interactive quizzes—to raise awareness about diversity, discrimination, and the importance of respecting individual differences. The activity is grounded in inclusive and participatory pedagogy, with implementation structured in five stages: introductory discussion and multimedia, individual self-representation through drawing, peer presentations, collaborative digital mural creation, and group reflection. These stages aim to foster empathy, critical thinking, and inclusive attitudes. Adaptability is ensured through flexible participation modes that accommodate learners' emotional and communicative needs. Although empirical assessment is not yet available, the initiative offers a replicable model for promoting social justice through digital education at the primary level. The project illustrates how technology-enhanced pedagogy can support equitable and respectful learning environments from an early age.

Keywords: Social inclusion; Digital education; Equity in learning; Interactive pedagogy; SDG 10

Acknowledgements

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Digital Pedagogical Resources for Food Security Awareness – SDG 2

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Abstract

This pedagogical activity plan, developed within the curricular unit Digital Pedagogical Resources of the TeSP in Accompanying Children and Young People at the School of Education of the Polytechnic University of Santarém, aims to promote awareness of food security and sustainable nutrition practices among students in the 1st and 2nd cycles of basic education (ages 6–12), aligning with Sustainable Development Goal 2: Zero Hunger. Lasting 90 minutes, the plan integrates interactive digital tools and hands-on activities to foster critical thinking and responsible food consumption. The activity is structured in three stages: (1) an introductory video presentation on SDG 2, (2) a digital quiz via Wordwall to assess prior and acquired knowledge, and (3) a sensory and reflective group game in which students classify printed food items as healthy or unhealthy. The session concludes with a digital feedback exercise using Mentimeter, encouraging personal reflection on eating habits and global hunger. The pedagogical model emphasizes participatory, sensory-based, and inclusive learning, using technologies like video, quizzes, and interactive polling to engage students. While the plan has not yet been empirically evaluated, it offers a replicable approach for integrating digital education with global food justice themes, highlighting the role of education in promoting sustainable development.

Keywords: Food security; Digital education; Sustainable consumption; Interactive learning; SDG 2

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Enhancing Quality Education through Digital Pedagogical Resources – SDG 4

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Abstract

Access to quality education is a key driver of equitable development, as reflected in Sustainable Development Goal 4 (SDG 4). This pedagogical initiative, developed within the course unit Digital Pedagogical Resources in the TeSP in Accompanying Children and Young People at the School of Education of the Polytechnic Institute of Santarém, involved the design, implementation, and analysis of a classroom activity for 5th and 6th grade students. The activity focused on the theme of inclusive and equitable education, using interactive and digital methodologies to promote reflection and civic awareness.

Grounded in the principles of Universal Design for Learning (UDL) and supported by the TPACK framework, the initiative integrated specific digital tools such as EdPuzzle (interactive video quizzes) and collaborative poster creation using multimedia resources. The learning scenario included guided video reflection, peer dialogue, and the co-construction of visual outputs, culminating in a participatory exhibition.

The pedagogical strategy aimed to foster digital and social competences, active participation, and critical thinking. Feedback was collected from student participants through observation and structured reflection prompts. The results indicated increased awareness of global educational inequalities and a deeper understanding of the role of technology in promoting inclusive learning environments.

This project demonstrates how digital pedagogical resources can effectively support curriculum goals, promote student engagement, and contribute to the broader aim of ensuring quality education for all.

Keywords: Digital education; Interactive learning; Inclusive teaching; Pedagogical innovation; SDG 4.

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Digital Pedagogical Resources for Climate Action – SDG 13

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Abstract

This educational proposal introduces a classroom activity designed to promote Sustainable Development Goal 13 (SDG 13) — Climate Action — by fostering environmental awareness and responsible behavior among young learners through the use of digital pedagogical tools. Developed within the "Digital Pedagogical Resources" curricular unit of the TeSP in Accompanying Children and Young People at the Polytechnic University of Santarém, the activity targets second-year primary students and encourages active participation through interactive, gamified learning. The methodology is structured around two core digital activities. The first, "Drag and Recycle," is a computer-based classification game that teaches children how to sort waste and understand recycling practices. The second activity, "Do You Know How to Take Care of Our Planet?", involves viewing a short video on climate change followed by a group-based digital quiz assessing students' knowledge of environmental actions aligned with SDG 13. These tools are complemented by playful energizers and a relaxation exercise that reinforce environmental themes. The pedagogical objectives are to help students understand the causes and effects of climate change, reflect on their own environmental habits, and identify concrete actions to reduce ecological impact. Observed outcomes included increased student engagement, improved understanding of sustainability concepts, and the development of teamwork and problem-solving skills. Informal assessment through group discussion and reflective questioning confirmed that students retained key messages and showed enthusiasm for future eco-friendly actions. This activity demonstrates the effectiveness of integrating digital technologies into environmental education, highlighting their role in cultivating critical thinking, ecological responsibility, and early climate action.

Keywords: Climate action; Digital pedagogy; SDG 13; Environmental education; Gamified learning; Early sustainability literacy.

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Digital Pedagogical Resources for Gender Equality – SDG 5

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Abstract

This study presents a classroom-based educational activity aimed at supporting Sustainable Development Goal 5 (SDG 5) — achieving gender equality and empowering all women and girls — through the use of digital pedagogical tools. Developed as part of the "Digital Pedagogical Resources" course within the TeSP in Accompanying Children and Young People at the School of Education of the Polytechnic University of Santarém, the activity involved first-grade students in reflecting on gender stereotypes and envisioning a world of equal opportunities. The methodology combined interactive digital tools with participatory learning techniques. The activity began with a short digital video on gender equality to introduce the theme and stimulate discussion. This was followed by a drawing task titled "I Can Be Whatever I Want!", where each child illustrated their future aspirations regardless of gender expectations. The drawings were then compiled into a collective mural accompanied by the inclusive message: "Boys and girls can be whatever they want." Assessment was carried out through classroom observation, analysis of student drawings, and a reflective closing activity in which children shared a word describing how they felt. The outcomes showed high levels of engagement, creativity, and openness to dialogue about gender roles. The use of multimedia content and digital prompts proved effective in encouraging critical thinking and breaking down traditional stereotypes among young learners. This project demonstrates the practical value of integrating digital resources into gender equality education. It highlights how creative, inclusive pedagogical strategies can foster empowerment and help build more equitable mindsets from an early age.

Keywords: Gender equality; Digital pedagogy; SDG 5; Inclusive education; Early childhood learning.

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CBTS - Simulation and Sustainability in the development of students' competences and learning

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Abstract

We propose to present the work carried out by the Santarém Polytechnic University with the partner institutions from Denmark, Romania, Turkey, Spain and Belgium under the international project CBTS - COMPETENCY BASED TRAINING AND SIMULATION IN HEALTHCARE EDUCATION, which aims to increase the quality and relevance of the teaching offered by the partner schools. The project will increase the capacity of partner institutions to collaborate on a transnational level, while supporting the professional and personal development of the teachers and students involved and using the results of other projects to develop new and sustainable solutions to respond to the needs identified. A collection of simulation activities in health education is being developed, designed to help schools integrate simulation into school activities in a systematic way, and a guide on how to address the 17 SDGs in health care education. The activities have involved students and teachers, with plans to extend them to the entire academic community. During the different stages of the project, students recognised the importance of simulation for learning, with a special focus on the acquisition and development of soft and specific skills, which can only be achieved through simulation integrated into the curriculum, contributing to more efficient performance in work contexts. They also considered the integration of SGDs to be very valuable in ensuring sustainability, both in the learning phase and in professional performance.

Keywords: Competency. Simulation. Training. Healthcare Education. Sustainable development goals.

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Sustainable Futures: A Gamified Virtual Reality Journey through the SDGs

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Abstract

'Sustainable Futures: A journey through the SDGs' is an educational Virtual Reality (VR) game designed to equip learners with the knowledge and competencies needed to address ongoing challenges related to the Sustainable Development Goals (SDGs). Serious games can engage students, develop their higher-order thinking, and foster retention and transfer of actionable skills (Hallinger et al., 2020). By navigating the virtual world and engaging in playful activities, learners are encouraged to rethink about their own actions and behaviours, and ultimately, improve their attitudes across the key dimensions of Sustainable Development (SD), namely Environmental, Social, and Economic. The game features visually appealing 3D graphics and utilises the playful nature of VR technology to immerse students into a unique learning experience. Upon launching the game, players enter an initial, orientation level to familiarize with the system controls and game mechanics, followed by three thematic levels dedicated to Environmental, Social, and Economic sustainability. Each level includes puzzles and challenges ranging from tree planting and recycling, to managing waste, designing a sustainable city using renewable energy, discovering secret codes, and unlocking levels. The final level aims to assess students' knowledge and energise them to take action towards a more sustainable future. Initial testing and evaluation with Higher Education students provided useful insights on the game's usability and students' degree of enjoyment (Nisiotis et al., 2024). The findings can inform further research and development highlighting the role of educational technology in fostering a sustainable mindset (Leal Filho et al., 2025) and driving positive change.

Keywords: Education for Sustainable Development (ESD) · Sustainability mindset · Game-based learning · Virtual Reality (VR) · Higher Education

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HIGHER EDUCATION'S IMPACT ON SOCIETY AND COMMUNITIES

Addressing Housing Inadequacy and Inequality: A Data-Driven Framework for Tackling Wicked Problems in Sustainable Development

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Abstract

Although social problems are often discussed in academic literature, they usually receive limited attention as primary units of analysis. Most research prioritises solutions, using social problems merely as context rather than deeply examining their complexities. This approach contrasts with the literature on innovation and entrepreneurship. This literature emphasises the importance of thoroughly understanding a problem before developing solutions. A comprehensive understanding of social problems enhances solution design by reducing biases, improving prototyping, and ensuring the engagement of key stakeholders. Housing inadequacy is an example of a sustainability challenge shaped by the dynamics of a globalised society. These challenges are complex, multidimensional, and interconnected, making them difficult to define and align with the concept of wicked problems. This study presents a data-driven framework for analysing and addressing these wicked problems in sustainability, using the case of the Serrinha slum in Rio de Janeiro, Brazil. Analyses use data from the first census of housing inadequacy conducted in 2022. The framework incorporates insights from management studies, the right to the city, and problem-based learning, providing a structured data collection and analysis approach. The proposed model supports researchers, policymakers, and educators in exploring and addressing social and environmental challenges. It contributes to sustainability research and innovation by offering a replicable framework for analysing wicked problems and bridging the gap between research and actionable policy solutions. Additionally, this framework can be utilised in higher education settings to help students and practitioners develop problem-solving skills for complex sustainability issues, thereby fostering more effective and impactful interventions.

Keywords: Housing Inadequacy; Inequality; Wicked Problems; Rigth to the City; Sustainable Development

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Sustainability in the healthcare sector: knowledge, attitudes and practices in hospital waste management

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Abstract

Introduction: Hospital waste management is a global concern due to its impact on public health and the environment. Inadequate waste management can cause epidemiological problems such as infectious diseases and adverse environmental effects, including soil, water and air pollution. This study aims to analyse the knowledge, attitudes and practices of healthcare professionals regarding hospital waste management, addressing the challenges and advances in the context of environmental sustainability.

Methodology: A systematic literature review was conducted according to the PRISMA guidelines. Open-access papers were included, published between 2020 and 2025, written in English, with a focus on hospital waste management and sustainability in the healthcare sector. The database search, conducted using PubMed and b-On, resulted in nine studies being analyzed, covering quantitative, qualitative and mixed methodologies.

Results: The results show that training interventions significantly improve the levels of knowledge, attitudes and practices of healthcare professionals. However, barriers such as lack of resources, work overload and the absence of robust policies limit the adoption of sustainable practices, especially in developing countries.

Conclusion: It is concluded that investment in training, infrastructure and organisational policies is essential to mitigate environmental impacts and promote sustainability in hospital waste management.

Keywords: Environmental impact, Training healthcare professionals, Healthcare waste management, Hospital waste, Sustainability in healthcare, Sustainable practices.

From the Linear to Circular Paradigm: Exploring the Transformation of the Blue and Circular Economy in São Tomé and Prince

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Abstract

The concept of the Blue Economy assumes the sustainable use of marine and coastal resources to promote economic growth, environmental conservation, and improved living conditions, with a very explicit focus on sustainability. Archipelagos, such as São Tomé and Príncipe, face unique challenges that make the Blue and Circular Economy even more relevant and strategic. Due to its geography, São Tomé and Príncipe is particularly vulnerable to climate change and environmental degradation. The implementation of Circular Economy practices can help reduce dependence on imports, improve waste management, and create growth and development opportunities. In island contexts like São Tomé and Príncipe, adapting Blue and Circular Economy practices is vital not only for sustainable development but also for diversified and balanced growth. Through a qualitative and exploratory approach (i.e., case study), the "*state of the art*" of the Blue and Circular Economy in São Tomé and Príncipe was studied. The need for greater awareness and education on the subject, as well as the importance of effective public policies and strategic investments to strengthen sectors such as fisheries and tourism, are the main conclusions of the study. Moreover, this study shows that the level of knowledge on the topic, financial incentives, and regulations have significant impacts on sustainable practices. In this context, international cooperation, along with more consistent government measures, can be fundamental to the development of the Blue and Circular Economy, thus ensuring the country's sustainable economic growth.

Keywords: Sustainability; Blue and Circular Economy; São Tomé and Príncipe; Development; Growth.

I already do it at home; what about on campus? Promoters of pro-environmental behaviours spillover across contexts

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Abstract

Awareness of environmental problems has increased significantly in recent years. This research focuses on how ecological choices in the private sphere, where control over performance is higher, can affect behaviours in other contexts, such as the university. The research also tested whether ecological identity and identity principles sequentially mediate the spillover effect, i.e., the relationship between self-reported pro-environmental behaviours (PEB) at home and the university. This implies that adopting PEB at home may lead to considering ecological concerns as part of one's identity, enabling higher self-efficacy and self-esteem (two identity principles) that can be maintained by recycling in the university context. The sample consisted of 497 university members, mostly female (69%), aged 18 to 64 years (M = 30.70; SD = 12.16), 71.4% students. Multiple regressions using SPSS macro Process showed that PEB at home were positively associated with university PEB, and ecological identity and identity principles played a sequential mediating role in this spillover (AdjR2 = 21%). It is discussed how identifying processes underlying the spillover effect can contribute to sustainability interventions, including avoiding moral licensing effects.

Keywords: Pro-environmental behaviour; Spillover effect; Ecological identity; Identity processes.

Exploring Sustainability in Beauty: Generation Z´s Views and Consumption Patterns

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Abstract

This study analyze sustainability in the beauty industry, focusing on the perceptions and behaviors of Generation Z, a group known for its concern with environmental and social issues. It investigates how this generation evaluates the sustainability of beauty brands, the factors influencing their purchasing decisions, and the impact of sustainability on brand loyalty. The text updates classical consumer behavior theories applied to Generation Z, highlighting cultural, social, and personal factors, with a focus on positive experiences, immediate benefits, and brand identification. It introduces this generation's sustainability preferences, such as eco-friendly packaging, natural ingredients, and ethical certifications, while critiquing greenwashing and demanding authenticity. It also emphasizes the emotional and aesthetic aspects of sustainable choices, deepening the connection between consumption, identity, and environmental responsibility. The aim is to understand how this generation's attitudes influence consumption choices. Data was collected through a structured questionnaire covering the importance of sustainability, willingness to pay more for ethical products, and responsible consumption behavior. The study sample consists of Generation Z individuals aged between 18 and 25 residing in Portugal with a total of 101 responses were collected. The study concludes that while Generation Z has the potential to reshape sustainable consumption, a stronger alignment between values and behavior is still needed, highlighting the importance of raising awareness.

Keywords: Sustainability; Generation Z; Beauty Industry; Beauty Standards.

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Water, Health, and Sustainability: The Role of Higher Education in Community Engagement and Policy Innovation

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Abstract

This interdisciplinary study aims to explore the crucial role of higher education institutions (HEIs) in promoting the health and sustainability of communities through language and communication in relation to water. Considering the deep link between water and public health, equity and environmental responsibility, the research emphasises how HEIs can promote water literacy and policy innovation by combining scientific education with clear, effective communication. Through initiatives such as AQUAE! Day, developed by the University of Rome 'Foro Italico', the study showcases participatory learning models combining traditional teaching methods, digital tools and peer-led outreach activities to raise awareness and encourage behavioural change regarding recreational water use, such as swimming pools, thermal baths and bio-pools.

Central to the project is the Flash Hub model, a cascading educational strategy in which students act as facilitators to promote the transfer of knowledge and empower communities by popularising scientific language. The study thus emphasises the power of simple, inclusive language to shape social reality and stimulate ecological responsibility. Through discourse analysis, the study provides a framework of effective communication strategies that encourage sustainable water practices.

By integrating linguistic reflection, participatory education and community outreach, HEIs can act as key players in driving change in the field of sustainable water management.

Finally, the research highlights the HEIs' potential to foster collaborative action among policymakers, citizens and industries, bridging the gap between academic knowledge and practical solutions for a water-secure and sustainable future.

Keywords: Environmental education; language learning and processing; circular economy; public policy; discourse analysis; technological innovation.

Gender and Green Entrepreneurship: Examining Intentions and Actions Among Moroccan Students

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Abstract

The transition to sustainable economic models has heightened interest in green entrepreneurship, particularly among young people. However, the role of gender in shaping entrepreneurial intentions and actions in this domain remains underexplored. This study examines how gender influences both the intention and realization of green entrepreneurship among Moroccan students. Using a qualitative approach, we analyze gendered differences in entrepreneurial motivation, perceived barriers, and access to resources. Our findings reveal that while both male and female students express interest in green entrepreneurship, gender-specific challenges and social expectations significantly impact their ability to transition from intention to action. The study contributes to the literature on gender and entrepreneurship by highlighting key factors that shape green entrepreneurial pathways in emerging economies. It also offers policy recommendations to foster inclusive and sustainable entrepreneurial ecosystems.

Keywords: Green entrepreneurship ; gender ; entrepreneurial intention ; entrepreneurial action ; Moroccan students.

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Promoting Peace and Justice Through Digital Pedagogical Resources – SDG 16

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Abstract

This study presents an educational activity designed to promote Sustainable Development Goal (SDG) 16 — Peace, Justice and Strong Institutions — among primary school students through the use of digital pedagogical resources. Developed within the framework of the "Digital Pedagogical Resources" curricular unit of the TeSP in Accompanying Children and Young People at the Polytechnic University of Santarém, the project aimed to foster social responsibility, critical thinking, and collaboration in young learners.

The methodology was action-oriented and participatory, involving the creation and classroom implementation of an interactive digital board game followed by the collaborative production of thematic posters. The pedagogical objectives were to encourage students to reflect on justice and peace, express their ideas creatively, and engage in group work to internalize democratic and inclusive values.

Data were collected through direct observation, student reflections, and analysis of the posters produced. The digital resource used — an interactive Genially board game — introduced children to real-life school-based scenarios involving fairness, empathy, and respect. The activity concluded with group presentations and a class discussion evaluating the students' learning and participation.

The results demonstrate that digital pedagogical tools, when integrated with cooperative and reflective practices, can be effective in engaging children in meaningful conversations about justice, rights, and peaceful coexistence. This approach supports the broader aim of SDG 16, contributing to the development of more inclusive and empathetic educational environments.

Keywords: Digital pedagogy; Peace and justice; Sustainable Development Goal 16; Primary education; Participatory learning; Social values.

Acknowledgements

This proposal was carried out as part of the Digital Pedagogical Resources curricular unit of the TeSP in Accompanying Children and Young People at the School of Education of the Polytechnic University of Santarém. The authors would like to thank their teachers and colleagues for their support in developing and implementing this educational activity.

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RESEARCH, INNOVATION AND TECHNOLOGY FOR SUSTAINABILITY

Environmental Awareness through UAVs: A Deep Learning Approach for Real-Time Object Detection and Tracking

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Abstract

This study proposes a YOLO-based model to improve object detection and tracking performance in Unmanned Aerial Vehicle (UAV) imagery, focusing on supporting sustainable urban mobility and intelligent environmental monitoring. UAVs play a critical role in agriculture, public safety, disaster response, and traffic management by capturing high-resolution images from diverse altitudes and perspectives. These capabilities hold significant potential for advancing sustainable infrastructure, optimizing emergency response systems, and reducing carbon emissions through intelligent transportation monitoring. However, UAV imagery presents substantial challenges, including complex backgrounds, small object sizes, and densely distributed targets. To address these issues, the proposed model integrates the high-speed, accuracy-focused YOLOv7 architecture with Efficient Multiscale Feature Fusion and a CSPDarknet53 backbone. Real-time object tracking is implemented using the SORT algorithm, while the ELAN (Efficient Layer Aggregation Network) structure further enhances feature fusion, improving classification and localization accuracy. Specifically designed for vehicle detection and tracking, the model achieves a mean Average Precision (mAP) of 88.2% on the VisDrone2019 and DOTA datasets. These results demonstrate improved small object detection performance and robustness in complex environments, making the proposed approach highly effective for UAV-enabled sustainable monitoring applications.

Keywords: UAV, YOLO, Object detection, Real-time object tracking, Deep learning

Artificial Intelligence Supported Waste Management: Sustainable Pharmaceutical and Biomedical Waste Analysis using ViT

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Abstract

Sustainable development has become one of the main goals of organizations and plays a critical role in decreasing environmental impacts and enabling resource management. This study uses the Vision Transformer (ViT) model to categorise pharmaceutical and biomedical waste and develop sustainable waste management strategies. In the experiment, the Pharmaceutical and Biomedical Waste dataset was used. At the end of the study, an accuracy rate of 97.94% was obtained to develop the ViT model. This result reveals the potential of visual-based big data analysis to make waste management processes more efficient. At this point, it shows that it is essential for organizations to benefit from artificial intelligence models to strengthen their sustainability efforts.

As a result, artificial intelligence approaches such as ViT should be encouraged in academic research on sustainability and organizations. This transformation will increase environmental awareness and enable artificial intelligence to build a sustainable future actively.

Keywords: Artificial Intelligence, Vision Transformer (ViT), Sustainability, Pharmaceutical and Biomedical Waste.

Assessment of Digital Literacy for Sustainability in Higher Education: An AI-Based News Classification and Pedagogical Test Approach

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Abstract

This study proposes an interdisciplinary approach aimed at enhancing digital literacy in the context of sustainability within higher education. A dataset comprising both accurate and misleading news related to sustainability was classified using advanced artificial intelligence techniques. The employed AI algorithms not only computed the accuracy rates of the news items but also identified the most influential positive and negative lexical clusters. In parallel with this technical analysis, a 15-item test, derived from the original dataset, was developed and administered to 23 higher education students. Statistical analyses of the test results were conducted to evaluate how students cope with misleading information, thereby gauging their digital literacy levels. The findings underscore the potential of AI-supported news classification and pedagogical assessment tools in bolstering digital literacy, particularly in relation to sustainability communication. Ultimately, this study aims to contribute to the development of a sustainable knowledge society in higher education through the integration of technological and educational methodologies.

Keywords: Digital literacy, sustainability communication, misinformation detection, news classification, pedagogical assessment, interdisciplinary approach.

Object Motion Analysis: A Framework for Object Detection, Tracking, and Future Position Estimation

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Abstract

In the technologically driven world of today, object detection, tracking, and motion prediction are essential in various applications, including autonomous systems, surveillance, activity monitoring, and so forth. To bridge latency and multi-stage inefficiencies, this study introduces a unified deep-learning framework that couples YOLOv8 for single-shot detection with a Bidirectional Long Short-Term Memory (BiLSTM) module for joint tracking and trajectory prediction. The methodology commences with data collection and preprocessing, wherein video frames are meticulously labelled, resized, and optimised. The subsequent phase involves the detection and classification of objects within the scene, followed by a tracking phase where unique identifiers are assigned, enabling the monitoring of their movement over time. To enhance situational awareness, the detected objects' motion patterns are analysed, facilitating future position estimation through predictive modelling. The final stage of the methodology focuses on visualizing and evaluating the results, ensuring the accuracy and reliability of the framework. This study focuses the importance of efficient object tracking and motion prediction in dynamic environments. The proposed approach achieved the objective by balancing computational efficiency with performance, providing valuable insights for applications requiring continuous object analysis and prediction to improve decision making in autonomous navigation, security surveillance, and intelligent video analysis. By streamlining the perception pipeline into a single pass, the framework lowers compute cycles, energy consumption and hardware wear, thereby advancing sustainability goals alongside performance gains.

Keywords: Object Detection · Object Tracking · Motion Prediction · Autonomous Systems · Computer Vision

Artificial intelligence for sustainable and inclusive education in Moroccan universities: challenges and opportunities

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Abstract

Artificial Intelligence (AI) is increasingly revolutionising higher education systems globally, offering possibilities for personalized learning, efficient administration, and reducing education inequality. In Morocco, AI adoption in universities is only beginning to gain pace, yet it has great potential to address both conventional and contemporary challenges. This article presents the results of an exploratory qualitative study examining how AI can promote a more inclusive and sustainable higher education system in Morocco, and identify structural barriers to its mass adoption.

The study is grounded on a literature review, national digital transformation strategies, and institutional case studies of early AI adoption in Moroccan universities [1]. Findings reveal that while AI-driven tools such as adaptive Learning Management Systems (LMS) and academic chatbots have been tested in some institutions, they remain concentrated in financially well-funded, urban campuses [2]. Rural universities lag behind, facing weak internet connectivity, outdated laboratories, and limited digital literacy among professors. Data from the High Commission for Planning (HCP, 2023) further highlight this divide, showing that only 58% of rural households have internet access compared to 89% of urban households.

To bridge such inequalities, the paper proposes a public-private partnership (PPP) model tailored for Moroccan higher education, fostering cooperation between government, universities, and private tech firms. This model supports decentralized infrastructure, mobile-based platforms for rural areas, and faculty training, while integrating ethical and cultural sensitivity.

By aligning with Sustainable Development Goals (SDG 4 and SDG 10), the study concludes that AI can drive justice, inclusion, and sustainability in Moroccan universities, provided infrastructural gaps are filled and ethics guide deployment [3][4].

Keywords: Artificial Intelligence, Higher Education, Sustainable Development, Inclusive Education, Public-Private Partnerships, AI Ethics.

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A Survey on Image-Based Approaches for Android Malware Detection: Toward Sustainable and Efficient Solutions

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Abstract

The rapid proliferation of mobile device usage has introduced significant cybersecurity threats. Among them, the Android operating system has become one of the primary targets for malware developers due to its open-source nature and vast user base. While traditional malware detection methods rely on static and dynamic analysis techniques, these often require extensive preprocessing and expert-driven feature extraction and selection, which can limit their efficiency and introduce performance bottlenecks. Furthermore, conventional approaches may fall short when confronted with advanced and sophisticated malware variants. In recent years, deep learning and image processing-based approaches have emerged as innovative and effective alternatives for malware detection. These methods not only enhance detection accuracy but also contribute to a sustainable and scalable cybersecurity infrastructure through their automation capabilities. This survey reviews the current literature on image-based methods for Android malware detection, providing a detailed analysis of the applied techniques, their strengths, and their limitations. In particular, approaches involving deep learning, convolutional neural networks (CNNs), and other machine learning algorithms are comparatively evaluated. The findings indicate that image-based analysis methods offer more reliable, comprehensive, and effective detection than traditional techniques. Moreover, these approaches hold significant promise for advancing sustainable digital security systems. Recommendations for future research directions are also presented, along with a discussion of the potential contributions to the academic body of knowledge in this domain.

Keywords: Android, Malware Detection, Image-based Analysis, Deep Learning, Convolutional Neural Networks, Machine Learning.

Towards More Compact Encrypted QR Codes: Enhancing Efficiency in Secure Data Sharing

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Abstract

The utilisation of QR codes has become pervasive, encompassing a wide range of sectors, including healthcare, finance, education and travel. The employment of encrypted QR codes is becoming increasingly common in order to prevent counterfeiting, ensure privacy and provide authorisation. However, the encryption process leads to a loss in data length compared to plain text, making it necessary to use larger QR code versions. This situation increases scanning times, requires larger areas for placement, and demands more precise camera angles for accurate reading. Furthermore, larger QR codes also necessitate a higher error-correction level. As the error-correction rate increases, the amount of data allocated for error correction instead of actual information also increases, which reduces the efficiency of the QR code. The primary objective of this study is to ascertain the most efficacious solution to enhance the data transmission capacity of encrypted QR codes and to propose possible improvements. Across various data types, the study systematically evaluates multiple combinations of key parameters: compression algorithms such as Brotli, zlib, and LZMA; encryption schemes such as AES-GCM, AES-CTR, and ChaCha20-Poly1305; and all QR error-correction levels. The proposed approach enhances efficiency in building encrypted QR codes, allowing the same data to be represented in smaller QR code versions. As a result, smaller and more legible QR codes are obtained, leading to better performance in practical applications while reducing material usage and thereby advancing sustainability goals. The findings demonstrate practical solutions that overcome capacity limitations in existing systems, significantly improving secure data transmission through QR codes.

Keywords: Quick Response Technology · Encrypted QR Codes · Data Transmission · Performance Optimization · Efficiency Enhancement

Disinformation and Misleading Information Detection with Natural Language Processing

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Abstract

The accuracy and reliability of the information ecosystem plays a vital role in achieving sustainable development goals. However, the rapid spread of disinformation and misleading content on digital platforms adversely affects the dissemination of scientific truth, undermines the effectiveness of environmental policies and misleads the public. In particular, climate change denial, misleading claims against environmental sustainability and health policies, and discourses that distort scientific facts shape public perceptions of public health, trust in scientific policies and environmental issues, and reinforce the cycle of misinformation. The avalanche of misinformation can even lead to panic and chaos in society and around the world. This study examines studies that use natural language processing (NLP) and machine learning methods to detect and analyze disinformation content spread on digital platforms. The study focuses on studies that apply NLP-based techniques such as sentiment analysis, topic modeling, and fake news detection to data sets collected from social media platforms. Additionally, the characteristics of misinformed discourse were identified in order to assess the impact, distribution, and spread of such content. The study is based on the examination and analysis of basic studies within the scope of disinformation, misleading and fake news detection. The goal of the study is to evaluate how well NLP models categorize false information and create plans to stop its spread while keeping in mind sustainability and scientific reality. To guarantee the accuracy of the information ecosystem, the results will offer evidence-based suggestions to sustainability scholars and policymakers alike. Disinformation detection systems with artificial intelligence support are regarded as an essential instrument for accomplishing sustainable development objectives and raising public awareness of significant issues with factual information.

Keywords: Disinformation Detection · Fake Detection · Social Media · Natural Language Processing · Deep Learning

Optimizing workflows through an AI-enhanced task management digital solution for effective and sustainable task management

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Abstract

Efficient task management is important to achieve personal and organizational goals. Especially in dynamic environments like in Higher Education (HE), streamlined workflows can help optimize resources and improve collaboration. This vision abstract explores the design of an AI-enhanced, context-aware task management application aimed at increasing productivity and user experience (UX). This may lead to improvements in sustainability, including innovative sustainable practices in HE (SDG 9). The vision of this research is to explore how the combination of Machine Learning (ML) and context-awareness can enhance UX, improve user productivity, and lead to the adoption of more sustainable practices. The app will utilize ML to recommend tasks based on user behaviour patterns, while context-awareness will enable in-context reminders to help users stay productive with timely, relevant notifications. The integration of digital calendars may enhance efficiency, reduce disruptions, and promote more focused work sessions. Moreover, the use of multi-view layouts may offer flexibility in work styles, enhancing time and resource allocation. Features such as a task dependency mechanism and analytics could identify workflow bottlenecks, leading to efficiency improvements by promoting user reflection. The app will be evaluated through a quasi-experimental approach focusing on usability and effectiveness in terms of user productivity. Particularly in HE, this system could serve as a tool for institutions to tackle various challenges relevant to Sustainable Development, such as optimizing resource allocation and distribution, improving productivity by using the system to minimize redundancies and inefficiencies, eliminating biases, and providing information to a diverse set of users (SDG 10).

Keywords: Context-awareness, Machine Learning, Task management, Sustainability, User Experience, Productivity analysis, Resource optimization, Digital transformation.

The integration of technology in ESD

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Abstract

This research investigates the ways that emerging new technologies such as deepfakes, and AI can be combined along with institutional collaborations to effectively contribute towards global sustainability.

The first focal point of this research is the following question, which GenAI trends can aid education for sustainable development (ESD)? AI-powered personalisation, adaptive learning, and data analytics show the potential to make ESD more effective and accessible. This data will be tested using comparative case studies of AI-integrated learning platforms, including simulations with both AI and deepfake-enhanced modules. Meaning, qualitative research will be utilised to assess technologically enhanced modules on their accessibility and effectiveness in promoting ESD.

The study further explores its own development of ESD materials such as a personalised digital course and an embedded educational mini game for raising awareness on said topic. The question used for this is, how can deepfake technology be utilised for the promotion of sustainability? Through leveraging immersive media and realistic simulations, deepfakes may effectively engage audiences with environmental issues. This assumption will be evaluated through post-course interviews and brief questionnaires with users.

Lastly, how can institutional partnerships with the usage of GenAI technologies assist in the promotion of ESD? This question will be answered through a qualitative approach, specifically, a thematic analysis. The data will be gathered through semi-structured interviews with educators in various sectors. Also, suggestions will be further given on the solution of the problem.

In summary, this research explores how new technologies and collaborations can boost sustainability.

Keywords: Deepfakes · Sustainability · Inclusivity · GenAI · Collaboration

Artificial Intelligence and Thesis Abandonment: Enhancing Sustainability and Gender Equity in Doctoral Journeys in Morocco

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Abstract

At this stage of immense digital transformation, the high adoption of Artificial Intelligence (AI) has begun to change the academic route, especially at the level of a PhD, in a major way. This study is an exploratory qualitative research about the impact of AI on doctorate persistence, and on gender inequality of doctoral pathways in Morocco. Drawing from semi-structured interviews with six doctorate students who gave up their theses in November 2024 in the higher school of technology in Fès-Morocco, this investigation sheds light on their perceptions, use, psychological implications, and motives concerning AI, in addition to the institutional and socio-cultural challenges they encountered. Findings indicate that although AI can help with time management, access to resources, and motivation, its efficacity is limited by access gaps, familial constraints, and gender biases. These obstacles are more difficult for female candidates, while male candidates also experience challenges because of excessive reliance and lack of institutional support when they have more confidence in their technical expertise.

This research highlights the necessity of an ethical, gender-sensitive, integrated, human-centered, and policy-driven approach to align the integration of Artificial Intelligence with doctoral success and sustainable transformation in higher education in Morocco.

Keywords: Artificial Intelligence. Doctoral Persistence. Gender Disparities. Academic Dropout. Higher Education .Sustainability. Qualitative Study . Morocco.

Sustainable Agricultural Advisory Using LLM and RAG: A Chatbot Application for Farmers

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Abstract

This study presents the development of a sustainability-focused agricultural chatbot application leveraging Large Language Models (LLMs) and Retrieval-Augmented Generation (RAG) architectures. The system utilizes a curated dataset consisting of approximately 19,000 question-answer pairs derived from official cultivation guidelines provided by the Turkish Ministry of Agriculture and Forestry, covering a range of topics such as crop management, soil analysis, pest control, and greenhouse practices. By embedding these question texts using OpenAI's text-embedding-ada-002 model and indexing them via FAISS, the chatbot is able to retrieve highly relevant contextual snippets in real time. Responses are generated using OpenAI's gpt-3.5-turbo model with an average response latency of 0.82 seconds. The chatbot supports both text and speech input by speech to text methods. The results demonstrate high accuracy and user satisfaction, indicating that the LLM+RAG architecture offers a robust, scalable, and low-latency digital assistant for sustainable agriculture. This work represents an important step in integrating AI-powered decision support systems into smart agriculture, in alignment with broader goals such as climate resilience and ecological sustainability.

Keywords: Agricultural Chatbot, Large Language Models, Retrieval-Augmented Generation, Sustainable Agriculture, AI in Farming.