Exploring the Intersection of Game-Based Learning and Sustainable Education in Engineering: A Bibliometric Analysis

Luiz Eduardo Uzeda[1], **Marcus Parreiras**[1], **Geraldo Xexéo**[1]

[1] LUDES - Programa de Engenharia de Sistemas e Computação
COPPE - Universidade Federal do Rio de Janeiro
Avenida Horácio Macedo, 2030, CT, Bloco H, sala 319, Rio de Janeiro, RJ - Brasil

{mparreiras,xexeo}@cos.ufrj.br

{luizeduardo.uzeda}@pep.ufrj.br

Abstract. *This study conducts a bibliometric analysis on the use of Sustainable Game-Based Learning in Higher Education in Engineering. Research reveals growing interest in this field, with a progressive increase in publications over the years. It also determined the journals that publish the most frequently on the topic and the most frequently used keywords. Our findings indicate that the intersection of games, sustainability, and education is being explored as an effective pedagogical strategy in higher education in Engineering.*
Keywords. *Bibliometric Analysis, Educational Games, ESG+P, Sustainability*

1. Introduction

The United Nations (UN) launched the 2030 Agenda, consisting of 17 Sustainable Development Goals (SDGs) [Mundo 2016]. Higher education plays a crucial role in preparing citizens to face present and future challenges, aligning with the SDGs [De La Torre et al. 2022] and SDG 4 on education [Didham 2018].

Sutili and Raineri (2022) [Sutili and Raineri 2022] emphasize the need to foster interdisciplinarity in Engineering education. Traditional teaching methods often result in an individualistic learning approach, with teachers possessing more knowledge than students. To address this, educators must go beyond technical knowledge and cultivate competencies required for collaboration across diverse fields.

Lectures alone are no longer sufficient, and active methodologies are preferred. Game-Based Learning is one such strategy, known for its ability to motivate and engage students [Xexéo and Taucei 2021]. Notable authors supporting this approach include Prensky (2001), Gee (2007), and McGonigal (2011) [Prensky 2001, Gee 2007, McGonigal 2011].

To deepen our understanding of Game-Based Learning and Serious Games in Sustainability within higher education Engineering, we conducted a bibliometric analysis using Scopus and Web of Science databases [Roemer and Borchardt 2015]. Our study aims to explore the historical evolution, research trends, productive countries and institutions, as well as the most cited works in this area.

Moreover, our study seeks to answer the following questions through a bibliometric analysis related to the topic.

1. Have publications on the topic increased or decreased over the years?
2. What are the main journals that publish on the topic?
3. What keywords are most frequently used to address the topic?
4. What are the top five cited works from both databases?

2. Theoretical Framework

2.1. Active Learning Methodology

Sutili and Raineri (2022, p.5) state that the concepts of active learning methodology "revolve around principles of engagement, self-management of learning, participation, autonomy, and reflection." Many other authors seek to define what active learning methodology is, some of the definitions can be found in Table 1

Table 1. Some definitions of active learning methodology

Authors	Definition of Active Learning Methodology
[Berbel 2011, p. 9]	"Active methodologies are based on ways to develop the learning process, using real or simulated experiences, aiming at the conditions to successfully solve issues arising from the essential activities of social practice, in different contexts."
[Prince 2004, p. 223]	"The central elements of active learning are the activity of the student and their involvement in the learning process. Active learning is often contrasted with the traditional lecture where students passively receive information from the instructor."
[Morán 2015, p. 18]	"The closer we learn to life, the better. Active methodologies are starting points to advance to more advanced processes of reflection, cognitive interaction, generalization, and re-elaboration of new practices."

Sutili and Raineri (2022) also argue that there are some active learning methodologies that are more suitable for higher education, specifically in the field of Engineering. These methodologies not only aim to provide students with technical knowledge, which is predominantly disseminated through traditional pedagogical practices, but also provide students with an ethical, analytical, and reflective education.

2.2. Game-Based Learning, Gamification, and Serious or Educational Games

According to Parreño et al. (2016), the term Game-Based Learning is often referred to as Gamification or Serious Games in the literature, as these terms are highly synonymous. Braghirolli (2014) shows that different authors use different nomenclatures for the same concept: Digital Learning Game, Edutainment Games, Persuasive Games, Epistemic Games, Instructional Games, Educational Games, among others. Xexéo and Taucei (2021) also highlight the difference between educational games and gamification in education and mention other nomenclatures for educational games with specific purposes, such as newsgames, business games, and corporate games.

Given the confusion surrounding these terms, it is at least necessary to distinguish what Game-Based Learning, Gamification, and Serious or Educational Games mean, at least in this article. This study will address these nomenclatures.

Xexéo and Taucei (2021) assert that serious games cannot be treated as entertainment games, as their basic premise is not entertainment, but rather transmission of

content, regardless of its nature. Furthermore, players are usually not playing voluntarily, but rather under obligation. Serious games are "artifacts that use the artistic media of games to convey a message, teach a lesson, or provide an experience" . The authors also classify educational games according to their intended objectives, such as motivation for the learning process, knowledge transmission, knowledge retention, knowledge assessment, skill practice through more or less realistic simulations, and knowledge creation through analysis processes.

Alves (2013) also proposes a classification of serious games based on their purpose, including the following categories: Advergames (games promoting a brand, product, organization, or viewpoint), Edutainment (entertainment games with an educational focus), Game-Based Learning (games that combine playful and didactic components), Newsgames (games addressing current events and occurrences), Training and Simulation Games (games that simulate real activities seeking accuracy), Persuasive Games (games that use persuasion for behavior change), Organizational-Dynamic (games promoting personal development), Games for Health (games based on the health field), Art Games (games that use art as the main factor), and Militainment (military games aiming for precision).

Overall, educational games are tools that motivate and engage students, improving the effectiveness of teaching and content absorption, considering the need to change the way teachers operate and how knowledge is acquired[Al-Azawi et al. 2016].

Both Game Based Learning and Gamification methodologies are employed because they can engage and motivate students through the fun of gaming, the ability to fail and try different approaches, the ability to track progress, among other aspects. The use of GBL and Gamification is considered much more motivating than traditional teaching methods, stimulating students to solve problems in a more enjoyable and effective manner, while promoting their critical thinking [Plass et al. 2015, Al-Azawi et al. 2016, Martí-Parreño et al. 2016, Krath et al. 2021].

We can argue that the major difference between the terms is that Gamification is the use of game elements in learning but does not need to use games, while GBL actually must use games, serious or not, in a learning context.

3. Methodology

A bibliometric analysis was conducted on the topic of Sustainable GBL using the Scopus and Web of Science databases.

To do so, it was necessary to define the filters and limits to be used. Given the various terminologies associated with the topic, the first step of the investigation was to identify, through literature review, the most commonly used terms. The second step was to structure the search filters in Scopus and Web of Science to address the four research questions.

The filters used in this research were a combination of words and expressions, as shown in Table 2. To improve precision, all combinations included exclusionary terms: `AND NOT - "High School" OR K-12"`, as the goal was to focus only on content used in universities and graduate programs.

Table 2. Terms used in search

Terms for Game Types	Terms for Games	Terms for Higher Education	Terms for Sustainability	Terms for Active Methodology
Educational	Game	Higher Education	Sustainable	Gamification
Edutainment	"Videogame"	Undergraduate	Sustainability	Game-Based Learning
Instructional	Video game	Graduate	ESG	GBL
Persuasive	"Boardgame"	Doctor	Green	"Game-Based Learning"
Serious	Board game	College		
Learning	Digital Game	MBA		
Advergames	Mobile Game	Master		
Newsgames				
Militainment				

To answer the fourth question guiding this study, after a historical analysis and examination of the main keywords used in the databases separately, it was time to perform a third combination of search terms. Therefore, it was necessary to conduct the searches again in the selected databases, combining all search terms. Thus, the new results are based on the following Combination #3. The combinations were formed using:

1. Terms for Game Types AND Terms for Games AND Terms for Higher Education AND Terms for Sustainability AND NOT Exclusionary Terms
2. Terms for Active Methodology AND Terms for Higher Education AND Terms for Sustainability AND NOT Exclusionary Terms.
3. Terms for Types of Games AND Terms for Games AND Terms for Higher Education AND Terms for Sustainability AND Terms for Active Methodology AND NOT Exclusionary Terms.

All searches were conducted on May 18th and 19th, 2023. For the analysis of the first combination of search terms, the most frequently used keywords were evaluated using the VOSViewer visualization tool [Van Eck and Waltman 2010]. Another analysis of the first combination involved removing duplicates based on document titles, in order to determine the actual number of unique documents found in both databases. The areas that published the most, according to each database, were also examined for both combinations.

4. Results

4.1. Sustainable Game-Based Learning and Active Methodology

Using the first combination without the terms for higher education and exclusionary terms, we found 2027 documents in Scopus and 1446 in Web of Science for verification purposes only. After including the terms for higher education (see all terms in Table 2), the numbers decreased to 174 documents in Scopus and 273 in Web of Science. Finally, after adding the exclusionary terms and completing the entire first combination, we obtained a total of 376 documents, with 165 in Scopus and 211 in Web of Science. The historical evolution of these documents is presented in Figure 1.

As shown in Figure 1, the topic of Sustainable Game-Based Learning is relatively recent, with the first publication found in 2004. Over the years, there has been a positive progression of publications, with the year 2021 being the most productive, with 66 published documents (35 in Scopus and 31 in Web of Science) (note that 2023 has not ended yet).

In Scopus, there were 165 documents analyzed, and the top 5 journals with the most publications were "Sustainability Switzerland" (16), "Proceedings of the European

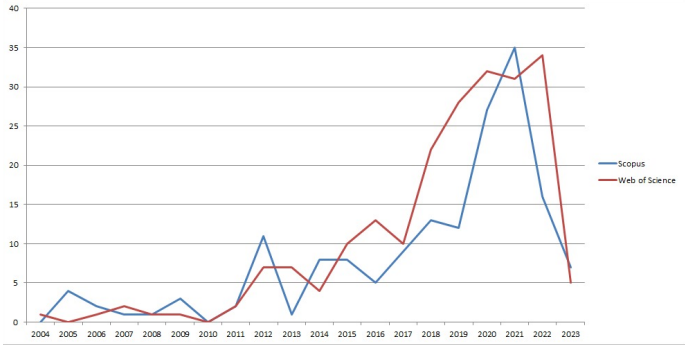

Figure 1. Historical evolution of documents on Sustainable Game-Based Learning.

Conference on Games Based Learning" (8), "Advances in Intelligent Systems and Computing" (7), "18th Americas Conference on Information Systems 2012 Amcis 2012" (6), and "International Journal of Sustainability in Higher Education" (5). The documents fell into 7 different types, including articles (67), conference papers (49), review articles (26), book chapters (14), early access (5), books (3), and editorial materials (1).

In Web of Science, there were 211 documents analyzed, and the top 5 journals with the most publications were "Sustainability" (31), "Edulearn Proceedings" (9), "Journal of Cleaner Production" (8), and "Inted Proceeding," "International Journal of Management Education," and "International Journal of Sustainability in Higher Education" (6 each). The documents fell into 5 different types, including articles (134), conference papers (68), review articles (9), early access (2), and editorial materials (1).

The top 10 most used keywords in Scopus included higher education, education, sustainable development, students, sustainability, teaching, serious games, gamification, game-based learning, and e-learning. In Web of Science, the top 10 keywords included education, higher education and gamification, sustainability, serious games, games, management, game-based learning, and sustainable development and game.

As shown in 2, the topic of Sustainable Active Metodology (referring to combination 2) is relatively recent, with the first publication found in 2004. Over the years, there has been a positive progression of publications, with the year 2021 being the most productive, with 54 published documents (29 in Scopus and 25 in Web of Science) (note that 2023 has not ended yet)

In the analysis of Sustainable Active Methodology in Higher Education, there were 116 documents in Scopus and 169 documents in Web of Science. The top 5 journals with the most publications in Scopus were "Sustainability Switzerland" (32), "Advances in Intelligent Systems and Computing" (9), "Proceedings of the European Conference on Games Based Learning" (8), "18th Americas Conference on Information Systems 2012 Amcis 2012" (6), and "International Journal of Sustainability in Higher Education" and "World Sustainability Series" (3 each). In Web of Science, the top 5 journals were "Sustainability" (32), "Edulearn Proceedings" (9), "Education Sciences," "Iceri Proceedings," "International Journal of Environmental Research and Public Health," and "Proceedings of the European Conference on Game Based Learning" (5 each).

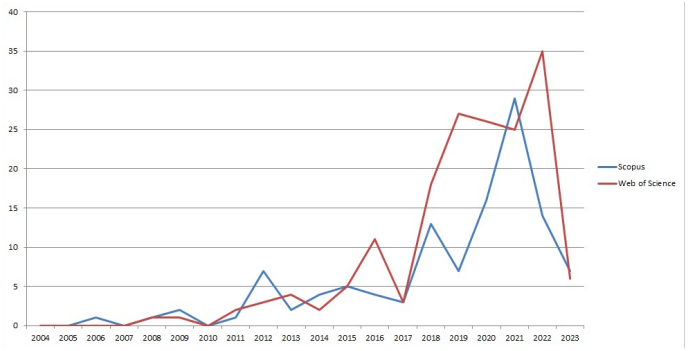

Figure 2. Historical evolution of documents on Sustainable Game-Based Learning.

The top 10 most used keywords in Scopus for Sustainable Active Methodology in Higher Education included higher education, students, gamification, game-based learning and teaching, sustainable development, education, sustainability, e-learning, and learning. In Web of Science, the top 10 keywords included gamification, higher education, education, sustainability, motivation, serious games, engagement, game-based learning, games, and design. A total of 245 documents of 7 different types were found in both databases.

4.2. Areas of Publication

Figure 3 reveals that in Scopus, the areas that were published the most were Social Sciences, Computer Science, and Engineering. Areas with less than 5 publications were not considered in the graph.

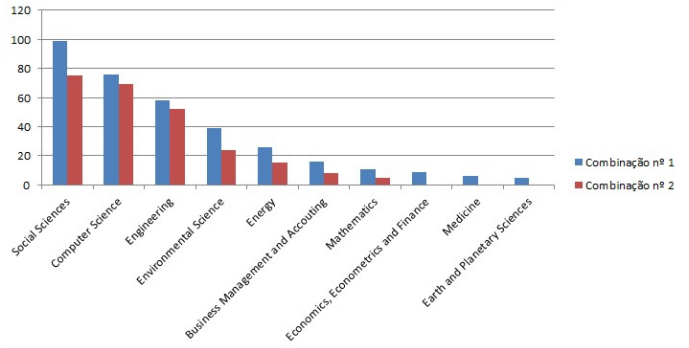

Figure 3. Areas of publication in Scopus.

Figure 4 reveals that in Web of Science, the areas that published the most were Education and Educational Research, Environmental Sciences and Ecology, and Science and Technology Other Topics. Areas with less than 5 publications were not considered in the graph.

4.3. Most cited works analisis

In both databases, searches were performed using terms in the titles, keywords, and abstract fields. We found 109 documents in Scopus and 166 on the Web of Science. The next step was to remove duplicates by analyzing the titles, resulting in 231 documents. However, the aim of this research is to examine only documents that are of the article

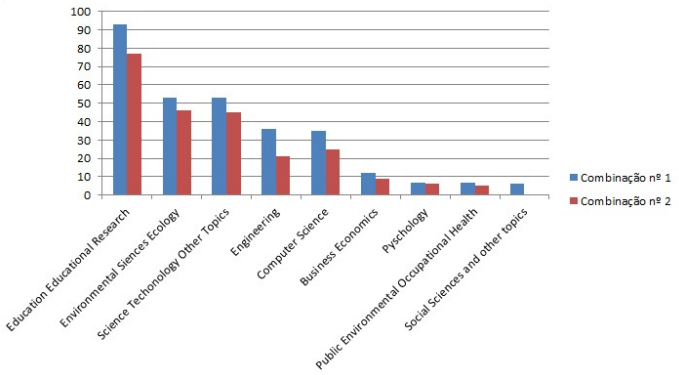

Figure 4. Areas of publication in Web of Science.

type, which includes Journals and Conferences. Thus, we found 73 documents in Scopus and 161 in the Web of Science. However, duplicates need to be removed again, resulting in a total of 193 documents.

Afterward, only documents considered in the field of engineering by the databases themselves were examined, resulting in 29 documents in Scopus and 22 in the Web of Science. After removing duplicates, we finally arrived at a total of 48 documents (Figure 5). From here, we can identify the top cited documents from both Scopus and Web of Science, which are:

1. Didatic Strategies to promote competencies in Sustainability [Tejedor et al. 2019] (Sustainability - 82 citations) - This study emphasizes the importance of integrating sustainability values into higher education. It discusses five active learning strategies (service learning, problem-based learning, project-oriented learning, simulation games, and case studies) that can be used to enhance sustainability education. The paper provides a systematic approach for implementing these strategies and offers valuable guidelines for teachers;
2. Education for Sustainable development through business simuation games: An exploratory study of sustainability gamification and its effects on students learning outcomes [Gatti et al. 2019] (Journal of Clearner Production - 71 citations) - This study explores the effects of using business simulation games as a teaching approach for sustainability in tertiary education. The results suggest that simulation and gaming can effectively enhance students' cognitive and affective learning outcomes, particularly in developing critical thinking skills. Motivation plays a central role in influencing students' learning outcomes in sustainability;
3. Towards an Education for the Circular Economy (ECE): Five Teaching Principles and a Case Study [Kirchherr and Piscicelli 2019] (Resources, Conservation and Recycing - 61 citations) - Five Teaching Principles and a Case Study: This paper focuses on an undergraduate course designed to introduce students to the concept of the Circular Economy (CE). The course utilized constructive alignment, problem-based learning, interactivity, non-dogmatism, and reciprocity as teaching principles. The study highlights the effectiveness of active learning strategies, such as service learning, problem-based learning, and simulation games, in promoting sustainability competencies among students;

4. All they do is win: Lessons learned from use of a serious game for Circular Economy Education [Whalen et al. 2018] (Resources, Conservation and Recycing - 53 citations) - Lessons learned from use of a serious game for Circular Economy education: This study explores the use of the serious game "In the Loop" for educating about the Circular Economy (CE). The findings indicate that the game encourages holistic thinking and reflection on material criticality. Students recognized the importance of adopting CE concepts to address resource challenges and understood the relevance of their own actions. The study suggests that serious games like "In the Loop" can facilitate systems thinking and have broader applicability beyond engineering education;
5. Gamification in MOOCs: Engagement Application Test in Energy Sustainability Courses [Romero-Rodriguez et al. 2019] (IEEE ACCESS - 40 citations) - Engagement Application Test in Energy Sustainability Courses: This study investigates the impact of gamification strategies in MOOCs focused on energy sustainability. The findings indicate that incorporating gamification strategies leads to higher completion rates and increased student engagement. The study suggests that interactive gamification elements are effective in generating interest and motivation among students.

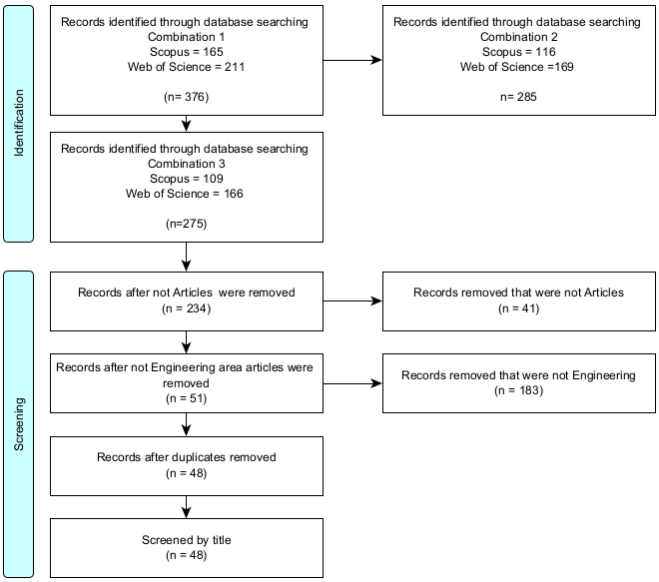

Figure 5. Engineering area documents records

The first five works cited were selected based on the classification of the database in which we conducted our research. Although not all of them are strictly related to engineering, our intention was to cover a representative sample of works considered relevant to the field, as determined by the database. This allowed us to explore a variety of perspectives and contributions within the field, even if some work is not exclusively engineering-oriented but still has relevance to our study. The five studies analyzed have a significant relationship with the field of engineering, as they all address educational strategies aimed at sustainability. They highlight the importance of integrating sustainability concepts into engineering programs, preparing future engineers to consider environmental and social aspects in their designs. Educational strategies range from the use of simulation games

and gamification to the application of specific teaching principles such as problem-based learning. These studies confirm that engineering plays a key role in creating sustainable solutions, and therefore, engineering education must incorporate innovative methods to promote awareness and develop skills to address global sustainability challenges.

The convergence among these articles lies in their shared focus on sustainability and their exploration of various educational approaches to enhance sustainability education. They all recognize the importance of student engagement and motivation in achieving learning outcomes and emphasize the need for assessment and evaluation of these approaches

However, there are also points of divergence among the articles. They each have specific topics and contexts, such as competencies in sustainability, education for the Circular Economy, or energy sustainability, and they are conducted in different educational settings, including higher education, engineering education, and MOOCs. Additionally, while they share an interest in active learning, problem-based learning, and simulation games, they employ different strategies and tools, such as service learning, case studies, a serious game called "In the Loop," and gamification in MOOCs. Furthermore, the disciplinary perspectives vary among the studies, which can lead to differences in approaches and methodologies used.

5. Conclusions

Based on the bibliometric analysis conducted on the use of Sustainable Game-Based Learning in Higher Education in Engineering, the following conclusions can be drawn.

Our first research question was “Have publications on the topic increased or decreased over the years?”. Indeed, we found out that the topic of sustainable game-based learning is a recent field of study, with a progressive increase in publications over the years. This indicates a growing interest and recognition of the importance of this approach in higher education in Engineering.

Regarding the second research question, “What are the main journals that publish on the topic?”, we found out that the top journals that publish on the topic include Sustainability Switzerland, Proceedings of the European Conference on Games Based Learning, Advances in Intelligent Systems and Computing, Journal of Cleaner Production, International Journal of Sustainability in Higher Education, among others. This suggests that these journals are important for keeping up with the latest research and developments in this area.

The third research question was “What keywords are most frequently used to address the topic?”. We found out that the most frequently used keywords in the documents include Higher Education, Education, Sustainable Development, Students, Sustainability, Gamification, Game-Based Learning, among others. This highlights the key themes and concepts addressed in the context of sustainable game-based learning in higher education in Engineering.

Concluding the fourth guiding question of this research: Firstly, all the studies emphasized the importance of sustainability and its integration into education. They aimed to promote competencies in sustainability, educate students about that. Secondly, the studies recognized the value of active learning methodologies in engaging students and

enhancing their learning outcomes. They explored approaches such as problem-based learning, project-oriented learning, simulation games, and case studies to facilitate experiential and participatory learning. Furthermore, the studies highlighted the positive impact of gamification and serious games on student motivation and engagement. They found that incorporating gamification elements and using serious games in sustainability education led to higher completion rates, increased student engagement, and improved learning outcomes. While there were these points of convergence, there were also areas of divergence among the studies. These divergences primarily stemmed from the specific topics, contexts, disciplinary perspectives, and educational strategies employed in each study. It is possible to identify that there is a valuable exploration of different approaches to education in sustainability. The cited documents highlight the shared goals of promoting sustainability and engaging students, as well as the various strategies used to achieve these goals. Findings from these studies can inform educators and policy makers in creating effective sustainability education initiatives and increasing student engagement in pursuing a more sustainable future, i.e., encouraging the use of active methodologies, such as the use of Educational games in sustainable engineering learning.

These conclusions indicate that the use of sustainable game-based learning in higher education in Engineering is gaining increasing attention and being explored as an effective pedagogical strategy. The intersection between games, sustainability, and education offers opportunities to promote student engagement, skill development, and critical thinking regarding complex challenges and issues of today.

There is criticism of databases regarding the classification of documents. We know that the area of Engineering is very broad and complex, but we believe that the inadequate classification of articles not strictly related to engineering raises concerns for future searches, creating difficulties for future researchers who want to immerse themselves in the topic. We believe that it is essential to improve the database in terms of its classification methods and ensure that the documents included are strictly aligned with the field of engineering, thus creating an alert for future work related to the topic of this research.

However, it is important to note that this bibliometric analysis is just a starting point, and there are many other areas to be explored within the topic of sustainable game-based learning in higher education in Engineering. Future research can investigate these issues, examine different methodological approaches, investigate the impact of game-based learning on student learning outcomes, and explore effective implementation strategies.

As a bibliometric analysis, this study has some limitations, but it is also a tool to provide insights on how to conduct research on Game-Based Learning and Sustainable Education in Engineering, which is a current focus of our research. We now expect to conduct a more extensive study on the acquired data, including expanding the questions on the bibliometric aspects, such as citation analysis, but also a Systematic Review on different aspects of those games.

References

Al-Azawi, R., Al-Faliti, F., and Al-Blushi, M. (2016). Educational gamification vs. game based learning: Comparative study. *International journal of innovation, management and technology*, 7(4):132–136.

Alves, E. (2013). Jogos sérios para ensino de engenharia de software. Master's thesis, Faculdade de Engenharia de Universidade do Porto.

Berbel, N. A. N. (2011). As metodologias ativas e a promoção da autonomia de estudantes. *Semina: Ciências Sociais e Humanas*, 32(1):25.

Braghirolli, L. F. (2014). *Aprendizagem por jogo computacional na engenharia de produção*. PhD thesis, Programa de Pós-Graduação em Engenharia de Produção da Universidade Federal do Rio Grande do Sul.

De La Torre, E. M., Perez-Encinas, A., and Gomez-Mediavilla, G. (2022). Fostering sustainability through mobility knowledge, skills, and attitudes. *Sustainability*, 14(3):1349.

Didham, R. (2018). Education for sustainable development and the sdgs: Learning to act, learning to achieve. *Policy brief; Advancing ESD policy, UNESCO global action program on education for sustainable development*.

Gatti, L., Ulrich, M., and Seele, P. (2019). Education for sustainable development through business simulation games: An exploratory study of sustainability gamification and its effects on students' learning outcomes. *Journal of cleaner production*, 207:667–678.

Gee, J. P. (2007). *What Video Games Have to Teach Us About Learning and Literacy. Second Edition: Revised and Updated Edition*. St. Martin's Griffin, 2 edition.

Kirchherr, J. and Piscicelli, L. (2019). Towards an education for the circular economy (ece): five teaching principles and a case study. *Resources, Conservation and Recycling*, 150:104406.

Krath, J., Schürmann, L., and Von Korflesch, H. F. (2021). Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. *Computers in Human Behavior*, 125:106963.

Martí-Parreño, J., Méndez-Ibáñez, E., and Alonso-Arroyo, A. (2016). The use of gamification in education: a bibliometric and text mining analysis. *Journal of computer assisted learning*, 32(6):663–676.

McGonigal, J. (2011). *Reality Is Broken: Why Games Make Us Better and How They Can Change the World*. Penguin.

Morán, J. (2015). Mudando a educação com metodologias ativas. *Coleção mídias contemporâneas. Convergências midiáticas, educação e cidadania: aproximações jovens*, 2(1):15–33.

Mundo, T. N. (2016). a agenda 2030 para o desenvolvimento sustentável. *Recuperado em*, 15:24.

Plass, J. L., Homer, B. D., and Kinzer, C. K. (2015). Foundations of game-based learning. *Educational psychologist*, 50(4):258–283.

Prensky, M. (2001). *The Digital Game-Based Learning Revolution*, chapter 1. McGraw-Hill.

Prince, M. (2004). Does active learning work? a review of the research. *Journal of engineering education*, 93(3):223–231.

Roemer, R. C. and Borchardt, R. (2015). *Meaningful Metrics: A 21st-Century Librariant's Guide to Bibliometrics, Altmetrics and Research Impact*. Association of College and Research Libraries, Chicago, Illinois.

Romero-Rodriguez, L. M., Ramirez-Montoya, M. S., and González, J. R. V. (2019). Gamification in moocs: Engagement application test in energy sustainability courses. *IEEE Access*, 7:32093–32101.

Sutili, F. K. and Raineri, I. A. D. (2022). Metodologias ativas na formação do engenheiro do século xxi: desafios e reflexões. *Olhar de Professor*, 25:1–23.

Tejedor, G., Segalàs, J., Barrón, Á., Fernández-Morilla, M., Fuertes, M. T., Ruiz-Morales, J., Gutiérrez, I., García-González, E., Aramburuzabala, P., and Hernández, À. (2019). Didactic strategies to promote competencies in sustainability. *Sustainability*, 11(7):2086.

Van Eck, N. and Waltman, L. (2010). Software survey: Vosviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2):523–538.

Whalen, K. A., Berlin, C., Ekberg, J., Barletta, I., and Hammersberg, P. (2018). all they do is win: Lessons learned from use of a serious game for circular economy education. *Resources, Conservation and Recycling*, 135:335–345.

Xexéo, G. and Taucei, B. (2021). ENDO-GDC: Projetando jogos educacionais. In *Minicursos da ERSI-RJ 2021 - VII Escola Regional de Sistemas de Informação do Rio de Janeiro*, pages 154–203. SBC.