Towards a Hopeful Future: A Literature Review of Gamified and Game-Based Approaches in Sustainability Education

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ABSTRACT

As eco-anxiety and feelings of powerlessness intensify, sustainability education faces the challenge of not only informing but also empowering individuals with the belief that meaningful action is possible. This paper explores the role of gamification and game-based learning in fostering hope and agency in the context of education for sustainable development. Using Snyder's Hope Theory as a guiding framework, the literature review highlights how gamified and game-based interventions can encourage goal-setting, pathway thinking and agency—key components for sustaining engagement and inspiring action. A systematic review of literature from 2021 to September 2024 reveals that while existing approaches can effectively enhance knowledge and short-term motivation, fewer interventions focus on long-term behavioral change or developing competencies like systems thinking and anticipatory skills. In conclusion, these findings point to the need for implementation of more robust and longitudinal research to ensure that initial enthusiasm translates into lasting contributions toward sustainability goals.

Keywords

gamification, game-based learning, sustainability education, agency

INTRODUCTION

Rising temperatures, declining biodiversity and increasing resource scarcity paint a grim picture of the planet's future. For many, particularly younger generations, these crises evoke confusion, emotional overwhelm and powerlessness. The vastness of the challenges often overshadows the perceived efficacy of personal actions, leaving many feeling helpless. Terms such as eco-anxiety have emerged to describe the chronic fear and hopelessness that arise when individuals feel powerless to address the scale of these issues. Exposure to sensitive and often distressing information about the state of the world exacerbates individuals' stress and lack of hope (Wamsler

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2020). The result is a troubling paradox: while sustainability education aims to inspire positive change, it can inadvertently heighten feelings of inadequacy and paralysis, particularly when it fails to offer tangible pathways for engagement. Amid this context, the challenge is clear: how can sustainability education move beyond simply raising awareness to cultivating a sense of constructive hope? A hope rooted not in blind optimism but in meaningful action and achievable pathways.

Hope, as a concept, occupies a complex and sometimes contentious space in discussions around sustainability and environmental education. It is often viewed as a double-edged sword. Critics argue that hope may serve as an illusion—a comforting but ultimately misleading emotion that fosters unrealistic optimism and potentially reduces active engagement. On the other hand, hope can be a powerful motivator when grounded in actionable pathways and personal or collective agency.

Drawing on Snyder's Hope Theory (Snyder 2000), hope can be understood as having three core elements: goal-setting, which involves setting meaningful and positive objectives; pathway thinking, which is the capacity to identify and develop strategies to achieve those goals; and agency thinking, the motivational energy to pursue those strategies despite obstacles.

Given the popularity of games across generations, particularly the young, gamification is often posited as hope—an approach that may appeal to a wide audience and help educate them on sustainability, increasing sustainable actions. While definitions of gamification vary, in this research, we understand it as a design process that aims to make engagement with non-game, and often non-engaging activities, such as learning about sustainability, more engaging and game-like (Landers et al. 2018). Most often, this may involve the use of game elements, such as badges and points (Deterding et al. 2011), but we argue that gamification is more about user-centric design that considers users' engagement needs and addresses them (Morschheuser et al. 2018). Gamification can theoretically aid with the three components of Snyder's Hope Theory (Hamari et al. 2018; Hassan and Leigh 2021; Loock et al. 2013). Through gamified and game-based experiences, learners may gain both the motivation and confidence to take meaningful action toward sustainability goals, transforming awareness into tangible outcomes. By strengthening agency, individuals may recognize their capacity to make a difference, turning feelings of helplessness into proactive engagement. Ultimately, hope comes from action, and games may be a key tool in enabling this shift from passive concern to active participation.

It has been debated (Hassan 2024), however, whether gamification truly represents the hope for sustainability education some think it is. This paper presents a systematic literature review that explores how the use of gamification and game-based approaches in sustainability education can foster hope. The aim is to holistically summarise the reported impact from use of gamification on sustainability education and to identify areas requiring further research. While there have been previous literature reviews on gamification and sustainability (Douglas and Brauer 2021; Pineda-Martínez et al. 2023; Stanitsas et al. 2019), the uniqueness of this literature review lies in its focus on summarizing reported outcomes across multiple dimensions of sustainability and diverse educational and geographical contexts, rather than simply focusing on environmental aspects, pro-environmental behaviors, higher education or European settings. We also simultaneously examine gamification and game-based approaches, rather than focusing on examining just one approach, given

that these approaches tend to be used interchangeably by researchers as they lack a standardised definition (Hassan 2024).

BACKGROUND

Education for Sustainable Development

The 2030 Agenda for Sustainable Development, adopted by the United Nations, outlines 17 interconnected Sustainable Development Goals (SDGs) aimed at guiding the transformation toward a sustainable society (UNESCO 2017). These goals address three fundamental dimensions: economic, social and environmental. However, only 16 percent of the SDG targets are on track to be met globally by 2030, with the remaining 84 percent showing limited progress or a reversal of progress (Sachs, Lafortune, and Fuller 2024). As UN Secretary-General António Guterres aptly stated, we are in a "*battle for our lives*," yet it still remains "*a battle we can win*" (UNESCO 2020).

Recognizing the pivotal role of education in driving sustainable development, UNESCO has called for the global adoption of Education for Sustainable Development (ESD) (UNESCO 2020). A framework for integrating sustainability principles and dimensions into education, ESD aims to equip individuals with the knowledge, skills, values and attitudes necessary to proactively address global challenges. Through interdisciplinary and participatory learning approaches, ESD emphasizes the development of competencies that empower learners to act as agents of change in addressing sustainability challenges.

At its core, ESD emphasizes the development of three interconnected components: cognitive (knowledge and understanding), affective (values and attitudes) and behavioral (intentions and skills) (Czok et al. 2023). Within these domains, ESD emphasizes the cultivation of the following key competencies essential for navigating the complexity and interconnectedness of sustainability issues (Wiek et al. 2011):

- **Anticipatory Competence**: Enabling learners to envision future scenarios and prepare for uncertainties.
- **Normative Competence:** Encouraging engagement with ethical questions and value-based decision-making.
- **Systems Thinking:** Promoting an understanding of the interdependencies within social, economic and environmental systems.
- **Strategic Competence:** Supporting learners in designing and implementing solutions to sustainability challenges.
- **Collaboration and Communication:** Building skills for cooperative problem-solving and dialogue across diverse groups.

The conceptualizations of these competences in the ESD field vary from more deterministic ones to more holistic ones. Sustainability competence is commonly understood as a holistic, contextual and relational concept that is inherently emergent (Wals 2015). It is emergent because a sustainable future cannot be precisely defined; we can only identify what is unsustainable today. Confronted with this uncertainty, complexity and magnitude, many grapple with eco-anxiety, helplessness and even hopelessness, which can hinder their ability to translate knowledge and skills into action. Scholars, therefore, suggest that in order to address these emotional barriers, ESD must explicitly incorporate affective dimensions, particularly anticipatory

emotions like hope, as a means of fostering resilience, optimism and agency (Ojala 2017; Wals 2015).

Hope

It is first important to understand what 'hope' is. Psychological and philosophical scholarship conceptualizes hope as a future-oriented mindset that integrates cognitive, emotional and action-based elements (Lazarus 1991; Snyder 2000). Lazarus (1991) associates hope with uncertainty, describing it as the desire for a specific goal despite unfavorable odds. This aspect makes hope different from optimism and is why hope is often regarded as a vital mechanism for navigating uncertainty, fostering agency and mobilizing efforts toward addressing pressing global challenges, including climate change and sustainability (Freire 1992; Ojala 2012).

However, hope has also been perceived as a way to escape from reality and responsibility, leading to passivity and inaction. Addressing this concern, Snyder (2000) proposed a theory that connected hope to action components. Snyder conceptualizes hope as a cognitive process involving three interrelated components: clearly defined goals, pathway thinking (the ability to identify strategies to achieve these goals), and agency thinking (the motivational force to act on these pathways). This theory positions hope as inherently linked to action, distinguishing it from related concepts such as optimism or wishful thinking. Individuals high in hope, according to Snyder, not only envision desirable futures but also actively navigate obstacles, adapt to setbacks and sustain their efforts toward achieving their objectives (Snyder et al. 2002).

While this framework focuses primarily on individual goals, it offers a valuable lens for understanding how hope can motivate action in broader societal contexts. In the context of societal transformation, critical hope, as described by Freire (1992), acknowledges the difficulties of the present while maintaining a belief in the possibility of change. This form of hope balances negative emotions, such as worry and fear, with a forward-looking perspective, motivating individuals to engage in actions that challenge unsustainable systems. Empirical studies support the idea that hope and worry can coexist dialectically, driving engagement by combining emotional investment in the present with optimism about the future (Ojala 2012). Similarly, existential hope—a trust in humanity's resilience and ingenuity—provides a foundation for more actionable forms of hope, although it risks becoming passive unless coupled with critical reflection and agency (Webb 2007).

Agency, defined as the belief in one's capacity to influence outcomes, is central to connecting hope to meaningful action. In sustainability education, cultivating agency is vital for empowering individuals to address complex challenges like climate change. Agency develops through mastery experiences, where individuals engage in tasks that challenge them and experience success, as well as through social support and opportunities for meaningful action (Bandura 1997). Social support and opportunities to act meaningfully further reinforce this sense of efficacy, encouraging individuals to persist even in the face of setbacks. Importantly, pathways toward hope must remain concrete and achievable. Unrealistic or overly abstract visions of the future risk undermining motivation, leading to disengagement and cynicism (Hicks 2014; Oettingen 2012).

METHODOLOGY

This review adopts a systematic approach similar to that adopted by Hassan and Hamari (2020) to investigate the integration of gamification and game-based methods in sustainability education. The literature search was conducted in September 2024. An initial exploratory phase was undertaken to identify and refine potential keywords for the search strategy. As with any literature review, no keyword selection could guarantee exhaustive results. The search query ultimately employed was: (sustainab* OR environmental*) AND (educat* OR learn* OR teach*) AND (gamification OR serious game* OR video game* OR storification OR board game* OR game-based*).

These keywords were selected to reflect both the broad spectrum of sustainability related education practices and the diverse terminology associated with game-based learning approaches. The keyword "environmental" was included to account for the frequent conflation of sustainability with environmental concerns in academic discourse, thereby ensuring comprehensive coverage of studies that address sustainability through purely an environmental lens.

The search was conducted across three major academic databases**:** Scopus, Web of Science and PubMed**.** These were chosen for their comprehensive coverage of interdisciplinary research, particularly in the fields of education, psychology, environmental studies and health related behavior change. The initial search yielded 2,738 records. After removing duplicates (403), the titles and abstracts of the remaining 2,335 records were screened resulting in 496 papers for full-text consideration. The inclusion criteria focused on studies that (1) explicitly addressed gamification or game-based learning; (2) engaged with sustainability education contexts; and (3) reported learning outcomes, impacts or indicators of cognitive, emotional or behavioral change, including the development of key ESD competencies.

Papers were excluded if they were literature reviews, written in a language other than English, or focused solely on describing game development processes without reporting on educational implementation or outcomes. The review coding is still ongoing with the current insights drawn from a systematically analyzed subset of 86 papers published between January 2021 and October 2024. Of the 496 papers selected for full-text review, these 86 papers were the ones that had been fully screened, read and coded at the time of writing. These formed the analytical base for this paper and were considered sufficiently diverse in topic, context and methodology to offer meaningful insights into current trends and gaps. Data coding followed a deductive approach and focused on examining how the studies align with sustainability education goals outlined in the ESD framework (Wiek et al. 2011), as well as game types, target audiences, educational contexts, and reported outcomes. Thematic synthesis was further employed to identify patterns and gaps within the literature. During this process, themes of agency and hope emerged from the data. These emergent themes were then explored in greater depth. To guide this exploration, Snyder's hope theory (Snyder 2000) was applied as an interpretive lens to explore how the interventions foster elements of hopeful thinking. Coding, at this stage, has been done by the lead author, with discussions over unclear cases with the co-authors where needed.

FINDINGS

This section presents the key findings. The review examined the types of game terms employed, the mechanics that drive engagement and the learning outcomes achieved. It also examines the competencies these interventions aim to develop and the SDGs addressed. Additionally, the review considers the intended impacts of these initiatives and the sustainability dimensions that are prioritized. In addition, the analysis also identifies how elements of hopeful thinking, as framed by Snyder's Hope Theory (2000), are reflected in the reviewed studies.

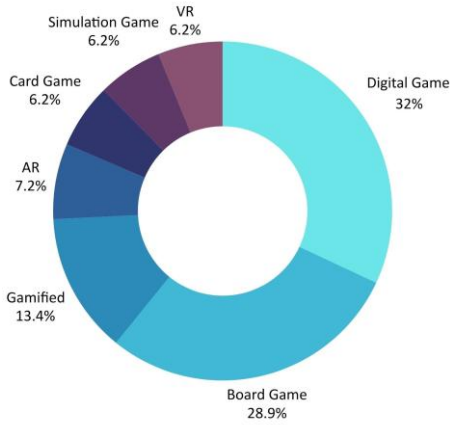

Figure 1: Distribution of interventions/terms found in the literature

Figure 1 illustrates the distribution of intervention types in the reviewed studies. The results indicate a preference for digital and board games, which constitute 32% and 29% of the interventions, respectively. This near-equal representation indicates a balance between technological and analog interventions. Gamified approaches accounted for 13% of interventions, reflecting a growing trend toward embedding engagement-driven elements into traditional learning frameworks. Augmented reality (AR) and virtual reality (VR) made up 7% and 6%, respectively.

The significant presence of board games emphasizes their unique value in fostering interpersonal skills and promoting communication—critical elements in sustainability education. With board games, participants engage in both human-to-human interactions and human-to-environment interactions. By encouraging face-to-face interaction and collaborative problem-solving, board games create social learning environments that drive engagement and enhance understanding (Manshoven and Gillabel 2021; Scurati et al. 2022). This hands-on, low-tech approach not only supports contexts with limited technological access but also leverages social dynamics to reinforce learning outcomes. Digital games, on the other hand, offer scalability, accessibility and the ability to simulate complex sustainability scenarios (Scurati et al. 2022). In addition, both digital games and VR have been shown to foster nature connectedness and relatedness, potentially helping players form emotional ties to natural environments (Avcu and Yaman 2024; Spangenberger et al. 2022).

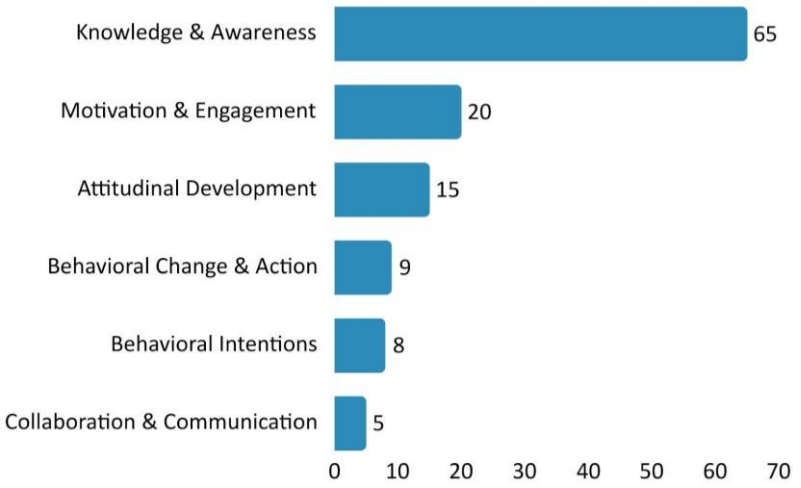

Figure 2: Outcomes reported in the literature

Figure 2 illustrates the distribution of learning outcomes across the reviewed studies, revealing a predominant focus on *Knowledge and Awareness*, which appears as the most frequently targeted outcome. This indicates that the primary goal of many gamified and game-based sustainability interventions is to enhance learners' understanding of sustainability concepts, challenges and potential solutions. Given the multifaceted nature of sustainability issues, emphasizing foundational knowledge is essential for equipping participants with the necessary information to make informed, responsible decisions. Moreover, such cognitive outcomes can serve as an important starting point in the formation of hope, as they can help learners articulate clear sustainability goals and begin to imagine actionable pathways toward them.

Following this, *Motivation and Engagement* emerges as the second most targeted outcome, reflecting the dual objective of not only informing learners but also inspiring active interest and involvement. This aligns with the core purpose of gamification, which often leverages motivational elements to increase participants' investment in the learning process. Interventions that effectively cultivate motivation and emotional engagement can help lay the groundwork for constructive hope, by strengthening the affective and agentic basis through which learners can come to see themselves as capable of pursuing meaningful sustainability goals.

Attitudinal Development ranks third, pointing to the efforts to shape mindsets, internalized values and dispositions that support sustainable behaviors. This suggests that gamified and game based interventions in sustainability education extend beyond knowledge transmission, aiming to instill pro-environmental attitudes that can drive long-term change.

By contrast, *Behavior Change and Action* and *Behavioral Intention* are among the least frequently targeted outcomes, reflecting the persistent challenge of translating awareness and attitude shifts into concrete, sustainable actions. While building knowledge and fostering engagement are important precursors, supporting learners in moving from intention to action often requires development of both individual and collective agency, along with opportunities to explore viable strategies for change. Although many interventions help articulate sustainability goals and stimulate emotional investment, fewer extend this trajectory by reinforcing the cognitive and

strategic tools learners need to envision and pursue actionable pathways. This gap may reflect the complexity of designing for and measuring long-term behavioral outcomes. As a result, the pathway from hopeful thinking to sustained behavioral engagement remains underrepresented within the reviewed literature.

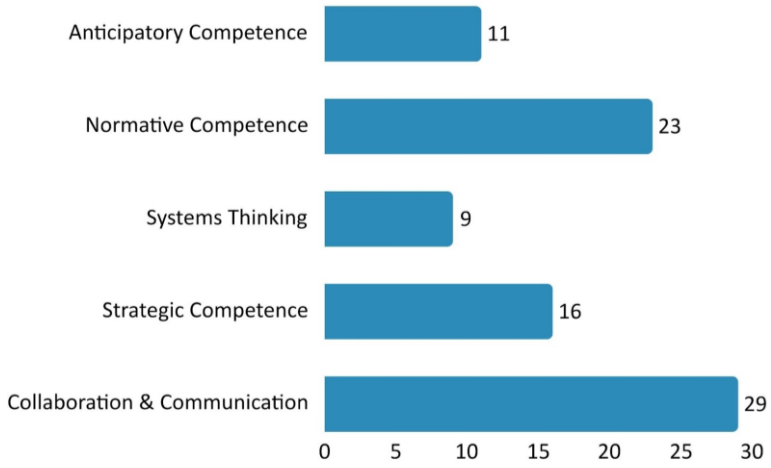

Figure 3: Sustainability competences targeted in the literature

Figure 3 presents the distribution of competencies targeted in the reviewed studies, categorized according to the framework proposed by Wiek et al. (2011). The results reveal a pronounced emphasis on *collaboration and communication*, reflecting the importance of interpersonal skills. This focus reflects the recognition that addressing sustainability challenges often requires collective action and effective stakeholder engagement. These can help cultivate a sense of collective agency, where learners come to see themselves as capable of effecting change through shared effort.

Normative competence also features prominently, highlighting the role of ethical reflection and value-driven decision-making in sustainability education. The prioritization of these competencies suggests that many interventions aim to cultivate learners' ability to navigate the moral and ethical complexities inherent in sustainability issues.

In contrast, *strategic competence and anticipatory* competence receive comparatively less attention, suggesting that many interventions do not fully engage with the skills needed to plan for and envision long-term sustainability pathways. These competencies are important for helping learners identify realistic routes toward desired outcomes and adjust their strategies in response to emerging challenges. Their underrepresentation suggests that while learners may be encouraged to commit to sustainability values, they may not be equally supported in developing the cognitive tools required to navigate complex or uncertain pathways toward those goals.

Systems thinking emerged as the least targeted competence. This points to a gap in supporting learners' understanding of interconnectedness and their capacity to perceive interdependencies and complex causal relationships. Without this perspective, it can be more difficult for individuals to identify where and how action is possible.

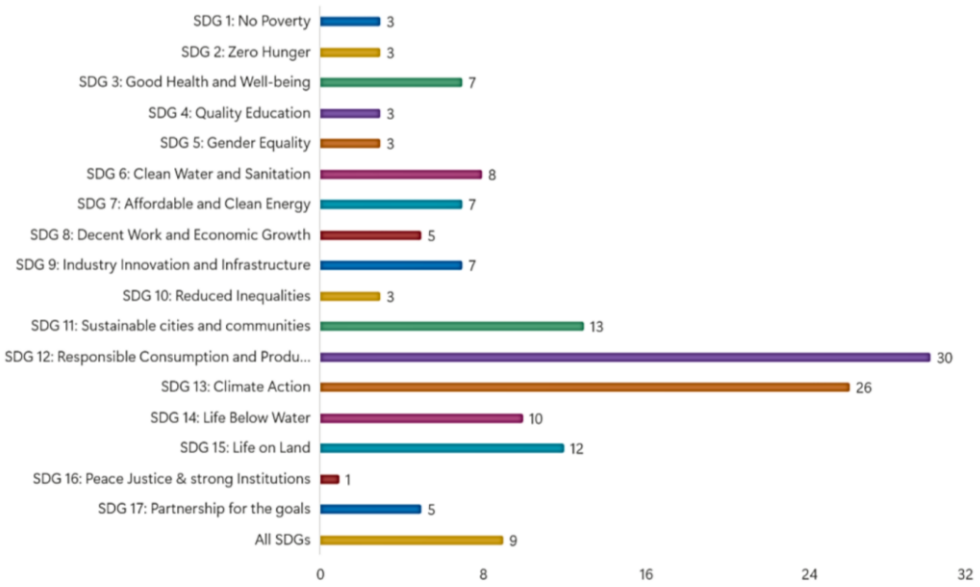

Figure 4: SDG goals addressed in the literature

Figure 4 illustrates the distribution of the SDGs targeted by the interventions. The data reveals that SDG 12 (Responsible Consumption and Production) is the most frequently addressed. This strong emphasis reflects the growing recognition of the need to foster sustainable consumption patterns and advance circular economy practices. SDG 13 (Climate Action) follows closely, demonstrating the critical role of environmental education in raising awareness and driving action on climate-related challenges. SDG 11 (Sustainable Cities and Communities) and SDG 15 (Life on Land) also feature prominently, illustrating the contribution of gamified and game based learning to urban sustainability initiatives and biodiversity conservation.

Conversely, SDG 16 (Peace, Justice, and Strong Institutions) is targeted by only one intervention, reflecting limited engagement with governance and institutional dimensions. Similarly, goals such as SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 4 (Quality Education), SDG 5 (Gender Equality) and SDG 10 (Reduced Inequalities) receive less focus, with just three interventions each.

This distribution reveals a prevailing concentration on environmental aspects of sustainability, with comparatively less attention directed toward social equity and institutional strengthening. This trend is echoed in the data presented in Figure 5, which shows that 55% of the reviewed studies prioritized ecological concerns over other dimensions. This highlights the urgency of addressing ecological challenges, such as climate change and resource depletion, within sustainability education. The social dimension is emphasized in 24% of the interventions. In contrast, the economic dimension receives attention in 22% of interventions, suggesting that while topics such as resource efficiency and the circular economy are addressed, they remain secondary to environmental and social priorities.

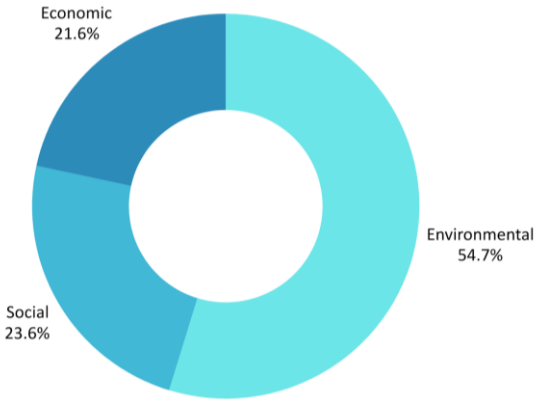

Figure 5: General focus of the reviewed literature

While environmental issues often serve as tangible and immediate entry points for engagement, the limited integration of social and economic dimensions suggests missed opportunities to cultivate more holistic understandings of sustainability. Broadening the focus to include these often-overlooked aspects can provide learners with a wider array of entry points and action possibilities, enabling them to relate sustainability challenges to their own contexts and concerns. This inclusive framing not only deepens understanding of the interconnected nature of sustainability but also promotes multiple routes to meaningful impact. In doing so, such interventions have the potential to strengthen pathways thinking and reinforce learners' sense of agency, thereby supporting the belief that diverse, collaborative and context-specific forms of action are both necessary and achievable for advancing sustainability goals.

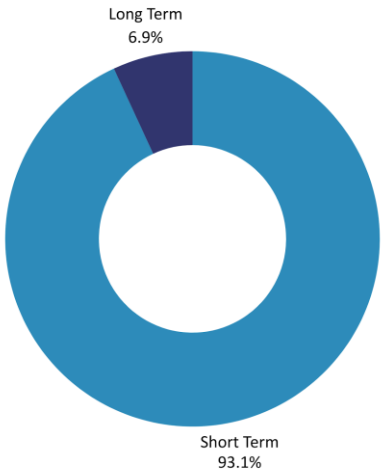

Figure 6: Temporal focus of the reviewed studies

Figure 6 illustrates that the majority of the interventions (93%) predominantly emphasize short-term impacts, focusing on immediate behavioral shifts, engagement and knowledge acquisition. This trend suggests that while these interventions are successful in fostering initial awareness and promoting pro-environmental behaviors, there is comparatively less attention given to assessing or fostering long-term, sustained change. This can make it more difficult for learners to imagine continuity between present actions and future outcomes. Without reinforcing longer term

orientation, the development of hopeful thinking, especially the capacity to chart pathways forward, may remain underdeveloped.

DISCUSSION

Amidst the global sustainability challenges and mounting uncertainty, hope is more important than ever. It can provide the motivation to act, even in the face of overwhelming difficulties (Pharris 2024). While systemic issues may seem beyond the control of any single person, individuals and communities can still contribute to meaningful change. Games and gamification, as tools for education and engagement, can play a significant role in this process. Through their interactive and immersive nature, they empower individuals to make decisions, collaborate and experience the impact of their choices in a controlled environment. At the same time, they foster a sense of agency and collective responsibility (Canossa et al. 2022; Cid et al. 2024; Novo et al. 2024). This discussion will examine how games and gamification can support sustainability efforts, utilizing Snyder's Hope Theory to analyze how these methods can cultivate pathways thinking, agency and collective action.

Goal-Setting

Snyder's (2000) theory begins with goal-setting. Clear, meaningful goals provide direction, transform abstract challenges into tangible targets and inspire action. This principle is directly mirrored in games, where goal-setting is a core mechanic (Salen Tekinbaş and Zimmerman 2003). Games motivate players by presenting achievable objectives, fostering a sense of progression and purpose, and enabling them to connect their actions to meaningful outcomes. This also reflects the core tenets of Goal-Setting Theory, which demonstrates that specific, challenging goals enhance motivation and performance (Locke and Latham 1990).

Goal-setting can also be understood as a behavioral nudge— a subtle intervention that shapes decision-making environments to encourage desired actions without limiting individual autonomy. Goals act as psychological anchors that serve as reference points, activating cognitive mechanisms like loss aversion, which motivates individuals to sustain effort and persist in goal-directed behavior. Research suggests that while nudges and similar interventions may not significantly enhance environmental knowledge, they effectively promote pro-environmental behaviors at low implementation costs (Kurokawa et al. 2023).

Our findings indicate that knowledge and awareness were the most frequently targeted outcomes across the reviewed interventions. This emphasis plays a crucial role in goal-setting and hopeful thinking, as it allows learners to define and refine their goals and envision viable sustainability outcomes. As Snyder (2000) argues, high-hope individuals tend to set more specific and meaningful goals, while vague goals are less likely to be pursued effectively. Providing learners with foundational knowledge helps them clarify what sustainability challenges exist and what is at stake. Thus, knowledge acquisition not only builds literacy but also helps learners form concrete, purposeful sustainability goals.

Similarly, in the context of gamification and game-based applications, clear goals are some of the key aspects that help users attain their desired goals from using an intervention (Hamari et al. 2018). We found that a lot of the reviewed interventions, if not all, leverage goal-setting to engage learners with global sustainability challenges,

aligning their efforts with specific SDGs. By linking in-game goals to these real-world objectives, such tools encourage learners to internalize sustainability concepts and envision actionable solutions (Monteiro and Sousa 2024; Novo et al. 2024). For example, research on energy conservation demonstrates that students who set higher goals show significantly greater awareness of energy-saving behaviors one month later compared to those who did not (Igei et al. 2024). However, most of the studies, as presented in figure 6, reported on short-term impacts of the interventions, leaving open questions on the long-term. Based on that, we call upon researchers to conduct studies that evaluate how users perform long term in reference to the goals set by the interventions. It is important to understand the extent to which behaviors remain aligned with the set goals, how phrasing of goals influences long-term adherence, and if there are personal differences based on, for example, demographics.

Pathway Thinking

While goal-setting provides important direction and focus, it does not guarantee that individuals will know how to reach their objectives. As discussed previously, knowledge and awareness are frequently targeted outcomes, and they can play a crucial role in initiating hopeful thinking. However, knowledge alone is insufficient. For goals to translate into meaningful action, learners must also be equipped with the cognitive tools and strategies necessary to chart realistic pathways forward. This is where pathway thinking becomes essential. According to Snyder (2000), pathway thinking reflects the perceived capacity to identify and navigate multiple routes toward desired goals. Yet, our findings revealed that strategic and anticipatory competences, were among the least frequently addressed in the reviewed interventions. Strategic competence involves planning and problem-solving through critical thinking and adaptive reasoning, while anticipatory competence draws on creativity, foresight and long-term planning to envision and prepare for future scenarios. These competences are vital for helping learners plan for uncertainty, consider alternative strategies and revise approaches as conditions evolve. Their underrepresentation suggests that while learners may be encouraged to commit to sustainability goals, they are often not supported in building the mental flexibility needed to act under complex or shifting circumstances.

The literature reinforces this challenge. This "knowledge-action-gap" has been a recurring theme in the literature on gamification in sustainability education (Muenz et al. 2023). This gap can be attributed to two key factors: a lack of clarity on actionable steps (pathway thinking) and skepticism about the efficacy of individual contributions (agency thinking). The challenges can be narrowed down to the fact that the impacts of one’s actions on the environment are hardly visible or experienced immediately (Fauville et al. 2020). To help address the knowledge-action-gap, video games have emerged as innovative tools for effective climate communication. The narrative elements in them have proven to be significant predictors of pro environmental cognitive attitudes, showcasing their interactive and persuasive features in the context of climate communication (Daiiani et al. 2024). Moreover, due to the affordances of presence and immersion, VR experiences have been shown to help overcome these challenges (Fauville et al. 2020; Xiong et al. 2024).

These tools are especially relevant given the nature of sustainability crises, such as climate change, which are often characterized as 'wicked' problems. These problems are marked by complexity, ambiguity, and unpredictability and defy easy solutions. Effective decision-making in these contexts often requires strategies that can adapt

to uncertainty and provide pathways forward despite incomplete information. Serious games, or more full-fledged narrative-based interventions, may offer a solution as they share a number of common characteristics with games, including the ability to capture complexity, to highlight the importance of effective communication and to provide space for reflexive learning, collaboration and dialogue. Quantitative and qualitative findings reveal how games designed with simulated scenarios enhance students' understanding of uncertainty and robust decision-making (Webber and Ozis 2024).

By framing uncertainty as an integral aspect of sustainability challenges rather than a limitation, serious games and narrative-based intervention can help build competencies to promote pathways thinking. Students may be able to develop strategies despite incomplete information, building resilience and a nuanced perspective on decision-making under uncertainty. This approach integrates cognitive understanding with experiential learning, enabling students to translate awareness into meaningful action and may be better suited to the task of sustainability education that translates into action.

Another significant gap in the reviewed literature concerns systems thinking, which emerged as the least frequently targeted competence across the interventions. Systems thinking equips learners to understand sustainability not as a set of isolated issues but as a complex, interdependent system of environmental, social and economic factors. It enables individuals to identify feedback loops, cascading effects and the broader implications of their actions. As reflected in the data collected from the reviewed studies, sustainability is often primarily associated with environmental issues, with SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action) being the most commonly targeted areas. However, sustainability is a multi-dimensional concept, encompassing not only the environmental but also the social and economic aspects, all of which are interconnected. A systems thinking approach invites learners to explore these interconnections. Several studies in our review showed how gamified learning tools can help participants recognize these interconnections, encouraging them to consider the broader impacts of their actions (Canossa et al. 2022; Jain et al. 2022; Kioupi et al. 2022; Muenz et al. 2023). Despite these promising examples, the limited attention to social and economic sustainability in current interventions reflects a missed opportunity. Without the ability to see how different dimensions interact, learners may struggle to envision holistic solutions or recognize the full scope of their agency. Designing more complex and nuanced narratives is therefore necessary to approach sustainability on all dimensions. By engaging with complex sustainability challenges, players are prompted to see how changes in one dimension can ripple through others, both positively and negatively, thus helping them envision practical pathways that integrate all three dimensions of sustainability (Jain et al. 2022). We therefore call upon researchers to expand their investigations into the social, economic and other underexplored dimensions of sustainability, while more deliberately integrating systems thinking into game design to enhance learners' capacity to perceive and navigate the complex interdependencies that characterize sustainability challenges.

Agency Thinking

Games that provide participants with the "right answers" tend to be less effective in learning since they limit the opportunity for personal discovery. In contrast, games that emphasize an open discovery process, where players face dilemmas and

challenges, allow for experimentation with various strategies (Andreoni and Richard 2023; Czok et al. 2023). By learning from both successes and failures, players gain experiential knowledge of real-world sustainability issues and possible paths forward (Andreoni and Richard 2023). This process strengthens the concept of agency, which is the belief that one can make a meaningful impact. When learners are given the autonomy to navigate decisions and explore alternative pathways, their sense of agency increases. Indeed, our review showed that perceived autonomy has been identified as a key contributor to Behavioral Intention to Learn (BIL), particularly when mediated by autonomous motivation and preferred learning modalities (Xiong et al. 2024). This sense of autonomy and agency often then extends beyond the virtual world, inspiring players to take tangible steps toward sustainability in their own lives (Hoffmann and Pfeiffer 2022).

Specific game mechanics are instrumental in fostering agency. Choice-based decision-making, where players' decisions influence the game's trajectory, provides players with a sense of control (Toprac 2013). Reviewed studies show that this perceived control was associated with the development of psychological ownership, which in turn influenced how learners valued and engaged with sustainability content (Zhang 2024). Notably, even simple choice mechanics, such as avatar selection, task choice or personal goal-setting, contributed to this effect by strengthening players' connection to their progress and outcomes (Zhang 2024). For instance, one study found that when students could choose which SDG-related questions to explore, they reported greater enjoyment, increased awareness, and higher engagement throughout gameplay (Leung et al. 2021).

In addition, feedback loops, such as consequences of player actions and real-time environment changes, reinforce the impact of individual decisions, encouraging players to recognize the significance of their choices (Hassan et al. 2019; Salen Tekinbaş and Zimmerman 2003). As seen in the reviewed studies, reflective elements, such as post-session debriefs or in-game prompts, can enhance this process, helping players develop metacognitive awareness of their decisions and build confidence in their capacity to act (Alp et al. 2024).

As mentioned previously, a key challenge in sustainability education is that individual actions often do not produce immediate or visible effects, leading to feelings of helplessness. Here, the concept of collective agency becomes crucial. Collaboration is central to addressing complex sustainability issues, as solutions often require the input and cooperation of multiple stakeholders. Games that incorporate collaborative mechanics, such as team-based challenges and cooperative goal-setting, are particularly effective in cultivating this competency. Data collected for this review indicates that collaboration is not just a key learner outcome targeted but also the competency most often addressed in sustainability-focused games.

Games that integrate collaborative mechanics not only enhance individual agency but also strengthen collective agency. Through team-based problem-solving and shared decision-making, players experience the interconnectedness of their actions within a group context. By providing real-time feedback on group progress, these games reinforce the importance of cooperative action, allowing players to recognize how collective efforts lead to more effective sustainability outcomes.

Importantly, both individual and collective forms of agency are closely linked to motivation and emotional engagement, which emerged as the second most

commonly targeted learning outcomes across the reviewed studies. Games that incorporate meaningful choices, responsive systems, and visible consequences can enhance intrinsic motivation by supporting learners' psychological needs for autonomy, competence and relatedness (Rigby and Ryan 2011; Ryan and Deci 2000). When learners perceive their decisions as impactful and relevant, they become more emotionally invested in the learning process. This affective engagement helps cultivate constructive hope by allowing learners to envision themselves as capable of contributing to sustainability transformations (Ojala 2012). In turn, this belief in one's efficacy can serve as a powerful driver of sustained engagement and action beyond the game.

Emotional Dimension

While anxiety was a foreseen emotion, anger emerged as an unexpected yet recurring theme across multiple papers reviewed (Alp et al. 2024; Bekoum Essokolo and Robinot 2022; Webber and Ozis 2024), often triggered by environmental injustices. Individuals may become overwhelmed by feelings of helplessness or channel their anger into unconstructive actions. While anger can serve as a powerful motivator, driving individuals to take action and increase engagement, it also has potential drawbacks. If not managed effectively, anger can lead to disengagement, frustration, or even counterproductive behavior. Such anger is, however, a natural and understandable response to the current state of the planet.

A contributing factor to these emotional responses is the tendency of individuals to view the problem of unsustainability as primarily a technical challenge, often placing their hope in the creation or development of a new technology as a solution (Monteiro and Sousa 2024; Ojala 2017). However, single minded focus on the technical point of view not only drives consumption but also results in lack of empathy and overlooks the broader systemic, social and ethical dimensions of sustainability challenges. True environmental sensitivity extends beyond knowledge of ecological issues; it requires an emotional connection, as sensitivity reflects a certain level of empathy (Bekoum Essokolo and Robinot 2022). Empathy plays a crucial role in fostering sustainable attitudes and pro-environmental behaviors, suggesting that cultivating empathy can drive more autonomous and enduring environmental action (Kurokawa et al. 2023).

Gamified approaches that incorporate scenario-based learning and collaboration have been shown to stimulate empathy towards nature, cultivate creativity and promote the meaningful exploration of environmental issues (Tramonti et al. 2024). Incorporating narratives, role play and team collaboration in pedagogical practice allows the use of imagination, enabling students to not just imagine new possible futures but more importantly put themselves in the shoes of others (Monteiro and Sousa 2024). For example, the *Blue Gold* (Rodríguez et al. 2024) role-playing game immerses participants in the lived experiences of characters affected by cobalt mining, such as a Congolese child or an American consumer. This approach not only deepens understanding of systemic injustices, like child labor and violence against women, but also prompts behavioral shifts, as participants may reconsider their consumption patterns, including delaying or refusing new purchases (Rodríguez et al. 2024). Embodying an archetypal character or the role of a stakeholder as part of a teamwork assignment, provides individuals with an opportunity to view the world through another perspective and set of lived experiences (Runnerstrom et al. 2024). Interestingly, it has been observed that there is no significant difference between roles but there is a very large gender effect (Rodríguez et al. 2024).

Incorporating real stakeholders into the classroom is often hindered by practical challenges such as scheduling conflicts and time constraints. While virtual platforms provide an alternative, coordinating meaningful stakeholder engagement remains a complex endeavor. Role-playing games offer an elegant solution by emulating stakeholder inclusion, allowing students to engage with critical perspectives and social dynamics in a manageable and immersive format (Waeber et al. 2023).

CONCLUSION & MORE FUTURE DIRECTIONS

Viewing games and gamification through the lens of Snyder's (2000) Hope Theory reveals their potential as powerful tools for fostering agency, supporting goal-setting and encouraging pathways thinking—key competencies for addressing sustainability challenges.

This review contributes new insights by identifying specific design features that support these processes. For instance, choice-based decision-making, meaningful feedback and collaborative challenges were consistently linked with enhanced motivation, perceived control and a stronger sense of agency. These findings offer practical guidance for developers of educational games, suggesting that interventions should deliberately incorporate autonomy-supportive mechanics, opportunities for collective problem-solving and visible progress indicators to build both competence and constructive hope.

However, the current body of research indicates areas for growth, particularly in achieving a balanced focus across environmental, social and economic dimensions of sustainability. A clear emphasis on environmental sustainability was observed, with social and economic dimensions receiving comparatively less attention. This imbalance highlights the need for a more integrated triple-bottom-line approach. Additionally, the limited focus on systems thinking—a critical competency for addressing the interconnections between ecological, social and economic factors—reveals a gap in fostering holistic problem-solving skills. Future interventions should embed systems thinking alongside economic literacy and social equity to cultivate comprehensive, interdisciplinary approaches to sustainability.

Quasi-experimental designs emerged as the most prevalent research methodology in our review of the literature. While this approach provides valuable insights, it is not without its limitations. A key concern is the absence of a control or comparison group, which prevents researchers from answering the critical question, "compared to what?" (Chatpinyakoop et al. 2022). This limitation undermines the ability to directly attribute observed changes to the intervention itself. Additionally, the lack of randomization in quasi-experimental designs restricts the ability to draw definitive causal conclusions regarding the effects of the treatment (Bilancini et al. 2023). These methodological constraints indicate the need for more rigorous experimental approaches to strengthen the validity, reliability and generalizability of findings in sustainability education research.

Given the recurring theme of anger, future research should explore how to balance emotional engagement with practical solutions to ensure that anger contributes positively to long-term sustainability goals. Moreover, limited exploration of long-term impacts points to a significant gap in promoting sustained behavioral and attitudinal change. Longitudinal studies and phased interventions are necessary to ensure that initial gains translate into lasting contributions toward sustainability goals.

By combining the motivational power of games with the psychological underpinnings of hope, educators can cultivate learners who are not only informed but empowered to take action. Through meaningful action, we move not just toward solutions, but toward a hopeful future shaped by those willing to envision and work for it.

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