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Article

Operationalizing the United Nations' Sustainable Development Goals: a Game Jam Experience

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Abstract

This study investigates the educational potential of Game Jams (GJs) for promoting critical engagement with the United Nations' Sustainable Development Goals (SDGs) among undergraduate videogame students. Therefore, it presents and evaluates the 2022 Meaningful Game Jam (MGJ22), a five-day, SDG-themed intervention involving 31 students who developed ten original games. Employing a mixed-methods design, the study integrates questionnaire data and a formal analysis of the games using three complementary frameworks: SDG thematic areas, games for civic learning, and moral learning design principles. Findings explore the potential of GJs in fostering interdisciplinary learning, critical reflection, and civic awareness through collaborative game creation. While students gravitated towards environmental and economic SDGs, themes related to dignity and partnership remained underexplored, revealing key gaps in thematic engagement and awareness. The analysis also highlighted discrepancies between intended learning goals and game mechanics, highlighting the importance of thoughtful design guidance. This work contributes novel insights to game-based learning by demonstrating how GJs can serve as pedagogical tools, helping students rethink their roles, both as designers and as citizens. Ultimately, the study offers evidence-based recommendations for implementing meaningful GJs in higher education, reinforcing their value in cultivating ethical awareness and promoting sustainable development through games.

1. Introduction

Undergraduate game development students often have limited exposure to sustainability topics and may not be familiar with the 17 Sustainable Development Goals (SDGs) or the United Nations' Agenda 2030 [1]. This gap is significant given the long-standing challenges in games education and the pressing need to renew both the games industry and higher education. To address this issue, the SDG-themed Meaningful Game Jam 2022 (MGJ22) at Lusófona University introduced students to sustainability themes through a mixed methods approach, combining pre- and post-event surveys, organizer observations

during the jam, and analysis of the resulting games. The MGJ22 had two aims: (a) explore a more sustainability-driven professional development of future game designers and developers; and (b) create and disseminate games representing creative approaches to sustainability. During five days in February 2022, 31 students, with an average age of 21.74 (*SD* = 2.74) participated in the MGJ22 event at Lusófona University.

This article explores topics such as students' acquaintance with the SDGs, how an extracurricular SDG-themed Game Jam (GJ) was organized within the context of a Videogames undergraduate degree, and its results regarding: student participation, kind of games created and how they related to the SDGs. Its research critically evaluates whether university students from a video game degree program can engage playfully in a GJ centered on serious themes with social impact. Additionally, this study aims to assess how successful the participants are in developing a game concept that addresses a meaningful and relevant theme, while producing a playable prototype that conveys that concept effectively through its game mechanics.

1.1 Sustainable Development Goals and Games in Higher Education

The 17 SDGs "provide an evidence-based framework for national, regional and global sustainable development planning and programming until 2030" [2], serving as a shorthand for sustainability initiatives. Given the interest in using games for sustainability and civics education (as already highlighted in Fabricatore and López [3]), game development students may encounter SDGs in their future careers. This relates how game development students see the medium of games and their role in its industry, which in turn relates to broader shifts in the relationship between games and society. Aligned with this, serious games have repeatedly been shown to support learning across educational and professional contexts. De Gloria et al. [4] provided a comprehensive review of serious games in education, systematizing the main mechanics and model successfully used in such designs.

The United Nations's 17 SDGs [1] are a voluntary non-legally binding framework for international development cooperation, tackling "the pillars of social cohesion, economic stability and environmental sustainability, and many of the other interrelated issues that contribute directly or indirectly to poverty, hunger and inequality, such as peace, stability, human rights and good governance" [5]. They are part of the United Nations' "2030 Agenda for Sustainable Development" [1], which contains 169 targets for achieving them. In favor of the SDGs are the focus on human rights, climate and environmental targets, the inclusive and participatory efforts in their creation, and their intent of universal applicability. The most obvious criticism is their breadth and complexity, particularly the 169 targets, which make them abstract and difficult to parse.

Students' prior experience with games is an inherent challenge in games higher learning. Students often start off thinking like game consumers, valuing games through commercial industry-favored values such as popularity, apparent budget, amounts of skilled person-hours going into the game's development and making use of cutting-edge hardware capabilities. This, alongside lack of diversity in exposure to games, can make students narrow-minded about reasoning "critically and analytically about the games they are studying or designing", about the medium and games' cultural significance [6]. The organizers of the MGJ22, who teach game development to its participants, recognize these issues. Overwhelmingly, students only see games as the industry's commercial outputs, particularly AAA outputs, and tend to only think of their creative development and future careers as finding a place in traditional industry molds [7]. This is creatively limiting,

harmful to student development, and closes off potential for students' artistic, critical reflection, serious game, and research outputs.

Most students arrive at the degree set on perpetuating a hegemony of play as defined by Fron et al. [8] and its "conservative vision of the definition of qualified developers, legitimate games, and stereotypical players", whereas the industry needs renewal towards "more humane, inclusive, and sustainable" practices, towards which higher education can play a crucial part [9] – namely through serious game projects. Universities are increasingly amenable to bridging initiatives between their departments and schools, and game development and research is highly desirable for research centers focused on, for instance, media studies, psychology, or healthcare. This extends to partnerships between research units in different universities. Games degrees can also develop partnerships with civil society, cultural institutions, local governments and more. Games degree students end up doing serious game projects to meet real-world needs, both as coursework and through junior researcher grants and scholarships. Consolidating these opportunities and partnerships has been an ongoing multi-year effort for Lusófona University. Introducing the 17 SDGs to students in a games' degree becomes more relevant given serious games' role in their training and careers, as part of consolidating a counter-hegemonic wider culture of games.

1.2 Game Jams as Pedagogical Practices

A GJ is an open, structured, relatively improvisational single or multi-day event, commonly for 48 hours [10], dedicated to game design creativity. GJ organizers set the theme and other constraints, and jam participants work individually or in small teams to author novel playable works within those constraints. Game Jams (GJs) are held by: AAA game studios as internal events; independent organizations to foster independent game development; non-profit organizations with social concerns; academia as a research process; and as part of game-based learning initiatives – particularly in higher-learning and specifically in game development higher-learning [11]. GJ themes can be about games and play or have broader implications. They can be an explicit arbitrary design constraint (e.g. a game controlled by one button) or a less explicit design rubric inviting reflection in playable form. The latter can be political and cultural subjects such as the 12 heritage-oriented themes in the *Sami Game Jam* [12] the implications of the word "borders" in the *Feminist Game Jam* [12], or even global issues such as climate change in the *Climate Game Jam 2018*. Supporting these notions, Matthews and Thomas [13] further demonstrated how even a virtual GJ could be structured to support the creation of health-related serious games, highlighting the adaptability of the format to diverse educational and societal challenges.

GJs are more about process than finished products. Departing from more ordinary forms of games authoring – particularly in the games industry – which can be more closed-off and results-led, GJs are about collaborative, open, and social game creation. Its participants need only succeed in producing a small, coherent playable prototype on time that demonstrates a response to the design provocation in the jam's theme, enabling idea-sharing between participants. In surveying the term's usage in academic research, Kultima [14] defines GJ as "an accelerated opportunistic game creation event where a game is created in a relatively short timeframe exploring given design constraint(s) and end results are shared publicly". Here, "opportunistic" refers precisely to learning, socializing and networking from the process, being participants' chief appeal of jamming – rather than the delivered game itself.

GJs are expected to foster innovation and break with established routines and patterns of game creation. Fullerton et al. [15] question the "fun way to innovate" of GJs by "brute force" as rarely producing "true innovation"; however, creating truly innovative games takes a backseat to the GJ as a learning opportunity, not just for design craft but also for topics beyond games. Most GJs have also been criticized for reinforcing established design conventions and non-inclusive design values, necessitating the introduction of radical design principles [16] as well as needing to further evolve through better consideration of GJs as performance [17].

Meriläinen et al. [11] reviewed scholarly literature's interest in GJs for informal and formal learning, starting from the notion that GJs "are situated at the intersection of pedagogy, design research, and game studies" and "the practice of educational game jamming has spread from the teaching of game design and development into public education". This interest even encompasses education for social and civic issues. The G4C Student Challenge, for example, was an itinerant GJ series for secondary education students in the United States tackling the topic of climate change in constrained game design activities in 2016-2017, leading to a manual for organizing GJs for this purpose [18].

Lusófona University, through its games program, has organized GJs for multiple purposes, hosting the local edition of the *Global Game Jam*, and regularly hosting GJs each semester to foster socialization between students of the Videogames undergraduate degree and develop soft skills along with technical and creative skills. This is in line with uses of GJs in game development higher education [19]. An ambitious applied GJ hosted at Lusófona University was *Neuro Game Jam* in 2018: a collaborative space for game developers and neuroscientists to develop interactive environments as experiments to answer various questions in neuroscience (the games are accessible in: https://github.com/NeuroGameJam). In 2018, Lusófona University also organized the *Horror Game Jam* (link to the jam here: http://horrorgamejam.ulusofona.pt) in collaboration with the Motel/LX - Lisbon International Horror Film Festival (https://www.motelx.org/en), for interactive and immersive horror experiences.

1.3 Game Jams for Sustainability and Social Impact

Garda et al. [19] mention that the 2030 Agenda for SDGs raised visibility for sustainability issues and looked at sustainability-related discourses in games, concluding that it is more strongly associated with cultural sustainability and heritage in the form of games preservation and materiality, linked to accessibility and inclusion issues. These authors also mention the social sustainability and carbon footprint of games while noting their expressive potential for engaging wider sustainability issues, before concluding that "the bitter truth is that, so far, videogames are more successful as educational tools to introduce the principles of sustainability, than they are at applying these principles on an industry level" [20].

One way to leverage the educational potential of games for sustainable development is through applied GJs, which provide a collaborative environment that fosters teamwork and learning while promoting creativity and playfulness. These events have been used to explore various themes, including education [21], health [22], and social inclusion [23]. A GJ applied to SDGs can serve as a platform for addressing specific sustainability related challenges, with students who participate being exposed to creativity stimulation and critical thinking while engaging in discussion with peers. This makes GJs an effective

method for tackling complex global issues, including sustainability [23]. Moreover, previous studies have shown how serious games can encourage pro-environmental behaviors. For example, Cowley and Bateman [24] explored *Green My Place*, an online game designed to promote sustainability practices, while Kotsopoulos et al. [25] explored gamification strategies to foster energy conservation in everyday contexts.

Embedding the SDGs into playful, design-oriented contexts such as GJs is also conceptually aligned with broader approaches of education for sustainable development and global citizenship education [26], [27]. These pedagogical approaches emphasize experiential, collaborative, and problem-based learning, which resonate strongly with the time-constrained and creativity-driven format of GJs. At the same time, while serious games have been studied as tools for sustainability awareness [24], [28] and GJs have been applied to topics such as cultural heritage [29], [30], or feminism [31], [32], there is still limited research examining how GJs can serve as structured interventions to operationalize the SDGs in higher education. This gap is significant given the need to cultivate not only technical and creative skills but also civic awareness, ethical reflection, and interdisciplinary collaboration among game design students. The present study addresses this gap by analysing how a Game Jam can be mobilized to foster SDG engagement, both in terms of the creative process and the resulting game outputs.

2. Intervention: Game Jam and Resulting Games

The MGJ22 was coordinated by five lecturers from the Videogames undergraduate degree, who acted as organizers and facilitators. They were responsible for designing the structure of the event, delivering preparatory workshops, and offering technical and thematic guidance throughout the jam. At the same time, they also served as researchers, gathering observational data and administering questionnaires. The event was deliberately positioned at the beginning of the academic semester to foster early interaction among students and set a collaborative tone for subsequent coursework.

Participation was mandatory but flexible in format, with the activity contributing a minor component to students' grades. This strategy was adopted to maximize engagement, particularly among students who might otherwise be reluctant to participate in collaborative, extra-curricular activities. In total, 31 students took part: eight first-year students (25.81%), 20 second-year students (64.51%), including the only four female participants), and three third-year students (9.68%).

The jam followed a set of simple but clearly defined rules: (a) students had to join groups of four to six, with each team including members from different years of the program to balance skill levels and experience; (b) each group was randomly assigned up to three SDGs to interpret and incorporate into their design; (c) the outcome had to be a game prototype, which could take the form of a physical paper model, a digital or tabletop prototype, or an alternative-controller (*alt.ctrl*) experience; and (d) groups were expected to actively participate in all jam activities, including iterative feedback exchanges with peers, tutors, and facilitators. Deliverables included a playable prototype, a six-minute pitch presentation, and the upload of the final game to itch.io.

The five-day program was structured into three phases: pre-jam training, collaborative development, and final showcase. The pre-jam phase began on Day 1 with a three-hour lecture introducing the SDGs and a curated set of examples of existing sustainability-related games. These case studies, compiled by the lecturers, included links, synopses, and

gameplay images, giving participants concrete references for how global challenges had previously been translated into playable experiences. This was followed by a three-hour workshop on game ideation, co-led by game design and SDG specialists. The workshop also introduced students to board games addressing sustainability themes and to *alt.ctrl*, including physical sensors and playful media case studies, which were presented as opportunities for innovative human–computer interaction. On the morning of Day 2, a hands-on workshop was delivered on Twine, an open-source tool for visual novels and interactive storytelling, specifically chosen to lower technical barriers and enable participation by less experienced students. Collectively, these activities are referred to as the "pre-GJ".

In the afternoon of Day 2, students were formally assigned into groups, each with members from across different years of study. At this stage, every team was given up to three SDGs to integrate into their design process. Days 2 through 4 were dedicated to collaborative development. Students worked intensively within their teams, while facilitators provided ongoing mentorship through structured daily pitch sessions. These short presentations allowed groups to share progress, receive formative feedback, and iterate on their ideas. In addition, facilitators maintained a dedicated Discord channel where students could request guidance outside scheduled hours, ensuring continuity of support.

The final day (Day 5) was dedicated to presentations and evaluation. Each group delivered a six-minute pitch, presenting their game concept, prototype, and a short gameplay demonstration to peers and facilitators. This resulted in the creation of seven digital games, two board games, and one *alt.ctrl* game, collectively addressing ten different SDGs. Following the pitches, all participants engaged in a collective playtesting session, where they could try each other's games and provide further feedback. The event concluded with the administration of two online questionnaires via the university's Moodle platform, which collected both quantitative ratings and qualitative reflections on the experience.

This structured approach ensured that the MGJ22 combined academic rigor with playful creativity. The intervention totaled approximately 12 hours of structured instructional activities, three full days of game development, and a final day of pitching and playtesting. By explicitly defining organizational roles, participation rules, preparatory training, and facilitation methods, the design of the jam enhances the transparency and repeatability of the research findings, making it possible for other higher education institutions to replicate or adapt the model in their own contexts.

3. Methods and Material

This study adopts a mixed methods design to understand students' creative processes and their perceptions of participating in the hosted GJ. Mixed methods research is generally understood as the integration of quantitative and qualitative data within a single study to strengthen breadth and depth of understanding [33]. Following Creswell's typology [33], our approach corresponds to a concomitant triangulation design, in which quantitative and qualitative data are collected in parallel, analyzed separately, and then integrated during interpretation to corroborate findings. This design was selected because it allows the combination of descriptive measures of students' experience with a deeper exploration of their reflections and creative outputs.

The study employed a convenience sampling approach, including 31 undergraduate students enrolled in the Videogames degree at Lusófona University. Participation was embedded in the curricular program, with engagement supported by its integration into course activities.

Data collection involved two complementary sources. First, a post-jam questionnaire was administered through the university's Moodle platform . The post-jam questionnaire included both closed and open-ended items, which is openly online at https://www.doi.org/10.6084/m9.figshare.31073155. Thirteen items were formatted on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) and targeted specific aspects of the event: (a) reasons for participating in the jam, (b) evaluation of the timing and organization, (c) perceptions of pre-jam workshops (e.g., Twine, *alt.ctrl*, SDG introduction), (d) perceptions of group collaboration, and (e) perceived learning outcomes. Each domain was represented by one or more items developed by the facilitators in consultation with prior GJ literature [11], [18]. In addition, one global item asked students to rate their overall jam experience on a 10-point scale (1 = very poor, 10 = excellent).

To complement the closed-ended data, three open-ended questions asked participants to describe (1) the best aspect of the jam, (2) the worst aspect of the jam, and (3) suggested improvements. These were included to capture experiential dimensions that might not be reflected in fixed-response items.

Second, qualitative data were also derived from the games produced during the jam. Each game was subjected to formal analysis using three complementary frameworks: (1) the thematic areas of the SDGs outlined by Leal Filho et al. [34]; (2) the conceptual framework for games and civic learning by Raphael et al. [35]; and (3) Schrier's [36] design principles for moral learning. These lenses were selected to capture, respectively, the sustainability content addressed, the civic learning potential embedded in gameplay, and the moral dimensions of the game design.

Analysis followed a multi-step procedure. Quantitative data from the Likert items and global rating were analyzed using descriptive statistics to capture trends in participants' self-reported experiences. This descriptive orientation was chosen given the exploratory nature of the study and the relatively small sample size, which did not justify inferential statistical testing. Qualitative data from the open-ended questions were analyzed through inductive content analysis [37], emerging from the answers provided by the students to explore their perceptions about the GJ and the overall pedagogical process. Afterwards, the game analyses were conducted systematically across the three frameworks. For both qualitative analyses, reliability was approached through constant revision, discussion and iteration within the team, during the analytical process.

Integration of data occurred at the interpretation stage. Quantitative results (like the mean ratings of workshops) were compared with qualitative feedback (namely the students' open comments on workshops) to triangulate findings. Similarly, students' perceptions of their learning were examined alongside the independent analysis of their games, allowing for cross-validation between self-reported experiences and demonstrated outputs.

A schematic overview of the methodological approach, including the data collection, analysis, and multi-method integration, is provided in Figure 1.

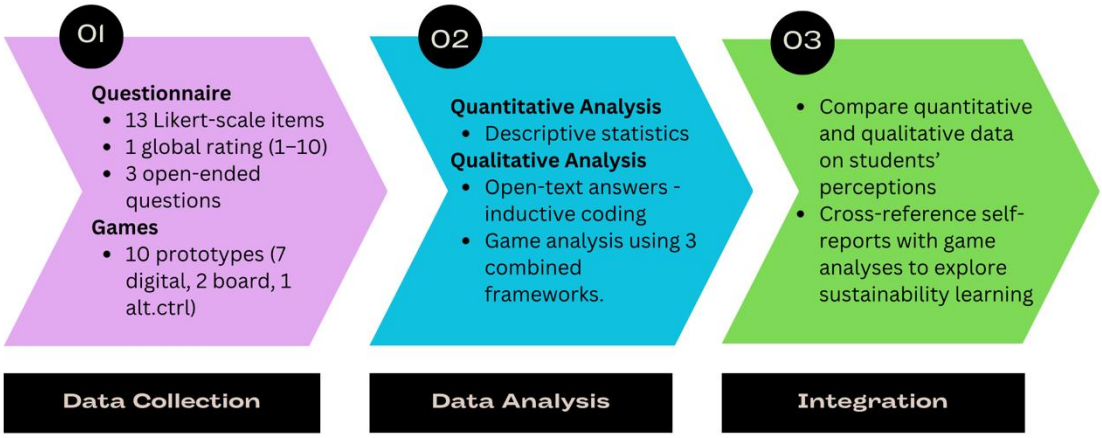

Figure 1. Flowchart of the adopted data collection analysis and integration. The three frameworks adopted for game analysis were based on previous work by Leal Filho et al. [34], Raphael et al. [35], and Schrier [36].

4. Results

4.1 Statistical Analysis of Post-Session Questionnaires

The post-jam questionnaire featured 13 questions with a 5-point Likert scale (from 1 - strongly disagree to 5 - strongly agree), and three open-text questions, which central tendency measures are systematized in Table 1. While no existing validated instrument was identified for evaluating SDG-themed GJs in higher education, the structure of the questionnaire drew inspiration from previous research on GJs and game-based learning, namely works from Meriläinen et al. [11] and Cornish et al., 2017 [18]. The 31 participants were also asked to provide a general evaluation of the GJ through a 10-point Likert scale (see Figure 2). Overall, participants appear to have regarded the GJ as a positive experience, receiving an average score of 7.55 (SD = 1.59). The other results of the questionnaire provide more information regarding the highs and lows of the participants' jam experience, and their motivations for participating.

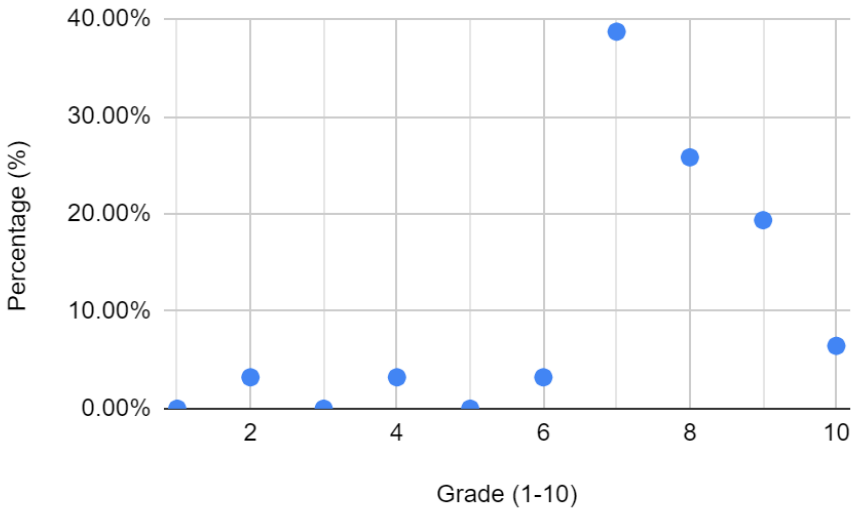

Figure 2. Global Rating of the jam experience, from 1 to 10 (N = 31).

4.1.1 Reasons for Participating in the Jam

These questions mentioned several factors surrounding the context of the jam as an activity integrated in the program of the course, asking about factors shared with GJs in general (ex. interacting with other participants) and others specific to this event (ex. jam impacted participants' grades). Over two thirds of all participants (n = 24; 77.42%) expressed a general interest in GJs (see Figure 3), listing this as one of the reasons for their participation in the event; two participants expressed disinterest in GJs.

When asked about the jam serving to kick off the semester, 18 participants (58.07%) liked the idea; however, nearly a third of participants (n = 10; 32.26%) lacked an opinion on the matter. Two participants also considered the jam occurring at the start of the semester as the main reason for participating (see Figure 3); 70.97% of participants (n = 22) disagreed. More comments about this were made in the open-text questions (see *Qualitative Results*).

Regarding how the jam's stated impact on the participants' grades affected their motivation. Opinions were mixed, as 29.03% of participants (n = 9) felt it pressured them to participate in the event, and 29.03% disagreed that the jam was 'a good opportunity *because* it had an influence on their grades' (see Figure 2).

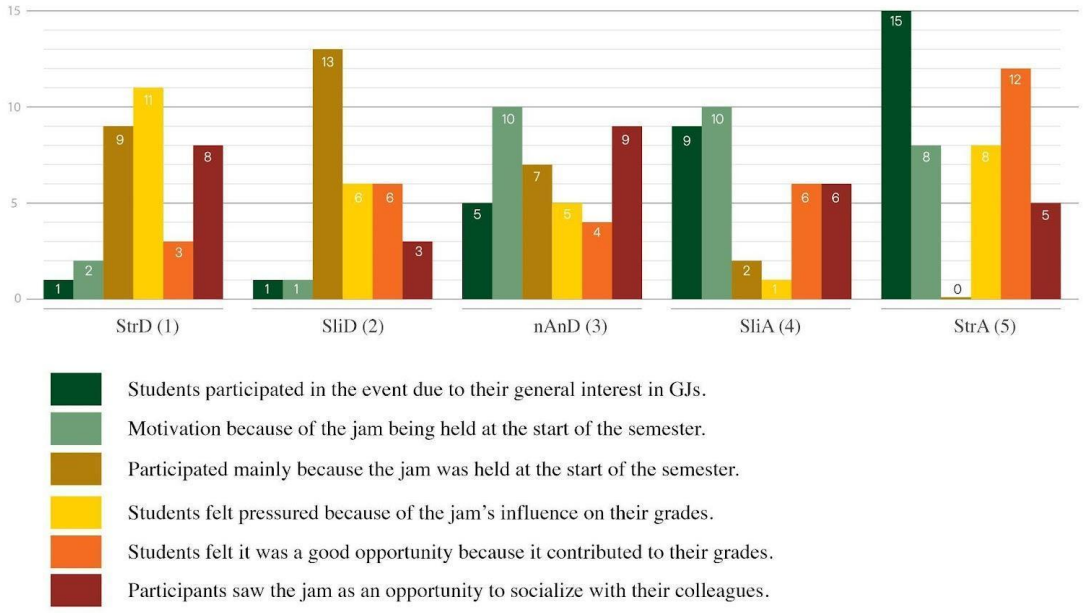

Figure 3. Students' answers 1-6 (5-point likert scale, from 1 - strongly disagree to 5 - strongly agree).

Lastly, when questioned if a reason for participating in the jam was to spend time with their classmates, answers were mixed, with 9 participants (29.03%) not having a specific opinion on the matter and the other 22 (70.97%) being split between agreeing and disagreeing (see Figure 2).

4.1.2 Organization of the Jam

Participants also attributed a level of relevance, from one to five, to each session and workshop from the pre-GJ, and graded the jam's inclusion of support for the projects along with the pitch session where they could get feedback. The pre-GJ activities generally received the same level of importance by the participants, ranging between averages of 3.58 and 3.77 (see Figure 3). The session introducing the SDGs had an average score of

3.58 (*SD* = 0.96), with the sessions on digital and analogue games integrating these goals gathering a score of 3.71 (*SD* = 0.86) and 3.61 (*SD* = 0.95), respectively. The *alt.ctrls* workshop received an average score of 3.77 (*SD* = 0.88), and the *Twine* workshop a score of 3.65 (*SD* = 1.17) (see Figure 4).

The organizers' decisions to provide weekly support to participants along with a pitch & feedback session appear to have been viewed favorably, receiving the respective average scores of 3.84 (*SD* = 1.04) and 4.00 (*SD* = 1.06).

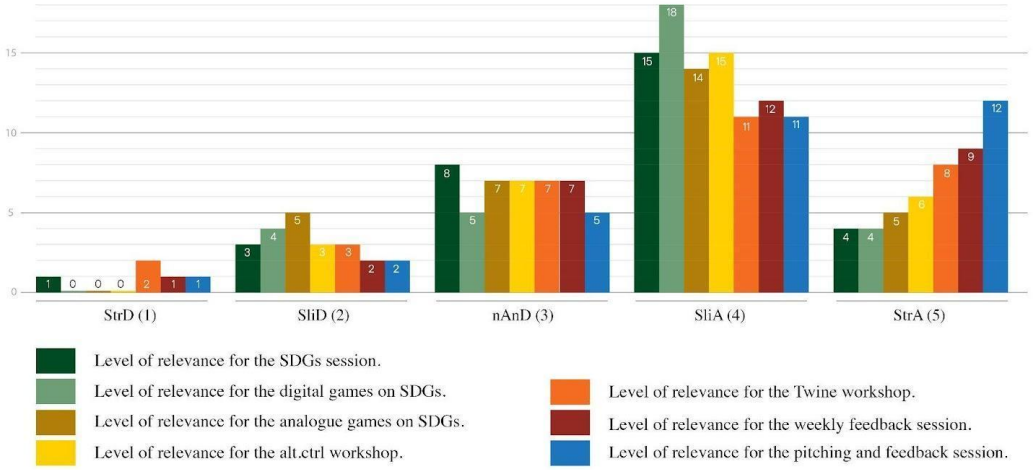

Figure 4. Students answers 7-13 (5-point likert scale, from 1 - strongly disagree to 5 - strongly agree).

Table 1. Mean and Standard Deviation of all 13 Likert-Scale Items.

Post-jam questionnaire item	Mean	SD
Level of relevance for the SDGs session.	3.58	0.96
Level of relevance for the digital games on SDGs.	3.71	0.86
Level of relevance for the analogue games on SDGs.	3.61	0.95
Level of relevance for the alt.ctrl workshop.	3.77	0.88
Level of relevance for the Twine workshop.	3.65	1.17
Level of relevance for the weekly feedback session.	3.84	1.04
Level of relevance for the pitching and feedback session.	4.00	1.06
Students participated in the event due to their general interest in GJs.	4.16	1.04
Motivation because of the jam being held at the start of the semester.	2.06	0.89
Participated mainly because the jam was held at the start of the semester.	3.68	1.11
Students felt it was a good opportunity because it contributed to their grades.	3.58	1.43
Students felt pressured because of the jam's influence on their grades.	2.65	1.62
Participants saw the jam as an opportunity to socialize with their colleagues.	2.90	1.42

4.1.3 Best Aspect of the Game Jam

When asked about the best aspect of the GJ, participants' answers mainly revolved around the opportunity to interact with other student developers while improving their own skills as developers. The most common highlight was the opportunity to interact with senior students of the course, with participants also mentioning: (a) the opportunity to hear other developers' ideas – that may be different from their own; (b) to work in a team of developers specializing in different aspects of game development; and (c) to meet new people.

Participants valued the opportunity to expand their experience in developing games – including the use of tools like *Twine*. Moreover, some specifically enjoyed working on games different from what they were used to – though it is unclear if this refers to the

design of these games or the topics of the SDGs. Additionally, some participants praised the organization of the jam itself. Specifically, the time provided to make the games, the opportunity to receive feedback, and the freedom to develop a game in any of the 'formats' presented in the pre-jam sessions (digital, analog, *alt.ctrl*). Lastly, one participant mentioned that, for them, the 'best' part of the jam was its status as mandatory – referring to its influence on the participants' grades – since it forced them to participate in something that they "likely would not have experienced otherwise".

4.1.4 Worst Aspect of the Jam

Participants' feedback regarding the worst aspect of the jam mainly revolved around its handling of the pre-GJ sessions and workshops. These were mostly scheduled for a time that several participants considered 'inconvenient', and participants also expressed frustration at how only a few of them had the opportunity to interact with the *alt.ctrl* project showcased at its respective workshop.

Some participants felt the workshops were too few and lacked variety. The first one, on SDGs, was especially criticized for being long and unengaging - one participant even called including SDGs the worst part of the jam. Other complaints made by individual participants were: (1) that the jam should not have occurred at the start of the semester – this comment was made by a new first-year student; (2) that the jam had an influence on the students' grades; and (3) that there was no quick access to a printer for analog games.

4.1.5 Game Jam Improvement Aspects

Though only one student called the jam's impact on grades its worst aspect, it was the most suggested change. Many felt making it mandatory brought in unmotivated students, affecting group dynamics. One participant suggested it should only boost grades, letting uninterested students opt out.

Besides this, a group of participants also gave suggestions regarding the pre-GJ sessions, asking for more variety (namely with regards to other development tools besides *Unity* and *Twine*), presentations from industry professionals besides those already employed as professors, and general 'improvements' to the presentation on SDGs. Some participants requested more opportunities for collaboration between students from the different years of the course, specifically requesting the recruitment of more senior-year students. Lastly, one comment asked for a more balanced focus between digital and analog games, and another requested that the GJ be moved to the end of the semester so that students could show what they learned while being assisted by the teachers (this suggestion was made by the same first-year student).

4.2 Developed Games

Through the GJ, participants created: seven digital games, two analogue games, and one *alt.ctrl* game. All were published on the *itch.io* platform. Of the seven digital games, six were made with the *Unity* game engine and one was made with *Twine*. A synopsis of each game, along with an analysis of how they represent their chosen SDGs, is provided below.

4.2.1 Digital Games

PROTEÇÃO DE PATUDOS (https://pedrofdev.itch.io/proteccao-de-patudos) – 'Dog Protection' translated to English language – is a digital 2D game focusing on how local communities should be involved in the care of abandoned animals. The financial side of a kennel is not ignored, and the victory condition is achieved by balancing money generated

with the happiness of the animals and the local community. With an economic mechanics system, this game aims to raise awareness of the dilemmas related to access to food (SDG 2), health, and well-being (SDG 3) for the main characters (animals).

WILD FIRE, WILD ANIMALS (https://baby-the-wind-fairy.itch.io/wild-fire-wild-animals) is a 2D endless-runner focusing on forest fires' threat to wildlife, forests, and society in general. This game tackles this problem forcefully, with a literal activist message. Players control a fox running from a fire that is relentlessly pursuing it, jumping over tree stumps that stand in its way. Since the game is endless, however, it has no solution – eventually the player will be caught by the fire and lose.

Through this pessimistic perspective, where the impacts of humans on the climate (SDG 13) and animal biodiversity (SDG 15) have no solution in the game, the aim is to demonstrate how critical game design can raise awareness of the urgency of these issues.

CANDY SELLER (https://dantheelementary.itch.io/candy-seller) is a 2D-isometric game drawing attention to the realities of child labor and extreme poverty plaguing many developing countries. In the game, the player-character is a child selling candy in the city traffic (see Figure 5). They must approach the cars waiting for the stoplight, get their request, and give the correct candy to get paid. On some occasions, drivers refuse to ask for candy, with the player having limited time to find valid requests before they leave in order to reach the required quota. The game depicts the dangers of this precarious situation, raising awareness of a common reality in many countries (SDG 1). Through movement and economic game mechanics, it aims to show players the real risks and difficulty of earning money when unable to secure employment (SDG 8).

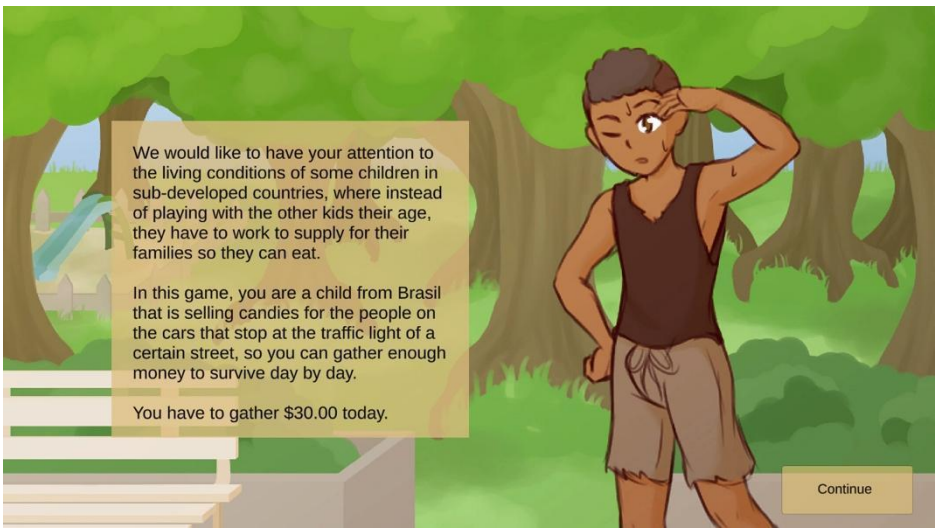

Figure 5. *CANDY SELLER* game screenshot.

DEPRESSIONISTIC (https://pickthekill.itch.io/DEPRESSIONISTIC) is a visual, poetic 2D platform adventure based on personal texts and words from different diaries in which the player progresses through emotions and feelings expressed typographically in platforms. The theme of depression is central to this game, aiming to show that this disease is reflected in periods of deep sadness and other happier periods, but that in the end we can always overcome and stay mentally healthy. The game's design allows the player to navigate through emotionally impactful phrases, aiming to enhance their literacy (SDG 4) on depression and well-being (SDG 3).

CLEANING INITIATIVES (https://pectron.itch.io/ci) – *CI* – tackles issues related to life on the ocean, where a scientist created a robot to remove different types of waste sent by humans to the sea (see Figure 6). The player collects garbage by moving the robot over it, obtaining upgrades over time that make it more effective at its task. Through this swimming and system mechanic (power growth and equipment system), the player needs to clean the ocean (SDG 14) before 2030 to convey that acting on ocean pollution is urgent (SDG 11 and 13).

Figure 6. *CI* game screenshot.

Similarly, *BOOBY TRAP* (https://andre-pucas.itch.io/booby-trap) draws attention to sea pollution. In this 2D, side-view, casual arcade game, players control a booby seabird catching fish in a sea threatened by oil pollution (see Figure 7). Players must manage a hunger meter and an oxygen meter by hunting fish and returning back to the surface, respectively. However, as the player is led to explore the game world , they eventually come across traces of oil pollution, triggering the arrival of a wave of pollution floating their way. If they come into contact with these areas, the seabird becomes covered in oil, restricting its ability to fly and swim. Eventually, they become unable to do either, leading the seabird to either starve to death or drown - both leading to game-over for the player.

The flying and swimming mechanics challenge the player to master the game, but it is the obstacles and constraints, represented by oil pollution, that raise awareness of SDGs 7, 13, 14, and 15.

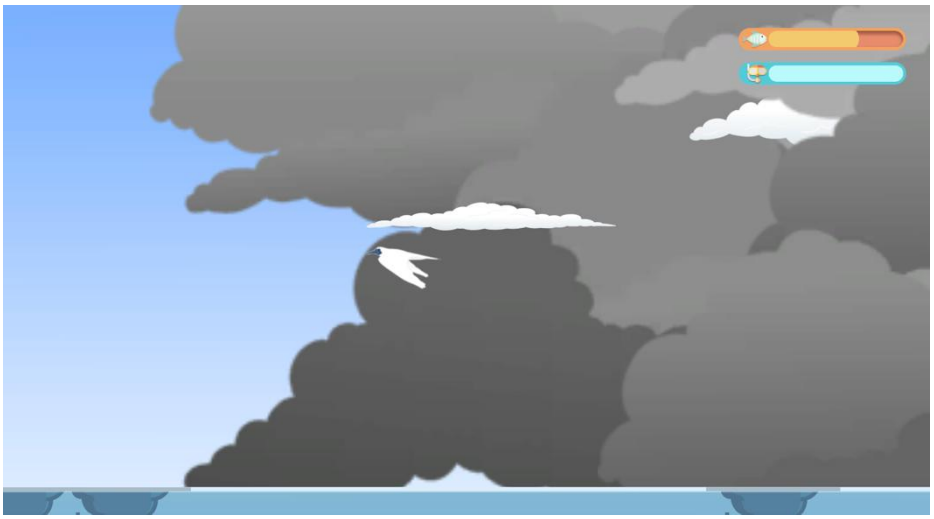

Figure 7. The clouds of pollution that threaten the seabird in *BOOBY TRAP*.

SPOILS OF WAR (https://vascord.itch.io/the-spoils-of-war) is a visual novel game in which the player takes on an emotional adventure as Heric, the son of a farmer who transports some goods to clients in a post-war world. Oriented towards challenging the player with the emotional and personal dilemmas of families involved in moments of war, this game focuses on SDG16 by specifically seeking to highlight the relevance of promoting peaceful and inclusive access to justice for all. Through his daily journeys, Heric's interactions with other characters reveal how people deal with the effects of war, such as post-traumatic stress disorder.

4.2.2 Analogue Games

GREEN MONEY (*https://raymanp2.itch.io/greenmoney*) is a board game where two players face each other in a battle of interests (see Figure 8). One player runs a fossil fuel company, and the other runs a company in the same energy sector that uses renewable energy instead. The fastest company to get rich wins, demonstrating that there are alternatives to fossil fuels. Challenging the player through the greed of increasing profit by exploiting natural resources, this game raises questions about our responsibility in consumption and production (SDG 12), its impact on the climate (SDG 13), and offers opportunities to win through more sustainable energy alternatives (SDG 7).

Figure 8. Game board and components of *GREEN MONEY*.

CORP. (https://bernardoschmidt.itch.io/corp-board-game) is a board game about SDG 8 (decent work and economic growth) as it relates to well-being at work. Players take on the roles of professionals within a company aiming to become wealthy, however, the pressure and workload that the characters face in this fast-paced game creates toxic workplace situations and stress.

4.2.3 *Alternative Controller Game*

GUARDIANS (https://cosmiicfox.itch.io/GUARDIANS), was the GJ's only alt.ctrl game, using the provided alternative rendering interface (hexagonal LED screen). Narratively inspired by the action of protecting the forest, its biodiversity, and restoring its degradation caused by human impact (SDG 15) and natural climate transformation phenomena (SDG 13), the game mechanics focus on the player's dexterity and quick reaction to interact with the environment, a forest represented through the LED interface. Both the game visual aspect and the alternative controller are represented in Figure 9.

Figure 9. *GUARDIANS*' visual rendering interface and custom input controllers.

4.3 Developed Games Within the SDGs

A first look at the games developed as part of this GJ allowed us – based on the contribution of Leal Filho et al. [34] – to organize them according to the SDGs students aimed to tackle through their design process and their thematic areas. This organization is presented in Table 2.

Table 2. Games organized by the thematic area of the operationalized SDGs, according to the classification by Leal Filho et al. [34].

Thematic Area	Included SDGs	Developed Games
Dignity	1 and 5	- *CANDY SELLER*
People	2, 3, and 4	- *PROTEÇÃO DE PATUDOS* - *DEPRESSIONISTIC* - *CORP.*
Planet	6,12, 13, 14, and 15	- *PROTEÇÃO DE PATUDOS* - *WILD FIRE, WILD ANIMALS* - *CLEANING INITIATIVES* - *BOOBY TRAP* - *GUARDIANS*
Partnership	17	No game was developed on the scope of SDG 17
Justice	16	- *SPOILS OF WAR*
Prosperity	7, 8, 9, 10, and 11	- *PROTEÇÃO DE PATUDOS* - *CLEANING INITIATIVES* - *GREEN MONEY* - *CORP.*

Table 2 shows students' interest in game creation related to issues concerning the planet and its prosperity. Conversely, sustainable development thematic areas more related to direct human aspects, namely people and dignity, are comparatively underrepresented. Moreover, "partnership" was not considered in any of the developed games. Nevertheless, it is important to note a certain incongruence between what the students perceive as their design objectives, in terms of SDGs, and what is expressed by the gameplay and/or aesthetic elements in their games. To illustrate this notion, we can explore two examples. First, *PROTEÇÃO DE PATUDOS* shows a mismatch between a high ambition in terms of sustainability awareness through gameplay – aiming to impact people, planet, and prosperity – while adopting a rather simplistic simulation framing. Second, *GUARDIANS*, although adopting both a cooperative play approach and an alternative physical interface, is not seen by its creators as having potential to foster neither partnership, through collaborative player behavior, nor dignity, through increased game motor accessibility.

A second analytical lens that supports the study is provided by the matrix developed by Raphael et al. [35] specifically to understand the operationalization of civic learning through games. As shown in Figure 9 – through the analyses of the developed games – this matrix is based on a system of two axes: one between agency and structure, and the other, between expediency and ethics.

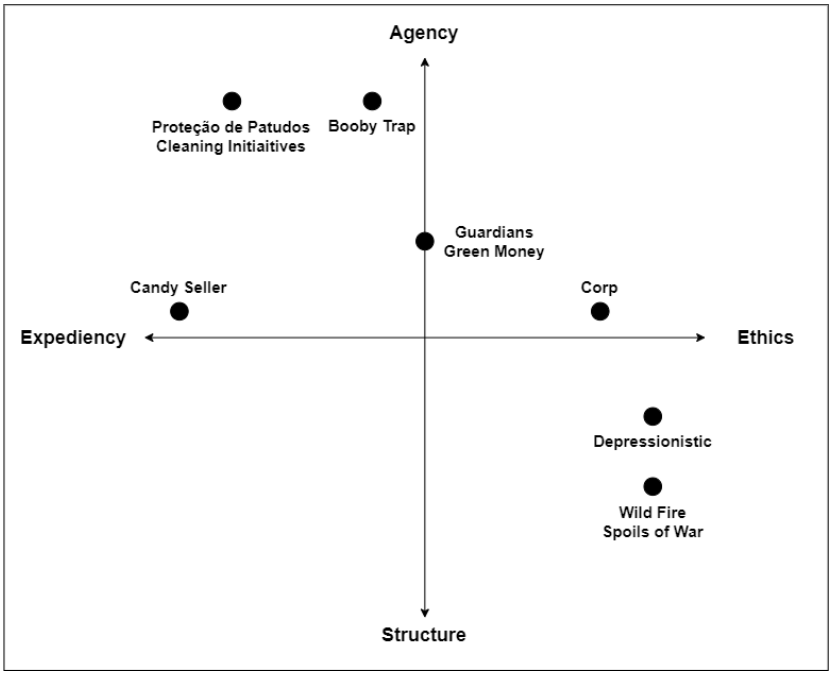

Figure 10. Distribution of the games made in the GJ in the matrix developed by Raphael et al. [28].

Considering this analysis, and in line with the *Games for Civic Learning model* (Raphael et al., 2010), it is important to emphasize the developed games' distribution across the different quadrants. In this respect, only the absence of games in the Expediency-Structure quadrant stands out. This factor can also be explained by the results obtained in the Ethics-Structure quadrant. Games such as *DEPRESSIONISTIC* or *SPOILS OF WAR*, being played through a linear story where decision-making has no narrative impact, appear to be structured. However, the civic learning and moral value component is operationalised here by the clear presence, in these structured narratives, of elements representative of "moral

systems or principles that should guide individuals but also institutional justice" [35]. At an even more extreme point in this quadrant, *WILD FIRE, WILD ANIMALS* presents itself as a simulation in which ethical aspects and systemic justice, or injustice, are presented in opposition. In simpler terms, otherness towards endangered species is promoted through a structured narrative with a strong ethical dimension, where the lack of a solution symbolizes the fragile condition of the game's main character. The combination of ethics and structure as relevant elements in the game design of the projects realized during this GJ can be best explained by the implementation of specific design principles as models for promoting moral learning, as defined by Schrier [36]. In this context, the three examples selected illustrate how these games provide appropriate dramatic and narrative opportunities, while at the same time being concerned with the similarity between the gaming experience and the societal reality reproduced.

On the other hand, the Ethics-Agency quadrant includes games where the player's actions in the gameplay change the political, social or economic status of the situation being played, while also tending towards ethical action – such as *GUARDIANS*, *CORP.*, and *GREEN MONEY*. However, the latter is a very specific case in which the player's action is at a central point on the ethics and expediency *continuum*. In other words, the game design has been conceptualized in such a way that the player – especially the one representing renewable energies – must find a balance between morally correct and economically effective action in order to succeed. Here, and returning to Schrier [36] categories of game design principles, the motto of the GJ was creatively interpreted by providing experiences in which players must move through a complex web of choices and their consequences.

Finally, the games represented in the Expediency-Agency quadrant show greater positional heterogeneity between them. On the one hand, Expediency can't be seen in such extreme terms in the games *PROTEÇÃO DE PATUDOS*, *BOOBY TRAP* and *CLEANING INITIATIVES*, since the management of resources and players' actions also has a strong ethical decision-making component. On the other hand, the game *CANDY SELLER* does not show the impact of the players' actions on the social injustice that the narrative replicates. Congruently, it is more about structure than agency because, although different players can perform differently, it is difficult to understand what impact this has on the poverty and lack of dignity in which the main character lives. In this sense, it is possible to mention this game as the one that seems to have the greatest difficulty in putting into practice the category of design principles associated with the promotion of critical awareness [36] as central to the process of moral learning through play.

5. Discussion

The present discussion is addressed from two different angles: (1) the involvement of students in a GJ, and (2) the promotion of meaningful themes in GJs.

From the first angle, the results demonstrate the relevance of maintaining a GJ in a playful and free format, even when aiming to empower young people in certain meaningful and 'serious' concepts. The fact that the GJ was part of a curricular program (Videogames degree) with an assessment counterpart did not motivate all the students in the same way, with some stating that 'reluctant participants' impacted the group dynamics; this exposes the need for recruitment methods that can reach and convince a significant group of interested participants to join the GJ – ensuring a more cooperative and positive experience for all. Similarly, the fact that broad areas of intervention were presented, but on a specific

umbrella (SDGs), didn't motivate all the students to get creatively involved in game development. Nevertheless, the participants found the overall experience very positive, and all the games developed addressed the SDGs topics in interesting creative ways.

From the second angle, the analysis reveals an inclination among students towards developing games that address environmental issues and economic prosperity which, to a certain extent, can indicate a growing awareness and concern for global challenges related to sustainability. However, the emphasis on these themes also points to a potential oversight of equally critical SDGs that focus on human-centric issues, such as dignity (SDGs 1 and 5) and partnership (SDG 17). Moreover, the absence of games unapologetically targeting the Partnership SDGs suggests a missed opportunity to explore collaboration-driven game mechanics or that those mechanics are undervalued even when they are part of a developed game (e.g. *GUARDIANS*).

Through the game analysis results, it is also possible to highlight a certain mismatch between design objectives and game elements, congruent with the complexity of effectively integrating educational content into engaging gameplay. These results are also aligned with previous research about the prevalence of ludonarrative dissonance in games for learning [38], [39]. Moreover, the analysis points to the need for games that not only entertain but also engage players in critical reflection on the societal issues they replicate. Games that fail to impact players' understanding of social injustices, such as *CANDY SELLER*, highlight the importance of incorporating design principles that promote an in-depth exploration of ethical and civic themes.

In methodological terms, the application of the matrix developed by Raphael et al. [35] offers valuable insights into how games developed through a GJ process can facilitate civic learning. For example, the existence of games – developed through the described process – in the Ethics-Agency quadrant showcases notions of player empowerment and of how they impact the game world through their decisions, emphasizing the political, social, or economic dimensions of their actions. *GREEN MONEY*, for instance, illustrates the delicate balance between moral and economic imperatives, challenging players to reconcile these often-competing priorities.

In summary, from a more conceptual perspective, this study extends the growing body of research on GJs as learning environments by exploring their potential not only for technical skill development but also for civic and moral learning. While prior work has emphasized the role of GJs in fostering creativity, collaboration, and design literacy [40], [41], [42], our findings highlight their capacity to operationalize complex societal agendas such as the SDGs within higher education. In particular, the application of Raphael et al.'s [35] civic learning framework and Schrier's [36] moral learning principles to the analysis of jam outputs demonstrates how theoretical models can be productively mobilized in short, time-constrained design settings. This work therefore bridges the literature on serious games and civic engagement with that on GJ pedagogy, suggesting that GJs can be framed as structured interventions for exploring ethical dilemmas and global challenges.

Conversely, and from a more practical standpoint, the study offers actionable insights for educators and organizers seeking to integrate SDG-related content into game design curricula. The findings give insights on how carefully structured pre-jam training, interdisciplinary team composition, and iterative facilitation can enhance students' engagement with sustainability themes, while also revealing challenges such as uneven motivation when participation is mandatory. These insights extend previous accounts of GJs as sustainability education approaches [40], [43], [44], aiming to provide a replicable

model of how to embed global citizenship education into existing degree programs. Furthermore, the identification of thematic gaps, more specifically the underrepresentation of dignity- and partnership-related SDGs offers concrete guidance for future jam organizers on how to scaffold engagement with less familiar or less intuitively "gameable" sustainability issues.

Finally, it is important to note the temporal gap between the implementation of the study in early 2022 and its current reporting in 2025. During this period, both sustainability discourses and research on game-based learning have continued to evolve, with increasing attention to how the SDGs can be operationalized through participatory and culture-driven pedagogies [29], [30], [45]. Nevertheless, the contribution of this study remains relevant for two main reasons. First, empirical accounts of SDG-focused GJs in higher education remain scarce, and therefore our findings continue to address a documented gap in the literature. Second, more recent studies reinforce rather than contradict the need for playful, collaborative formats that cultivate civic awareness and ethical reflection in students [45], [46], [47]. As such, the implications of the present work seem to be aligned with current directions in both sustainability education and serious games research.

5.1 Limitations and Future Studies

This study lacked a questionnaire recording participants' knowledge of the SDGs prior to the GJ, meaning that the facilitators' observations that most participants appeared to not have had any previous knowledge of the SDGs cannot be effectively validated. Future editions of this GJ could ask participants if they knew about SDGs prior to their introduction. Similarly, participants' apparent affinity for environment- and economy-related SDGs raises relevant questions regarding their perceptions of the different SDGs and their relevance. In addition, the study relied on a relatively small and regionally specific sample ($N = 31$, all from a single Portuguese university), which limits the generalizability of the findings to broader higher education contexts.

The pre-GJ was essential to inform students about the SDGs and critical game design. However, limiting it to one day, along with the absence of experienced students affected the critical depth of the games, especially when compared to other GJs with more experienced participants. While having the GJ impact students' grades led to some discovering they enjoyed such activities, it also led to uncomfortable group dynamics with those less motivated. Methods to recruit motivated participants, ensuring supportive and proactive group dynamics, need to be explored. Integrating the SDG GJ in the monthly GJ activities now being hosted by the course could help gather more seasoned GJ participants to assist student participants further explore the topics through their games' mechanics. Other improvements might include having facilitators from institutions related to SDG topics actively participating in the event.

Another limitation concerns the questionnaire design: although items were carefully developed to reflect the goals of the intervention, they were not drawn from an existing validated instrument, which constrains the comparability of results with other studies. Similarly, the choice to employ only descriptive statistical analyses, while appropriate for exploratory purposes, restricts the depth of inference that can be drawn from the quantitative data. Future research should therefore combine descriptive and inferential analyses and consider using or developing validated scales for constructs such as motivation, collaboration, and civic learning to improve robustness.

Future studies could include an analysis framework dedicated to the fast and iterative creative processes of GJs, as their specific environment may influence the participants' creative process and their games' design. Additionally, the study's observations point to the possibility that the tendency to focus on mental skill when designing games on 'serious topics' may play a role in the low appeal of 'serious games'. This same tendency being observed in university game-dev students may demonstrate an established perception of how these topics 'should be approached' – which results in a damaging cycle affecting the possible variety and appeal of meaningful games. Another aspect would be to deepen the analytical connection between the games' mechanics and the SDGs they aim to address, through more studies focused only on the gameplay analysis. While the present study primarily relied on a more descriptive categorization of outputs, subsequent research could more explicitly examine how specific gameplay mechanics (like resource management, cooperation, or narrative branching) can operationalize sustainability outcomes or foster cognitive and emotional engagement with global challenges. Such an approach would enrich understanding of how game design choices translate into meaningful educational and civic impacts.

Lastly, an interesting direction for future development is the creation of new GJs focused on specific SDG themes, which could provide insights into how students engage with sustainability through critical and applied reflection in game development. Future research should also examine which frameworks are most effective for guiding organizers in achieving these goals, as well as how the time constraints inherent to GJs influence participants' choices of genre and mechanics when working with meaningful themes.

6. Conclusions

The MGJ22 demonstrates the potential of structured, curriculum-integrated GJs to serve as pedagogical tools in higher education. Through students' engagement in the creative challenge of developing games based on the United Nations' SDGs, this initiative not only fostered technical and collaborative skills, but also promoted ethical reflection and critical engagement with global challenges. Despite varying levels of motivation among participants, potentially influenced by the event's impact on academic grading, the experience was largely perceived as positive and meaningful, suggesting that playful, purpose-driven learning environments can effectively complement traditional teaching formats.

Through the formal analysis of the games created, this study reveals both the promise and complexity of embedding sustainability and civic learning in game design education. While participants showed a clear preference for environmental and economic themes, issues such as dignity and global partnerships were underrepresented. Furthermore, instances of disconnect between design intentions and gameplay mechanics highlight the need for more targeted mentorship and support during the development process, through notions of ludonarrative dissonance. These insights call for the refinement of pre-jam training and facilitation strategies to ensure deeper critical engagement with diverse SDG themes.

Ultimately, this work contributes to an evolving discourse on applied game design and game-based learning by offering a potentially replicable model of how GJs can promote interdisciplinary thinking, civic responsibility, and moral learning. Future iterations should continue to explore how design constraints, collaborative structures, and pedagogical

approaches can be optimized to empower students not just as future professionals, but as thoughtful engaged citizens and agents of change in an increasingly complex world.

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Conflicts of interest

The authors declare no potential competing interests on the scope of this research.

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