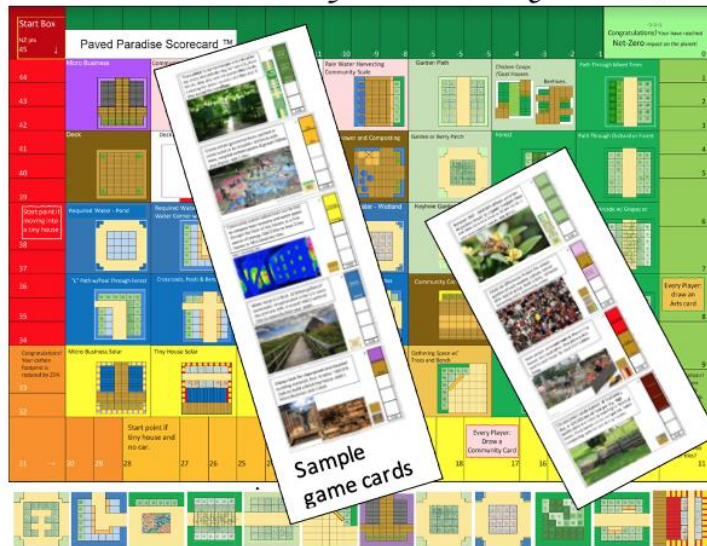


Paved Paradise™ – A Tiny House Ecovillage Board Game



Board Games as Educational Tools Leading to Climate Change Action: A Literature Review

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Abstract: The use of board games in education is under-utilized. As we come out of this pandemic, and adjust to new directions, education can reinvent itself, and create better learning environments. Games can engage students with different learning styles and inspire individual creativity. Board games represent the missing tool in our toolboxes, and they can replace the traditional lectures with a method that reaches all students. This literature review introduces the background needed to incorporate games into curriculum and to encourage educators to embrace that possibility of engagement. Games have the potential to lead us into action in our communities and find solutions for global climate change issues.

Keywords: board games, global climate change, sustainability education, literature review

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Due to its comprehensive nature, sustainability can be a difficult subject to teach as it requires that we attempt to be an expert in every field. The consequences of not adopting sustainable behavioral changes and our continued unsustainable actions have led us to the climate change climax we currently face. Therefore, there is an urgent need to find innovative ways to engage others in learning about global warming and climate change. Wu and Lee write that first-hand experience is a better teacher for this subject, due to the emotional triggers inherent in necessary behavioral changes. New perspectives can happen more productively, allowing for self-change instead of imposed change, when players participate in games designed to encourage climate action (Wu & Lee, 2015).

Addressing climate change is a serious matter and you may think we can't afford to waste time playing games. Mazur-Stommen and Farley (2016) state, however, that according to the Institute for the Future, the opposite is actually true: we do not play enough games. Games release our creativity, increase our efforts to express collaboration and enhance our ability to learn. To solve the world's most urgent sustainability problems, Mazur-Stommen and Farley (2016) state that even 3 billion hours of game play a week is not enough to enact all the urgently necessary changes.

Kids learn by playing games, until, according to Mackay (2013), they go to school. Then the games stop, and so does learning (Mackay, 2013). Additionally, Mackay asserts that human minds are designed to learn together, taking advantage of a "collective intelligence," and that people play everywhere except in school. Tasnim (2012) writes that "games are the most ancient and time-honored vehicle for education." He also posits that to even pose the question regarding the value of games in education is absurd (Tasmin 2012).

Treher (2011) says that the outmoded idea of interactive learning, as consisting of a presentation followed by questions and quizzes, or short discussion sessions and case studies with reliance on PowerPoint presentations, is "unlikely to lead to learning retention, skill development, or behavior change," as the ability to retain information after 10-20 minutes of lecture is no more than 50% (Treher, 2011). She notes that, although board games have gained some traction in the corporate world, the view persists that games of any kind for adults are inappropriate, despite the fact that the power of play and entertainment in learning is based on solid, reputable, decades-old research. Treher feels that the value of board games designed for learning is not fully recognized, and that current research supports the power of games to "facilitate rapid learning and retention" (Treher, 2011).

Despeisse (2018) writes that games provide opportunities particularly well adapted to sustainability education. Students are immersed in complex situations providing active roles in decision-making and collaboration in uncertain conditions (Despeisse, 2018). Eisenack (2012) asserts that board games excel in simulating real-world climate negotiation because the face-to-face discussions necessary in playing them are more representative of real-world exchanges. Fábrega (n.d.) agrees, stating that games provide the most effective way to learn, and provide an authentic experience that is "entertaining, engaging, and exciting," in addition to teaching skills and transforming thoughts. Stirling (2013) writes that, although game players do not always reach a game's intended goals, this is not an obstacle to learning as repeated attempts at something provide their own lessons.

Experience leads to learning, but experience alone is not enough. According to Treher (2011) a combination of “hands-on and heads-on learning works best,” and asserts that “properly designed board games are an effective way to provide this combination” (Treher, 2011). Dahlin et al. (2015) also list many acquired skills from game playing, including “know-how, awareness, understanding, exploring attitudes and values, systems thinking, information processing, decision making, collaborative working and communication skills” and state that these strongly contribute to an ability to learn about sustainability.

Definitions

Becker (2021) writes that any game must have the following properties: be interactive; have rules; have at least one goal; have a means to measure progress or success; and have a recognizable ending. Mazur-Stommen & Farley (2016) agree and add that games may be either competitive or cooperative in nature, with points being frequently awarded as one possible outcome. There is little agreement and often considerable discussion regarding how the various gaming terms are used within the industry and between the various disciplines. Although a search for digital games in 2020 alone recorded nearly 30,000 hits, many authors, digital and non-digital, are still confused regarding the terminology and do not clearly distinguish between serious games, educational games, game-based learning, and gamification (Becker, 2021).

Educational Games

Allery (2014) defines an educational game as “a specific learning tool which requires learners to engage in some form of competitive activity undertaken within a set of predefined rules.” She also outlines the skills that are developed as “including decision making, problem solving and negotiation.” Rouse (2013) defines educational game as “competitive activities governed by rules and regulations which provide a mechanism for connecting experience and understanding to allow students a better grasp of the world.” Educational games can include board, card, and video games.

Serious Games

Serious games are “games that do not have entertainment, enjoyment or fun as their primary purpose” (Chen & Michael, 2005). Trifonov (2012) defines serious games as those designed to teach a specific lesson. Mohamad et al. (2018) agree, and state “a serious game has the appearance of a game but is designed for specific purposes so as to achieve something.” Noemi and Máximo (2014) state that there is no single definition for serious games, but that they usually involve “training, advertising, simulation, or education,” representing real-world events designed to solve a problem. Mohamad et al. (2018) add “simulation is similar to serious games, simulating real world things and they are always used for trainings. Serious games combine education, communication, with the play of a game. Although often delivered via video or digital games, serious games are not limited to these, and may include other non-digital game formats (Fatta et al., 2018).

Game-Based Learning

Game-Based Learning (GBL) is a type of gameplay with defined learning outcomes designed to balance subject matter with gameplay and the ability of the player to retain and apply said subject matter to the real world (Team, 2017). According to Mohamad et al. (2018), it involves “actual games in the classroom to enhance teaching and learning experiences.” Qian and Clark (2016) describe game-based learning as “an environment where game content and game play enhance knowledge and skills acquisition, and where game activities involve problem solving spaces and challenges that provide players/learners with a sense of achievement.” Fatta et al. (2018) note that “educational game” is a term that sometimes replaces game-based learning.

Although many feel digital games are the direction of the future, Wiggins suggests that non-digital games are engaged more frequently, possibly due to the limitations that digital versions face. The frequency of use in the classroom for digital games is 27%, whereas for non-digital games the frequency is 56%, possibly due to lower accessibility threshold.

Gamification

Some argue that gamification is just a new word for traditional instructional strategies. However, gamification has been used to change behavior for over 120 years – an example is when Sperry & Hutchinson began offering stamps (S&H Green stamps) to retailers back in 1896 to encourage additional purchases at stores offering them (Mazur-Stommen & Farley, 2016).

Wiggins (2016) cites that many authors use the terms game-based learning and gamification interchangeably, and suggests that gamification may be a subset of game-based learning. In looking at both digital and non-digital games and the use of both GBL and gamification, Wiggins defines gamification as “the use of game design elements in non-game contexts” (p. 19) and describes the power of gamification to motivate people.

Gamification may not be a familiar word, but most people are familiar with its strategies: levels, points, badges, leaderboards, etc. Gamification is defined by Rouse (2013) as “the process of adding game mechanics to processes, programs, and platforms that would not traditionally use such concepts.” Mohamad et al. (2013) would add that “gamification is the concept of applying game mechanics to engage and motivate students in learning,” with the use of “game elements and game design methods in a non-game context.” Although the term can be applied more broadly, gamification generally refers to digital game-based learning (Fatta et al., 2018).

Due to climate change mitigation factors, gamification (for primarily video games) has gained a lot of attention for its potential to harness the attention of large numbers of people as well as to change their behaviors (Mazur-Stommen & Farley, 2016). Online, games have the potential to reach billions of people.

Sustainable Development Education

Dieleman and Huisingh (2006) note that sustainable development (SD) education involves teachers and students in a multidisciplinary collaboration, bridging “different professional cultures, traditions, gender differences and ages.” They state that when games are played, the roles of others can be easily stepped into, allowing an emotional understanding of why other groups act as they do, and without negative consequences, provide learning by both doing and failing. According to Dorn (1989), learning is enhanced when real rather than vicarious experiences are used, as when participating in decision-making. Dorn also states that simulation games have a basis in experiential learning rather than just information processing.

Plass et al. (2015) writes, “the debate around how games are defined cannot be resolved here, this may not be a problem, as play—the essential activity in games—has long been thought of as a critical element in human development.”

History and Background

According to Noemi and Máximo (2014), simulation games were introduced in 1946 in a project that enabled military pilots to train in controlled situations. There is research by Coleman et al. (1973) that supports game-based learning as early as the 1970s, when a large-scale review looked at more than 150 studies. More recently, Stanitsas et al. (2019) looked at 77 games to uncover the role these games could play in facilitating sustainability education. They found the most popular serious games are board games and computer games, but that it was difficult to determine which one was most appropriate to meet their sustainability education goals. However, many of the games did incorporate all three of sustainability’s triple-bottom line parameters: economic, social, and environmental (Stanitsas et al., 2019).

Wu and Lee (2015) tell us that the first environmental games related to climate change were made available over 30 years ago. One of the first commercially available games was *Keep Cool*, which gives players the chance to choose to represent either low or high emitting factories and negotiate issues related to economic growth while avoiding floods and droughts caused by climate change.

Crookall and Thorngate (2009) provide an interesting historical viewpoint regarding the relationship between knowledge acquisition and game playing. Their view that “action ultimately precedes knowledge” means that knowledge acquisition is dependent upon action, that the experience provided by action is what actually impels learning. They support their view with several historical references, including a quote from famed educational reformer John Dewey: “Give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking; learning naturally results” (Crookall and Thorngate (2009)).

Crookall and Thorngate (2009) aim to restore what we have known for thousands of years, that “action and knowledge are intimately intertwined,” and unfortunately Western education has created in humans an inability to translate knowledge into beneficial actions. On a grand scale, this point of view has resulted in knowing what to do but not taking the necessary action. When we consider the early reports from the Club of Rome in *The Limits to Growth* (Meadows, Randers, & Meadows, 1972), the sequels *Beyond the Limits* (Meadows, Meadows, & Randers, 1992) and finally the *Thirty-Year Update* (Meadows, Randers, & Meadows, 2004), we see that the messages in these books describing the dire potential outcomes due to inaction did

not inspire us to action. Public education regarding these dire forecasts either fell behind or perhaps never even started (Crookall and Thorngate, 2009).

Sustainability education is not widespread yet and, when available, the methods used to present information are not always effective in changing people's behavior (Chappin, 2017). Chappin describes workshops that study the impact of playing sustainability related games and their impact on the players. Research shows that teaching sustainability through games shows an untapped potential. Dieleman and Huisingh (2006) state that although sustainability education is growing in higher education programs, it is much less so in lower education programs. Due to the complexity of the subject, Fabricatore and Lopez (2012) write that traditional methods of teaching – lectures, assignments etc. – may be difficult and may not engage students. Whereas according to Chapin et al. (2017), “some consider gaming to be the most important tool for education because it grounds the educational effort in experience” and the complex topic of sustainability can be more easily communicated through games. Dorn (1989) reveals that games make learning a more direct experience, that they relieve tedium and demand 100% of the gameplayers' attention and participation. Students that do poorly in the traditional classroom (tests and lectures) are the most receptive to simulation through games, rarely expressing apathy. Dorn (1989) also notes that racial barriers can be reduced among students from different social and ethnic backgrounds. Dorn (1989) summarizes with one persistent finding that simulation games are as effective as other forms of teaching and that students learn as much from games as they do from films or science experiments.

Features of Board Games in Education

Purposes and Benefits – the Pros

Learning Styles and Teaching Methods

Every individual has a unique learning style. In order to reach a wide range of students, Tasnim (2012) tells us that a substantial body of literature confirms that games are valuable teaching tools, providing the means by which students with a mix of learning styles can be engaged. Spiegelman and Glass (2008–2009) also recognize that games can be learning tools, immersing players in the game and challenging them at the same time. Allery (2014) writes that there is something about a game with a winner that learners find to be highly motivating. With board games, it is also pleasurable to move game chits and Meeples around the game board while participating with real human friends, according to Kraus (2015), and that the games are much more sophisticated and addictive than the games played by our parents. Stirling (2013) says games have the ability to be a totally immersive experience like reading a good book. Mackay (2013) remarks, “you have to interact,” and that traditional classrooms can stifle qualities needed for learning such as “persistence, risk taking, collaboration, and problem solving.” Treher (2011) and Tasnim (2012) remark that games prepare gamers to react to unpredictable events and prepare students to solve problems outside the classroom.

Tasnim (2012) describes a study done by Hake (1998) involving 48 physics classes using interactive engagement as a teaching method, and 14 classes where traditional lecture methods were used. She noted that pre- and post-tests were performed, and that students' conceptual knowledge “had considerably larger gains” in the interactive courses, no matter what level of

education (high school, college or university). She describes the consistency of the positive results of the 6,500 students as reinforcing the idea that activities in the classroom benefit learning.

Tasnim (2012) states that reflective teaching methods (lectures, handouts, required readings, content-oriented examinations) ignore the complexities of the environment and are ineffective. Whereas in active pedagogy, the facilitator guides the learning process through the use of “role play, simulation, brainstorming, team tasks, and interactive discussions.” Listening and note taking are not paths to learning. The number one reason people play games is to face a challenge and overcome it (Tasnim, 2012).

Types of Game Players

A well-designed game addresses the different types of learners as well as the needs of the different types of game players. In a review of 40 games, Mazur-Stommen and Farley (2016) introduce the idea of different types of players:

- **Achievers:** players who work hard to achieve game-related goals, like accumulating treasure or completing specific challenges.
- **Socializers:** players who want to converse and interact with other players.
- **Explorers:** players who are interested in learning as much as they can about the game world—both the story lore and the limits of the game engine.
- **Customizers:** those who like to customize their online avatar or habitat.
- **Killers:** players who impose themselves on others (griefers), or who work hard to win at the expense of others.

Chappin et al. (2017) described the various types of players in the game *The Island of Catan*:

- A “green hard-liner,” only convinced of his moral values, implying that he is purely driven by environmental concerns.
- A “fundamentally green” player who understands the potentially disastrous consequences of using oil.
- An “opportunistically green” player who focuses on his individual gains.
- A “purely self-interested” player who focuses on his individual gain and makes use of the opportunities of oil for as long as he can.
- Lastly a “calculative player” who aims for a balance between the disastrous consequences of oil consumption and the advantages oil consumption brings.

General Skill Building

Opportunities to learn are provided as players plan, negotiate, analyze, make decisions and get immediate feedback, thus their learning becomes memorable (Allery, 2014; Treher, 2011). Both Catapano (2009–2019) and Hockaday et al. (2017) expand on this by adding the benefits of building social skills, self-esteem, overcoming shyness and developing language skills, as well as learning to understand game rules, competition, fair play, and values. Stathakis (2013) adds critical thinking skills, creativity, teamwork, and good sportsmanship. In agreement, Chong (2019) points out that board games require that players interact with each other and increase the development of skills such as speaking and interpersonal skills, critical and strategic

thinking, and the ability to negotiate. Chong (2019) agrees with Allery (2014) and notes that in cooperative games, players have to come together to solve or prevent a problem by putting their brains together, interacting and negotiating through teamwork. Dieleman and Huisingh (2006) say that games provide opportunities to create shared experiences that involve diverse stakeholders. Climate change solutions cannot focus on a single outcome, such as those stakeholders interested in the economic aspects, but must acknowledge the equal importance of the social and environmental aspects as well. This shared experience facilitates a mutual understanding and contributes to better team building.

Fábrega (n.d.) mentions that “board games help to develop mental flexibility, and the ability to bounce back quickly when adversity strikes,” tools that are much needed in developing sustainable systems. Fábrega (n.d.) also describes the usefulness of some games as life learning tools. For example, Chutes and Ladders teaches that even when everything is planned out carefully, sooner or later you slide down a chute, but that this can be a great thing just when you expect it least. The game of Monopoly explains capitalism. Pandemic, a cooperative game, has players discussing their options and make plans out 4 or 5 turns to prevent a disease from wiping out humankind (Fábrega n.d.). Despeisse (2018) feels that learners adopt a more positive mindset to see sustainability as an opportunity, rather than an oppressive limiting factor.

Dahlin et al. (2015) also lists many acquired skills, including “know-how, awareness, understanding, exploring attitudes and values, systems thinking, information processing, decision making, collaborative working and communication skills” and that these strongly contribute to an ability to learn about sustainability.

In comparing a game application and an equivalent non-game version, Girard et al. (2013) found the “game-based application to be more attractive and more educationally effective,” with students acquiring more knowledge than the control group. Hockaday et al. (2017) describe the skill-building and learning that takes place using games occurs during the debrief period where written reflections are asked of the participants. A method called the Description, Interpretation, Evaluation (DIE) Model is described by Hockaday et al. (2017). Kirkpatrick (2012) agrees that a written reflection is of great value, having the following advantages:

- Students are forced to organize their thoughts.
- Students integrate the game experience into real life experiences.
- Students express their own feelings and thoughts.
- Teachers hear the thoughts and experiences of all students.
- Teachers improve their teaching skills through the feedback.

Tasnim (2012) notes that computers can never duplicate the complexity and richness of competing and cooperating among humans, the “old-fashioned” board games remain well-admired, even among young adults today. The advantages to board games are especially noted in developing countries where teachers are in short supply and electronic games are often not available.

Typically, boys read a couple of grade levels below their age group but read decidedly above their grade level if the reading is related to online games (Mackay, 2013). Mackay noted that when students choose what they want to read, they push themselves harder, and games provide this avenue to greater learning.

Petsche (2011) informs us that learning should be fun and that educational games can turn a “potentially boring subject into something exciting and desirable,” and also illuminates the idea that the educational element can be heavy or very much in the background (sneaky learning). We learn from our mistakes. Games are an escape from the real world because those mistakes do not produce serious or lasting harm, write the authors of “Why Use Games to Teach (2018). Often a player can recover within a game and successfully complete tasks; personally, there are no real consequences with game play choices.

Overall, Noemi and Máximo (2014) describe many directions to consider in games:

- Sustainability and how environments will be managed.
- Spirit of innovation as a driver of competition.
- Initiative and entrepreneurship including a variety of decisions.
- Problem-solving for unforeseen circumstances.
- Risk-taking and the consequences.
- Continuous improvement for each player.
- Orientation towards quality to produce the best overall design.
- Value of effort to make progress throughout the game and subsequent games.
- Mathematical and analytical skills.
- Capacity to plan and organize and monitor the process.
- Strategy skills to determine when some objectives may have to be abandoned.
- Technological competence when sophisticated technologies are being used.
- Information management capabilities valuing information from multiple sources.
- Independent learning to develop initiative and responsibility from one’s own learning.
- Adaptability to different environments that addresses the randomness of the game.
- Creativity to find different solutions when faced with problems.
- Accuracy in dealing with the details of decisions.
- Responsibility of managing all the resources involved in the game play.
- Resource management to reach the goals of the game with limited resources.

Negotiation Skill Building

Hockaday et al. (2017) defines the purpose of using games in negotiation. He notes that using games to mediate between parties involved in water conflict issues helps to dissolve the “petty attitude between parties.” He reminds us that the primary reason that games are used in negotiations is that they increase participation of all parties while breaking down barriers of communication. The games allow the practice and development of mediation and negotiation skills during the games. This also creates a better learning environment.

Hockaday et al. (2017) informs us that they found over 40 water-related games focusing on “water conflict resolution, water diplomacy, and in some college courses, water management, environmental conflict resolution, and business.” Some were board games, others digital computer games, or a combination of the two. Magombeyi, M.S., D. Rollin, and B. Lankford. (2008) explored river basin negotiations and found that, as a result of the game, small-holder farmers were able to share knowledge and set agreements on equitable water sharing that resulted in additional benefits including community harmony, transparency, and acceptance of operating rules.

Board games present opportunities to simulate situations of conflict and, through repetition, determine the best path forward. Chong (2019) tells us that once gameplay has been established, board games “foster the critical thinking, negotiation and interpersonal skills that simple word games do not nurture.” Redpath et al. (2018) agree when they state that games help us to understand patterns of conflict and have the potential “to highlight effective management solutions.” Hockaday et al. (2017) describe the purpose of simulation games as including the imitation of real-life scenarios and, by playing different stakeholders, each is encouraged to discuss their varying positions and come up with a mutually agreed upon solution. In making decisions about a shared resource, the scope of their understanding broadens, enhancing negotiation skills between stakeholders. He describes the work by Craven et al. (2017) and a river basin management simulation game. Redpath et al. (2018) says that, in reality, problems involve a complex layering of multiple stakeholders, all of which have “different interests, values, goals and life experiences in different political, cultural, and historical settings.” When studying some of these issues, Redpath et al. (2018) tell us that traditional ecological approaches have often failed and have even exacerbated the existing problems.

Redpath et al. (2018) powerfully outline the benefits of games when they write that games provide the framework necessary to analyze conflicts and can clarify the key elements of a conflict. They also state that games illuminate the beliefs and behaviors of the participants and result in productive discussion between the various stakeholders. Novel solutions can be uncovered that promote cooperation and build trust between stakeholders. Redpath et al. note that during games, conflicts can be mapped, and underlying patterns be exposed. A key element can be uncovered: how conflicts evolve and change over time, and the moment when the conflict switches to cooperation.

If hesitating to use a game to solve a conflict, Redpath et al. note that while games may “spark conflicts or add fuel to existing ones, conflicts are rarely created by the interactions of the games but are inherent to the situation being explored. Games bring these processes to light so that the conflict can be managed instead of suppressed by the power structure of the status quo.” Games have the potential to provide genuine insight even as conflicts are challenging to study due to their complexity, but they also have potential to be fun, according to Redpath et al. (2018). The potential of using games in negotiations is ready for development, as long as their limitations and ethical constraints are considered. When games and role-play are used in negotiations, Sanpietro (2018) tells us that participants get to explore options on both sides of the situation and see the potential results of different solutions to the conflict. Sanpietro (2018) describes an organization, the Teaching Negotiation Resource Center (TNRC), that offers more than 200 negotiation games, teaching materials, 30 videos, more than 100 books, many

periodicals, and critical case studies. The materials offered by TNRC are intended for educational purposes in colleges and corporate training settings, and for individuals who want to improve their own negotiation skills (Sanpietro, 2018).

Redpath et al. (2018) outline three different approaches to one conflict in Sweden between agriculture and growing geese populations: 1) a theoretical game example that predicts the results of management practices that include collaboration; 2) an experimental game example where farmers have the potential to use a lethal method to control the geese; and 3) a constructivist game example wherein stakeholders explore lethal versus non-lethal methods under changing economic situations. Their examples show the potential of offering various scenarios in game play.

Decision-Making Skill Building

In the game *Island*, Noemi and Máximo (2014) describe an environment to be managed as one that is extremely fragile, and that the innovation of the players is a distinctive element that drives competition. There is no clear path described in the game, but alternative ways to manage the island are considered in the decisions. Many unforeseen circumstances arise and must be solved by the players. The authors describe situations where risk-taking may be profitable, however the citizens of the island do not forgive any mistakes that are made! From an educational point of view, decisions that require the ability to perform mathematical calculations can be of benefit, according to Noemi and Máximo. They describe an orientation towards quality and continuous improvement as important factors, as well as recognizing the value of effort as a beneficial aspect in the game. The use of analytical skills may also be required to ascertain if the right decisions have been made.

In the game of *Island*, Noemi and Máximo (2014) noticed that, after game play, most students had improved their “skills in sustainability, teamwork, solidarity, innovation, creativity, problem-solving, continuous improvement, energy efficiency, mathematical precision, initiative, goal achievement, result orientation, flexibility, and working with the environment,” all as a part of the game having a “positive influence in the process of learning.” McGonigal (2010) outlines ways to evaluate whether a game has had a positive effect, and includes the following questions:

- Are these games increasing the happiness, the health, the well-being of the people who play them?
- Are these games enhancing positive social relationships with friends, family, colleagues, and neighbors?
- Do these games connect players to something bigger than themselves, purpose, mission, or a collective endeavor?
- Do these games give people opportunities to wake up and do something that matters, to achieve something in their daily lives?

Links to Reality

It is important for the game to have strong links to reality. In a game that simulates irrigation solutions in Senegal, Bousquet et al. (2001) report that the players were fully capable of interpreting the results of the game and linking the model to reality. A great deal of satisfaction was expressed by game players due to a precise real local and the use of a GIS map with detailed, relevant information. In simulations related to real designs to be implemented, Bousquet et al. (2001) suggest that it may be useful to switch roles in order to better understand constraints faced by others, as well as understand their behavior. This encourages richer discussions.

Mazur-Stommen and Farley (2016) tell us that gamification is used to approach problems in a way to tap into the psychology of motivation. Game mechanics can heighten real-world activities. Eisenack and Reckien (2013) write that games can raise awareness and empower people when it comes to dealing with climate change issues.

Hockaday et al (2017) also found that although games foster collaboration, they “can only be used to intervene in real-life negotiations if they are crafted in a realistic way” and that “real-life participants want the opportunity to consider all options.” Gaming does create a common ground between players, especially those that are unable to cooperate with each other.

Cooperation versus Competition

In a study by Creighton and Szymkowiak (2014), teachers rated the amount of cooperative actions after game play versus before game play. They rated cooperative interaction significantly higher after game play compared to low rates before game play. For one thing, cooperative game play resulted in more conversation. Dorn (1989) writes that simulation games are not value-free. There are sociological, economic, and political lessons that are learned; implicit and often explicit moral and value lessons are also presented.

Knowledge into Action

In many academic situations, knowledge is transmitted in the form of lectures, tests, reading, and essays, and action is discouraged, as though it were of no value (Crookall and Thorngate, 2009, pp. 10-11). According to Crookall and Thorngate, action should be the prime goal for education. They state, for example, that action is not taken often enough to achieve the changes being sought and that people know about problems but do nothing to prevent them (2009, p. 13). There is a persistent feeling that actions to address problems lag behind scientific knowledge and possible solutions. “It’s not that we don’t know what to do. It’s that we don’t do it” (Ireland, 2007). Summarizing, they state, “clearly, neither concern nor knowledge of climate change necessarily translates into personal action to mitigate it.”

Crookall and Thorngate (2009, p. 8) discuss in detail the complex relationship that exists between action and knowledge as a two-way interaction. They illuminate the notion that currently we take-for-granted the idea that knowledge must exist before action can occur. They describe the connection as if it were a two-way highway, with traffic in both directions. Without action, knowledge is not possible.

Crookall and Thorngate (2009, p. 9) state that this understanding has a national bias. British culture prefers to do before conceptualizing. The French prefer theory before action. Eastern cultures believe that the written knowledge can be the only means to have effective action, whereas non-alphabetic East Asian cultures believe it is the direct engagement of tasks that leads to knowing rather than the use of abstract written signs and symbols. Western culture feels that doing and observation leads to learning. It is a Western preoccupation that believes “knowledge-creation-application-performance” as the only path towards learning and action. Crookall and Thorngate (2009, p. 10) find it interesting to examine this gap in understanding and how it is being currently addressed in simulation and gaming in “education, industry, organizations, and teacher education” to bring the knowledge-action gap closer together.

Value of Games in Education

Despeisse (2018) writes that serious games are emerging as strong educational tools because they can immerse students in complex situations and give students experience in the role of decision-makers. Despeisse (2018) also asserts that board games are needed to provide experiential and participatory methods for teaching sustainability. Eli (2014) agrees, stating that educators have long understood the potential of games to benefit both teaching and learning, and recommends the possibility of structuring an entire course as a game.

Games that were not initially designed as educational games are being mapped to school curricula by Libraries Got Game (Nicholson, 2011). Nicholson tells us it is important to engage as many players as possible as often as possible in order for an educational game to be successful as a learning tool. He recommends designing the goal of the game within this context: “Do not ask questions.” Winning has to do more with who does the best job, according to Nicholson (2011), and it is better if all players either win or lose as a team. He also states that too many new games look just like other commercially available games in existence already. He recommends that game designers look beyond mass-market games. Building a game out of learning outcomes and content, Nicholson states, is a challenging one, but can “teach, motivate, and engage learners...in ways much more effective than a simple trivia-game model. Kraus (2015) informs us of a series of books called *Teaching Through Games*. Harris and Harris (and sometimes Mayer) (2015) have worked a wealth of activities and exercises that incorporate the use of a game in the classroom, including a one-week lesson plan as well. Some examples of games in current use for the purposes of sustainability education are:

- In *Clim 'way* players can design the infrastructure of a city and watch the evolution of their design over a simulated 50 years. Players are challenged to address climate change issues in the games *PowerAgent*, *Habitat*, *Greenify*, *SMARTIC*, *Eco Chains: Arctic Crisis*, *Fate of the World*, *Climate Mission 3D*, and *FutureCoast* (Wu and Lee (2015)).
- Some games are aimed at the individual and changing potential behaviors in their own homes, such as *Me Eco-Home (MEH)* where the consequences of sustainable versus unsustainable actions are tried by the players (Trifonov et al., 2012).

- Snowflake Education has developed an entire suite of board games for sustainability education, including ClimeOut, which teaches students the value of discussing scientific data and to understand the vocabulary of climate research (n.d. Snowflake Education).

Allery (2014) tells us that games level the playing field, allowing all players to have an equal opportunity. Prior skills or knowledge are not required. Bousquet et al. (2001) outline a variety of roles that games employ to extend knowledge:

- To simulate a variety of schemes.
- To help in mediation.
- To predict the impact of development.
- To simulate scenarios of adaptation.
- To test hypotheses.
- To facilitate discussions between populations.

Dorn (1989) recognizes the difference between the two methods used in education.

In the banking system of education:

1. Students receive information in the form of a book or lecture.
2. Students assimilate and understand this information.
3. They infer particular applications of what is learned to general principles.
4. They learn to use the general principles to act in some way.

Whereas in the experiential model:

1. Students act in a particular instance of application.
2. They attempt to understand the effects of their behavior.
3. They seek to understand the general principles.
4. They apply the general principle to a new circumstance so that learning is valuable in their future behavior.

Catapano (2009–2019) asks if there is a carryover after the game. He suggests that students should be offered games that develop skills that can extend into other potential areas. Crookall and Thorngate (2009) suggest that facilitators should run two games back-to-back, and that, in the second game, participants can draw upon what was learned in the first game. This can result in additional learning when participants recognize that the second-round results have improved. When teamwork and cooperation are reinforced, Digital Pedagogy (2019) says that better outcomes are created as opposed to individual representation in the game. Eli (2014) agrees and states that when games are designed for teams, collaborative skills are built as a result.

Considerations for Education: What is Missing? – The Cons

There are few negative articles about board games. Madani et al. (2016) noted that in environmental management games, the main shortcoming was the omission of an assessment of

the game's effectiveness and the pedagogical foundations on which the game was based. Madani et al. note that the development of standardized methods to evaluate game effectiveness is essential for future game research, including the game design features, mechanics, game narrative and environment.

Eisenack (2012) describes an increased tension near the end of the game when players strive to reach their goals. Initial discussions may focus on the "strategic aspects of winning the game." Eisenack continues by reminding us that learning only takes place if the game is carefully debriefed, and that repeated game play could allow for a deeper understanding. He facilitated the game sessions over 3 to 4 hours in seminar-type settings, including the game introduction, game play, and debrief time for 25 students divided into smaller groups. Due to the complex themes in sustainability or climate change issues, games are also often quite complex. Eisenack states that objectives of the games are still met at least to some degree. He also states that introductions can require some time, especially if the participants are not frequent board game players. He also reminds us that the use of a board game creates a common language where different views can be discussed.

Since it is difficult to get humans to act on knowledge, Crookall and Thorngate (2009) say that it is also difficult to prove the effectiveness of using games as a learning tool. Although it is easy to see progress in participants after playing a game, it is hard to measure. They state that they intuitively sense that learning took place even when it is difficult to quantify that learning. In the banking concept of education (Freire, 1968), action follows learning, and the incentive for learning is not clear until the end. In experiential learning, action occurs first and learning already has a reason to be motivated (Dorn, 1989). It can often take two rounds of game play to get used to the game play sequence and the mechanics of the game (Despeisse, 2018).

There are situations when game participants have a negative view of the game play. Despeisse (2018) described one participant as being skeptical regarding the potential to learn from a game and was not expecting to actually play a real game. Some players wanted to change the game so that their team would have won, and Despeisse notes that it can be challenging to get players to focus on what they learned as opposed to why they lost the game, focusing on their own small mistakes. If, during the game, the players are required to work as a team towards a common goal, Despeisse notes that players take the time to consider their own strengths when working in combination with others.

Despeisse (2018) informs us of several limitations of game play. One, it can oversimplify the real world. Also, the frustration of losing a game, in a worst-case scenario, can turn into a blame game. In some cases, there is a prejudice against games, not recognizing their value. At the other extreme, the game can be so exciting that it causes a barrier to learning.

Crookall and Thorngate (2009) remind us that as long as knowledge is used as a measure of effectiveness, there will be problems brought up by anti-gamers: "the hiatus between action and knowledge may, thus, be one reason that it is notoriously difficult to prove that simulations work." Stanitsas et al. (2019) agree and find the clarity of the findings to be hard to evaluate. They also felt that the effectiveness of meeting sustainability's educational requirements did not

apply to all games, and that a large number of studies did not properly define their research methods and lacked quantitative results.

Wu and Lee (2015) also complain that studies regarding games in education “lack rigor and validity in experimental design.” However, they also reference 7 other authors in their conclusion “that people can learn from playing games” and gameplay “is overwhelmingly supported by a large base of empirical evidence.” Girard et al. (2013) inform us that it can be very challenging to form ideal control groups when conducting research.

Tasmin (2012) notes that although board games are extremely popular with all age groups, there is inadequate research regarding how learning is affected by the use of board games. Wu and Lee (2015) agree when they question whether there are long-lasting behavioral benefits of *Habitat* and *Greenify*, stating researchers have not provided conclusive results. Wu and Lee (2015) describe climate change progress as a matter of civic engagement. And civic engagement requires that people are able to process information, debate the issue, and, ultimately, take action. They do note that games are in a unique position to aid in this transition and foster trust, but that real behavioral changes have not yet been seen. The scant research regarding how a climate change game may influence a players’ behavior could promote a change in civic engagement (Wu & Lee, 2015).

Mazur-Stommen et al. (2016) suggest that there is ample research that shows that games can lead to behavioral changes, but to “truly harness the power of games to change the world, designers need to look beyond simple stimulation and response and towards the deeper possibilities of engaging players through positive content and context...to consider shifting their perspectives towards one of *gameful* design and its focus on positive interactions and outcomes instead of mindless repetition.”

Although Stanitsas et al. (2019) recognize the positive effects that serious games have on learning outcomes, they also note that the data from most studies end in 2013; since then, an enormous expansion has occurred. They reviewed 81 journal articles, 10 conference papers, 5 books, 4 reports from international organizations, and 1 online database. The overall purpose of their research was to “reveal the contribution of serious games as effective tools in facilitating sustainability education and to group them according to their nature and direction in relation to sustainability.” In particular they were interested in finding games that addressed all three aspects of the triple bottom line: economy, environment and the social aspects. Although some games met their standards, there were many that did not include all three aspects.

Learning Assessment and the Incorporation of Games

Dorn (1989) recognizes the challenges that teachers face as they attempt to incorporate games into their curriculum. Games can be difficult to grade and assess; they can be difficult to fit into schedules. Eli (2014) agrees with Dorn regarding grading game activities but suggests that feedback rather than grades might be more appropriate, allowing students to retrace their steps and make corrections, or try again until they succeed. Eli suggests that this permits students to realize that multiple attempts are sometimes necessary as a part of learning and success. In this way, students learn from games in ways that traditional forms of teaching cannot offer.

As reported by Treher (2011), when students from 23 states, age 12 to 24 and their teachers, were surveyed before and after playing a game, answers improved from 55 to 93 percent, even without incorporating additional lessons.

To evaluate a game design, Despeisse (2018) enlisted the help of 29 individuals in 8 pilot sessions. The sessions began with a 5 to 10 minute short lecture regarding the topic, and 10 to 15 minutes to explain the game rules emphasizing a real-world context. Dorn (1989) says that one third of the total time should be reserved for debriefing. Eisenack (2012) agrees with the need for preliminary instruction and concluding time to debrief. This debriefing allows students the analytical time required to process the information gained by the experience. Despeisse (2018) tells us that time is needed for students to absorb the benefits of the game, even 24 hours can be needed for participants to understand what they learned, once the excitement level has decreased.

In order to assess the potential of games in learning, Girard et al. (2013) suggest using two or more types of training, such as pencil and paper versus a game. They suggest comparing a group of students with no training versus one with a different type of training material. In their own studies, Girard et al. found that “children in the virtual world environment were more motivated, more satisfied and more engaged than those in the traditional learning groups.” Girard et al. also suggest the need to assess the effect that the gameplay has on the everyday lives of the players.

Participants should also be allowed to criticize the game so that it can be redesigned to model reality more accurately. Eisenack (2012) also remarks that not all objectives can be incorporated directly into a game without the game becoming too complex.

In order for Chappin et al. (2017) to measure changes in knowledge, attitude and behavior, a baseline perspective was measured before the game, and repeated following the game. They performed 6 workshops with 4 to 9 participants each (total of 35 participants). They describe a survey that took place directly before the game and then again immediately after the game. The surveys measured knowledge, attitude, and behavior regarding sustainability issues (Figure 1).

Crookall and Thorngate (2009) remind us that “playing a game without debriefing is like playing a soccer game without scoring goals.” Dieleman and Huisingh (2006) remind us that debriefing is a crucial action that weaves action and knowledge together. By listening to the learning expressed by others, students realize that people learn differently from performing the same activities. The debriefing questions they considered were:

- What did I learn about myself, my behavior, my values, my thoughts, my fears, and my eagerness to win, while participating in this game or games?
- What did I learn about the others, their behavior and attitudes?
- What did I learn about different forms of communication?
- What was new to me?
- What did I know but do not do?
- What did I learn concerning the topic of my study or work (SD) and how can I use this in the future?

Dieleman and Huisingsh (2006) feel that educators and teachers should incorporate games and change their curricula to facilitate usage of games. This will inspire us to become increasingly more productive in helping our students to become effective change agents in building a more sustainable society. Despeisse (2018) agrees with debriefing, encouraging participants to reflect on their actions during the game. Despeisse's debriefing included a checklist to see if the learning objectives had been met, if students understood the purpose of the game, and if they had fun (did they want to play the game again?). The initial questions asked by Despeisse were:

- Was the aim of the game clear?
- Was it easy to learn the rules?
- Did you learn about concepts for industrial sustainability?
- Did you learn about eco-efficiency as a set of practices?
- Did the game raise your interest/awareness on these topics?

Dorn (1989) recommends that in-depth interviews or formal questionnaires can provide an overall effectiveness assessment of the game. He also felt objective observers could be employed to record observations during the game and provide some indication as to the success or failure of the game. Eisenack (2012) listed questions related to understanding, for example, the meaning of the various climate cards and protection tokens.

Treher (2011) reported that post-test results were significantly higher after game play than scores after a lecture or library assignment, and no difference was found in pre-game tests. She noted that the game was the most effective and most enjoyable way to learn. Long-term retention was also significantly enhanced by gameplay, more than any other teaching method.

Changes in Behavior

Trying to get people to change their habits in order to reduce their carbon footprint is largely unsuccessful, according to Ro et al. (2017). However, they report this is due to the traditional educational focus on simply increasing knowledge. Ro et al. developed a game to encourage the reduction of household electricity use, and found that, 6 months after the game, electricity use was significantly reduced, especially in high-energy consumers. Their study showed that it is possible to elicit a long-term change in sustainability habits by building awareness through action.

Mazur-Stommen and Farley (2016) tells us there is evidence to suggest that games can encourage positive behavior changes. Where a game is played (in schools, universities, workplaces, and in communities) may influence the outcome of the game, according to Mazur-Stommen and Farley (2016). They feel that in order for a player to be challenged to do better, achieve more, score higher, the players need someone to compete against. They also recommend quests, levels of achievement, special narratives, and the acquisition of badges as a reward. Badges can indicate a player's status within a game and be added to users' profile pages. They describe situations where badges were found to act as powerful motivational tools, and that players are often willing to put in a significant amount of effort to attain them.

Ro et al. (2017) were encouraged by the results provided by gamification to produce changes in attitude as well as behavior. They discuss the use of “points, levels, and badges” as a means to communicate progression through the game, citing that competitions have been incorporated to motivate players to engage in various activities. The tangible reward, however, can make players feel they are doing the activity for the reward and not because they are actually interested in changing their habits.

Because it can be overwhelming to be presented with a number of behaviors to change, Ro et al. suggest offering a few sustainable behavior changes and then waiting before offering additional options. Ro et al. (2017) report that there are a “number of psychological barriers that prevent behavior changes” but say that people do change when made aware of the severity of the problem, if they understand what to do or if it is in their best interest financially. They also report that although monetary rewards can be effective in the short term, once the incentive is removed, people return to their old patterns. Unfortunately, most behavior change research relies on self-reports, uses sample sizes that are too small, or neglects to have a control group. Ro et al. also report that most information is collected immediately after the game and did not determine if there was a long-term lasting effect. Additional research, especially longitudinal studies are greatly needed.

During game play for *The Island of Catan*, players changed their gameplay as the game progressed and they tried to prevent “the tragedy of the commons.” Chappin et al. (2017) reported that qualitative analysis would suggest that playing the game results in a change in the players understanding and behaviors. However, as with most gameplay research, due to “the small sample size and deviating demographics,” the sample could not be representative of the population or allow a generalization of the results.

Chappin et al. (2017) note that game players are exposed over and over again to ways to ration resources, learn from disasters, and learn by shock. In the game *The Island of Catan*, Chappin et al. inform us that 15% of the game sessions ended in a fatal disaster.

To address climate change, behavioral changes must be addressed. Although board games do not explicitly aim to induce those changes, they are, however, a powerful tool that can reach a broad audience with a particular interest in changing behavior, for example to lower the participants’ carbon footprint (Mazur-Stommen & Farley, 2016). Treher (2011) agrees with Mazur-Stommen and Farley (2016) and reports that learning through game play does translate into behavior changes and reduces the time needed to apply new information. They also state that the behavior change can occur after the game, as in educational or activist games which aim to influence behavior after the game is concluded.

Conclusion

According to Tasnim (2012), there is a vast potential for games and simulations in our classrooms. She notes that games have the potential to contribute to “active learning pedagogy, breaking new grounds and creating momentous impact of the perception of gaming as credible pedagogical features in classrooms.” Chappin et al. (2017) agree and add that games have the

potential to transmit sustainability concepts to the public at large. They feel serious gaming can be an effective teaching tool, although it is not yet widespread in its use.

Tasnim (2012) remarks that if games are to be part of a meaningful language, then they should be central to a teacher's repertoire, and not used at the end of the term or when it rains. It is a learning tool and not just a time-filler. She states that schools are the new notion, not games.

Recently, Schrier (2014–2019) has written three books, describing the incorporation of games into educational formats, including a description of over 100 games and their potential use in the classroom. Using the tools, she offers can provide the appropriate assistance necessary to move into a different paradigm, that of using games as a teaching tool in our everyday experience.

All of the information in this literature review has guided the development of a board game, *Paved Paradise™ – A Tiny House Ecovillage Board Game*. In this game, participants strive for net zero impact on the planet as an ecovillage is designed. If interested in participating in the gameplay research, please contact the author.

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