

The Effect of Gamification on 2nd-Year Primary Education Students at ISCED-Benguela: A Proposal for the Inclusion of Environmental Education and Sustainability in Primary Education in Benguela

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Abstract

This study presents the results of a gamification-based pedagogical intervention implemented in the “Environmental Education and Sustainability” course unit during the second year of the Primary Education degree program at ISCED-Benguela. The objective was to analyze changes observed in student motivation, engagement, and learning following the implementation of a gamified strategy, as well as to discuss the implications of these results for initial teacher training and the future application of this approach in primary education. An exploratory mixed-methods methodology was adopted, utilizing a pre-test/post-test design without a control group. Participants included three instructors (evaluated via semi-structured interviews) and 40 students (evaluated via an academic motivation questionnaire, an environmental knowledge test, semi-structured interviews, and observation grids). The intervention took place over one academic semester, integrating ecological missions, collaborative challenges, and continuous feedback. Results showed improved post-intervention scores, increased student participation, and positive perceptions regarding learning in Environmental Education and Sustainability. Given the absence of a control group, the results are interpreted as exploratory evidence of improvement rather than a demonstration of causal effects of gamification on primary education. It is concluded that gamification, combined with active learning methodologies, constitutes a promising pedagogical strategy for initial teacher training, enabling future teachers to adapt these approaches to the primary education context in Benguela.

Keywords

Gamification, Environmental Education and Sustainability, Initial Teacher Training, Active Learning Methodologies, Primary Education

1. Introduction

The intensification of global environmental problems—such as climate change, ecosystem degradation, biodiversity loss, and improper waste management—has reinforced the need to promote Environmental Education and Sustainability (EES) capable of fostering citizens who are critical, responsible, and committed to sustainable development. In this context, schools play a strategic role in shaping the values, attitudes, and competencies that encourage environmentally responsible behavior; likewise, it is essential that initial teacher training incorporates innovative methodologies enabling educators to address contemporary educational challenges.

In recent decades, gamification has emerged as a promising pedagogical approach to enhance student motivation, engagement, and meaningful learning. By integrating game elements—such as challenges, missions, immediate feedback, levels, scores, and symbolic rewards—into educational settings, this methodology seeks to transform the teaching-learning process into an experience that is more participatory, collaborative, and student-centered. Numerous international studies have demonstrated that gamification fosters intrinsic motivation, improves academic performance, and stimulates skills such as problem-solving, teamwork, and critical thinking, especially when aligned with active learning methodologies and clearly defined pedagogical objectives.

In the specific field of Environmental Education and Sustainability, gamification reveals particularly significant potential by bridging the gap between scientific content and the real-life situations experienced by students and their communities. The use of ecological challenges, contextualized narratives, and collaborative activities can help strengthen environmental awareness, civic engagement, and the adoption of sustainable behaviors, thereby making learning more meaningful and socially relevant.

Despite growing scholarly interest in gamification, most research has been conducted in educational contexts distinct from the Angolan reality; studies analyzing its application in initial teacher training—particularly within the Environmental Education and Sustainability course unit—remain scarce. In Benguela, challenges persist regarding the predominance of lecture-based teaching methods, limited integration of active learning strategies, and the need to prepare future teachers to implement innovative pedagogical practices in primary schools. This gap highlights the importance of generating empirical evidence to understand how a gamification-based pedagogical intervention can enhance the motivation, engagement, and learning of future teachers.

It is against this backdrop that the present study was conducted with second-year students from the Primary Education degree program at ISCED-Benguela, involving the implementation of a gamified pedagogical intervention within the Environmental Education and Sustainability course unit. The study employs a mixed-methods approach using a pre-test/post-test design without a control group. It aims to analyze changes observed in students' motivation, engagement, and academic performance following the intervention, as well as to discuss the implications of these findings for initial teacher training and the future adaptation of this approach to the primary education context in Benguela. Consequently, the study seeks to contribute to the scientific discourse on innovative teaching methodologies and provide evidence to support the strengthening of Environmental Education and Sustainability within teacher training in Angola.

2. Theoretical Framework

2.1. Concept of Gamification

The term gamification refers to the process of applying game design elements in non-game contexts, particularly in education, with the aim of enhancing motivation, engagement, and meaningful learning. In other words, gamification is defined as the use of game design principles within educational settings to make the learning process more dynamic, interactive, and engaging. According to [Deterding, Dixon, Khaled, and Nacke \(2011\)](#), gamification is the “use of game design elements in non-game contexts” (p. 12), seeking to create experiences of playfulness and immersion in activities with educational or professional purposes.

Within the educational field, gamification has emerged as an innovative pedagogical strategy capable of transforming traditional teaching practices into more interactive, learner-centred approaches ([Deterding et al., 2011](#); [Kapp, 2012](#)). By incorporating elements such as points, levels, challenges, feedback systems, and rewards, gamification creates learning environments that encourage active participation and sustained engagement ([Zichermann & Cunningham, 2011](#); [Werbach & Hunter, 2012](#)).

However, gamification extends far beyond superficial entertainment. Rather than merely adding playful components to instruction, it should be understood as a structured pedagogical approach grounded in learning theories, in which game elements function as tools to promote cognitive development, problem-solving skills, and collaborative learning ([Gee, 2003](#); [Hamari et al., 2014](#)).

Consequently, gamification contributes to the development of meaningful learning experiences by enabling learners to interact with educational content in a more immersive, contextualised, and motivating manner ([Buckley & Doyle, 2016](#); [Domínguez et al., 2013](#)).

2.2. History and Evolution of the Concept

The educational use of playful activities is not a recent phenomenon. Since the beginning of the twentieth century, educational theorists such as [John Dewey](#)

(1938) and Jean Piaget (1970) recognised the value of play as a means of promoting active and experiential learning. Nevertheless, the term gamification only gained widespread academic recognition in the early twenty-first century (Deterding et al., 2011).

According to Werbach and Hunter (2012), the concept became particularly popular between 2010 and 2012, when businesses and educational institutions began applying game design principles to improve performance, motivation, and behavioural outcomes. Deterding et al. (2011) were the first scholars to provide a widely accepted academic definition, describing gamification as the partial application of game elements rather than the use of complete games.

Kapp (2012) argues that educational gamification should be firmly grounded in established learning theories, including experiential learning (Kolb, 1984) and meaningful learning (Ausubel, 2000). From this perspective, game elements should serve educational purposes rather than merely providing entertainment.

Within the field of Environmental Education and Sustainability, recent studies (Hamari, Koivisto, & Sarsa, 2014; Johnson, Carvalho, & Tavares, 2022) indicate that gamification is particularly promising for encouraging changes in environmental attitudes and sustainable behaviours by making environmental learning more practical, contextualised, and participatory.

Over recent years, the integration of gamification into educational practice has received increasing attention as an effective strategy for enhancing student engagement, motivation, and active learning (Fardo, 2013; Deterding et al., 2011).

According to Kapp (2012), educational gamification is grounded in motivational psychology and constructivist learning theories, where learners are regarded as active agents in the construction of knowledge. Learning therefore occurs through interaction, experimentation, and continuous feedback.

From an educational perspective, Kapp (2012) emphasises that gamification “is not about turning content into a game, but about using game thinking and game mechanics to engage learners and motivate them to learn” (p. 16). Werbach and Hunter (2012) further argue that successful gamification requires a clear pedagogical purpose rather than the superficial incorporation of points and rewards.

Educational gamification may therefore be understood as a strategy that combines intrinsic motivation-derived from the satisfaction of learning and overcoming challenges-with extrinsic motivation, including recognition, rewards, and visible progress. Together, these elements foster learner autonomy, competence, and social relatedness, which constitute the core principles of Self-Determination Theory (Ryan & Deci, 2000; Jesus, 2023).

2.3. Review of Previous Research on Gamification, Environmental Education, and Sustainability

The international literature reveals a substantial increase in research examining the application of gamification in environmental education. In a systematic review of 24 empirical studies, Hamari et al. (2014) concluded that gamification generally produces positive effects on motivation, engagement, and learning outcomes, alt-

though its effectiveness varies according to the educational context and the design of the intervention.

More recent investigations reinforce these findings. [Novo et al. \(2024\)](#) demonstrated that gamified digital applications enhance education for sustainability by increasing student engagement and encouraging environmentally responsible behaviours. Similarly, [Marlés-Betancourt et al. \(2024\)](#) found that gamification strategies implemented in higher education facilitated the integration of Environmental Education and Sustainability through practical, collaborative learning experiences.

[Galeote \(2025\)](#) argues that gamified methodologies are valuable tools for supporting sustainability transitions because they encourage pro-environmental behaviours while integrating theoretical knowledge with practical learning experiences. Likewise, [Johnson et al. \(2022\)](#) reported that digital games and ecological storytelling platforms significantly increase environmental awareness and promote long-term behavioural change.

Studies conducted in primary education have also reported encouraging results. Thematic challenges, continuous feedback, and symbolic recognition have been shown to increase student participation while strengthening sustainable values and environmental responsibility among young learners ([Mabalay, 2025](#); [Dudok & Pigniczki-Kovács, 2024](#)).

2.4. The Benguela Context

Within the field of Environmental Education and Sustainability, gamification offers unique potential to promote environmentally responsible behaviours, ethical values, and ecological awareness through interactive learning experiences. As argued by [Jacobi \(2003\)](#), Environmental Education and Sustainability should be understood as a formative process that fosters the development of critical, participatory, and environmentally responsible citizenship.

Furthermore, the theories of meaningful learning ([Ausubel, 1982](#)) and social constructivism ([Vygotsky, 1978](#)) provide strong theoretical support for the use of gamification, as it enables the contextualisation of environmental content, encourages peer collaboration, and stimulates reflective learning through action.

Accordingly, integrating gamification into the Environmental Education and Sustainability course represents an important opportunity to introduce methodological innovation while preparing future primary school teachers who are more environmentally aware, critically minded, and committed to sustainable development ([Brundtland, 1987](#)).

Benguela faces several environmental challenges, including inadequate solid waste management, inefficient water use, and the degradation of coastal ecosystems. Within primary schools, teaching practices remain largely teacher-centred, with limited adoption of active learning methodologies and insufficient teacher preparation in Environmental Education and Sustainability.

Against this background, we propose a pilot project that could be implemented in primary schools located along Benguela's coastal area, including Goa, Golfinho, Casseque Marítimo, and Casseque Macau, involving fourth- and fifth-grade classes.

Through gamification, each pupil would become a "Benguela Eco-Guardian", completing missions such as sorting waste, planting trees, reducing water consumption, and participating in community environmental initiatives.

Each completed mission would earn points, digital badges, and collective recognition, encouraging the internalisation of sustainable values. This approach promotes not only the acquisition of environmental knowledge but also behavioural change, civic responsibility, and environmental stewardship.

This proposal is consistent with the principles of Critical Environmental Education (Leff, 2001; Jacobi, 2005), which advocate transformative, context-based educational practices that emphasise student agency and community participation.

2.5. Active Learning Methodologies for the Inclusion of Environmental Education and Sustainability in Primary Education

This section presents several active learning methodologies that, in our view, provide an effective foundation for implementing gamification in the integration of Environmental Education and Sustainability into primary education.

2.5.1. Project-Based Learning (PBL)

Inspired by the educational philosophies of Dewey and Vygotsky, Project-Based Learning (PBL) promotes the active construction of knowledge through the integration of Information and Communication Technologies (ICT) (Thomas, 2000). Digital collaborative tools enable learners to investigate environmental issues, plan interventions, work cooperatively, and reflect collectively while proposing creative solutions to authentic environmental problems.

Project-Based Learning constitutes an excellent methodology for designing and implementing Local Sustainability Plans with Children. Through projects developed in partnership with local communities, pupils can identify real environmental problems and propose practical solutions. This approach encourages research, collaboration, and the application of classroom knowledge to address local environmental challenges (Barrows, 2002).

During the implementation of local sustainability plans, children not only learn about environmental issues but also develop leadership, teamwork, communication, and decision-making skills. Furthermore, interaction with the local community strengthens their sense of belonging and environmental responsibility.

Project-based education, involving the design and implementation of local sustainability initiatives, is particularly effective because it enables learners to apply acquired knowledge in authentic contexts, thereby promoting meaningful learning (Tilbury, 2017). School-based sustainability projects encourage active participation in solving community environmental problems, while fieldwork and ex-

perimental activities make environmental education more relevant, practical, and engaging (Sterling, 2018).

The development of pedagogical projects is based on the principle that “students construct knowledge through action”. From this perspective, a project may be defined as “an idea concerning an object to be created or a result to be achieved” (Bordallo & Ginestet, 1993).

According to the document on Essential Competencies of the National Basic Education Curriculum (Ministry of Education, Department of Basic Education [ME-DEB], 2001), a project is “an investigative methodology centered on problem-solving, where the problems must be relevant to learners, and their resolution should imply changes in physical or social reality”.

Project development follows an action-research approach, in which the process is as important as the final product (ME-DEB, 2001), and unfolds across three main dimensions: affective, cognitive, and social (Bordallo & Ginestet, 1993), as we presented in Table 1.

Table 1. The three poles of project development: affective, social, and cognitive. Adapted from Giordan (1999, cited in Carvalho & Freitas, 2010: p. 22).

Productive dimension
*Social
The project has social usefulness and takes into account the resources and limitations of reality.
Educational dimension
*Cognitive
The project enables the acquisition of knowledge, know-how, and skills.
Spontaneous dimension
*Affective
The project engages motivation, pleasure, and desire.

The implementation of the project involves prior planning, which can be developed in a group or individually, and this plan should include (ME-DEB, 2001, cited in Carvalho & Freitas, 2010: pp. 22-23):

- “Objectives of the work;
- Sequence of tasks and their distribution;
- Work locations;
- Timeline of activities;
- Expected outputs (written/oral presentations, exhibitions, portfolios, etc.);
- Presentation date;
- Evaluation criteria;
- Dissemination strategies”.

2.5.2. Problem-Based Learning (PBL)

Define abbreviations and acronyms the first time they are used in the text, even

after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

2.5.3. Flipped Classroom

The Flipped Classroom model is based on constructivist and cognitivist principles, in which students access content before class, allowing in-class time to be used for practical activities and discussions (Bergmann & Sams, 2012, 2014). Based on Mayer's (2009) principles of multimedia learning, it is important to avoid cognitive overload and ensure that learning materials are clear and well-structured.

2.6. Proposals for the Implementation of Gamification in Environmental Education in Benguela

The introduction of gamification in primary schools in Benguela can be achieved through structured steps adapted to the local context:

- **Teacher Training**—Teachers should be trained in active methodologies and gamified design, with emphasis on integrating environmental content into the curriculum.
- **Creation of Local Narratives**—Development of stories inspired by the Benguela context (e.g., “Mission Sustainable Benguela”), where students assume the role of environmental guardians.
- **Practical Missions**—Weekly activities such as: “Plastic-Free Day”, “Water Challenge”, “Waste Hunt”, “Recycle and Create”.
- **Symbolic Reward System**—Use of points, badges, and achievement boards displayed at school. Recognition should be collective and non-monetary.
- **Feedback and Reflection**—Guided discussions and learning journals should be used to promote metacognition and environmental awareness.
- **Community Involvement**—Partnerships with local associations and NGOs help legitimize actions and ensure social sustainability.

The implementation of gamification in Environmental Education in Benguela is justified by three main reasons:

- **Pedagogical:** promotes active engagement and critical thinking.
- **Environmental:** encourages sustainable behaviors from an early age.
- **Social:** strengthens school-community relationships, fostering participatory citizenship.

As Kapp (2012) emphasizes, “effective gamification requires not only fun, but also educational purpose, immediate feedback, and emotional engagement” (p. 52).

Therefore, the proposed model for Benguela seeks to combine playfulness, environmental responsibility, and meaningful learning.

3. Objectives

3.1. General Objective

To analyse the changes observed in students' motivation, engagement, and learn-

ing following the implementation of a gamification-based pedagogical intervention in the Environmental Education and Sustainability course unit, and to discuss the implications of these findings for initial teacher education and the future implementation of this approach in primary schools in Benguela.

3.2. Specific Objectives

- To characterise students' levels of academic motivation and engagement before and after the gamified intervention.
- To compare students' performance on Environmental Education and Sustainability knowledge tests administered before and after the intervention.
- To analyse students' perceptions of the use of gamification in the teaching and learning process.
- To discuss the potential contribution of gamification-based initial teacher education to the future adaptation of this approach in primary schools in Benguela.

3.3. Hypotheses

H1. It is expected that students' levels of academic motivation will improve following the gamified intervention.

H2. It is expected that students' academic performance will improve between the pre-test and the post-test.

H3. Participants are expected to report positive perceptions regarding the use of gamification in learning Environmental Education and Sustainability.

4. Study Rationale and Design

This manuscript presents a pedagogical intervention study employing a mixed-methods approach (quantitative and qualitative) of an exploratory nature, utilizing a pre-test/post-test design without a control group. The objective was to analyze changes observed in the motivation, engagement, and learning of prospective teachers following the implementation of a gamification strategy within the Environmental Education and Sustainability course unit.

This methodological design was selected because it allows for the assessment of changes occurring throughout the intervention; however, it is acknowledged that the absence of a comparison group precludes establishing causal relationships between the intervention and the observed results. Consequently, the evidence presented is interpreted as exploratory improvements associated with the gamification implementation process.

4.1. Nature of the Research

The study follows a descriptive-exploratory research design, as it seeks not only to characterise existing methodologies and educational practices but also to identify innovative proposals for integrating Environmental Education and Sustainability into teacher education curricula. According to Gil (2021), descriptive research

aims to identify and describe the characteristics of phenomena and the relationships among variables, whereas exploratory research is particularly appropriate when investigating topics that remain underexplored and require new theoretical and methodological perspectives.

4.2. Research Procedure

The study was conducted over the course of an academic semester (approximately 14 weeks), following three main phases:

- **Initial Assessment:** administration of a questionnaire in the first week regarding students' perceptions of the use of ICT, active learning methodologies, and gamification in learning.
- **Implementation of the Intervention:** development of gamified modules within the course unit-incorporating digital games, scoring systems, immediate feedback, and collaborative rankings-throughout the remaining weeks. During classes, students were organized into game teams ("environmental tribes") and accumulated points by solving challenges related to topics such as recycling, biodiversity, and clean energy.
- **Post-intervention Assessment:** administration of questionnaires and semi-structured interviews to evaluate motivation and learning.

4.3. Participants

The study involved:

- Three (3) lecturers responsible for teaching Environmental Education and Sustainability at ISCED-Benguela, who participated through semi-structured interviews.
- Forty (40) second-year undergraduate students enrolled in the Bachelor's Degree in Primary Education at ISCED-Benguela, aged between 19 and 25 years.

The inclusion criteria were as follows:

- enrolment in the "Environmental Education and Sustainability" course unit;
- attendance of at least 75% of the scheduled classes;
- voluntary agreement to participate in the study.

A non-probability convenience sampling strategy was adopted, which is considered appropriate for educational research conducted in higher education settings (Gil, 2021).

4.4. Research Instruments

For data collection, in addition to the intervention plan, four complementary instruments-described below-were used. These instruments were analyzed and validated by three specialists in Environmental Education and Educational Technologies-comprising the instructor of the course unit at ISCED-Benguela and two experienced, veteran professors of the same course unit at ISCED-Benguela-which, in our view, ensured satisfactory internal consistency.

4.4.1. Academic Motivation and Engagement Questionnaire

Adapted from Pintrich and De Groot (1990), and administered to students before and after the pedagogical intervention, it consists of five sections comprising 20 items organized on a five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree); it assesses motivation, the prominence of learning strategies, self-efficacy, learning engagement, and the difficulties encountered before and after the pedagogical intervention.

4.4.2. Environmental Knowledge Test

Students completed the Environmental Knowledge Test before and after the pedagogical intervention. The instrument comprised three sections: multiple-choice questions; true-or-false questions; short-answer questions. The assessment covered topics including: waste management; biodiversity; water resources; energy; sustainability. Although administered to university students, the content was intentionally aligned with primary education curricula, since the purpose was to prepare future teachers to replicate similar learning activities in primary schools. The test content was validated by the three Environmental Education specialists involved in the study.

4.4.3. Semi-Structured Interviews

Semi-structured interviews were conducted with both lecturers and students in order to complement the quantitative findings and provide a deeper understanding of participants' perceptions regarding the pedagogical intervention. The interviews with the three lecturers sought to explore their perspectives on the design, validation, and implementation of the pedagogical intervention, the adequacy of the research instruments, and the identification of innovative teaching strategies that could be integrated with gamification in Environmental Education and Sustainability within the Primary Education degree programme. Furthermore, lecturers were invited to discuss the potential transferability of these pedagogical approaches to primary schools in Benguela. The interviews conducted with the forty students aimed to investigate their perceptions of changes in motivation, classroom participation, learning, and the challenges experienced before and after the implementation of the gamified pedagogical intervention.

4.4.4. Observation Grids

Observation grids were used throughout the intervention to systematically monitor students' behaviour during classroom activities. A five-point Likert scale was employed: 1 = *Very Low*, 2 = *Low*, 3 = *Moderate*, 4 = *High*, 5 = *Very High*. The observation instrument recorded indicators related to: classroom participation; collaborative work; problem-solving skills; persistence when completing gamified learning activities. These observations complemented the quantitative and qualitative data, allowing methodological triangulation and providing a more comprehensive understanding of students' learning experiences.

4.5. Statistical Analysis

Quantitative data were initially organised through coding procedures and ana-

lysed using descriptive statistics, including means, minimum values, and maximum values. Subsequently, paired comparisons between pre-test and post-test scores were performed in order to examine changes in students' academic performance following the intervention and to facilitate interpretation of the magnitude of the observed differences.

Qualitative data obtained from the interviews were analysed using content analysis, following Bardin's (2016) methodological framework.

4.6. Pedagogical Intervention

The pedagogical intervention was implemented over one academic semester (14 weeks, as summarized in **Table 2**), consisting of one face-to-face session per week, each lasting approximately three hours. All activities were conducted within the Environmental Education and Sustainability course unit of the Bachelor's Degree in Primary Education at ISCED-Benguela. Gamification was integrated into the course through interactive digital resources and classroom-based educational game activities, including ecological missions, recycling challenges, collaborative competitions, and environmental simulations. This intervention model was selected because it enables data triangulation, combining students' perceptions with measurable indicators of academic achievement (Creswell, 2014). Additional details of the intervention, such as objectives, activities, and the evaluation of each mission, are presented in **Appendix**.

Table 2. Summary of the intervention's organization.

Week	Theme	Gamified Strategy
1	Introduction and Diagnosis.	Pre-test on environmental knowledge and motivation; "Core Mission: Sustainable Benguela".
2 - 3	Basic Concepts: Environmental Education and Sustainability.	Mission 1: "Green Awakening"; Interactive class; Kahoot and individual challenges. Mission 2: "Green Community".
4 - 5	Local Environmental Issues.	Mission 3: "A Look at Benguela"; (Group debate); Mission 4: "Plastic-Free Day"; Narrative.
6 - 7	Water and Sustainability.	Mission 5: "Water Guardians"; (Discussion); Mission 6: "Water Challenge"; (Narrative; Collaborative challenges).
8 - 10	Solid Waste; Recycling and Reuse.	Mission 7: "The Waste Problem"; Mission 8: "Trash Hunt"; (Project); Mission 9: "Transform to Save"; (Wordwall and problem-solving; Team competition; Narrative).
11 - 12	Recycling and Reuse; Energy and Sustainability.	Mission 10: "Recycle and Create"; (Narrative; Project). Mission 11: "Clean Energy"; (Debate).
13	Review and Consolidation.	Mission 12: "Grand Final Challenge"; (Teamwork).
14	Post-test and final evaluation.	Reflection and feedback.

4.6.1. Gamification Elements

The gamified instructional strategy incorporated several game mechanics care-

fully aligned with the learning objectives of the course. The principal gamification components included: Experience Points awarded after each completed activity; Digital badges linked to specific competencies; Progressive achievement levels; Team-based leaderboards organised through Environmental Tribes; Ecological missions; Cooperative challenges; Immediate instructor feedback; Self-assessment; Peer assessment. Together, these elements were designed to strengthen intrinsic motivation, collaborative learning, and continuous engagement throughout the intervention.

4.6.2. Digital Platforms Used

Several digital learning platforms were employed to diversify instructional experiences: Kahoot—content review and formative assessment; Wordwall—conceptual reinforcement through interactive games; Classcraft—management of gamified progression and team performance; Google Forms—administration of questionnaires and data collection; Microsoft PowerPoint and educational videos—instructional support during face-to-face sessions.

4.6.3. Team Organisation

Students were organised into five Environmental Tribes, each composed of eight members. Individual performance contributed simultaneously to each team's overall score, encouraging cooperation rather than purely individual competition. At the end of every session, students received immediate feedback on both individual and team performance, enabling continuous monitoring of learning progress and reinforcing reflective learning throughout the intervention.

5. Results

5.1. Academic Performance before and after the Intervention

An increase in students' mean scores was observed following the implementation of the gamified pedagogical intervention, indicating an improvement in academic performance. Given that the study adopted a pre-test/post-test design without a control group, these findings should be interpreted as exploratory evidence of improvement rather than proof of a causal relationship between the intervention and the observed learning gains.

Table 3 compares students' performance on the Environmental Education and Sustainability knowledge test before and after the pedagogical intervention. The findings reveal a substantial improvement, with the proportion of correct responses increasing from 45% in the pre-test to 95% in the post-test, while incorrect responses declined from 55% to 5%. The observed increase of 50 percentage points suggests that the gamified instructional approach contributed to strengthening students' understanding of environmental and sustainability concepts through challenge-based learning, immediate feedback, and active participation, consistent with the principles of meaningful learning proposed by Ausubel (1982) and Tilbury (2017).

These findings are also consistent with previous empirical evidence indicating that gamification can enhance academic performance (Hamari et al., 2014). Alt-

though the present study does not permit causal inference, the magnitude of the observed improvement suggests a pedagogically meaningful impact.

Table 3. Environmental knowledge test (Pre-test vs. Post-test).

Indicator	Pre-test		Post-test	
	Frequency	(%)	Frequency	(%)
Negatives	22	55%	2	5%
Positives	18	45%	38	95%
Total	40	100%	40	100%

5.2. Academic Motivation and Engagement

The Academic Motivation Questionnaire also revealed improvements across several psychological dimensions associated with learning. Most participants reported feeling more engaged during classroom activities, identifying the interactive nature of the missions, collaborative teamwork, and immediate feedback as the main factors facilitating their learning.

Table 4 demonstrates substantial improvements in students' academic motivation (87.5%) and participation in the proposed learning activities (95%). According to [Kapp \(2012\)](#), educational gamification is grounded in principles of motivational psychology, a perspective that supports the findings of [Fardo \(2013\)](#) and [Deterding et al. \(2011\)](#), who argue that gamification effectively promotes student engagement, motivation, and active learning. Furthermore, these findings reinforce Self-Determination Theory ([Ryan & Deci, 2000](#)), which proposes that educational environments fostering autonomy, competence, and social relatedness enhance intrinsic motivation.

Table 4. Academic motivation and engagement (Pre-test vs. Post-test).

Indicator	Pre-test		Post-test	
	Frequency	(%)	Frequency	(%)
Highly motivated students	15	37.5	35	87.5
Engagement with learning strategies	10	25.0	38	95.0
Self-efficacy	20	50.0	35	87.5
Learning engagement	18	45.0	26	65.0
Total	40		40	

5.3. Semi-Structured Interviews

The analysis of lecturers' interviews provided valuable qualitative insights that contributed to refining the pedagogical intervention, improving the research instruments, and strengthening innovative gamification-based strategies designed

to prepare future teachers for implementation in primary schools throughout Benguela Province. According to Werbach and Hunter (2012), such improvements contribute to the creation of learning environments characterised by sustained participation and continuous engagement, which constituted one of the principal objectives of this intervention. Content analysis of students' interviews identified four major themes: increased motivation to learn; greater classroom participation; improved understanding of environmental concepts; stronger collaboration among peers.

Interview Question: "Do you believe that the competencies developed during the intervention—such as collaboration, problem-solving, the use of digital resources, and the integration of Environmental Education and Sustainability into practical activities—constitute important foundations for the future adaptation of gamification to primary education in Benguela? Please justify your answer."

Selected responses illustrating the dominant themes are presented below.

Participant E3: "Yes. The competencies I developed have helped me as a future teacher to make my lessons more participatory and to connect Environmental Education with real community problems."

Participant E4: "Yes. I believe that collaboration and the use of digital resources make learning more interesting and encourage students' active participation."

Participant E7: "Yes. Learning through challenges and games helped me better understand how to protect the environment and work collaboratively with my classmates."

Participant E8: "Yes. Problem-solving activities and practical tasks enable children to learn how to protect the environment in a simple and meaningful way."

Participant E21: "Yes. The weekly challenges and team organisation promoted active participation and reduced the passivity usually observed in traditional lecture-based classes."

Participant E18: "Yes. Learning through gamification provides an excellent foundation because it encourages teamwork, creativity, and the application of environmental knowledge in everyday school life."

Participant E39: "Yes. The gamified classes and the competencies I acquired have prepared me as a future teacher to implement innovative teaching strategies adapted to the realities of primary schools in Benguela and to the needs of their pupils."

Overall, students described the gamified lessons as more dynamic, interactive, and meaningful, emphasising that they facilitated practical and contextualised learning.

These qualitative findings reinforce sociocultural learning theory (Vygotsky, 1978), supporting the view that gamification promotes active, socially constructed learning experiences. Furthermore, the interviews demonstrate the development of socio-emotional and environmental competencies, consistent with Jacobi's (2003) conception of critical and participatory Environmental Education. Collectively, these qualitative findings provide additional support for Hypotheses H1,

H2 and H3, that gamification contributes to improving levels of academic motivation, meaningful learning, and the development of sustainable attitudes.

5.4. Classroom Observation

The observation grids confirmed a progressive increase in students' participation throughout the fourteen weeks of the intervention. A higher frequency of peer interactions, greater initiative in solving challenges, and increasing autonomy in carrying out the proposed missions were observed.

The results obtained, as shown in **Table 5**, suggest that the use of gamification promoted improvements, as confirmed by the average variation on the Likert scale, which shifted from very low and low levels in the pre-test to moderate to very high levels in motivation, participation, and learning among the future teachers participating in this study in the post-test. Although the methodological design does not allow causal relationships to be established, the observed evidence is consistent with previous research that has identified similar benefits resulting from the use of gamified strategies in educational contexts.

Table 5. Classroom observation—dimensions and indicators.

Dimension	Indicator	Scale (1 - 5)	
		Before	After
Autonomy	Solves tasks without assistance	3	4
Collaboration	Works as a team	2	4
Environmental behaviour	Demonstrates sustainable attitudes	2	4
Engagement	Shows interest in tasks	1	3
Interaction	Communicates with peers	2	4
Motivation	Shows enthusiasm	2	5
Participation	Takes part in activities	2	4
Persistence	Does not give up easily	2	3

Scale: 1 = Very low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very high.

6. Discussion

The data corroborate the findings of [Hamari et al. \(2016\)](#), who identified positive effects of gamification on students' motivation and engagement across different educational contexts. Similarly, studies by [Kolb \(1984\)](#) and [Kapp \(2012\)](#) highlight that the effectiveness of gamification depends on the balanced integration of pedagogical objectives, continuous feedback, and challenges, elements that were also present in the intervention developed with the second-year students of the Bachelor's Degree in Primary Education at ISCED-Benguela.

In the specific field of Environmental Education, the results are consistent with the conclusions of recent studies that highlight the potential of gamification in

promoting pro-environmental attitudes and active learning. The use of ecological missions, collaborative challenges, and contextualised narratives appears to foster a stronger connection between scientific content and environmental problems experienced by the local community.

However, it is important to acknowledge that the absence of a control group represents a methodological limitation. Therefore, the observed improvements may also have been influenced by other factors inherent to the teaching and learning process during the semester. Future research should employ quasi-experimental or experimental designs that allow comparisons between different teaching methodologies and strengthen the internal validity of the findings.

Regarding the connection with primary education, although the intervention was developed with higher education students, the results are relevant for initial teacher education, as these future teachers will be responsible for implementing innovative methodologies in primary schools. The competencies developed during the intervention—collaboration, problem solving, use of digital resources, and integration of Environmental Education and Sustainability into practical activities—represent important foundations for the future adaptation of gamification to the primary education context in Benguela. Thus, the recommendations presented in this study do not result from a direct generalisation of findings to primary school children, but rather from the pedagogical preparation of future teachers who will work in these contexts.

The quantitative data were analysed through descriptive and inferential statistics, while qualitative data were subjected to content analysis (Bardin, 2016). Preliminary results indicate that: there was an increase in average academic performance between the pre-test and post-test; most students reported feeling more motivated and participative during classes; and interviews revealed greater interest in environmental topics and strengthened collaborative spirit.

These findings corroborate the hypotheses presented and international studies demonstrating that gamification enhances motivation and active learning (Hamari et al., 2016; Fardo, 2013).

7. Conclusions

The results of this study demonstrate that the implementation of a pedagogical intervention based on gamification was associated with improvements in motivation, engagement, and academic performance among students enrolled in the Environmental Education and Sustainability course at ISCED-Benguela. Although the methodological design does not allow causal relationships to be established, the pre- and post-intervention results suggest that the use of gamified strategies represents a promising approach for promoting more active and meaningful learning experiences in initial teacher education.

The intervention enabled the integration of Environmental Education and Sustainability content with participatory methodologies, fostering the development of collaboration skills, problem-solving abilities, critical thinking, and socio-envi-

ronmental responsibility. These findings reinforce the importance of pedagogical innovation in teacher education, preparing future teachers to implement more dynamic and contextualised teaching practices in primary schools.

Although the proposal for applying gamification in primary education does not derive from a direct generalisation of the results obtained, there is nevertheless the conviction that teachers trained through active methodologies are better prepared to adapt these strategies to the characteristics and needs of their future primary school students.

Future research should employ quasi-experimental or experimental designs, including control groups, larger samples, and longitudinal follow-up, in order to produce more robust evidence regarding the effectiveness of gamification in Environmental Education and Sustainability.

8. Study Limitations and Pedagogical Considerations

This study presents some limitations that should be considered when interpreting the results.

Firstly, the use of a non-probabilistic sample from a single institution limits the generalisation of findings to other educational contexts. Secondly, the absence of a control group prevents the causal attribution of the observed improvements exclusively to the gamified intervention. Furthermore, the duration of the intervention restricts the assessment of long-term effects on learning outcomes and environmental behaviours.

Despite these limitations, the study provides relevant evidence regarding the applicability of gamification in initial teacher education and represents an important foundation for future research in Angolan educational contexts.

On the other hand, although promising, gamification requires careful implementation. Hamari et al. (2014) warn that the inappropriate use of extrinsic rewards may reduce intrinsic motivation if the focus shifts from learning towards the accumulation of points. Therefore, the design of gamified experiences should prioritise meaning and purpose rather than competition alone. Furthermore, conditions of equity and inclusion must be ensured, particularly in schools with technological constraints, such as those involved in this study (Werbach & Hunter, 2012).

Based on this assumption, this study does not establish material, infrastructural, or competency-based comparisons between different educational contexts in which similar interventions may be implemented. Finally, we humbly acknowledge that there are no perfect or complete studies; rather, continuous improvement and ongoing research are what make science continually evolve.

9. Ethical Considerations

The research complied with the ethical principles applicable to educational research. All participants were informed about the objectives of the study and signed an informed consent form before the beginning of data collection. Anonymity,

confidentiality, and the exclusive use of data for scientific purposes were ensured. The study followed the ethical guidelines of the American Educational Research Association (AERA, 2019) and, according to Moran (2021, p. 115), ensured respect for the rights and dignity of participants throughout all stages of the research process.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix: Gamified Pedagogical Intervention Plan

CENTRAL NARRATIVE

“Central Mission: Sustainable Benguela—Guardians of the Earth”

Storyline

In Benguela Province, signs of environmental degradation and sustainability challenges are becoming increasingly evident. Beaches are polluted with waste, several communities face water scarcity, and local species are gradually disappearing.

In response to these environmental challenges, the **Council of Nature Elders** summons a special group of young people known as the **Environmental Guardians of Benguela**.

Each student becomes an Environmental Guardian with the following mission:

- Protect natural resources;
- Restore environmental balance;
- Educate the community on environmental protection and sustainable practices.

To accomplish this mission, the Guardians must complete weekly challenges, earn **Eco-Points**, and unlock progressive game levels.

Game Levels

- 1)  Green Beginner
- 2)  Nature Protector
- 3)  Environmental Defender
- 4)  Sustainable Guardian
- 5)  Ecological Master

CHARACTERS (Student Roles)

Each team represents an **Eco-Tribe**:

-  **Water Guardians**—responsible for water conservation.
-  **Forest Defenders**—responsible for biodiversity protection.
-  **Recycling Masters**—responsible for waste management.
-  **Clean Energy Agents**—responsible for promoting sustainable energy use.

DESCRIPTIVE GAMIFIED WEEKLY PLAN (14 WEEKS)

“Mission Sustainable Benguela: Environmental Guardians”

General Objective: To promote meaningful learning in **Environmental Education and Sustainability** through gamification by enhancing students’ motivation, engagement, participation, and academic achievement.

□ GENERAL PROGRAMME STRUCTURE

Duration

- Three-hour classroom sessions over fourteen consecutive weeks.

Organisation

- Students work collaboratively in teams called **Eco-Tribes**.

Gamification System

- Eco-Points
- Badges

- Levels
- Collaborative Team Ranking

Assessment

- Pre-test (Week 1)
- Continuous assessment (throughout the programme)
- Post-test (Week 14)
- Classroom observation (throughout the intervention).

□ WEEK 1—Introduction and Diagnostic Assessment

Objectives:

- Introduce the Gamified Pedagogical Intervention Plan.
- Administer the Environmental Knowledge Pre-test.
- Administer the Academic Motivation and Engagement Pre-questionnaire.

Mission: “Welcome to Mission Sustainable Benguela”

Students are officially welcomed as members of the **Environmental Guardians of Benguela**, where they receive their mission, are assigned to Eco-Tribes, and begin their journey towards becoming Environmental Guardians.

Activities

- Presentation of the intervention programme: **Mission Sustainable Benguela**.
- Formation of Eco-Tribes.
- Administration of:
 - Environmental Knowledge Pre-test;
 - Academic Motivation and Engagement Questionnaire (Pre-test).

Scoring

Participation → **+10 Eco-Points**.

□ WEEK 2—Fundamental Concepts of Environmental Education and Sustainability

Mission 1: “Green Awakening”

Objective: To recognise environmentally responsible and sustainable behaviours within the community.

Activities

- Interactive lecture.
- Gamified quiz using **Kahoot** or **Wordwall**.

Scoring

Participation → **+10 Eco-Points**

Correct quiz answers → **+5 Eco-Points**.

□ WEEK 3—Fundamental Concepts of Environmental Education and Sustainability (Continued)

Mission 2: “Green Community”

Objective: To encourage environmentally responsible and sustainable attitudes within the local community.

Narrative

Real environmental transformation begins within the community. Every Environmental Guardian has the responsibility to inspire positive environmental

change through awareness and practical action.

Activities

- Design environmental awareness posters or educational messages.
- Raise awareness among classmates, relatives, or neighbours.
- Present practical ideas for improving environmental sustainability within the community.

Scoring

Participation → **+10 Eco-Points**

Community impact → **+10 Eco-Points.**

□ WEEK 4—Local Environmental Problems

Mission 3: “Looking at Benguela”

Objective: To identify local environmental problems and propose feasible and sustainable solutions.

Activities

- Identification of environmental issues affecting Benguela Province.
- Collaborative group discussion.
- Presentation of possible solutions.

Scoring

Participation → **+10 Eco-Points**

Contribution to the discussion → **+5 Eco-Points.**

□ WEEK 5—Local Environmental Problems (Continued)

Mission 4: “Plastic-Free Day”

Objective: To reduce plastic consumption for one full day while promoting environmental awareness.

Narrative

Morena Beach, one of Benguela’s most emblematic coastal areas, is increasingly threatened by plastic pollution. As Environmental Guardians, students are challenged to protect marine ecosystems by reducing plastic waste and encouraging environmentally responsible behaviour.

Practical Activities

- Avoid using plastic bags for 24 hours.
- Carry and use a reusable water bottle.
- Encourage at least one person to reduce plastic consumption.
- Produce a short written reflection describing the experience.

Scoring

Successful completion of the challenge → **+10 Eco-Points**

Community awareness action → **+5 Bonus Eco-Points.**

● WEEK 6—Water and Sustainability

Mission 5: “Water Guardians”

Objective: To promote the sustainable use and conservation of water resources.

Narrative

Water is one of the planet’s most valuable natural resources. As Environmental Guardians, students are challenged to understand its importance and encourage

responsible water-use practices in their daily lives.

Activities

- Interactive lecture.
- Case study on water conservation.
- Guided classroom discussion.

Scoring

Participation → **+10 Eco-Points.**

WEEK 7—Water and Sustainability (Continued)

Mission 6: “The Water Challenge”

Objective: To encourage responsible water consumption through practical everyday actions.

Narrative

Several communities in Benguela Province, including **Casseque Marítimo, Casseque Macau, Bela Vista, and Navegantes**, experience recurrent water shortages. Environmental Guardians must learn and promote effective water-saving practices to contribute to sustainable water management.

Activities

- Apply water-saving practices at home.
- Reduce shower duration.
- Turn off the tap while brushing teeth.
- Identify situations of water wastage within the household.
- Prepare a brief reflective report describing the experience.

Scoring

Submission of the practical report → **+10 Eco-Points**

Proposed solution for reducing water waste → **+5 Eco-Points.**

WEEK 8—Solid Waste Management

Mission 7: “The Waste Problem”

Objective: To raise students’ awareness of the importance of proper waste separation and management.

Narrative

Waste generation is one of today’s greatest environmental challenges. Proper waste segregation is an essential step towards protecting ecosystems and promoting sustainable communities.

Activities

- Practical lesson.
- Identification and classification of different types of waste.
- Discussion on appropriate waste management practices.

Scoring

Participation → **+10 Eco-Points.**

WEEK 9—Solid Waste Management (Continued)

Mission 8: “Waste Hunt”

Objective: To organise a community-based clean-up campaign within the school and surrounding neighbourhood.

Narrative

Public spaces around schools, beaches, and the Tombas Market have become increasingly polluted. Environmental Guardians are called upon to restore environmental balance through collective action.

Activities

- Collect litter within the school grounds and surrounding community.
- Separate collected waste into recyclable categories:
 - Plastic;
 - Paper;
 - Organic waste.
- Document the activity through photographs or a written report.

Scoring

Participation → **+15 Eco-Points**

Correct waste separation and organisation → **+5 Eco-Points.**

□ WEEK 10—Recycling and Reuse**Mission 9: “Transform to Protect”**

Objective: To encourage students to create useful objects using recyclable materials.

Narrative

Many materials considered waste can become valuable resources when creativity and environmental responsibility are combined. Environmental Guardians are challenged to transform recyclable materials into practical products that contribute to sustainability.

Activities

- Demonstration of recycling techniques.
- Planning and designing recycled products.
- Construction of useful objects using recyclable materials.
- Presentation of the finished product to the class.
- Explanation of its environmental relevance and practical usefulness.

Scoring

Completed recycled product → **+15 Eco-Points**

Creativity and innovation → **+5 Eco-Points.**

□ WEEK 11—Recycling and Reuse (Continued)**Mission 10: “Recycle and Create”**

Objective: To foster creativity through sustainable recycling practices.

Narrative

Waste should not always be regarded as rubbish. Many discarded materials can be transformed into valuable resources. Environmental Guardians are challenged to demonstrate creativity by converting recyclable materials into useful products that contribute to environmental sustainability.

Activities

- Design and create useful objects from recyclable materials.
- Present the recycled product to the class.

- Explain its practical function and environmental benefits.
- Discuss how similar initiatives could be implemented within the local community.

Scoring

Completed recycled product → **+15 Eco-Points**

Creativity and innovation → **+5 Eco-Points**.

● WEEK 12—Energy and Sustainability**Mission 11: “Clean Energy”**

Objective: To identify different types and sources of clean and sustainable energy.

Narrative

Energy plays a fundamental role in social and economic development. However, the excessive use of fossil fuels has contributed significantly to environmental degradation. Environmental Guardians are encouraged to explore renewable energy alternatives capable of supporting sustainable development.

Activities

- Interactive lecture.
- Classroom debate.
- Analysis of practical examples of renewable energy sources.
- Discussion of local and global applications of clean energy technologies.

Scoring

Participation → **+10 Eco-Points**

□ WEEK 13—Review and Knowledge Consolidation**Mission 12: “The Grand Final Challenge”**

Objective: To review and consolidate the knowledge acquired throughout the intervention programme.

Narrative

After successfully completing all previous missions, the Environmental Guardians must face the Grand Final Challenge. This mission allows them to demonstrate the knowledge, competencies, and environmental awareness developed during the programme.

Activities

- Comprehensive gamified quiz.
- Collaborative review of the main concepts studied throughout the semester.
- Team discussion and reflection.

Scoring

Performance in the Grand Final Challenge → **+15 Eco-Points**.

□ WEEK 14—Final Assessment

Objective: To evaluate students’ learning outcomes, motivation, and overall participation throughout the gamified intervention programme.

Activities

- Environmental Knowledge Post-test.
- Semi-structured interviews.

- Awards and recognition ceremony.

Scoring

Participation → +20 Eco-Points

GAMIFIED ASSESSMENT SYSTEM

Overall Scoring Distribution

- Weekly learning activities → 60%
- Practical missions → 25%
- Participation and engagement → 15%

GAMIFICATION ELEMENTS

The intervention programme incorporates the following gamification components:

-  Eco-Points
-  Achievement Badges:
 -  Water Hero
 -  Recycling Champion
 -  Environmental Defender
 -  Sustainable Guardian
-  Symbolic rewards (certificates and public recognition).
-  Guardian's Reflective Journal, completed weekly.
-  Healthy Collaborative Team Ranking (team-based rather than individual, promoting cooperation and minimising unhealthy competition).

SCIENTIFIC EVALUATION

Quantitative Data

- Environmental Knowledge Pre-test and Post-test.
- Academic Motivation and Engagement Questionnaire.

Qualitative Data

- Semi-structured interviews.
- Classroom observations conducted throughout the intervention.

WEEKLY REFLECTIVE COMPONENT

At the end of each weekly mission, students are invited to reflect on the following questions:

- What did I learn this week?
- How did I contribute to environmental protection?
- What can I improve in future missions?

These reflections encourage self-assessment, critical thinking, and continuous learning.

PEDAGOGICAL CONSIDERATIONS

Throughout the intervention, the following principles should be observed:

- Avoid excessive competition among students.
- Emphasise meaningful learning rather than merely accumulating points.
- Ensure the active participation and inclusion of all students.
- Prioritise symbolic rather than material rewards.
- Promote collaboration, responsibility, creativity, and environmental citizenship.

EXPECTED OUTCOMES

By the end of the intervention programme, students are expected to demonstrate:

- Increased learning motivation.
- Higher levels of classroom participation and engagement.
- Improved academic achievement in Environmental Education and Sustainability.
- Stronger environmental awareness and more sustainable attitudes and behaviours.
- Enhanced teamwork, problem-solving, communication, and critical-thinking skills.
- Greater commitment to environmental stewardship and sustainable community practices.

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