Review

Impact of Video Games, Gamification and Game-Based Learning on Sustainability Education in Higher Education

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Abstract: Nowadays, the European Union and the governments of the different countries have focused on the development of the Sustainable Development Goals (SDG) and the 2030 agenda, something that has been translated into education itself. Video Games, Gamification, and Game Based Learning have become different strategies and tools to enhance the learning process and some of the growing approaches used by teachers to develop sustainable education in the classrooms. This research aims to analyze the characteristics to promote sustainability in education using games and technology, specifically its learning benefits for Higher Education. A systematic review of the literature was conducted following the PRISMA methodology. At first, 2025 documents were found which, after the filtering phases, the number of articles has been reduced to nine, which subsequently were analyzed in depth. The results indicated that among the benefits of the use of games mediated by technologies are the following: it favors education for sustainability and it promotes the educational inclusion and the work of various social skills such as collaborative and cooperative work. Also, showed an increase of the number of publications between 2019 and 2023, reflecting the growing interest in the topic. However, there are some research gap in this field.

Keywords: Video Games; Gamification; Game Based Learning; Sustainable Development; Sustainability; Higher Education; Undergraduate Students; College Students

1. Introduction

The current reality presents a series of challenges that will be difficult to overcome without global collaboration to promote sustainable development from a future-oriented perspective [1]. The United Nations (UN), through the implementation of the Sustainable Development Goals (SDGs) and the 2030 Agenda for Sustainable Development, seeks to create a more equitable environment that can alleviate the existing difficulties in the world today [1]. This is where education plays a fundamental role and, with the help of available technological resources and appropriate pedagogical strategies, must build an education oriented towards achieving the SDGs in order to achieve a fairer and more equitable world.

As the UN explicitly states in the theoretical development of the SDGs [1], number four shows the greatest linkage with the educational field, as it advocates "ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all." Among the goals set for this objective, some aim to ensure free primary and secondary education for all, to ensure quality education that promotes equity for men and women at all stages, providing equal opportunities. Similarly, the goal is to eliminate disparities in education between men and women; promote literacy for the entire population; and promote the inculcation of sustainability, peace and non-violence, global citizenship, and positive valuing of differences, with a deadline of 2030 for achieving all these goals.

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Society, therefore, is in constant change, and due to this undeniable fact, education is one of the areas facing the greatest challenges, as it is responsible for responding to the needs of learners and also has the capacity to adapt to new realities arising from society's advancement at all levels [2].

On the other hand, gamification and game-based learning have emerged as one of the most current approaches to promoting the development of the population in the proposed values. Especially, video games have emerged as one of the main entertainment options in our society and have also shown to have a high degree of impact on other socio-cultural aspects. This has allowed new forms of player interaction online to emerge, as well as the appearance of new platforms created around video games, such as Twitch, which brings together a plethora of people [3]. For all these reasons, implementing didactic strategies based on gamification or games in education promotes student motivation, making the proposed exercises more attractive to them [4]. This fact is evidenced in other proposals [5] that argue that gamified approaches have the ability to increase student motivation and, therefore, improve their participation and involvement in the proposed activities. Such proposals become an interesting approach for teachers to improve their teaching-learning process and promote active participation and involvement of their students in the classroom.

Despite the similarity of the concepts of gamification and game-based learning and their interchangeable use of terms in the literature [6], game-based learning involves using games and video games as a means to improve learning. However, gamification uses tools and dynamics specific to games in non-playful contexts, although the game itself is not played [7].

In line with this theme, the objective of this article was to collect, synthesize, and integrate information regarding gamification and game-based learning and video games and their relationship with sustainability education and the Sustainable Development Goals in higher education in the European context.

2. Materials and Methods

Given the growth of works interested in this theme and to find the main findings and research gaps related to it, a systematic review was conducted using a systematic mapping approach based on the PRISMA methodology [8]. This allowed for a description, critical review, and synthesis of findings in a reproducible manner for future research [9]. For the review, five mapping questions were proposed to help contextualize the research topic (Table 1) and eight research questions to critically analyze the phenomenon of study in depth (Table 2).

Table 1. Mapping Questions.

MQ1: What are the most prominent authors in this field?
MQ2: What has been the evolution of scientific production over the years?
MQ3: In which countries has research on sustainable education related to gamification, video games, or game-based learning been predominantly published? MQ4: What are the most frequently used channels for publishing research in the field of sustainable education related to gamification, video games, or game-based learning?
MQ5: What are the most commonly used research methods in this field?

Table 2. Research Questions .

RQ1: What research methods are most commonly used in works?
RQ2: What types of practices are most commonly used depending on the educational stage?
RQ3: What SDGs are most developed using these approaches?
RQ4: What benefits do they have in learning?
RQ5: What impact do these practices have on SDGs 4: Ensure inclusive and equitable quality education?
RQ6: What evaluation methods are used to assess the impact of these practices?
RQ7: What limitations do current studies in this field have?
RQ8: What research gaps exist?

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The sample collection was based on the search for keywords extracted from the UNESCO and ERIC thesauri, combined with the Boolean operators shown in Table 3.

Those research studies related to Sustainable Education, Sustainable Development Goals (ODS), Gamification, Video Games, and Game-Based Learning were selected.

Table 3. Keywords used in the search and combinations of Boolean operators used.

(sustainability education or sustainable development goals) AND (gamification OR video games OR game based learning)
(sustainability education or sustainable development goals) AND (gamification OR video games OR game based learning) AND (higher education OR college OR undergrad OR graduate OR postgrad)
(sustainability education or sustainable development goals) AND (gamification OR video games OR game based learning) AND (K-12 OR kindergarten OR primary school OR elementary education OR middle school OR high school)
(sustainability education OR sustainable development goals) AND (gamification OR video games OR game based learning) AND (higher education OR college OR undergrad OR graduate OR post-grad) AND (K-12 OR kindergarten OR primary school OR elementary education OR middle school OR high school)

Six of the most commonly used scientific-educational databases were consulted: Web of Science (WOS), SCOPUS, EBSCO, PubMed, Dialnet, and Taylor & Francis. The search was filtered to cover the years 2019-2023, narrowing the search to the last five years to obtain up-to-date reports.

The references found in the bibliographic search were downloaded in RIS format and stored in the intelligent systematic review virtual system Rayyan, for subsequent filtering according to the PRISMA method. Inclusion and exclusion criteria were established to identify relevant studies (Table 4) and based on these criteria, the most relevant articles on the topic were selected. From here, the process followed three phases: identification, screening, and inclusion [8].

Table 4. Inclusion and exclusion criteria for the studies.

Inclusion Criteria	Exclusion Criteria
CI1: Related to programs or studies applied in higher education.	CE1: Not related to programs or studies applied in higher education.
CI2: Includes the terms gamification, video games, game-based learning (GBL), education for sustainability and/or Sustainable Development Goals in the title, keywords or abstract.	CE2: No includes the terms gamification, video games, game-based learning (GBL), education for sustainability and/or Sustainable Development Goals (SDGs) in the title, keywords or abstract
CI3: It is a primary research article.	CE3: Contextualized in Europe
CI4: It has been published between 2019 and 2023.	CE4: It is not published between 2019 and 2023.
CI5: Written in English or Spanish.	CE5: It is not written in English or Spanish.
CI6: Published in an impact journal.	CE6: It is not published in a high-impact journal
CI7: It is possible to access the full publication.	CE7: "The full publication is not accessible
CI8: Contextualized in Europe.	CE8: It is not contextualized in Europe.

Identification phase:

In the first phase, 2025 articles related to the subject were identified, covering the stages from primary education to university studies. The aim of this initial search was to determine the scope of resources published on the topic. Of these, 1212 were automatically eliminated by the *Rayyan* software because they had metadata with low readability for the program, leaving 813 articles for review.

Screening phase:

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In a second phase, after eliminating duplicate articles (n=112), 701 articles were identified. A screening was performed by reviewing the title, keywords, and abstract and applying inclusion and exclusion criteria. Of this screening, 659 documents were discarded, leaving a group of 42 selected papers for the next phase.

Inclusion phase:

In the third phase, a second screening was carried out using a quality checklist (Table 5). It was based on a checklist [8] of 6 questions with predefined answers and a score associated with each answer (Yes = 1 / Partially = 0.5 / No = 0). A cut-off score of 3 points was established, and studies evaluated with a score below this were discarded from the final review.

Table 5. Quality criteria used in the second screening [8].

Question	**Answer: Yes = 1.0, Partially = 0.5 and No = 0.0.**
1. Are the research objectives clearly specified?	
2. Has the study been designed to achieve these objectives?	
3. Are the prediction/measurement techniques or educational program used clearly described and their selection justified?	
4. Are the data collection methods adequately described?	
5. Have the variables considered in the study been adequately measured?	
6. Has it been published through a peer-review system?	
TOTAL The cutoff score is 3 (minimum score to be accepted).	

After the quality evaluation, 31 articles were excluded, in addition, one of them was removed for being a duplicate (previously not detected by the Rayyan tool) and another one was also eliminated due to lack of access to the full document. This resulted in a final sample of n=9 articles for in-depth review.

Figure 1 shows the screening process carried out in the three phases using the PRISMA method.

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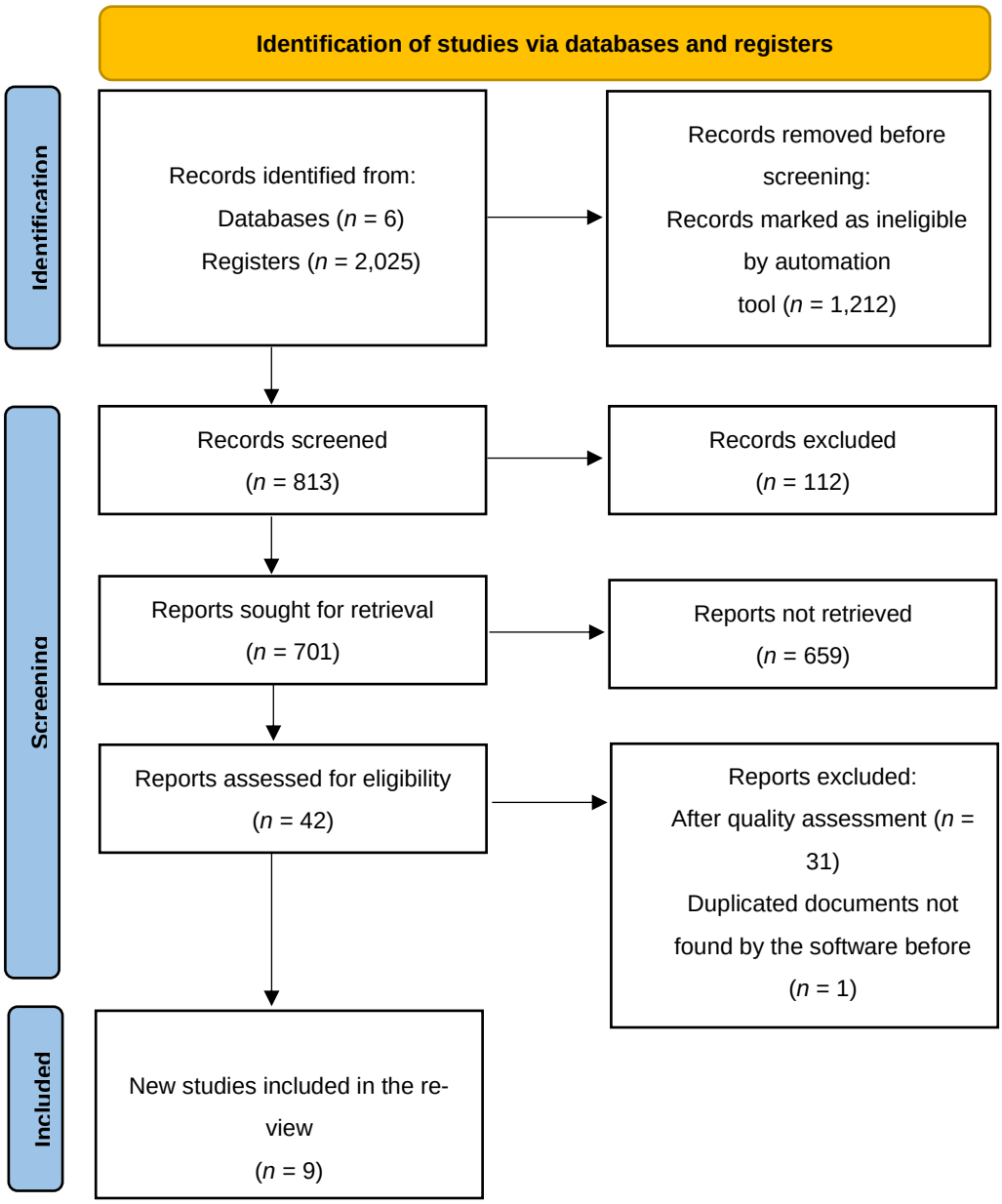
Figure 1. Process carried out based on the PRISMA method [8] [11].



Finally, with the final corpus of articles, a manual review was carried out based on an Excel table systematically organized by columns to extract information from each work considering the mapping and research questions. Regarding data processing, the information was synthesized in order to obtain an updated study of the current state of the field of study and the research gaps detected.

3. Results

The data obtained after reviewing the final sample of primary studies yield the following results.

Description of the final sample:

Regarding the critical appraisal, Table 6 shows the scores obtained by each study to be included in the final sample. The cut-off score was set at 3 points, therefore, all nine evaluated articles have been included. Question number six stands out, showing that all studies were extracted from peer-reviewed resources. As for the rest of the questions, all have obtained scores equal to or above the cut-off score, it is only worth noting that question number three has generated the lowest score, corresponding to the measurement techniques used in the analysed studies and their transparent, replicable and justified description.

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Table 6. Process of quality assessment of selected research documents [10].

QUESTION	ARTICLE Nº (Respuesta: Yes = 1.0, Partially = 0.5 and NO = 0.0.) / Total								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Are the research objectives clearly specified?	0,5	1	1	1	1	0,5	1	1	0,5
2. Did the study design adequately address these objectives?	0,5	1	1	1	1	0,5	1	1	1
3. Were clear prediction/measurement techniques or educational programs described and justified for their selection??	0,5	1	1	0,5	0,5	0,5	1	1	1
4 Are the data collection methods adequately described?	0,5	1	1	1	1	0,5	1	1	1
5. Have the variables considered in the study been adequately measured?	1	1	1	0,5	1	1	1	0,5	1
6. ¿Está publicado mediante un sistema revisión por pares?	1	1	1	1	1	1	1	1	1
TOTAL ARTICLE RATING / OUT OF 6	**4**	**6**	**6**	**5**	**5**	**4**	**6**	**5,5**	**5,5**

Answer to mapping questions:

Table 7 shows the final corpus of selected works, as well as the authors, year, country of publication, and resource. The year is 2022, and Spain is the country where the most research has been developed.

Table 7. Research documents were selected according to the evaluation criteria established for their final study.

N	ARTICLE TITLE	AUTHORS	YEAR	COUNTRY INSTITUTION AUTHORS	RESOURCE
1	Using a Cooperative Educational Game to Promote Pro-Environmental Engagement in Future Teachers. [12]	Vazquez-Vilchez, M; Garrido-Rosales, D; Perez-Fernandez, B; Fernandez-Oliveras, A.	2021	España (Universidad de Granada).	EDUCATION SCIENCES Volume 11, Issue 11.
2	The transforming generation: increasing student awareness about the effects of economic decisions on sustainability. [13]	Sierra, J; Suárez-Collado, A.	2021	España (Universidad de Salamanca).	INTERNATIONAL JOURNAL OF SUSTAINABILITY IN HIGHER EDUCATION

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					Volume 22, Issue 5, pp. 1087-1107.
3	The Moderating Role of Teamwork Engagement and Teambuilding on the Effect of Teamwork Competence as a Predictor of Innovation Behaviors among University Students. [14]	Martin-Hernandez, Pilar; Gil-Lacruz, Marta; Cristina Tesan-Tesan, Ana; Raquel Perez-Nebra, Amalia; Luis Azkue-Beteta, Juan; Luz Rodrigo-Estevan, Maria.	2022	España (universidad de Zaragoza).	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH Volume 19, Issue 19.
4	Active methodologies and knowledge management to promote creativity and innovation in the classroom. [15]	Cecilia Inés Nóbile; Celeste Gauna Domínguez; María Paz Aude Berozonce; Julián Pérez	2022	Argentina (Universidad Nacional de la Plata).	INNOEDUCA-INTERNATIONAL JOURNAL OF TECHNOLOGY AND EDUCATIONAL INNOVATION Volume 7, Issue 1, pp. 61-74.
5	The Microfinance Game: Experiencing the dynamics of financial inclusion in developing contexts. [16]	Sierra, Javier; Rodriguez-Conde, Maria-Jose.	2023	España (Universidad de Salamanca).	INTERNATIONAL JOURNAL OF MANAGEMENT EDUCATION Volume 19, Issue 3.
6	The CHEM Jam - how to integrate a game creation event in curriculum-based engineering education. [17]	Fornós, S; Udeozor, C; Glassey, J; Cermak-Sassenrath, D.	2022	Dinamarca (Universidad de Copenhague) y Reino Unido (Universidad de Newcastle).	EDUCATION FOR CHEMICAL ENGINEERS Volume 40, Issue 0, pp. 8-16.
7	An Evaluation of the Relationship Between Perceptions and Performance of Students in Serious Game. [18]	Chioma Udeozor, Fernando Russo Abegao y Jarka Glassey.	2022	Reino Unido (Newcastle University.	JOURNAL OF EDUCATIONAL COMPUTING RESEARCH Volume 60, Issue 2, pp. 322-351.
8	Implementing Sustainability into Virtual Simulation Games in Business Higher Education. [19]	Gawel, Aleksandra; Strykowski, Sergiusz;	2022	Polonia (Universidad de Economía y Negocios de Poznan.	EDUCATION SCIENCES Volume 12, Issue 9.

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		Madias, Konstantinos.			
9	Lifelong Learning from Sustainable Education: An Analysis with Eye Tracking and Data Mining Techniques. [20]	Sáiz Manzanares, M.C., Rodríguez Díez, J.J., Marticorena Sánchez, R., Zaparaín Yáñez, M.J. & Cerezo Menéndez, R.	2020	España (Facultad de ciencias de la salud, Politécnica superior, Humanidades y Comunicación de Universidad de Burgos y Facultad de Psicología de la Universidad de Oviedo.	SUSTAINABILITY Volume 12, Issue 5.

Regarding the impact of the journals where the articles were published, it should be mentioned that the Journal Citation Indicator (JCI), Journal Impact Factor (JIF), and Journal Citation Report (JCR) were used to verify the scientific impact of the articles, and their values are shown in Table 8.

According to the data collected regarding the category and topic of the journals where the works were published, it can be stated that five articles (55.5%) belong to the category of "Education and Educational Research", two articles belong to the category of "Environmental Sciences" (22.2%), one article to "Education and Scientific Disciplines" (11.1%), and one article to the topic of "Business" (11.1%).

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Table 8. Compilation of journals of the selected articles in the study, their category and/or topic, and their impact values (JCI, JIF, and JCR) are presented in Table 8.

N	RESOURCE	TOPIC	JCI (Journal Citation Index)	JIF (Journal Impact Factor)	Quartil (Q) (JCR 2021)
1	EDUCATION SCIENCES	Education and Educational Research	1,21	-	Q1
2	INTERNATIONAL JOURNAL OF SUSTAINABILITY IN HIGHER EDUCATION	Education and Educational Research.	1,27	4,120	Q1
3	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	environmental Sciences	0,93	4,614	Q2
4	INNOEDUCA-INTERNATIONAL JOURNAL OF TECHNOLOGY AND EDUCATIONAL INNOVATION	Education and Educational Research	0,20	-	Q4
5	INTERNATIONAL JOURNAL OF MANAGEMENT EDUCATION	Business	1,37	4,564	Q3
6	EDUCATION FOR CHEMICAL ENGINEERS	Education, Scientific disciplines	0,95	3,200	Q2
7	JOURNAL OF EDUCATIONAL COMPUTING RESEARCH	Education and Educational Research	2,20	4,345	Q1
8	EDUCATION SCIENCES	Education and Educational Research	1,21	-	Q1
9	SUSTAINABILITY	environmental Sciences	0,65	3,889	Q2

Response to research questions:

Below are the main findings regarding the responses to the research questions posed. Based on the data collected from the sample of articles, the selected documents specifically focus on the university stage contextualized within the European framework.

According to the most commonly used research methods in the selected works (RQ1), Table 9 shows that four research studies were mixed-methods and five were developed using quantitative methods. From a quantitative perspective, the Likert-type questionnaire is the most commonly used tool [12], [13], [14], [15] or [18], but complementary evaluations can also be observed, such as semi-

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open questions [16] and [19], and the analytical scoring of game levels developed in the methodological essay of the research study [17] or records [20].

At the qualitative level, group oral exams, discussions, and debates are preferably used as the optimal methodology for data collection [19].

Regarding the educational practices used (RQ2), Game Based Learning is present in eight of the nine selected articles, and learning based on video games and games based on virtual reality in three articles, as can be seen in Table 9. It should be noted that other teaching methodologies, such as Problem-Based Learning (PBL), Cooperative Learning, and Learning Based on A+A (Learning + Action), are also present in several selected articles.

Table 9. Typology of research methods (RQ1) and educational practices considered (RQ2) in the selected articles.

N	AUTHORS AND YEAR PUBLICATION.	METHOD US IN THE STU (RQ1).	EDUCATIONAL PRAC USED (RQ2).
1	Vazquez-Vilchez, M; Gar Rosales, D; Perez-Fernande Fernandez-Oliveras, A. (2([19]. [12]	Mixed.	Game based learning. Co ative games (board ga Game-based Learning an gagement for Sustainabil
2	Sierra, J; Suárez-Collado (2021). [13]	Mixed.	Video games, Games b learning.
3	Martin-Hernandez, Pilar; Lacruz, Marta; Cristina T Tesan, Ana; Raquel Perez bra, Amalia; Luis Azkue-B Juan; Luz Rodrigo-Estevan, ria. (2022). [14]	Quantitative	Game based learning.
4	Cecilia Inés Nóbile; Ce Gauna Domínguez; María Aude Berozonce; Julián F (2021). [15]	Quantitative	Problem-Based Lea (PBL), Learning Based on (Learning + Action), and ification.
5	Sierra, Javier; Rodriguez-C Maria-Jose. (2023) [16]	Quantitative	Active learning. Game-E Learning through online ulation and real-life case narios.
6	Fornós, S; Udeozor, C; Glass Cermak-Sassenrath, D. (2 [17]	Mixed.	Game-Based Learning. V games. Game Editor Learning (GEL), which customized editor thr which users can create, and play 2D platform levels.

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7	Chioma Udeozor, Fern Russo Abegao y Jarka Gla (2022). [18]	Quantitative	Serious Game y Digital G Based Learning.
8	Gawel, Aleksandra; Stryko Sergiusz; Madias, Konstant (2022) [19] .	Mixed.	Game-Based Learning virtual simulation games rious Games).
9	Sáiz Manzanares, Rodríguez Díez, J.J., Martic Sánchez, R., Zaparaín Y. M.J. & Cerezo Menénde (2020). [20]	Quantitative	Game Based Learning y ous games.

According to the analysis of the selected articles (RQ3), two articles (4 and 7) address the SDGs in a generalized manner (20%), while the remaining seven (80%) specifically mention at least one of them.

Among them, the SDGs most developed in the articles are SDG 4 (Quality Education), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 10 (Reduced Inequalities), SDG 13 (Climate Action), and SDG 15 (Life on Land). These objectives are considering in the teaching and learning methodology of at least three of the ten selected articles (30%). Table 10 shows the different SDGs addressed in the selected articles.

Table 10. Relationship of SDGs addressed in the selected articles.

	ARTICLE								
SUSTAINABLE DEVELOPMENT GOALS (SDGS)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
SDG 1. End of poverty.		x							
SDG 2. Zero Hunger.		x							
SDG 3. Health and well-being.		x			x				
SDG 4. Quality Education.		x			x				x
SDG 5. Gender Equality..		x			x				
SDG 6. Clean Water and Sanitation.		x							
SDG 7. Affordable and Clean Energy.		x			x	x			
SDG 8. Decent Work and Economic Growth.		x	x		x				
SDG 9. Industry, Innovation and Infrastructure.		x			x				
SDGs 10. Reduced Inequalities.		x			x				x
SD 11. Sustainable Cities and Communities.		x							
SDG 12. Responsible Consumption and Production.		x							
SDG 13. Climate Action.	x	x						x	
SDG 14. Life Below Water.									

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SDG 15. Life on Land..	x	x	x
SDG 16. Peace, Justice and Strong Institutions.			
SDG 17. Partnerships for the Goals.		x	

According to the benefits of the SDGs for student learning collected in Table 11 (RQ4) in the selected articles, the importance of active learning through cooperative games and their benefit in raising students' awareness can be seen, as well as their creativity and innovation in addressing various relevant issues and problems related to the Sustainable Development Goals.

In addition, it highlights the cognitive, emotional and behavioural commitment of the participating students, developing key competencies and relevant skills to act critically and responsibly with regard to the SDGs proposed.

Table 11. Relation of learning benefits observed in the selected articles with respect to the Sustainable Development Goals (SDGs).

N	AUTHORS AND YEAR OF PUBLICATION	SDG (RQ3)	BENEFITS FOR LEARNING (RQ4)
1	Vazquez-Vilchez, M; Garrido-Rosales, D; Perez-Fernandez, B; Fernandez-Oliveras, A. (2021) [15]	SDG 13 - Climate Action (related to climate change). Explicitly addresses the need to act to combat climate change, while implicitly working towards SDG 15 - Life on Land, which focuses on protecting and restoring terrestrial ecosystems. Climate change is a set of environmental changes caused by human activities, particularly changes in the functioning of systems, and addressing this issue is crucial for the preservation of ecosystems and the life they support.	The proposed cooperative game fostered in the users a sense of personal responsibility for the environment. It also developed the cognitive, emotional, and behavioral commitment of the players. They developed key competencies as well as skills related to environmental issues. (The students commented that they learned very important things about the Earth and became aware of the danger that our actions pose to our planet through the game in a fun way). The majority of the students (66%) felt that their thinking was stimulated during the game and they were cognitively engaged with the game-based learning. The participants recognized that the game helped them understand the importance of protecting the ecosystems of our planet to save species. They developed a strong emotional, cognitive, and behavioral commitment, where a balance between positive and negative feelings promoted a sense of empowerment. The cognitive engagement that was generated heightened the students' awareness of human activity as an important driver of

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			Global Change (GC). Behavioral commitment was encouraged, as cooperation, a feature of the board game, was recognized as key to mitigating GC, leading to a change in behavior in the participants.
2	Sierra, J; Suárez-Collado, A. (2021) [16]	It focuses on several SDGs related to economic sectors: SDG 3 - Good Health and Well-being, SDGs 4 - Quality Education, SDG 6 - Clean water and sanitation (Clean water and sanitation) and SDG 11 - Sustainable cities and communities (Cities and sustainable communities) Employment linked to SDG 5- Gender equality is closely linked to SDG 8 - Decent work and economic growth - Energy is linked to SDG 7 - Affordable and Clean Energy. - Education is closely linked to SDG 4 - Quality Education. - Poverty and inequality are linked to SDG 1 - No Poverty, SDG 2 - Zero Hunger, SDG 5 - Gender Equality, SDG 10 - Reduced Inequalities, and SDG 13 - Climate Action. - Health is closely linked to SDG 3 - Good health and well-being. - Commerce is linked to SDG 12 - Responsible consumption and production. -I+D+I with the SDGs 9 - Industry, Innovation and Infrastructure, 6 - Clean Water and Sanitation, and 11 - Sustainable Cities and Communities.	Games and simulations are effective educational tools for developing key learning outcomes and increasing student awareness of the potential consequences of economic decisions on society and the environment at three different economic levels: local, national, and international. The implementation of this teaching and learning method demonstrated not only that active learning can increase students' awareness of the potential social and environmental consequences of economic decisions, but also that students perceive games and simulations as useful teaching and learning tools (learning not only invites transforming original ideas into successful projects, but also aligning financial outcomes with social and environmental objectives). The methodology presented in this research allows for improved learning from a multidisciplinary perspective, helping students analyze different economic sectors and their connection to a range of SDGs through the lens of public economics.
3	Martin-Hernandez, Pilar; Gil-Lacruz, Marta; Cristina Tesan-	SDG 8 - Decent work and economic growth.	Contribution to innovation, as well as the development of other key competencies, including teamwork.

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	Tesan, Ana; Raquel Perez-Nebra, Amalia; Luis Azkue-Beteta, Juan; Luz Rodrigo-Estevan, Maria. (2022) [17]		The integration of active teaching and learning methodologies, such as GBL, facilitates the promotion of innovation and the development of healthy teamwork skills among university students, thereby enabling the achievement of the SDG. The competency of teamwork (TWC) has been found to strongly and positively predict innovation work behaviors of individuals (IWB), according to previous studies, primarily conducted among workers in various work environments, including educational ones. The development of proficient teamwork skills among university students promotes the sharing and combination of knowledge and ideas, leading to greater innovation. Educating university students in teamwork competencies and cultivating a commitment to teamwork enhances their capacity for innovation. It is possible to establish more precise curriculum guidelines for training innovative individuals capable of working in teams, thereby contributing to the sustainability of innovation.
4	Nóbile, Cecilia Inés; Celeste Gauna Domínguez, C; Aude Berozonce, M.P., Pérez. J. (2021) [18]	It refers to resolving issues related to the Sustainable Development Goals (SDGs) in general.	Stimulation of creativity and innovation. Knowledge management contributes to innovation and problem-solving. Some of the key mechanisms for socialization are sharing experiences and collaborating together. Activities carried out in the classroom can contribute to knowledge construction. Teaching practices allow for feedback with students and the creation of improvement proposals.
5	Sierra, J; Rodriguez-Conde, M.J. (2023) [19]	They aim to explicitly demonstrate how microfinance could be used to promote financial and social inclusion in relation to several SDGs such as quality education (SDG 4); gender equality (SDG 5); affordable and clean energy (SDG 7); decent work and economic growth (SDG 8); industry, innovation and infrastructure (SDG 9);	Assisting students in better understanding the dynamics and complexities of the microfinance sector.

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		reduced inequalities (SDG 10); life on land (SDG 15); and partnerships for the goals (SDG 17). The simulation, on the other hand, addresses nine SDGs: five of which are addressed by all participants (SDG 1, 2, 8, 10, and 17) and four SDGs by different customer profiles (SDG 3, 5, 9, and 15).	
6	Fornós, S; Udeozor, C; Glassey, J; Cermak-Sassenrath, D. (2022) [20]	Sustainability (SDG 15) and Energy (SDG 7) goals are implicitly addressed in the work.	Game creation activities should be integrated into STEM-based education curricula to enhance the way students learn in higher education. Student-centered activities, such as game creation events, can facilitate an environment in which students experiment and explore to solve a problem (Game creation with an engineering process design course).
7	Udeozor, C., Russo Abegao, F. y Glassey, J. (2022) [21]	All SDGs in general.	Facilitates extrinsic motivation for approaching the proposed learning discipline.
8	Gawel, A., Strykowski, S. Madias, K. (2022) [22]	SDG 13 - Climate Action.	Raise awareness among students that managing a company requires coordinating decisions from various areas within it.
9	Sáiz Manzanares, M.C., Rodríguez Díez, J.J., Marticorena Sánchez, R., Zaparaín Yáñez, M.J. & Cerezo Menéndez, R. (2020) [23]	SDG 4 - Quality Education and SDG 10 - Reduced Inequalities.	Facilitates the detection of at-risk students and individual learning needs. Educational Data Mining for studying supervised (prediction) and unsupervised (clustering) learning facilitates the detection of individual and group learning patterns.

The impact of Gamification, Video Games, and Game-Based Learning on SDG 4 - Quality Education and SDG 10 - Reduced Inequalities (RQ5) is evident in the sample of articles. The results allow us to discern the importance of these SDGs during the teaching and learning process in the European educational context.

Table 12 shows that, according to the report results, active student participation through multidisciplinary cooperative games, as well as the development of equality and competitiveness, allows for better assimilation and internalization of knowledge. It also develops practical and creative skills acquisition, promoting performance, critical thinking, and innovation in the educational context.

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Table 12. Impact of Gamification, Video Games, and Game Based Learning on SDG 4 in terms of Inclusive, Equitable and Quality Education according to the selected articles.

n	AUTHOR AND DATE PUBLICATION	IMPACT OF GAMIFICATION, VIDEOGAMES AND/OR GAME BASED-LEARNING IN SDG 4
1	Vazquez-Vilchez, M; Garrido-Rosales, D; Perez-Fernandez, B; Fernandez-Oliveras, A. (2021) [15]	The participation of future primary school teachers in sustainable communities improved. This approach can be useful for others considering opportunities for cooperative game-based learning and teaching. Game-based learning can be used as a tool to improve knowledge about Global Change and promote pro-environmental engagement while reinforcing the capacity for Education for Sustainability (EfS) in future primary school teachers.
2	Sierra, J; Suárez-Collado, A. (2021) [16]	This has social and environmental effects of economic decisions. These active learning methodologies help to improve learning from a multidisciplinary perspective, allowing for the analysis of different economic sectors and their connection to a range of SDGs through the lens of public economics.
3	Martin-Hernandez, P., Gil-Lacruz, M., Tesan-Tesan, A.C, Perez-Nebra, A.R., Azkue-Beteta, J.L., Rodrigo-Estevan, M.L. (2022) [17]	Development of regions and nations, as well as competitiveness and organizational success. Higher Education (HE) is expected to prepare innovative and competent individuals for teamwork.
4	Nóbile, C.I., Gauna Domínguez, C., Aude Berozonce, M.P. y Pérez, J. (2021) [18]	It promotes equality among learners. Creative classes promote student learning, allowing them to progress and grow in innovation for their current or future job market.
5	Sierra, J; Rodriguez-Conde, M.J. (2023) [19]	Helping students better understand complex and multidimensional concepts such as poverty, inequality, and financial and social inclusion in a developing context.
6	Fornós, S; Udeozor, C; Glassey, J; Cermak-Sassenrath, D. (2022) [20]	Addressing future sustainability and energy issues.
7	Udeozor, C., Russo Abegao, F. y Glassey, J. (2022) [21]	Helps to integrate students. Students' perceptions of Game-Based Learning (GBL) have a significant impact on performance and educational effectiveness
8	Gawel, A., Strykowski, S. Madias, K. (2022) [22]	The anthropogenic nature of changes in climate and the natural environment requires a shift in the way society thinks and acts, especially in the business context, which calls for the implementation of sustainability in business higher education.
9	Sáiz Manzanares, M.C., Rodríguez Díez, J.J., Marticorena	Detecting learning needs leads to better distribution of learning resources. This detection is essential in the field of sustainable education, as the adjustment and accuracy of educational

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	Sánchez, R., Zaparaín Yáñez, M.J. & Cerezo Menéndez, R. (2020) [23]	resources leads to a better distribution of resources and the achievement of effective learning resulting from increased motivation and autonomy of students, all of which leads to more continuous and sustainable personalized learning.

Regarding the evaluation methods used to assess the results of the selected articles (RQ6), these are presented in Table 13. The most commonly used are questionnaires of various types; pre-test and post-test application, self-assessment or group control and experimental. Other types of evaluations were also seen depending on the nature of the study, such as oral tests, analysis of game experience results, or observation, although the latter to a lesser extent.

Table 13. The evaluation methods employed in the selected articles (RQ6).

n	AUTHORS AND DATE PUBLICATION	EVALUATION METHODS (RQ6)
1	Vazquez-Vilchez, M; Garrido-Rosales, D; Perez-Fernandez, B; Fernandez-Oliveras, A. (2021) [15]	Questionnaires.
2	Sierra, J; Suárez-Collado, A. (2021) [16]	Two surveys were conducted before and after the three simulations, comparing the students' responses to measure the extent to which their perceptions changed as a result of the educational experiment.
3	Martin-Hernandez, P., Gil-Lacruz, M., Tesan-Tesan, A.C, Perez-Nebra, A.R., Azkue-Beteta, J.L., Rodrigo-Estevan, M.L. (2022) [17]	Questionnaires (self-assessed by the students themselves).
4	Nóbile, C.I., Gauna Domínguez, C., Aude Berozonce, M.P. y Pérez, J. (2021) [18]	Likert scale questionnaires were conducted, consisting of 13 items.
5	Sierra, J; Rodriguez-Conde, M.J. (2023) [19]	Questionnaires were administered at the beginning and end of the program, consisting of semi-open opinion questions, as well as a 7-item Likert scale questionnaire to measure the level of agreement among students.
6	Fornós, S; Udeozor, C; Glassey, J; Cermak-Sassenrath, D. (2022) [20]	Through the teacher's objective understanding and through oral tests. Student-centered activities can be integrated into curriculum-based education if the evaluation of the activity is aligned with the learning objectives. Measuring understanding through the perspective of the worlds created during the experience, i.e., the game levels.
7	Udeozor, C., Russo Abegao, F. y Glassey, J. (2022) [21]	Method 1: Control group and experimental group through an online questionnaire consisting of 31 items (evaluation of experiences and perceptions).

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		Method 2: At a practical level, 3 weeks of gameplay are allowed to complete 25 levels, collecting information through another 31-item questionnaire (identical to that of Method 1).
8	Gawel, A., Strykowski, S. Madias, K. (2022) [22]	Results from simulation gameplay and through analysis of information in discussions (throughout the semester and at the end with an evaluative presentation).
9	Sáiz Manzanares, M.C., Rodríguez Díez, J.J., Marticorena Sánchez, R., Zaparaín Yáñez, M.J. & Cerezo Menéndez, R. (2020) [23]	Questionnaires for sociodemographic variables. Physical trait calibration test for the eye tracking session/Evaluation of the session by two experts: a psychologist expert in the field and a computer engineer, both with experience in the functioning of eye tracking.

Finally, the limitations of each study (RQ7) and research gaps (RQ8) are presented in Table 14. Regarding limitations, it should be noted that in some of the analyzed programs, game-based learning activities were complex for students and this may affect learning outcomes.

Additionally, in most cases, a single data collection method was used, either at a single time point or with a small sample size. On the other hand, regarding research gaps, there is a need to expand research methods and data collection. It is also important to detail studies in a comprehensive manner so that they can be replicated by the scientific community. Finally, the nature or complexity of some game-based learning activities may cause students' perceptions of their learning outcomes to differ from those of the same didactic approach without using games. In this regard, it would be necessary to expand studies from a pedagogical perspective.

Table 14. Limitations and research gaps of the studies.

n	AUTHORS AND YEAR OF PUBLICATION	LIMITATIONS OF THE STUDY (RQ7)	RESEARCH GAPS (RQ8)
1	Vazquez-Vilchez, M; Garrido-Rosales, D; Perez-Fernandez, B; Fernandez-Oliveras, A. (2021) [15]	The study is a small-scale one conducted over a short period of time (a long-term experiment to collect follow-up data and assess the impact of behavior changes and exposure to board games on learning would be useful).	There is no section that clearly specifies the objectives of the study.
2	Sierra, J; Suárez-Collado, A. (2021) [16]	It is difficult to "isolate" the complexity of the three simulations to establish their potential effect on the results. The computer game *SimCity* may require less mental effort, as players can better manage the duration of the simulation and do not have to address all possible scenarios of the game. On the other hand, the two board games may be more	The real world is much more complex than what can be recreated in a classroom activity using games and simulations.

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		demanding, as they require students to be aware of their classmates' strategies and also involve some mathematical calculations.	
3	Martin-Hernandez, P., Gil-Lacruz, M., Tesan-Tesan, A.C, Perez-Nebra, A.R., Azkue-Beteta, J.L., Rodrigo-Estevan, M.L. (2022) [17]	Cross-sectional study: the results obtained do not allow establishing causal relationships. A single source of data was used with only one data collection method: a self-evaluation survey. Non-longitudinal perspective.	The research could use more sources and methods for data collection (observation, peer ratings, etc.).
4	Nóbile, C.I., Gauna Domínguez, C., Aude Berozonce, M.P. y Pérez, J. (2021) [18]	The information is collected at a single point in time and compared with other subjects that do not follow the same teaching practice. They do not explain why they discard certain questionnaires or the software used for analyzing the collected results.	There are certain difficulties to replicate the study because it does not explain in detail the teaching and learning methods followed.
5	Sierra, J; Rodriguez-Conde, M.J. (2023) [19]	The sample size is relatively small. The study provides useful qualitative and quantitative information, but it is limited, on the effectiveness of the methodology. The simulation was implemented in a relatively short session of about two and a half hours, due to the students' tight schedule at the end of the semester. It is possible that it only gave an initial idea of how the microfinance sector works.	The organization and structure of the article could be improved for better connection between some of its sections. There were restrictions on interaction due to the COVID-19 pandemic.
6	Fornós, S; Udeozor, C; Glassey, J; Cermak-Sassenrath, D. (2022) [20]	The information is collected at a single time point and from a relatively small sample (49 students). The activity (CHEM Jam) was included with little advance notice. Common errors in the application that affected the playability of the video game editor.	The event could not be held again because the application later, in 2022, had availability issues.

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7	Udeozor, C., Russo Abegao, F. y Glassey, J. (2022) [21]	Difficulty in generalizing to other grades due to the specificity of the game used.	Self-reported perceptions that may not reflect the actual viewpoints of the students.
8	Gawel, A., Strykowski, S. Madias, K. (2022) [22]	The students' results were limited with respect to their prior knowledge. Further research requires deeper qualitative and quantitative analysis to understand sustainability aspects in businesses using simulators. The perspective is perceived from only one university.	Limited methodology regarding the stated objectives.
9	Sáiz Manzanares, M.C., Rodríguez Díez, J.J., Marticorena Sánchez, R., Zaparaín Yáñez, M.J. & Cerezo Menéndez, R. (2020) [23]	There may be hidden variables that could be influencing the results. Small sample: working with this methodology is laborious and involves a micro-analysis structure, which complicates the use of large sample sizes.	More studies are needed to analyze this methodology and these results in different learning environments. Discrimination techniques are needed to lead to greater accuracy in the behavior studies explored in this study.

4. Discussion

This section summarizes the research and identifies gaps in the field. The purpose of this study was to review the implications that game-based and technology-mediated learning can have on sustainable education. Scientific evidence from the last five years was analyzed to understand the current situation and future trends of this phenomenon. Next, the results are discussed, considering previous studies and the research questions.

Firstly, the first research question aims to answer what methods are implemented for data collection. It should be noted that the quasi-experimental design followed by time-series designs and randomized experimental design have been the most evidenced methods in the literature review. In certain studies, single-group experiments were used and applied to subsequent time-series design to measure learning gains of a group of students after the game and technology intervention.

Regarding the second research question, on what types of practices are used for using game-based learning for sustainable education in university students, two pieces of evidence described programs that used gamification strategies. Findings on the benefits of using video games were also found in two documents, and the use of serious games was found in three pieces of evidence. The rest described didactic situations related to the use of games in a generalized way.

As for the third research question on the development of sustainable education, it is worth noting that previous studies show the benefits of using game-based and technology-mediated methodologies. These include students' awareness of the consequences of economic decisions on society and the environment [13] or understanding the importance of protecting ecosystems. In addition, students' perception of game-based strategies is positive, seeing it as a useful component for learning. Other studies [12] showed that students were cognitively engaged in game-based learning.

In line with the fourth research question of this study, regarding the benefits obtained through the use of Game-Based Learning mediated by technology in university students, it was found that the purpose of using these strategies and their benefits covered various areas:

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- Helps in understanding the content: One aspect that is worth noting in the use of game-based and technology-mediated methodology is the promotion of understanding of subjects. Several studies show how the use of technology-mediated games in the context of higher education has the main benefit of helping students better understand the content of the subjects [16].
- On the other hand, others argue that it also helps to develop extrinsic motivation towards the discipline [15].
- Promoting inclusive education: another study [20] showed that among the benefits of using game-based methodology along with technology is the facilitation of identifying at-risk students and their individual learning needs. However, it is important to note that this research is focused on areas other than inclusion, so there may be disparity in results among the studies consulted.
- • Development of social skills: with regard to the impact of game-based learning, this educational approach has great usefulness in the development of key competencies, such as teamwork, and in other areas such as creativity and innovation [14].
- It was also found that it improves the interaction between the academic and work world [22]. Others affirm that its use fostered cognitive, emotional, and behavioral engagement of the players [12]. In this sense, they also highlight the importance of student engagement in providing positive experiences, as well as spaces for participating in informal conversations that also help develop digital literacy skills [25].

Continuing with the order of questions, the fifth question to be addressed was the impact that these educational practices have on SDG4 - Ensure inclusive and equitable quality education. The reviewed scientific literature does not make explicit reference to the development of this goal, although some of the objectives of various studies [13] indicate that it allows for improving learning from a multidisciplinary perspective.

According to the sixth research question about the evaluation methods used to assess the impact of the reviewed programs, the predominant instruments were questionnaires, both pre-test and post-test, as well as control and experimental group questionnaires. Observation and documentary review were also used in two of the reviewed articles. It is important to note that many studies involving questionnaires on educational innovation activities focus on satisfaction levels, often ignoring the impact on learning.

The limitations of the study are addressed in response to the seventh research question. After several tests, the search strategy is considered adequate, using terms based on education thesauri. However, the topic does not seem to be widely addressed in the literature currently, and the scant results regarding SDG4 or the benefits for learning in higher education stand out.

Finally, several future research lines have been identified in response to the eighth research question. It would be necessary to apply the search to other educational stages to compare the results of the studied phenomenon and its benefits in learning at different ages. In addition, other lines of research could broaden their intervention from a pedagogical perspective to educational inclusion, including different groups and people with diverse abilities in didactic programs and scientific evaluations. On the other hand, more randomized experiments with a reasonable sample size of participants would be needed to make more reliable statements in this regard, as well as transparent and replicable methods.

5. Conclusions

The results of over 800 documents found related to Video Games, Gamification, and Game-Based Learning confirm the growing interest in this topic in educational technology research. A large number of these studies described experiences that integrate games in didactic contexts mediated by technology. However, only nine documents were found that addressed these methodologies in conjunction with Education for Sustainability in Higher Education. This highlights the research gap that currently exists in this field.

The distribution of articles by year of publication showed an increase in the number of publications between 2019 and 2023, reflecting the growing interest in the topic. The results show that the benefits of using game-based technologies in education include promoting education for sustainability, including the work of SDG 4 - Quality Education -; fostering educational inclusion, and promoting various social skills such as collaborative and cooperative work.

Most of the analysed documents described and evaluated a game or educational experience, and some conducted empirical studies to assess their effectiveness for learning.

To conclude this work, it should be noted that in order to maintain progress in the use of digital game-based learning for teaching sustainable education in the university context, more studies should be conducted on its effectiveness in different stages and with different groups. Implementing these methodological strategies in the classroom requires knowledge of game design and creation, a set of skills that many educators may not necessarily have. Therefore, more reviews focused on pedagogical approaches, underlying learning theories, and game design principles and themes related to education for sustainability would be needed. This would help to expand different ways of implementing it in the classroom and to provide pedagogical training to teachers.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Figure S1: title; Table S1: title; Video S1: title.

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