CIRCULAR ECONOMY INTEGRATION, RESOURCES AND LEARNING FOR ECONOMIC SUSTAINABILITY: A FRAMEWORK FOR YOUTH EMPOWERMENT

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Abstract

In a time when we face ongoing global sustainability issues, traditional educational approaches are often found to be insufficient for engaging young people in the challenging complexities of the circular economy. The CIRCLES (Circular Economy Integration, Resources and Learning for Economic Sustainability) project offers several tools and solutions to this academic problem. With a holistic approach involving gamification, structured curriculum design, and community-based learning, this project works to build a deep understanding among young people of circular economy principles. The main methodological processes include an interactive video game, CycleQuest: Path to Sustainability, a fully developed curriculum for youth workers, and a university syllabus. The project objectives are to deliver impact in Europe by measuring environmental awareness, digital literacy, and active citizenship in youth while enabling them to counter the rise of unsustainability and encourage civic engagement to shed light on sustainable actions. This article explores the theoretical contexts and methods of the CIRCLES project and discusses its integrated model as a scalable and sustainable framework for contemporary circular economy education.

Keywords: Circular Economy, CIRCLES, Gamification, Sustainability, Youth

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Introduction

This article details the CIRCLES project, providing an overview of its structure, innovative design, and anticipated impacts. An important central argument is that the project brings an integrated approach that combines gamified learning with both formal and non-formal curricula and experiential practices in the real world, which can be considered a substantial and innovative model for current academia. This approach aims to develop knowledge as well as a holistic, action-based environmental literacy relevant to a more sustainable, informed, and active generation of young people across Europe.

A main change in our economic systems – to shift them from a linear "take–make–dispose" model to one that is circular, with a focus on efficiency from resource extraction to production, waste, and longevity of materials – is a requirement for a sustainable global society (Cervantes Puma *et al.*, 2024; Huttmanová *et al.*, 2023). Concepts related to circular economies are becoming more established within the language and outlook of policy and industry; however, sharing systemic and complex knowledge regarding the circular economy is an educational challenge when dealing with stakeholders such as the public and youth (Kosta *et al.*, 2025; Krajnc *et al.*, 2022). Conventional didactic approaches do not typically embrace the holistic and connected understandings of circular economies needed to inform further study and application within our societies (Hamid *et al.*, 2024; Blomsma, 2022; Kirchherr and Piscicelli, 2019).

The circular economy is emerging as a key pathway to sustainable development. While the private sector's role is well studied, higher education lecturers also have a vital, yet underexplored, role in shaping circular economy education (Kirchherr and Piscicelli, 2019: 10). Transitioning to a circular economy requires systemic change, starting with education. Informed citizens are more likely to adopt sustainable habits and promote the circular economy, understanding its benefits for both people and the environment (Tiippana-Usvasalo *et al.*, 2023).

The CIRCLES project takes on this urgent educational need by providing a series of interactive and immersive tools to develop skills that support a sustainable future. The urgency of the project is fuelled by the need to ensure that young people have the ability to understand complex information, differentiate facts from misinformation, and develop as informed citizens and decision-makers (Švecová *et al.*, 2019). Its aims are threefold: to develop understanding of the circular economy, to improve digital literacy, and to inspire active citizenship and entrepreneurship among young people in Europe (CIRCLES Project, 2025).

Circular Economy Integration in Education

The incorporation of circular economy concepts in education represents an important strategy for enabling sustainability and working towards systemic transformation in societies. Higher education institutions are considered valuable actors in this transition, not only by integrating circular economy principles in their academic programmes and educational pathways but also by modelling circular behaviours at the institutional level, through research endeavours, and through engagement with stakeholders (Renfors, 2024; Vergani, 2024; Serrano-Bedia and Pérez Pérez, 2022; Nunes *et al.*, 2018). Recent literature indicates the need for systemic, comprehensive thinking and applications across disciplines and educational levels, including technical and vocational education programmes, business programmes, engineering, and design programmes (Hamid *et al.*, 2023; Van Dam *et al.*, 2020). Authors present key themes, which include developing circular economy competencies, experiential and project-based learning as intentional, innovative pedagogies, the importance of digital technologies, the incorporation of artificial intelligence, and collaboration with industry and communities (Renfors, 2024; Guerreschi *et al.*, 2023; Demestichas and Daskalakis, 2020; Kopnina, 2019). Despite rising interest and awareness, challenges remain, including the delivery of education in a fragmented way; institutional, cultural, and knowledge-awareness issues; and crisis adaptations to evidence-based models.

Transitioning towards a circular economy necessitates the opposite of a siloed, linear view of understanding – a systems-thinking approach to the economy (Scheel and Aguiñaga, 2025; Hassan and Faggian, 2023; Iacovidou *et al.*, 2020; Van Dam *et al.*, 2020). As authors report, sustainable, self-reinforcing growth with the systems thought process, as opposed to siloed thinking, relies on regional conditions that link infrastructure, institutions, educated communities, and the rule of law to allow for the successful operation of circular systems (Scheel and Aguiñaga, 2025: 19). This seems to be a very difficult educational challenge, since conventional classroom-based instruction does not typically conceptualise how supply chains, material flows, and resource management are interconnected (Kavota *et al.*, 2024; Salinas-Navarro *et al.*, 2022).

The literature on circular economy education has found a lack of pedagogical models surrounding hands-on, problem-based, or collaborative learning (Kirchherr and Piscicelli, 2019; Nguyen, 2023). Constructivist learning theories would be useful, as they assume learners' understanding is built during direct experience and reflection on those experiences (Miettinen, 2000). Learning contexts based on constructivist frameworks promote critical thinking and decision-making skills, which are central to the successful application of circular economy thinking when extended into real-world contexts (Do *et al.*, 2023).

Gamification as a Pedagogical Tool in Circular Economy

The use of gamification and games in education has been extensively studied, demonstrating their efficacy in increasing learner engagement, motivation, and knowledge retention (Cavus *et al.*, 2023). One study has already contributed to the understanding of how gamification affects the engagement and learning behaviour of university students based on their personality traits (Smiderle *et al.*, 2020). Research shows that gamification can enhance student engagement in online learning, similar to how games do, and improve their skills (Baah *et al.*, 2024; Zeng *et al.*, 2024; Cavus *et al.*, 2023). This also demonstrates the motivational aspects that practically propel an individual to engage in goal-oriented behaviour, thus engaging in tasks more effectively while being entertained.

Academic literature has established video games as a viable pedagogical tool to teach complex systems thinking and dynamic decision-making processes (Lie *et al.*, 2022; Adžić *et al.*, 2021; Fjællingsdal and Klöckner, 2019; Egenfeldt-Nielsen, 2006). Video games leverage essential mechanisms for learning: challenges, rewards, narratives, and immediate feedback. The compelling nature of video games can entice players to immerse themselves in different worlds. Serious games simulate real-world experiences in a consequence-free virtual space. Players can engage with the game system, test their strategies, experience the outcomes of their decisions, and better integrate complex conceptual ideas than through observation or lectures (Whalen *et al.*, 2018). This focused level of decision-making is on par with active learning strategies, which can increase student engagement, improve performance, and raise satisfaction (Smiderle *et al.*, 2020; Staiano, 2014). The CycleQuest video game, as the central methodological tool of the CIRCLES project, is designed to apply these principles to engage players with the nuances of circular economy concepts.

Digital Literacy and Active Citizenship

Civic engagement in the modern era goes beyond traditional participation and encompasses a range of digital citizenship skills, which include not only technical abilities but also the desire and capacity to evaluate information online and interact within digital communities (Christensen *et al.*, 2021). The CIRCLES project's intentional focus on equipping youth with knowledge to combat misinformation is a vital goal that elevates its mission from merely environmental awareness to a principle of modern democratic education.

A circular economy is often misrepresented or greenwashed, and at times used as a negative political agenda. The CIRCLES project, on the other hand, provides young people with an opportunity to develop critical thinking skills to avoid stereotypes, distinguish between genuine and misleading sustainability

initiatives, and become active, well-informed citizens. This builds on research into the empowerment of young people and community-based learning, which supports a shift from simple knowledge acquisition to active, applied, real-world learning. Project-based learning can develop critical thinking skills and equip students to approach uncertainty and synthesise information creatively (Hryn *et al.*, 2024). This transition to active, applied learning contributes to community engagement in ways that go beyond "slacktivism" and encourages more meaningful civic participation. News literacy is also a vital element of this type of learning.

Integrated Framework of the CIRCLES Project

The CIRCLES project is based on a new, integrated learning model that unites formal, non-formal, and informal education into a seamless ecosystem. The intellectual outputs of the project are designed to move through the various contexts of education to develop the capacity for learning as a fluid and interchangeable continuum.

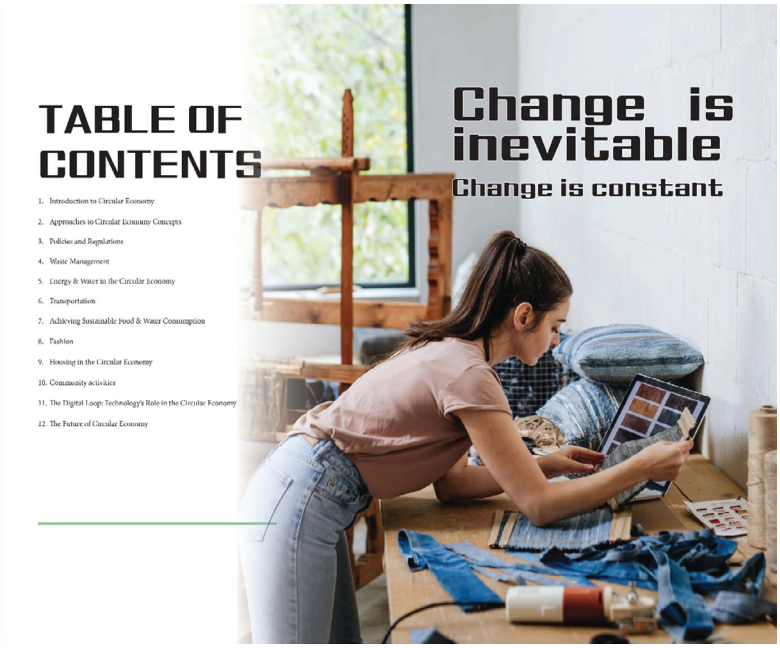
The university syllabus is an important point of entry for formal education into the project, as it lends academic credibility and aligns with the processes of thinking in higher education. The syllabus outlines a prospective academic course on the circular economy, designed for theoretical and practical application by students in economics, social sciences, and the humanities.

On the other hand, the curriculum for youth workers (Fig. 1) reflects the project's role in fostering non-formal education; it ensures that the principles can be applied within non-formal educational settings, enabling youth workers to engage directly with young people.

The syllabus and curriculum are linked and interrelated, advocating for the connection of university teachers, students, youth workers, and engaged youth through an integrated learning model that combines formal, non-formal, and informal education. The university syllabus formally contextualises an academic course on the circular economy with theoretical components and practical applications for university students. Conversely, the curriculum applies these principles in a non-formal educational process so that they can be directly implemented with young people. Although there is a curriculum for youth work, it is not a school curriculum and therefore is highly adaptable, allowing learning to occur in a way that complements the formal university syllabus. The table of contents of the curriculum for youth work is illustrated in Fig. 2.

At the project's core is CycleQuest: Path to Sustainability, a free and entertaining game available on platforms such as Steam. This new experience is an informal learning opportunity that provides a more playful, informal, and interactive way for youth and the general public to engage with the project's core themes or topics without being in a typical learning experience. As it is structured as informal, free, fun, game-based learning, it allows the project to go far beyond structured curricula (e.g. schools, community centres, etc.) and provides audiences with learning opportunities in a variety of informal settings. The cross-dimensional approach ensures there is never just one formal way of learning. It is a continuous and, in that sense, dynamic process, with people taking part in formal, non-formal, and informal learning environments that validate each other in order to provide a deeper and more holistic learning experience.

1: Curriculum on Circular Economy – cover page
Source: Curriculum on Circular Economy, 2025 (in print)



2: Curriculum on Circular Economy – Table of Contents
Source: Curriculum on Circular Economy, 2025 (in print)

Gamification in the CIRCLES Project

The CycleQuest: Path to Sustainability video game stands at the forefront of the project's approach, serving as the primary tool for transformative learning. Crafted to simulate real-world sustainability challenges (Fig. 3), the game offers players an immersive, hands-on experience that allows them to actively engage with the long-term consequences of their decisions.

Rooted in the principles of serious games, the game is specifically designed to meet educational and training objectives by turning abstract concepts into tangible, interactive experiences. By embedding circular economy principles into an engaging narrative, CycleQuest enables players to explore and internalise complex cause-and-effect dynamics within a sustainable system, providing a deeper, more intuitive understanding of how individual actions can impact broader environmental and societal outcomes.

The game's design strategically cultivates critical problem-solving abilities, strategic decision-making, and a heightened awareness of resource management – all within an entertaining, narrative-driven framework. Through gameplay, players develop essential skills for navigating sustainability challenges while also fostering a sense of agency in shaping real-world solutions.

3: CycleQuest: Path to Sustainability video game screenshot

4: CycleQuest: Path to Sustainability video game screenshot

Experiential and Community-Based Learning

Moving from knowledge to practice is one aspect of the project's methodological approach. This is accomplished by engaging in community-based projects that are grounded in experiential learning principles. Experiential learning models such as Kolb's experiential learning cycle (Kolb, 1984) explain how doing and concrete experience lead to understanding. In the CIRCLES project, young people apply the knowledge they gained from the game and curriculum to actual local settings, guided by trained youth workers. The process of "learning by doing" enables participants to facilitate a transition from broader principles into meaningful, actionable solutions while developing civic and social entrepreneurial skills, enabling them to realise their own sustainability ideas.

The European-wide aspect of the project is not simply a logistical one but a core component of its pedagogical and operational design. The consortium of five partners from four countries provides many opportunities for a rich exchange of cultural and educational differences. In this collaborative process, the consortium partners need to create educational products that are not cultural representations but instead universally usable and locally adaptable. This design strengthens the outputs and their transferability to other educational contexts and socio-economic conditions across Europe. Consequently, the consortium model is integral to the project's approach to constructing a sustainable educational solution for the longer term.

CIRCLES Methodology

The CIRCLES project's methodology is structured around three core, interconnected work packages that systematically translate its theoretical framework into concrete deliverables.

Work Package 2 focuses on the design and development of the CycleQuest: Path to Sustainability video game. This intellectual output is the central element of the project's gamification strategy, designed to immerse players in circular economy principles through interactive, problem-solving scenarios. The game will be made available for free on accessible platforms such as Steam – a strategic choice to ensure widespread accessibility and potential for long-term impact that extends well beyond the project's initial funding period.

Work Package 3 is dedicated to creating the formal and non-formal educational materials that will embed the project's principles into existing learning systems. The intellectual outputs of this package include a comprehensive curriculum for youth workers, which formalises a non-formal educational pathway, and a full 12-week syllabus designed for university-level integration. These materials serve as the official dissemination channels, ensuring the project's content is professionally adopted by educators and institutions across Europe.

Work Package 4, titled Community Projects Focusing on Experiential Learning, is where the project moves from theory to practice. At least one community project will be implemented in each of the four partner countries. These projects are designed to provide a tangible platform for young people to apply their knowledge in local settings, mentored by trained youth workers. The experiential nature of this work package is a critical component for fostering the civic and social entrepreneurship skills that are key to the project's objectives. As a result, young people will gain first-hand experience with the circular economy, which will complement their learning through the game. They will be empowered to take a lead in their communities or localities in this field.

A clear overview of the project's intellectual outputs, their target audiences, and their dissemination channels is presented in Tab. I, which illustrates the strategic planning behind each deliverable.

I: Project Intellectual Outputs and Dissemination Channels

Output	Target Audience	Primary Function	Dissemination Channel
"CycleQuest" Video Game	Youth, General Public	Gamified learning, Engagement	Free download on platforms like Steam
Comprehensive Curriculum	Youth Workers, Educators	Formalizing non-formal education	Educational Toolkit for facilitators
University Syllabus	University Lecturers, Students	Formal education integration	Consortium partner universities
Educational Toolkit	Facilitators, Mentors	Practical application, Mentorship	Consortium-specific distribution

Expected Results and Project Outcomes

The project is designed to generate a suite of both tangible and intangible results, moving from the creation of educational tools to a measurable impact on individual and community behaviour.

The main intellectual outputs – the CycleQuest game, the curriculum, the syllabus, and the educational toolkit – are not merely project deliverables but durable and accessible tools designed to create a lasting legacy. The decision to make the game free on platforms such as Steam ensures maximum reach and continued access well beyond the project's funding period. Similarly, the formal curricula are structured for easy integration, allowing partner organisations and others to continue utilising the materials in their regular activities.

A key anticipated result is a measurable enhancement in environmental awareness and digital literacy among participating youth and youth workers. This implies the implementation of a rigorous pre- and post-assessment methodology to quantitatively evaluate knowledge acquisition and skill development. Furthermore, the project anticipates a "greater adoption of sustainable practices". This represents a crucial shift from simply understanding concepts to actively changing behaviour, which is the ultimate goal of effective environmental education.

Beyond individual skill enhancement, the project anticipates fostering a new generation of engaged citizens and social entrepreneurs. The community projects are expected to empower a minimum of 20 young people in each of the five partner countries to realise their sustainability ideas. This outcome reflects the project's commitment to transitioning theoretical knowledge into tangible civic and entrepreneurial action, thereby strengthening community sustainability and inspiring a proactive approach to environmental challenges.

The anticipated relationship between the project's activities, expected outcomes, and potential indicators of success is formalised in Tab. II, providing a clear framework for project evaluation.

II: Project Activities, Outcomes, and Indicators of Success

Project Activity	Expected Outcome	Potential Measurement Indicator
Playing "CycleQuest"	Enhanced environmental awareness and digital literacy	Pre/post-test scores on CE knowledge; Surveys on self-reported digital skills
Using Curriculum/Syllabus	Enhanced professional competencies of youth workers/educators	Number of trained educators; Self-reported confidence ratings
Participating in Community Projects	Fostered active citizenship and social entrepreneurship	Number of projects implemented; Post-project surveys on civic engagement intentions
Pan-European Consortium Collaboration	Universally applicable and locally adaptable outputs	Review of project outputs by external experts; Adoption rates in diverse contexts

Discussion and Conclusion

The true innovation of the CIRCLES project lies not in any single component, but in its integrated, multi-faceted approach. This is rooted in its cohesive and multi-dimensional strategy, which integrates gamification, digital literacy, and active citizenship within the domain of environmental education, weaving these elements together into a unified educational framework. This synergy creates a more robust and effective learning experience than any single method could achieve in isolation. The game provides the immersive and engaging hook, the curricula offer a structured theoretical basis, and the community projects create a vital link for translating and applying knowledge into practice.

This approach fosters a comprehensive learning journey – a transition from intellectual comprehension to behavioural modification and active civic participation, which is one of the project's goals. The outputs of the project have been strategically designed to ensure long-term scalability and durability. By ensuring the durability and accessibility of educational tools, particularly the CycleQuest game, syllabus, and curriculum, the project expects that its legacy will extend well beyond its initial funding period – the game will be published on the Steam platform, the syllabus will be utilised at universities, and the curriculum will be available for youth workers.

The project consortium partnership also contributes to this scalability by embedding the outputs into the regular activities of partner organisations, thereby creating a lasting network of environmentally conscious educators and youth professionals. The CIRCLES project is of considerable significance for education in general, and particularly for the wider context of education within multidimensional academic fields such as political science, economics, sociology, and other disciplines. Its success could become an important example for educational policy in the future. Such policy could be shaped at local, regional, national, and European levels.

The demonstration of how well an integrated, digital-centric, and action-oriented learning model works has the potential to influence future EU funding priorities and educational policies. This framework provides a model for modern education to tackle complex subjects across disciplines, moving away from rote memorisation to encourage critical thinking and practical skills needed to solve real-world problems.

Although the project design is innovative, potential challenges remain. It is difficult to measure long-term behavioural changes and to ensure that a new syllabus is fully integrated into university curricula. The project's success depends on the consistent and active engagement of youth workers and educators, who are the key to connecting the project's intellectual outputs with the target audience. These challenges can be managed but represent important considerations for assessing the project's long-term impact.

The CIRCLES project represents a significant and valuable investment in creating a generation that is more sustainable, informed, and engaged. By teaching young people about the circular economy through innovative and engaging methods, the project demonstrates how environmental education can evolve to meet the needs of the modern world. Combining gamification, structured curricula, and real-life experiential learning provides young people across Europe with opportunities to develop their understanding and skills. The project's creation of durable, accessible educational tools will have a positive long-term impact on communities and support young people's professional development for years to come.

In conclusion, the CIRCLES project stands as an exemplary model for a new, holistic approach to education. It equips young people with the knowledge and skills necessary to create positive change in the future.

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