Abuzaharen's Challenge: Building Sustainability Competencies through Science-Fiction Narratives and Game-based Learning

Stathi Paxinos and David Robertson
Monash Sustainable Development Institute, Monash University, Melbourne, Australia

Stathi.paxinos@monash.edu
David.robertson1@monash.edu

Abstract: This paper presents a case study of the evolution of science-fiction themed game-based learning across two Masters units in a higher education course on sustainable development. The authors created three sustainability games to be played by classes in live workshop settings – a card matching game about urban challenges, a hackathon-style sustainability innovation challenge, and a systemic change analysis game - to build students' capacity to think about systems, sustainability values, and strategies to advance positive change. The story of a bumbling, but well-intentioned, alien protagonist, Abuzaharen, serves as a dynamic backdrop to the games, which see students 'transported' to an alternative reality to complete time-bound challenges in a rigorous yet engaging manner in order to find their way 'home' to Earth. This paper documents how each game's narrative, storytelling, design, and play evolved through multiple iterations over four years, drawing on critical reflection, evidence of engagement and student feedback. The paper also reflects on the affordances of generative artificial intelligence (GenAI) for game-based learning designers. One of the games has integrated GenAI to make Abuzaharen a real-time character in the delivery of the game, including judging student's innovation pitches and generating live narrative content about game outcomes. The GenAI alien agent subsequently appears in 'regular' learning content as a course tutor. Qualitative feedback and educator observations suggest the games increased active class participation, built peer connections, fostered skills in problem-solving, promoted collaboration, and modelled creativity. The games also challenge existing narratives about negative impacts of GenAI on tertiary education by illustrating productive and creative uses of GenAI for students and educators. This paper argues that immersive, narrative-driven approaches, coupled with the strategic use of GenAI, can significantly enrich higher education for sustainability and other educational experiences by scaffolding selected competencies and applying complex concepts to real-world challenges in a light-hearted way. It concludes with practice-led insights and directions for future exploration of interest to sustainability educators, designers of interactive learning, and those experimenting with GenAI in narrative-based games.

Keywords: Game-based Learning, Education for Sustainable Development, Generative Artificial Intelligence (Genai), Science Fiction, Narratives, Sustainability

1. Background

This case study focuses on the development and evolution of a series of games that used a common fictitious character and narrative world to enhance learner engagement with complex sustainability concepts. The case is set within two units (subjects) of a postgraduate degree, the Master of Environment and Sustainability (MES), at Monash University, Australia. This interdisciplinary degree has a very diverse learner cohort (Abbonizio and Ho, 2020) and is taught by educators from three Faculties (Science, Arts, and Business and Economics), as well as, the Monash Sustainable Development Institute. The two units in the case are *ENS5340: Transforming Cities for Sustainability* and *ENS5510: Innovation to Influence System Change*, with enrolments between 20-50 per iteration. The units attract students primarily from the MES, but also include students studying business, public policy, urban planning, media and communication and more.

Transforming Cities for Sustainability was first run in 2021 and was developed and taught by the authors of this paper. However, Melbourne, the host city of Monash University, was facing sporadic and sometimes extended lockdowns due to the COVID-19 pandemic, forcing the unit to run primarily online. We were faced with an educational and design challenge of engaging diverse students, who were experiencing isolation, with complex content about wicked problems and sustainable urban management strategies. Our aspiration was to create a fun, social, virtual classroom experience, which we sought to achieve through experimentation with game-based learning (GBL). From this initial challenge, a game (based on card matching) and science-fiction narrative to drive the gameplay was created.

At first, the narrative that underpinned the game was intended to add intrigue, uncertainty, drama and humour. The alien protagonist, Abuzaharen, was a desperate being from a far-away world on the brink of collapse after generations had ignored warnings about the same sustainability challenges currently facing Earth. Over a period of four years and a total of seven iterations of three distinct sustainability-themed games, this storyline has remained as a narrative driver, but the nature of Abuzaharen's character, prominence in the game design, and

the character's relationship with the educators evolved over time. This paper will first set a theoretical foundation for game-based sustainability learning, then describe the three games, then examine the case of Abuzaharen, drawing out critical reflective insights of relevance to educational game design and sustainability learning practice.

2. Theoretical Framing

We frame the contribution of this paper as triangulating three aspects of game-based sustainability learning: the benefit to students; the impact on educators; and the relationship with the attainment of sustainable development competencies.

2.1 Game-based Learning for Student Engagement Gamification

The popularity and acceptance of GBL as an effective tool for learning has been growing as educators look for ways to increase student engagement and motivation (Dicheva et al. 2014). Oliviera et al. (2021), in a review of gamification literature, found that gamification could enhance student motivation, engagement and satisfaction with education, with particular reference to online learning. Tavares (2022) found in a systematic literature review, that GBL improved relationships, enhanced short-term knowledge and learning retention, and had high levels of student engagement and motivation. Mawasi et al. (2021), found, in an article that explored narrative-based learning with digital games through an affordance perspective, that narratives could also enable the development of mental models. This selection of literature shows that GBL can, depending on the type of game, have a range of benefits and the use of a narrative can be particularly impactful.

2.2 Game-based Learning for Educators

Adoption of game-based learning by educators faces a range of barriers, including development time, educational suitability, and evidence of impact (Lester et al. 2023). However, Hung et al. (2017) show that the process of engaging with gamification can encourage meta-awareness of teaching and learning approaches in faculty, potentially leading to benefits accruing not just to students in their direct experience of a particular game, but to the learning culture of the organisation and the wider educational practices of the teachers. Frossard et al. (2015) describe a wide variety of potential benefits to both students and educators when game-based approaches are adopted, which manifest in-class, as well as, in the wider practices of educators. These include fostering a clear focus on student-centred learning necessitated by the game design process, and that tailored games encourage the production of customised learning materials to suit the target cohort. Specifically, the notion of creative educational practice is examined, and the research found that game design and implementation enabled teachers to enact most aspects of creative pedagogy.

2.3 Game-based Learning in Relation to ESD Competency Development

Scholarship in education for sustainable development (ESD) over the past decade or so has converged upon a broadly-agreed set of competencies to inform program design and implementation (Brundiers et al. 2021). These are values thinking, futures thinking, strategic thinking, interpersonal competence and systems thinking (Wiek et al. 2011), along with implementation and intrapersonal competencies (Brundiers et al. 2021) to form an 'integrated problem-solving competency'. Current literature highlights the need for research into effective educational implementation of this competency framework in courses, with a particular emphasis on pedagogies which enable simultaneous or synergistic development of multiple competencies at once (Wiek and Redman, 2022).

In the context of this case study, the two units prioritise student development of strategic, anticipatory, interpersonal, and normative competencies (cities unit) and systems thinking, strategic and interpersonal competence (innovation unit). Lozano et al. (2017) identify game-based learning and serious games as holding promise for supporting student engagement with sustainability learning. Existing research and experimentation with serious games for sustainability, or game-based sustainability education, tend to focus on single-game cases rather than contextual integration of multiple games into a learning process, and there are also few explicit connections made between competency development and sustainability game-based learning to date. Further, there are more papers reporting on gamification of education using tools such as points, badges, levels and

leaderboards than aspects such as storytelling (Dicheva et al. 2014). As such, this paper is novel in its focus on a single fictitious character and narrative which spans multiple sustainability-themed games.

3. Methodology

This paper presents a case study from a process of ongoing educational practice innovation, emerging from the shared interests of the authors in game-based learning, creative pedagogy, and education for sustainable development competency building. Stake (2013:2-3) describes a case as "entities … an arena, host or fulcrum to bring many functions and relationships together for study" and argues that "the most meaningful data-gathering methods are often observational—both direct observation and learning from the observations of others".

Here, the case entity is, literally, a fictitious character - Abuzaharen the alien - and their integration across multiple game-based learning experiences as a narrative device. The case was not initiated as a direct product of structured research inquiry. Rather, the character was invented and deployed as one of many small educational experiments in the shared practice of the authors. The character and narrative gained traction and grew in utility and educational impact over a period of several years, and it only became clear that this particular experiment warranted more thorough critical reflection and analysis when the character made a successful 'leap' from its original context (the initial card game about cities and sustainability) to a new one (the innovation challenge game). We see this as an example of "making to know", after Buchman (2021:37), who articulates how practitioners use the foundation of their existing skills and knowledge to reach for new possibilities, but that, "until we are in the actual process of creating [an uncertain thing], we can't fully know what it will be".

As such, data gathering for this case study did not have a fixed and formal starting point. In order to understand, evaluate and learn from the case study, we combined qualitative data from the range of sources outlined in Table 1.

Table 1: Data sources collated for analysis in the production of this educational case study.

Data gathering method	Cities Card Game	Innovation Challenge Game	Systemic Change Game
Collation of detailed game designs, creative collateral, such as, narrative scripts, and prototyping artefacts for analysis and reflection	X	X	X
Educator meetings to reflect on and discuss games, class observations and student feedback, documented through rolling meeting notes dating back pre-case inception	X	X	X
Formal educational research into learner creativity (including observations, reflective materials and assessment artefacts) - human ethics obtained		X	X
Reflection on in-class live evaluation and student insights using digital feedback tools, such as, polls		X	X

Our combined analysis of this data took place through a series of dialogue meetings between the authors in 2024 in which we reviewed and critically reflected on the collated data above, which had been gathered across the time period of 2021-2024, and engaged in recorded discussions around three core research questions:

RQ1: How do narrative-based games enhance learning about complex challenges?

RQ2: How do game characters and narratives enable educators to innovate?

RQ3: How can game-based learning contribute to the development of specific ESD competencies?

During this process, we discussed the educational challenges we sought to address with the invention of these games and the character; how and why we made certain choices in the evolution and transfer of the narrative across multiple units and games; our understanding of the impact of the game on student engagement and

learning; thematic learnings we have derived as sustainability educators; and future directions for exploration. A transcript of these recorded dialogues was used to structure the remaining sections of this paper.

4. Game Designs

This section describes three sustainability-themed games across two Masters units, their design and content, and the role that the character of Abuzaharen and the surrounding science-fiction narrative played in these games over time. Oliviera et al. (2021), in a review of educational gamification literature, identified seven gamification elements that can stimulate learning, of which four are common to all of the games described below. These are: challenging and clear missions; narrative and fantasy; competition and social engagement; and feedback and reflection. Figure 1 provides an overview of the game structures and aligns their gameplay phases to ESD competencies articulated by Brundiers et al. (2021).

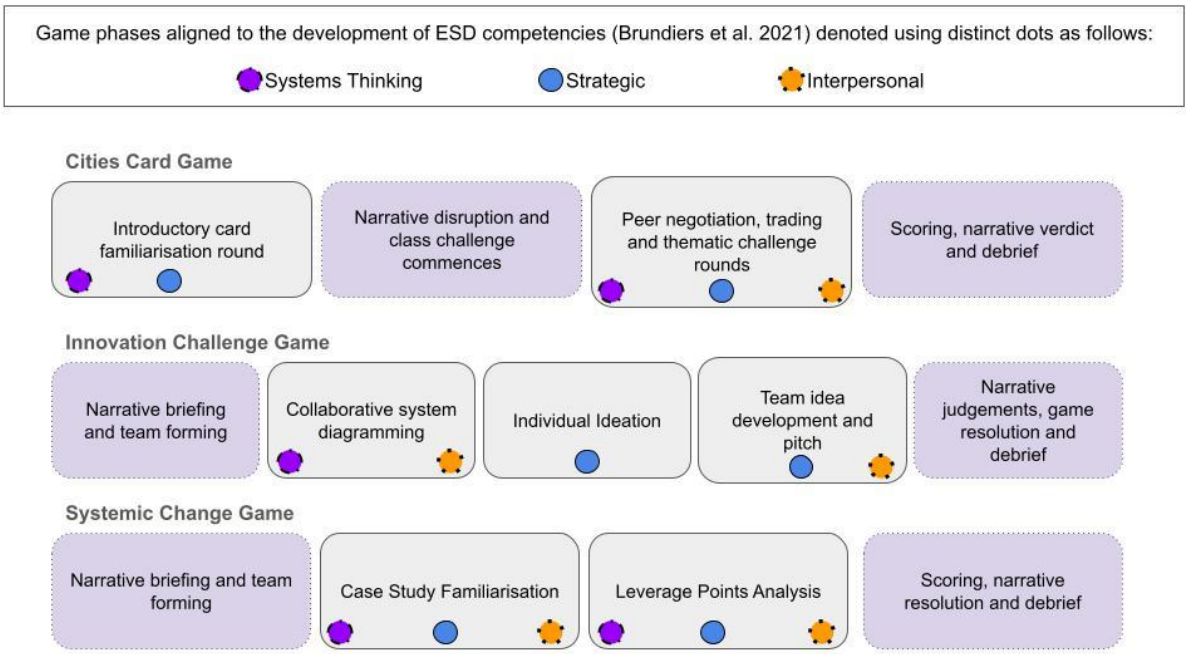

Figure 1: Basic game flow of the three sustainability game-based learning experiences. Boxes with dotted borders denote key narrative components, all others indicate periods of student gameplay. Distinct dot types map ESD competencies onto game-play phases.

4.1 Cities Card Game (2021-2022)

This online card game enables students to explore interactions between challenges cities face and the strategies they can adopt in response. Each student is allocated a Google slide containing five cards that reflect urban challenges (e.g. habitat loss, social inequality) and five that illustrate possible strategic responses (e.g. top-down planning, high density development). Faced with being 'trapped' in an endless temporal loop if they do not meet Abuzaharen's needs, the aim is for player to find positive card alignments (e.g. matching 'bottom-up planning with communities' with addressing 'social inequality') and minimise negative interactions (eg. when 'urban sprawl' is matched with 'habitat loss'). Challenge cards were randomly allocated levels of severity to reflect the uncertainties and complexities of the real world. Students have several rounds to negotiate with other players and trade response cards and can earn bonus points by correctly answering trivia questions based on course content between rounds.

Overall, this was a game of collaboration as well as strategy, because the outcome of the game and the 'fate' of all the students was determined by a combined class score. Players used a tailored scoring system to tally their individual scores from which the educators calculated the class average. If it fell close to the maximum possible result, the class would be 'returned' to Earth.

4.2 Innovation Challenge Game (2023-24)

The Innovation Challenge Game is designed in a hackathon-style format where students are presented with a sustainability challenge, and its original iteration, designed in 2018, is described by Bos and Robertson (2023). Teams follow an innovation process to understand their system of interest, generate an innovative idea for change and deliver a short pitch. In 2023, the students were tasked with developing potential innovations that would improve the sustainability of a large building located on the Monash University campus. In 2024, the students faced a new challenge, with Abuzaharen seeking ideas that would make higher education learning more inclusive, engaging, memorable and interactive, and revive their failing alien society.

Students taking part in these iterations of the game would be returned to Earth if their ideas satisfied Abuzaharen. The alien's feedback was created by GenAI (ChatGPT 3.5) which was prompted on the task requirements and innovation parameters before the workshop. The key criteria given to the GenAI in 2023 required students to show the proposed innovations were more than gimmicks and that they had the potential to create real sustainable change, while the 2024 cohort had to show that their ideas were original, effective and practical.

4.3 Systemic Change Game (2024)

The Systems Change Game was designed to help students identify targeted leverage points used by a range of case studies attempting systemic change, based on a framework proposed by Meadows (1997). During the on-campus class, the students read, discussed and ranked the case studies with the aim of matching the ranking of the class educators. However, we felt a strong narrative hook was needed for the game to work effectively in an online workshop, so we introduced a new storyline for Abuzaharen that set up and landed the game. In the new narrative, a relaxed and happy Abuzaharen wants to reward the students for their success in the Innovation Challenge Game that was played earlier in the unit, by transporting them to his world so they can study the case studies. However, things (again) do not go as Abuzaharen planned and a video shows the portal collapsing to leave the students stranded on an unknown planet. The only way they can 'return' home is by synchronising their thoughts with their on-campus peers, which will allow Abuzaharen to open and direct a portal home. They must achieve this by discussing the provided case studies and assessing their potential to create change. If their scores align with those of the on-campus teams, Abuzaharen can 'send' the students off with a final GenAI-created monologue where the alien expresses their pride and happiness at the result.

5. Evolution of the Abuzaharen Narrative

The overarching narrative of a powerful alien using an appeal for help to save their home planet from sustainability challenges has remained consistent across most of the games. However, Abuzaharen's personality - and therefore the type of tension they brought to the scenarios - has changed. Initially Abuzaharen was a malevolent force willing to use manipulation (ie. 'controlling' the educators against their will) and ultimatums. In the first iterations of the game, the alien protagonist explained that they had 'transported' the class to Xanax (or was about to do so) so the ruling Overseers could use the students' urban sustainability knowledge to save the planet. This is accompanied by a warning that failure would result in students being banished to live out their lives in an endless temporal loop, and Abuzaharen ending the message by telling them to "do not disappoint". However, while still maintaining an authoritative tone, Abuzaharen, in the most recent iterations, possesses a more benevolent presence as a well-meaning, but bumbling, protagonist. In the Systems Change online game, Abuzaharen is seen happy and relaxing on a Xanaxian beach after the success earlier in the unit of the students' ideas to revive the planet's failing education system in the Innovation Challenge Game (although Abuzaharen remains prone to errors that could leave the class in peril).

The method of telling Abuzaharen's story has also become more sophisticated. In the first iteration of the Cities Card Game, the Abuzaharen persona was delivered in a relatively rudimentary manner, with one of the educators setting the alien's image as their Zoom background and attempting, but not entirely succeeding, to hide themselves from view, while reading a short script. This prompted us to pre-record Abuzaharen's parts in the subsequent games, rather than performing them in real time. New scripts and recordings were created for most of the games, which allowed for refinements and to better reflect an increasing range of game narratives. This also allowed for world building as science-fiction themed images and digital footage were sourced, voice modulating tools were experimented with to produce Abuzaharen's voice, and GenAI was integrated as a real-

time participant to play parts of Abuzaharen's role in a more dynamic way. In 2024, we also used visuals generated by GenAI platforms, such as DALL-E, which allowed us to further develop the story's imagery. Figure 2 shows some of the workspaces/game slides used by the students and gives examples of images that were generated to illustrate the recorded and live narrations of Abuzaharen's instructions and judgements.

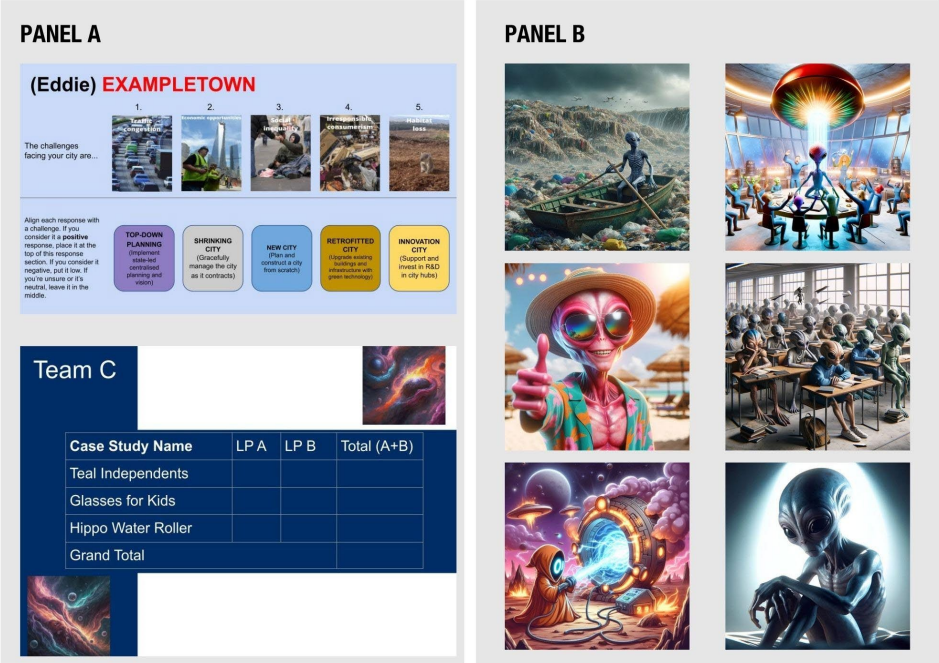

Figure 2: Student workspaces and game images. Panel A, shows, at top, an example of the playing card used by students in the Cities Card Game, and, at bottom, an answer sheet for the online Systemic Change Game. Panel B, clockwise from top left to middle left, shows a Xanaxian rowing a boat among an 'island of plastics', scientists celebrating a discovery before the Xanaxian societal collapse, a classroom of bored alien youth, and a sad Abuzaharen contemplating the fate of their planet (Innovation Challenge Game); and Abuzaharen attempting to power up a faulty portal and a 'thumbs up' from a happy, and relaxed, Abuzaharen on a Xanaxian beach enjoying their society's recovery (Systemic Change Game). The images in Panel B were generated using Gemini (bottom left), and DALL-E, facilitated by ChatGPT.

6. Discussion

In this discussion section, we address the research questions in turn, drawing on analysis and insights from our reflective process.

6.1 RQ1 How do Narrative-based Games Enhance Learning About Complex Challenges?

Learning about sustainable development can be daunting for students, and without careful integration of content and pedagogy, students may not grasp the complexity of the subject matter or may distance themselves from it (Seatter and Cuelemans 2017). The initial intention of introducing a bumbling alien character and sci-fi universe was to enable students to fully engage with the content of a sustainability game without self-censorship and feeling the need to be 'correct' in all of their interpretations of complex material. Setting the culture of the class as one of play and exploration aligns to a guiding principle of the Inner Development Goals project, that "we are far more effective advocates when we are having fun … just because these things are serious doesn't mean they need to be boring" (Inner Development Goals, n.d). In a sci-fi universe, a student may feel more empowered to experiment with combinations of ideas or suggest options that go beyond their current confidence or understanding - a freedom to fail enabled by the game, as described by Oliviera et al. (2021), and explicitly modelled by Abuzaharen, who makes repeated mistakes in their well-meaning attempts at communication with the group.

A specific contribution of the narrative element was the adjustment of traditional classroom roles, which we believe made them more effective than an equivalent game without the narrative aspect (i.e. as a

straightforward card game or hackathon). The first role change is that the Abuzaharen narrative positions the class collectively as themselves, but *themselves as heroes in another dimension with agency over their fate*. This 'permission to be heroes' granted by Abuzaharen comes alongside a second function: the traditional educator-student relationship is disrupted by Abuzaharen, who acts as judge, director, and instructor in the class, while educators have the role of guides and supporters in the game journey - a relationship we believe is appropriate for sustainability learning and in seeking to cultivate wider learning processes in these units. This aspect of games on educators is noted by Frossard et al. (2015), who describe the shift of an educator to a moderating role when games are in progress.

We saw the efficacy of the game-based narrative approach in a variety of ways. One was strong student engagement and motivation in-class. For example, in the four instances that Abuzaharen games ran fully online via Zoom, every student had their cameras switched on throughout the gameplay - in contrast to more conventionally-run classes, where often one third to two thirds would switch cameras off, depending on the type of learning taking place (lecturing, peer discussions, etc). Also, the classes have 'won' every Abuzaharen game - and given that the victory conditions are set to require engagement from all participants with the specific sustainability materials integrated into the multiple phases of each game, and often depend on quite advanced judgement or novelty in interpretation, we can be confident that they have been effective vehicles to provide motivation and engagement.

Student discussion during class debriefs has generally reflected the diversity of benefits of game-based learning. As educators, we lead debriefs with a simple open question: "Why did we do this?". Themes suggested by students across game iterations include:

Becoming comfortable sharing with peers

Creating a sense of belonging

Encourage a sense of responsibility in working together

Being more open to ideas

Bring fun and creative thinking to the class

Think differently about solutions beyond what they consider practical

Generating peer dialogue and debate

Thinking critically about the sustainability topics in the games

This shows students appreciate a mixture of academic and social benefits afforded by the game-based approach.

6.2 RQ2: What did we Learn About the Power of Narrative and how it Influenced the Design of the Learning Activities?

The most surprising aspect of this case study was not that the games were effective - both educators had prior experience with various game-based learning approaches. It was the power of the specific character of Abuzaharen and the science-fiction narrative, and what it afforded us as practitioners over time. After our initial experiment showed promise and the students responded well, we were able to enrich and expand the narrative aspects, and this evolution of Abuzaharen's story has delighted us in many ways. Our confidence in 'selling' the narrative and its value have grown over time, and both authors genuinely embrace science fiction as a genre, which encourages students to place trust in our approach and, therefore, enrol in the games. Students see we are having fun with the narrative while setting serious and productive tasks in-game. We encourage educators to reflect on narrative genres or styles that they authentically enjoy, and use them as a device to transport students to a game-world.

Another lesson we have learned across game iterations is that a narrative approach does not require perfect technology integration or high-fidelity supporting materials. The immersion needs to be sufficient - but striving for perfection may actually undermine the overall success of the experience. Even as our creative artefacts such as videos, imagery and story were refined, we retained some 'rough edges' which are visible to students, such as deliberately cliched imagery and cheesy humour (Abuzaharen's appearance also changed slightly each time a new GenAI image was created as it was not possible - and we did not attempt to - ensure complete

consistency). We believe this is important in modelling a 'safe to fail' environment and freedom to explore. It also means we can develop and adapt the games more quickly - sometimes even live in-class - to respond to the educational needs of different cohorts - reducing the known barrier of development time per iteration (Lester et al. 2023). We have termed this enough-fidelity or 'e-fi' - neither low fidelity or high fidelity - and believe this is both pedagogically effective and supportive of rapid educational experimentation.

The 'e-fi' approach has been important in our experimentation with GenAI. We have deployed ChatGPT 3.5 and Gemini in the games to 'act as' Abuzaharen and provide live-generated judgements, awards and tailored narrative descriptions in the innovation game. GenAI has proven, when given appropriate structuring prompts, capable of delivering surprising and interesting narrative content, often faster and more creatively than the educator team feel they would be capable of in live settings, as well as acting as a dynamic judge of student game outcomes.

However, GenAI can be highly unpredictable - the same set of prompts piloted with one tool ahead of a class may provide different responses when used live. For example, in the Innovation Challenge game, we used ChatGPT to generate a secret target score which student innovations needed to exceed to win the game. This worked in testing, but when identical prompts were used in-class the following week, the software refused to generate a secret number on the grounds that it could facilitate gambling. Rather than ruining the game, we were able to use this as a teaching moment about the pitfalls and drawbacks of GenAI, and show that we, like the students, are on a learning journey about constructive use of these tools. Because Abuzaharen's character (played by the AI) is already established in the narrative as unreliable, we could laugh off this visible failure, pivot to a qualitative judgement method, and continue using GenAI to embody Abuzaharen and move the narrative forward.

Further extending the affordances of Abuzaharen as a character, we have integrated tips and hints throughout curriculum materials in the innovation unit on how to critically and constructively engage with GenAI, using "Ask AI-buzaharen" prompts. Students are encouraged to think of Abuzaharen the alien as a metaphor for AI as a learning tool - potentially super-intelligent, often lacking in 'human common sense', and sometimes flat-out wrong. Thus, as educators, our sustained engagement with this alien character and narrative world has offered us creative approaches to emerging educational challenges well beyond the initial learning intention.

6.3 RQ3: How can Game-based Learning Contribute to the Development of Specific ESD Competencies?

The games have shown strong potential in serving multiple learning functions in relation to education for sustainable development competencies. We designed the games carefully to fit within a wider curriculum design and learning sequence of each sustainability unit. The card-matching cities game synthesises earlier, traditionally-structured online learning content about complex challenges and urban development strategies - that is, it 'tests' students ability to apply what they have learned in novel ways. The Systemic Change Game is similar, but instead of bringing together two content-driven sections, students analyse real-world case studies using a previously-introduced theoretical framework, 'testing' their ability to bring theory together with practice examples. These two games served to support the development of strategic and systems thinking competencies. The novelty, collective challenge, time pressure, incomplete information and dynamic peer interplay meant that the games were vehicles for what Wiek (2011:204) identifies as competence development: "a functionally linked complex of knowledge, skills, and attitudes that enable successful task performance and problem solving".

The innovation game, on the other hand, is the first learning activity in the innovation unit's curriculum and serves to build foundations for later learning. It builds class connection, models safe-to-fail innovation, gives a sense of fun, and previews the later, larger tasks, such as, system analysis. While it touches on systems and strategic competence, its primary function is the development of interpersonal competence and establishing the desired collaborative culture of the class for the upcoming semester. The game is played in teams, each working on distinct aspects of the challenge, and the success of the entire class is used to determine whether victory is achieved. This is a microcosm of the endeavour of sustainable development - a myriad of collaborative projects and processes, with collective success the aim.

As such, we feel this case study shows the potential for game-based sustainability learning to both 'set up' or 'land' aspects of sustainability competency development, and encourage educators and game designers to

explore relationships between game-based learning and more traditional components of curriculum and learning activities in student learning progression.

7. Conclusion and Future Directions

Overall, the case study of Abuzaharen and the application of a sci-fi narrative across three sustainability game-based learning experiences has demonstrated the potential of this approach for driving student engagement and motivation, synthesis and application of learning materials, and to promote interpersonal connection, collaboration and exploration of strategic ideas in relation to complex challenges. It has also demonstrated ongoing benefits and opportunities for the educators, stimulating creativity and enabling engagement with emerging technologies, such as generative AI, in constructive ways.

We feel that future directions for exploration and research include more rigorous evaluation of the efficacy of specific games in relation to targeted learning outcomes and interpersonal abilities. We also believe that generative AI as a game-play agent/character and dynamic narrative generator could have strong applications in more realistic sustainability or other learning contexts, such as organisational simulations, especially when the generative AI agent enables educators to adopt new or different roles in relation to students to enhance the overall learning experience.

A specific example of an intention we have is to use a generative AI character and notions of time travel in the cities unit to support students in exploring real-world urban contexts on a live field tour. We are exploring the potential of a character-driven, time-travel narrative challenge, to build anticipatory (futures-thinking) competency and the ability to 'see' the present, past and future of a place in creative ways, bringing the game-based learning out of the classroom and into even more complex and rich learning contexts.

References

Abbonizio JK, and Ho SSY (2020) 'Students' Perceptions of Interdisciplinary Coursework: An Australian Case Study of the Master of Environment and Sustainability', *Sustainability*, 12(21):8898, doi:10.3390/su12218898

Bos A, and Robertson D (2023) 'Innovation challenges: developing sustainability competencies through experiential learning', in Feldman I (ed) *Key Competencies*, USA.

Brundiers K, Barth M, Cebrián G, Cohen M, Diaz L, Doucette-Remington S, Dripps W, Habron G, Harre N, Jarchow M, Losch K, Michel J, Mochizuki Y, Rickmann M, Parnell R, Walker P and Zint M (2021) 'Key Competencies in Sustainability in Higher Education—toward an Agreed-upon Reference Framework', *Sustainability Science* 16(1):13–29, doi:10.1007/s11625-020-00838-2

Buchman LM (2021) *Make to Know: From Spaces of Uncertainty to Creative Discovery*, Thames & Hudson, London.

Dicheva D, Dichev C, Agre G and Angelova G (2015) 'Gamification in Education: A Systematic Mapping Study', *Journal of Educational Technology & Society* 18(3):75–88.

Frossard F, Trifonova A and Barajas M. (2015) 'Teachers Designing Learning Games: Impact on Creativity', in Green GP and Kaufman JC (eds) *Video Games and Creativity*, Academic Press, London, doi:10.1016/B978-0-12-801462-2.00008-4

Hung A, Yuan C, Dembicki D, Zarco E, Kase M, and Yang M (2017) 'Gamification in the Wild: Faculty Perspectives on Gamifying Learning in Higher Education', *Issues and Trends in Educational Technology*, 5(2).

Inner Development Goals (n.d.) Inner Development Goals (website), accessed 3 May 2024.

Lester D, Skulmoski G, Fisher D, Mehrotra V, Lim I, Lang, A and Keogh, JW (2023) 'Drivers and Barriers to the Utilisation of Gamification and Game-Based Learning in Universities: A Systematic Review of Educators' Perspectives', *British Journal of Educational Technology*, 54(6):1748–1770, doi:10.1111/bjet.13311.

Lozano R, Merrill M, Sammalisto K, Ceulemans K, and Lozano F. (2017) 'Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal', *Sustainability*, 9(10):1889, doi:10.3390/su9101889

Mawasi A, Nagy P, Finn E & Wylie, R (2022), 'Narrative-Based Learning Activities for Science Ethics Education: an Affordance Perspective', *Journal of Science Education and Technology,* 32(1):16-26, doi:10.1007/s10956-021-09928-x

Meadows D (1997) 'Places to Intervene in a System', *Whole Earth*, *91*(1):78-84.

Oliveira R, Pereira C, de Souza CG, da Cunha Reis A, and de Souza WM (2021) 'Gamification in E-Learning and Sustainability: A Theoretical Framework', *Sustainability,* 13 (21):11945, doi:10.3390/su132111945

Seatter C and Ceulemans, K (2017) 'Teaching Sustainability in Higher Education: Pedagogical Styles That Make a Difference', *The Canadian Journal of Higher Education* 47(2):47–70, doi:10.47678/cjhe.v47i2.186284

Stake RE (2013) Multiple Case Study Analysis, Guilford Press, New York.

Tavares, N (2022) 'The use and impact of game-based learning on the learning experience and knowledge retention of nursing undergraduate students: A systematic literature review', *Nurse Education Today*, 117, doi:10.1016/j.nedt.2022.105484.

Wiek A, Withycombe L and Redman CL (2011) 'Key Competencies in Sustainability: A Reference Framework for Academic Program Development', *Sustainability Science,* 6(2):203–218, doi:10.1007/s11625-011-0132-6

Wiek A, and Redman A (2022) 'What Do Key Competencies in Sustainability Offer and How to Use Them', in Vare P, Lausselet N and Rieckmann M (eds) *Competences in Education for Sustainable Development: Critical Perspectives*, Springer International Publishing, Cham, doi:10.1007/978-3-030-91055-6_4.