Online game-based learning on climate change: innovation in the internationalization of higher education

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Abstract. Education for Sustainable Development (ESD) is essential for achieving SDG’s goals, including goal 13: take urgent action to combat climate change and its impact. Game-based learning is a promising cutting-edge innovation in learning methods. Nevertheless, the internationalization of higher education demanding more technology utilization to enable transnational classes. This study provides a SWOT analysis of the online game-based learning (OGBL) method on climate change issues. Based on the PRISMA guidelines, this study concludes that OGBL has more strengths and opportunities than weaknesses and threats. Strength factors namely flexible, engaging, and enhance the learning process. Opportunities such as emerging academic community and events, developing new professions, and abundance of the development areas. However, game development is complex as a weakness. The varieties of technology savviness levels among facilitators and users and the digital divide are threats to OGBL.

1. Introduction
In the face of increasingly volatile, uncertain, complex, and ambiguous (VUCA) world conditions, countries in the world through the United Nations have made a joint agreement in determining the vision of world development in the future. On September 25, 2015, world leaders set the Sustainable Development Goals (SDGs) under the theme “Changing Our World: The 2030 Agenda for Sustainable Development” [1]. To achieve the goals of the SDGs, people cannot rely solely on the government through its programs as the holder of executive power. Education also needs to participate in realizing the SDGs through education to the community, which is commonly called Education for Sustainable Development (ESD) [2].

Recently, more and more disasters have come from natural imbalances such as storms, floods, landslides, and the COVID-19 pandemic [3,4]. SDG number 13 seeks to increase the adaptability and mitigation of countries in the world from natural disasters by “taking urgent action to fight climate change and its impact” [5]. ESD plays an important role in raising awareness and understanding of climate change issues and the efforts that everyone can take to address them. Unfortunately, there are still many obstacles in ESD learning, especially at the higher education level. One of the most common problems is the boring learning process [6].

Game-based learning is a promising breakthrough to overcome these problems [7]. Embedded gamification in the learning process can increase student engagement [8]. Nevertheless, in the era of internationalization of higher education, game-based learning needs to be strengthened by the use of
information and communication technology. Internationalization requires universities to be able to develop their institutions in providing services, one of which is by utilizing information technology in the form of online classes [9]. An online class can be attended by students from various countries and can be carried out synchronously or asynchronously. In short, the learning process should be done anywhere and anytime.

One solution to this problem is the development of an online game-based learning (OGBL) method. This is similar to serious gaming [10], but this game is done in online media. This is something new and for its development, it is necessary to further investigate the strengths, weaknesses, opportunities, and threats of OGBL. Therefore, this study aims to analyze the strengths, weaknesses, opportunities, and threats of the use of OGBL in ESD related to the climate change issue.

2. Methods

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method was employed in this study [11]. First of all, the researchers obtained all articles in the SCOPUS database with the keywords “climate,” “game,” and “education.” Of the 246 articles obtained, the researchers conducted the first stage of screening using the following criteria: (1) articles in a journal or conference proceedings, (2) articles published between 2017 – 2021, (3) articles categorized as open access. From the screening process, 46 articles were obtained. Furthermore, the researchers conducted a second stage of screening using the words “digital” or “online,” obtaining 25 articles. The next stage conducted was testing eligibility by looking at whether "online game" and "climate change" become the main discussion in the results and discussion section. Thus, the researchers got 8 articles as the main reference material for this study. In the next step, the researchers analyzed strengths, weaknesses, opportunities, and threats (SWOT) [12] on OGBL related to the issue of climate change based on source articles.

![Figure 1. PRISMA procedure of this study](image)

3. Result and discussion

3.1. Source article description

Of the 8 selected articles, the average citation was 4.5 times. The most popular authors are Ouriachi et al. with a total of 3 articles, 21 times cited. There has been no research with pure qualitative methods. This shows that the opportunity for the development of the OGBL study area in the climate change issue is still very wide open.
Table 1. List of studies included in qualitative synthesis.

| No | Title                                                                 | Authors                  | Research Method | Year | Cited |
|----|-----------------------------------------------------------------------|--------------------------|-----------------|------|-------|
| 1  | Evaluation of online games for teaching and learning on climate change | Ouariachi et al. [13]   | Mix Method      | 2017 | 10    |
| 2  | A framework for climate change engagement through video games         | Ouariachi et al. [14]   | Qualitative     | 2019 | 10    |
| 3  | Current climate for digital game-based learning of science in further and higher education | Brown et al. [15] | Qualitative | 2018 | 6     |
| 4  | Serious gaming for climate adaptation—assessing the potential and challenges of a digital serious game for urban climate adaptation | Neset et al. [10] | Mix Method | 2020 | 5     |
| 5  | Teaching climate change science to high school students using computer games in an intermedia narrative | Smith et al. [16] | Mix Method      | 2019 | 3     |
| 6  | Analysis of online climate change games: Exploring opportunities      | Ouariachi et al. [17]   | Qualitative     | 2017 | 1     |
| 7  | Playing with complex systems? The potential to gain geographical system competence through digital gaming | Lux and Budke [18] | Mix Method     | 2020 | 1     |
| 8  | Games on climate change: Identifying development potentials through advanced classification and game characteristics mapping | Gerber et al. [19] | Qualitative     | 2021 | 0     |

3.2. SWOT analysis

3.2.1. Strengths. OGBL is very flexible in terms of game objectives, target audience, game modes, and game media. The objectives of OGBL vary, from just entertainment, increasing awareness, learning, or creating a direct impact on climate change issues [19]. The game is intended for both the general public, students, and professionals [19]. The game can be played as single player [10,13,16–19], multiple player [10,13,18,19], or massive multiple player online game (MMOG) [19]. Multiple player games can be played collaboratively or competitively [19]. The game can be run synchronously or asynchronously [10,16,18]. Commonly, the game is in the form of a simulation that is both exploratory and creative [17]. The media used can be in the form of mobile phones and personal computers [15,19].

OGBL is more engaging than learning through texts, both emotionally, cognitively, and behaviorally [14]. The game is run interactively and relates to real life, thus making the game fun and interesting for the audience [16]. Interaction is carried out by providing feedback and rewards for what players do in the game [13,15,17]. The game provides time pressure and skills challenges [17], the experience of discovering new things [13], and the dynamics of decision-making throughout the game [17]. A clear narrative like the real world or a wild fictional imagination [19], the sensation of various senses used in the game [14], and adequate personalization [15,17] gives players personalized emotions or commonly called immersion [17], a feeling that as if the player is in the game. Thus, with engaging learning, audiences are motivated to learn more about climate change [10].

OGBL improves the learning process and provides an understanding to the audience on the issue of climate change more clearly through clear visualization, simulation, active learning, and adequate detailed narratives [13,15,16]. This can increase the audiences' faith in the existence of climate change issues [16]. They become more aware of the complexity of making climate change policies in the real world, how the existing issues are interconnected, how to determine the aspects that must be considered in policymaking [10,17,18], both adaptation and mitigation policies [19]. Audiences are given the experience of feeling a dilemma in making decisions and determining the aspects to be considered, where every policy there must be a party who benefits and there is a disadvantage [10,18]. The aspects that commonly need to be considered are visualized in the game in the form of parameters such as the
amount of money, the number of residents, the quality of the environment, and others depending on the complexity of the game [18]. Time pressure is also a very relevant simulation for decision-making related to climate change because, in the real world, people are racing against time to address the issue of climate change [17]. The game also presents various alternative solutions such as individual actions, private organizations, public institutions, or technology enhancement [19]. Various key sectors are used as the focus of the game such as the energy sector, water service, transportation, tourism, financial service, or health [19]. The game level system can vary from global, regional, country, city, community, household, to individual levels [19]. The complexity of the game trains the system thinking and system competence of the audience [18], besides basic competencies such as analysis, evaluation, problem-solving, decision making, reasoning, and memorizing [10,13,17,18].

OGBL’s flexibility in solving space and time issues in learning is following the results of Carrión-Martínez (2020) literature study. The majority of the use of ICT in learning is in the form of mobile learning (36.84%) and e-learning (15.79%), this allows the learning process to be carried out anywhere and anytime [20]. Furthermore, although not yet popular, learning methods using ICT have been shown to increase student motivation and participation, enhance learning experiences, and encourage the learning of new skills [20,21]. This supports the statement of Hartt et al. (2020) that game-based learning is preferred and more attractive to students than the traditional learning process [22].

3.2.2. Weaknesses. Creating OGBL is not as easy as making traditional learning materials in the classroom. Climate change itself is a combination of various disciplines [16]. Sometimes, because there are so many interconnected issues in a game, it makes players confused in understanding the game [13]. Furthermore, there is not a lot of advanced education that is specifically involved in the field of game making, hampering the development of OGBL to become a mainstream learning media [15]. There is no standard from an official scientific institution that can be used as a reference regarding game content quality standards [13].

Developing OGBL is not something simple. It requires cross-sectoral collaboration and at the same time creates new career opportunities. This supports the study of Linderoth & Sjöblom (2019) which states that at least it takes two people who understand pedagogical content knowledge and knowledge about game development to create a learning game [23]. Without these two specialists, a game cannot be optimal to be used as a learning instrument.

3.2.3. Opportunities. Although not many have developed OGBL, especially related to climate change, the attention of the scientific community to this OGBL opportunity to become a more effective and efficient learning media shows an increasing trend [15]. Peer-reviewed journals specializing in game-based learning have also started to exist, such as the Journal of Computer Games Technology, International Journal of Game-Based Learning, or International Journal of Mobile Learning and Organization [15]. Moreover, there are also events such as conferences and competitions at the regional, national, and international levels as an incubation medium for practitioners and scientists in the field of game-based learning [15].

The process of making OGBL which is not simple and involves various areas of study provides opportunities for the development of new professions such as game designers and game developers [15]. Experts in education and environmental fields related to climate change cannot build an OGBL on their own without people with game design and game development expertise, and vice versa. The game industry is also starting to become a financially promising industry. Thus, there are funding institutions that are willing to finance the development of games for education such as the National Science Foundation-USA, UK Games Fund, or the Bill Gates Foundation [15].

Besides career opportunities, OGBL also has a very wide area of development because it has not yet become a mainstream learning method [19]. In terms of media, educational mobile games have not been developed much compared to the educational web-based game. In terms of the target audience, there are already many games targeting students and the general public but still rarely targeting professionals. In terms of the level of the game’s social system, not many provide individual and household levels. Most
of the game system levels are global or country level. In terms of objectives, the majority are for cognitive and affective learning, but there are still few games that aim to provide a direct impact on the issue of climate change. Games that present fictional storylines that are far from reality are still fewer than those that present simplification of reality, even though fictional games can provide an opportunity for the audience to practice thinking more objectively in finding solutions without being influenced by assumptions obtained from the real world [19].

3.2.4. Threat. The implementation of OGBL also faces challenges. One of the common challenges in implementing technology is the digital divide. Not all of these games are played by users with certain disabilities [13]. There need to be special adjustments to enable people with disabilities to play the game as well.

The digital divide in the use of OGBL does not only occur to people with disabilities for this study found that it might also occur to older adults [24] who are less proficient in using technology, people in remote areas without internet connectivity [25], or even the ability of the educators who do not know the use of technology sophisticatedly [26]. It is no exaggeration to state that the digital divide is an inherent risk in the use of technology.

4. Conclusion
From the results of the SWOT analysis as previously explained, OGBL is very promising to be an effective and efficient ESD learning method, especially learning related to climate change issues. OGBL is very much in line with the spirit of internationalization of higher education where learning must be carried out anytime, anywhere, and by anyone. The potential benefits obtained from OGBL are numerous, and the development opportunities are wide, but indeed there are still some shortcomings and challenges that need to be resolved and anticipated. Contributions from various parties, especially educational practitioners and scientists are needed to involve game media in the learning process. Thus, the development of OGBL in the future can be faster and can provide wider benefits in various fields of science.

References
[1] International NGO Forum on Indonesian Development 2021 Apa itu SDGs infid.org
[2] Latchem C 2018 Education for sustainable development SpringerBriefs Open Distance Educ. 155–65
[3] Ritchie H and Roser M 2014 Natural Disasters - Our World in Data https://ourworldindata.org/natural-disasters
[4] Cardil A and de-Miguel S 2020 Saf. Sci. 130 104861
[5] UNDP 2018 United Nations Development Programme: Sustainable development goals (New York: UNDP)
[6] Edwards D B J, Sustarsic M, Chiba M, McCormick M, Goo M and Perriton S 2020 Achieving and monitoring education for sustainable development and global citizenship: A systematic review of the literature Sustainability 12 1383
[7] Legaki N Z, Karpouzis K, Assimakopoulos V and Hamari J 2021 Technol. Forecast. Soc. Change 167 120725
[8] Donath L, Mircea G and Rozman T 2020 Eur. J. Sustain. Dev. 9 1–19
[9] Barbas M P, Morze N, Widla H, Esteban P G, Guncaga J, Hruby M, Bogdanova D, Yakovleva O and Smyrnova-Trybulska E 2021 ICTE J. 10 13–31
[10] Neset T S, Andersson L, Uhrqvist O and Navarra C 2020 Sustain. 12 1789
[11] Page M J et al. 2021 BMJ 372 71
[12] Puyt R W, Lie F B, de Graaf F J and Wilderom C P M 2020 Academy of Management Proceedings 2020 132
[13] Ouariachi T, Lobo M D O and Pérez J G 2017 Ensen. las Ciencias 35 193–214
[14] Ouariachi T, Lobo M D O, Pérez J G and Maibach E 2019 Environmental Education Research
25 701–16
[15] Brown C L, Comunale M A, Wigdahl B and Hartmann S U 2018 FEMS Microbiology Letters 365 fny237
[16] Smith G G, Besalti M, Nation M, Feldman A and Laux K 2019 Eurasia J. Math. Sci. Technol. Educ. 15 em1698
[17] Peralta T O, Lobo M D O and Pérez J G 2017 Revista Electronica Investigacion Educativa 19 101–14
[18] Lux J D and Budke A 2020 Education Sciences 10 130
[19] Gerber A, Ulrich M, Wäger F X, Puigròs M R, Gonçalves J S V and Wäger P 2021 Sustain. 13 1997
[20] Carrión-Martínez J J, Luque-de la Rosa A, Fernández-Cerero J and Montenegro-Rueda M 2020 Sustain. 12 3288
[21] Sousa M J and Rocha Á 2017 Game based learning contexts for soft skills development Advances in Intelligent Systems and Computing vol 2 ed Rocha A et al (Cham: Springer International Publishing) pp 931–40
[22] Hartt M, Hosseini H and Mostafapour M 2020 Planning Practice Research 35 589–604
[23] Linderoth J and Sjöblom B 2019 Simulation and Gaming 50 771–88
[24] Blažič B J and Blažič A J 2020 Educ. Inf. Technol. 25 259–79
[25] Hillier M 2018 Distance Educ. 39 110–21
[26] Kormos E and Wisdom K 2021 Theory and Practice in Rural Education 11 25–39