# Learning by Co-Designing Environmental (In)Justice Games

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**Abstract:** This paper describes undergraduate students' learning after researching environmental topics and co-creating and disseminating environmental justice games to fulfill their course and university service-learning requirements. Post-play reflections revealed motivation toward improvement in providing a game format that audiences would find engaging while learning about the seriousness of the environmental topic. Further, evidence of students' critical thinking, reflecting on the lack of environmental justice was noted. Students remarked that disseminating information by "spreading the word" is a key to raising awareness about environmental injustices. Essays also revealed students' intrigue with the game's co-creation process and enjoyed playing games with others. These findings may benefit researchers and educators interested in game creation as critical pedagogy.

**Keywords:** environmental justice education, co-creating games, critical pedagogy, constructionism, active learning

## 1. Introduction

Who is responsible for ocean cleanliness? What is the relationship between the location of hazardous waste sites and host communities' racial/socioeconomic composition? What is the environmental toll of uncontrolled wildfires? Who or what suffers for that 2-carat engagement ring? Which world nations constitutionally protect their environment? Why does a dichotomy of oppressors and oppressed exist in society? What laws protect the environment? How do we solve environmental problems? This study employed game-making as a learning strategy within the framework of critical pedagogy.

Critical pedagogy aims to raise learners' critical consciousness and awareness of their sociopolitical surroundings and fight against the status quo, with the intent of transformation both in the classroom and the larger society (Norton & Toohey, 2004). The study's process included researching, co-creating, testing, and disseminating/leading a game. First, in teams, students researched an environmental topic and delivered an oral presentation in a university environment. Students then co-created and tested their games in a university setting with the goal of improvement based on peer feedback. Finally, gameplay ensued at an approved public organization to educate about the environmental issue. Given that there is less research on materials development in critical pedagogy (e.g., Crookes, 2009; Norton & Toohey, 2004), this study presents one curricular option to immerse participants in game-making and reflection on learning so that they might assume active roles in, as Freire (1970) suggests, "transforming the world."

## 2. Literature Review

Game-based learning as a broad category has made significant strides over the past ten years, emerging as a powerful instructional strategy. Several empirical studies evaluating the impact of game use in varied disciplines show positive outcomes in student motivation and learning effectiveness (e.g., Papastergiou, 2009; Virvou, et al., 2005; Wouters et al., 2013). However, game development, or the *game creation process*, has received less attention compared to learning from game play (Engstrom, 2020; Weitze, 2021). Lack of interest in the game creation process may be associated with a trend in the literature of ignoring the author and focusing on the text and the readers' interpretations (Engstrom, 2020). Nevertheless, numerous researchers and scholars indicate that student learning through creating educational games is an emerging learning strategy showing promise (Earp, 2015; Kafai & Burke, 2015; Kuhmonen et al., 2019; Weitze, 2021). For example, one study at the post-secondary level revealed more satisfaction in learning course content through game design compared to more traditional methods. Further, the ability to discuss topics and network with peers during game co-creation was noted as a plus (Kuhmonen et al., 2019).

The current study employed a few conceptual frameworks that support educational game design as a learning strategy. The first conceptual framework is critical pedagogy, designed to encourage students to critique structures of power and oppression and encourage their participation toward solutions (Freire, 1970). In critical pedagogy, a teacher encourages students to question and challenge societal inequalities. Critical pedagogy discourse helps to demystify democratic authority or power and encourage a transformative discourse focused on equality (Freire, 1970). In his most celebrated tome, *Pedagogy of the Oppressed*, Freire (1970) argues against

traditional education's "banking" model in favor of a dialogic and problem-posing/problem-solving education. He objects to the traditional education frame in which students are "empty vessels" filled by the teacher (p. 79). Instead, he argues, education is to help students learn to think for themselves, solve problems, and participate in forming a more just society. However, emphasis must be on the processes involved in learning. Within the critical pedagogy framework, reflection on action is employed. Students reflect on their assumptions, beliefs, and understandings of the topics investigated. Kolb (1984) suggests that evaluating one's progress toward understanding is reflection, allowing the individual learner to form abstract concepts from their experience to guide active experimentation and inform future learning experiences.

Another framework employed in this study is constructionism. Papert's constructionism focuses on the art of learning and the significance of making things while learning (2008). Constructionism focuses on how learners engage in a conversation and social negation with their own or other people's artifacts and how these conversations boost self-directed learning and ultimately facilitate the construction of new knowledge. This learning theory stresses the importance of tools and media toward human development. It focuses on the processes through which individuals come to make sense of their experiences, gradually optimizing their interactions with the world (Papert, 2008).

Within the constructionist framework, an active learning pedagogical approach was employed. Active learning strategies and collaboration are student-centered in focus (Jonassen as cited in Maddux, Johnson, & Willis, 2001). Such types of instructional strategies serve as mental bridges for learning. As defined by Meyers and Jones (1993), student-centered active learning strategies provide opportunities for students to talk and listen, read, write, and reflect as they approach content in collaborative groups where students apply what they are learning.

The collaborative creation ("co-creation") process, where a team produces something that previously did not exist, is another active learning strategy employed to stimulate reflection. Sanders & Stappers (2008) explain, "The evolution in design research from a user-centered approach to co-designing is changing the roles of the designer, the researcher, and the person formerly known as the user" (p. 1). In this study, students worked with team members to co-create games. Co-creation engaged students in reflection through their consideration, reconsideration, and negotiation with the processes involved in developing their game for an intended audience. "Co-creation is more than a 21st-century phenomenon, utilizing which innovative solutions are being provided. The co-creation movement is a journey in the organizational transformation to the next paradigm of value creation – one that can lead to new growth and sources of competitive advantage" (Ramaswamy, 2009, p. 17). In addition, active participation in co-creation experiences can help prepare students for their future employment.

The game assignment under study consisted of activities in which students created and reflected on in their written and oral contributions of ideas and solutions toward envisioning the future and humankind's responsibility in helping to shape it. Activities involved student investigation of how they can contribute to a more compassionate and just world for humankind and the Earth itself; and promote just, healthy, and sustainable ways of living on our planet. In addition, embedded in the course is university required service-learning. Service-learning has emerged as a central component connecting disciplinary learning and general education to the public purpose (Felten & Clayton, 2011). Quality service-learning experiences offer students the opportunity to apply their knowledge and skills through an authentic experience. Moreover, well-designed service-learning experiences can facilitate the significant transformation of student perspectives and practices (Clayton & Ash, 2004). This transformation occurs when learners shift their frame of reference or belief system by critically reflecting on their assumptions, beliefs, and understandings of the world.

This study investigates if learning by designing and leading a game could foster reflections about environmental justice problems. Would the opportunities provided evoke students' awareness of humankind's responsibility in helping to shape the future? Does game creation have the power to move students toward contributing to a more compassionate and just world for humankind and the Earth itself?

## 3. Materials

Materials employed include discussions and activities about the purpose and mission of the United Nations and the Universal Declaration of Human Rights (UDHR), along with a comparative analysis of national constitutions

that have a concern for the environment. Another source was the United Nations 2030 Sustainable Development Goals, which sets an ambitious action plan for the U.N., its member states, and civil society. The games discussed in this article are specific to United Nations 2030 Sustainable Development Goals 6, 10, 12, 14, and 15 that address the environment (United Nations Department of Economic and Social Affairs, 2015). In addition, the class played the board game *(Go Goals!),* developed by the United Nations (2017). This game teaches players about the 2030 Sustainable Development Goals and stands as a model for participants when developing their own games.

## 4. Method

This study uses a qualitative content analysis with a convenience sample to examine the development of awareness of environmental injustices through the lens of a co-created tabletop game. Content analysis is well suited for analyzing and summarizing exploratory research data (Babbie, 2007).

## 5. Participants

In a general education course at a private university in the mid-Atlantic region (USA), undergraduate honors students (n=19) researched a specific environmental justice issue, co-developed a game, game tested with peers, and led game play with the general public. Participants included 16 females and three males, ages 19-21, of varied majors (e.g., nursing, finance, accounting, English, graphic design) and ethnicities. None of the participants had any prior experience with game development however, one student is planning a career as a graphic designer.

## 6. Instruments

This study employs two modes of inquiry. Mode one is the collaboratively developed game and components. The second mode of inquiry is the reflective essays. The essay was based on the writing prompt, "*Please document your thoughts about the environmental topic; your main learning takeaways, and your thoughts about the co-creation game development process and game dissemination at the community organization*."

## 7. Procedures

Environmental topics were explored for three weeks via assigned readings and videos, class discussion, small group activities, tabletop games, and independent reflective writing responses. Sample environmental topics discussed were the effects of microplastics, mining, carbon emissions, pesticides, deforestation, and ocean pollution on the environment.

Working in teams of 4-5, participants researched and presented on an environmental topic, co-designed a tabletop game, game tested, and developed a final version of an environment game. Details of the assignment began by providing participants with a list of environmental topics for their consideration. Guidelines required a 30-minute group oral presentation on the chosen topic. Feedback on the presentation content provided students with an opportunity to further direct their research for the game development. Games were developed over three weeks. Then, each game was tested by peers during class. Peer feedback was offered to each team. The game testing provided participants the opportunity to reflect on their assumptions and beliefs about the topic and consider the ability of their game to effectively communicate knowledge to its players. Gameplay was led by teams at a community organization in weeks 10 and 11, and the final reflective essays were due in week 12.

## 8. Data Analysis

This study employed a qualitative content analysis with a convenience sample to examine the development of awareness of environmental injustices through the lens of a co-created tabletop game. Upon conclusion of the game unit, the researcher collected the game boards, game components, and participants' final written reflective essays.

The reflective essays were read and used to develop themes. Examination of the final essays revealed the following broad themes*: learning about environmental issues through game design, learning about game design through game testing, learning to value others through co-creation,* and *learning about the power of game dissemination.* Below are excerpts from students' essays associated with each theme.

### 8.1 Learning about Environmental Issues Through Game Design

The following sub-themes emerged from post-play reflective essays: *growing awareness of environmental issues, associated hazards,* and *possible solutions.* The following excerpts are examples that provide evidence of these sub-themes.

*R.P (Diamond Mining) "This experience - researching and creating a game revolving around diamond mining - helped me become more aware of the negative effects on the health of humans and the environment. Before this project, I knew there were lab and natural diamonds on the market. However, I was unaware of the importance of the shift we must make as responsible humans from natural diamonds to artificial diamonds."*

*S.V. (Ocean Microplastics) "Researching ocean microplastics and their effect on marine life has been enlightening yet disturbing and concerning. Plastic and ocean pollution are discussed in society, but not nearly as much as they should be. Furthermore, it is costly to manage pollution. Therefore, it would make more sense to revamp waste and plastic disposal systems and recycling techniques sooner, as these are long-term solutions to ocean pollution."*

*Y.A. (Environmental Racism) "One of my main take-aways was how environmental racism occurs in minority groups, noting that certain areas that experience the most health disparities also happen to be the areas that experience environmental discrimination. As a student nurse, I am now more aware that the environment one lives in has a great impact on one's health. It is heartbreaking to see that minority groups are marginalized for their skin color, but that it also has a greater effect on their lives concerning health -- as if their psyches have not already had enough."*

*J.R. (Wildfires) "Before researching this project and game, I was slightly educated on wildfires in the United States. However, many fast-spreading, dangerous wildfires have hit the western U.S. and Canada within the last five years. The main takeaways from this research and game development were that the policies around wildfires are lacking, and they need to be created to protect American citizens and our land."*

### 8.2 Learning about Game Design Through Game Testing

Participants observed their games tested by peers in during class. Teams made notes about possible *game improvements* based on issues they observed during peer testing. Following are descriptions of the changes made by teams, evidenced in the final version of the game and the accompanying reflective essays.

The ocean microplastics team changed their crossword puzzle, revealing a few issues during the game testing. First, the team adjusted the sizes of boxes that were too small and the numbering within the boxes. In addition, discussion ensued about the need to include a word bank as the team was reminded that they needed to lead the gameplay in the next step of the project, game dissemination at a community organization.

The game testing session for the wildfires group revealed that their questions were too high level for the players to answer. After the game test, the team discussed all game questions, deciding which to revise or replace. The team determined they needed to provide some pre-play information about wildfires when disseminating their game at their chosen community organization.

The environmental racism game team noted that some players had difficulty reaching a new area on the game board because they kept landing in a "risk" section (outlined in dotted lines – see Figure 1). However, a group discussion taught them that this was a good thing because just as it was difficult for the player to move on to a new area, it was difficult for the people who lived in these areas to move on. In other words, players could perhaps experience empathy through gameplay. Therefore, they decided to keep the gameplay "as is" for the game dissemination event.


**Figure 1:** Environmental Racism Game Board

The diamond mining squad observed that some of their peers never landed on a designated spot during testing, so they did not have questions posed to them during the game (Figure 2). The team met and changed the game board and questions based on feedback. All questions were reviewed for applicability to their intended third-grade audience (ages 8-9). Figure 3 shows that the team added ten more question spots to the board, indicated by a "mining tools" icon to make the game more interactive. The team also divided the icons on the game board (i.e., diamond ring and mining tools) into true/false and multiple-choice questions. In addition, the team developed a small presentation so that the third-grade students would have some prior knowledge about diamond mining before gameplay. In total, thirty question cards were made for the game. The student who plans a career in graphic design developed the game board.


**Figure 2**: Original Diamond Mining Game Board

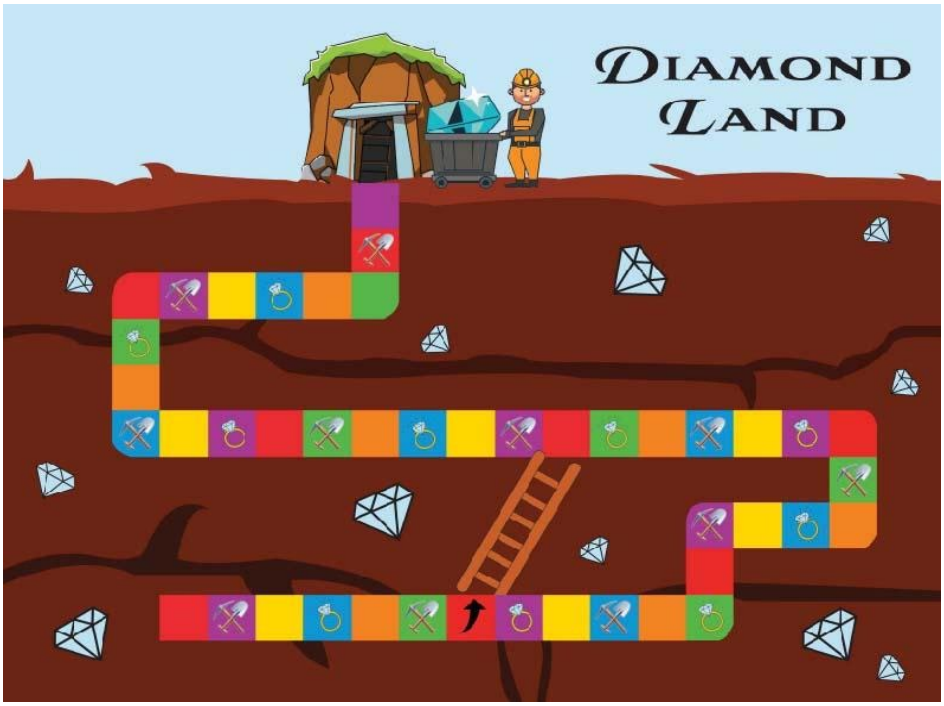


**Figure 3:** Final Diamond Mining Game Board

### 8.3 Learning to Value Others through Co-Creation

The following sub-themes emerged from post-play reflective essays under the broad category of learning through co-creation: *game development was a novel and creative experience; problem-solving skills were improved; collaboration was the key to game development success* and *developing engagement strategies to evoke player empathy.* The following excerpts are examples that provide evidence of these sub-themes.

*A.M. (Diamond Mining) "College students do not get many opportunities to create unique projects like board games. I gained many useful life skills and information from this experience, such as collaborating with groupmates and adjusting language to a young audience. Our game, dubbed Diamond Land, was both an enjoyable experience and one that tested me in new and interesting ways. The hardest phase of game-making as a business major in finance was determining the content and making the questions fit a third-grade audience. It was difficult for me to articulate my thoughts so that young children would understand. I relied on my team members for assistance in this area."*

*J.M. (Environmental Racism) "The game creation process was a little difficult for me, given that this is such a serious topic. At first, it almost felt wrong to make a "game" out of it. Then I realized that just because it is a serious topic does not mean that the education about it must be dark and serious. Most people do not learn the best that way, so together we decided to make a board game about the harsh realities of environmental racism. We decided that creating a mixture of multiple choice and open response questions was the best option to ensure people learned and thought about the topic. The questions varied from the health and mental effects of environmental racism to advocacy ideas and laws. We also included "danger zones," which described real places in the United States and real things happening in these areas. This inclusion was to show that when people end up here, they can feel stuck, and many things happening to them are just unfair."*

*S.C. (Wildfires)"The game development process was based on team efficiency and sub-topic equality. We knew our game would be played virtually, making it more adaptable for the audience due to the pandemic. Therefore, we looked for ways to collaborate and represent each wildfire sub-topic equally; wildfires and their impact on land and air, children, minorities, the elderly, and policies. This way, we had enough representation of questions regarding each sub-category, allowing the players to get a better overall grasp of the topic".*

### 8.4 Learning About the Power of Game Dissemination

The following themes emerged from post-play reflective essays under the broad category of learning about the power of game dissemination. The sub-themes are *spreading information is key to raising awareness, games*

*can be fun and informational,* and *leading a game fosters more profound knowledge.* The following excerpts are examples that provide evidence of these sub-themes.

*R.L. (Ocean Microplastics) "As a result of our game development and play, more people now know what can be done to counteract ocean pollution at an individual and organizational level and will hopefully continue to spread knowledge. It is imperative to be educated on topics like this one because it is something that will not necessarily impact current but rather younger generations. Sometimes we are blinded by these global problems because we do not want to feel responsible, but we are. But we hide. Spreading the word is the first step to changing our world; therefore, we need to keep talking about what needs to be done."*

*E.J. (Diamond Mining) "I think this process was interesting and unique. I am not going into the teaching field yet being able to impact a younger group (3rd graders) was a nice change of pace for me and gave me a sense of joy. I saw young students take to the topic and think about how to fix the presented problem. To conclude, I liked how this project was presented to us; we could take it and run with it. We were able to create a game about a topic the group felt strongly about and then got out into the community and made some of the younger generation aware of a current topic and how solutions are addressed. As knowledge on this topic develops, these kids will be able to grow in their understanding and tell others about it!"*

*A.M. (Diamond Mining) "Having students pair up during play made the experience enjoyable for them, as they quietly deliberated over the answers. Students also got to share the highs and lows of answering questions. Some questions were worded in difficult ways for the students to understand, so we had to improvise and reexplain or reword a question or two so that the 3rd-grade players would comprehend. The students seemed to have a great time playing the game and learning a lot of new things. Honestly, the students did not seem to know anything about diamond mining. One student said, "I do not know anything about Africa."*

*S.H. (Diamond Mining) Being able to extend this research project to a game design and audience made it feel like a beneficial assignment. In school settings, it is so typical to delve into a research, write a paper, and submit it for a grade and that is the end of it. It seems wasteful. All that work! In this project, we were able to do something with the information by designing a game and presenting it to our peers and then play it with an audience. It was super rewarding."*

*J.M. (Environmental Racism) "During gameplay with our audience (university faculty, administrators, and students), it was clear players lacked knowledge regarding environmental racism. Some questions were admittingly difficult, and some players even felt ashamed for not knowing or being aware of the real-life issues this type of racism is causing. It was interesting to see university faculty and administrators play while learning about the United Nations Sustainable Developments Goals, the Universal Declaration of Human Rights articles, and one country's constitution. We felt that our game modeled a just and inclusive environment—our game night connected with the campus Diversity and Inclusion student club. Players were very interested in our game and wanted to meet again to play and discuss this topic further. I love that a class project had the power to help others by teaching them about environmental racism. We put a lot of time and dedication into the game development. It is great that other people want to continue using this game to raise awareness because awareness and advocacy are the most important parts of creating change. I enjoyed this investigation because I could educate myself, and now, I can educate those around me and hopefully spark change."*

### 8.5 Limitations

This study reports on the results of a small-scale, case study research project in which the collected data focuses on content analysis and participants' reflections.

## 9. Discussion

Offering a game development option within the frame of critical pedagogy and constructionism to participants who knew nothing about the game development process and little about environmental issues provided them with a novel experience. Based on the reflective essays, most participants reported this as a unique creative assignment, and most reported they liked working with others on a team. Participants became more aware of environmental injustices through conducting scholarly research and co-creating a game. Preparing to lead the game with others created an additional depth to participants' learning as it required team members to review and reformat some game questions. This preparation facilitated deeper learning about the environmental topic.

This finding is similar to a study (Kuhmonen et al., 2019). In addition, pride was mentioned numerous times by participants upon the close of the game development project.

The feedback from the reflective essays revealed that students' frames of reference shifted due to this game project; most participants mentioned not knowing anything about this topic at the outset. Other participants said that although they had some knowledge about the topic, they now possessed more knowledge that enabled them to teach others. Through research and game development, students' critical consciousness emerged along with discovering societal inequalities, the dichotomy of oppressors and the oppressed, and the lack of clarity of the laws and policies designed to protect the environment.

The role of the game developer remains in question regarding the ability to articulate their message and meaning to others, which at least four participants similarly expressed in this study. Each of these participants indicated that they needed to collaborate with others to express clarity of thought. Although none of the participants in this study plan for a career in game development, it is essential to note that all people can sometimes experience articulation difficulties. Therefore, collaboration should be encouraged and rewarded. Unfortunately, this view is not pervasive in game development. Instead, technical expertise is favored (Whitson, 2020, p. 283). Messiness, including social conflict and skill-building does not fit with the larger cultural discourses of what game development is supposed to look like. So, it is largely ignored, thus replicating and perpetuating blind spots in the game development literature (p. 283).

## 10. Conclusion

Well-designed experiences can facilitate the transformation of student perspectives and practices (Clayton & Ash, 2004), occurring when learners shift their frame of reference or belief system by critically reflecting on their assumptions, beliefs, and understandings of the world. The general education course in which this study took place allows for consideration of inequalities and injustices in society. The gaming unit focused on the environment so students could become aware of the issues surrounding ocean cleanliness, environmental racism, the environmental and human toll of uncontrolled wildfires, and the human suffering and environmental degradation caused by diamond mining. Through active learning and reflection pedagogy, students saw the dichotomy of oppressors and the oppressed. They investigated the laws or lack of laws that protect the environment and people —employing a framework of critical pedagogy, which spotlights social realities allowing for the intended learning to occur. It is hoped that the environmental issues that were learned during game co-creation enables students to use this knowledge, not “just store it in their heads so that twelve years later it's going to be good for them” (Papert, 1990).

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