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Vitalia: Development and Preliminary Validation of a Scalable Gamified Educational Model for Pediatric Oncology Support

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***Abstract*—This study proposes and analyzes *Vitalia*, a cooperative board game designed as an educational tool to support emotional accompaniment and enhance understanding of treatment processes in pediatric oncology contexts. The project was developed under a Design-Based Research approach, integrating phases of conceptual design, physical prototyping, and exploratory validation through an evolutionary hybrid model. Preliminary validation was conducted in a non-clinical academic setting using a pretest–posttest design applied across four dimensions: treatment comprehension, motivation, emotional state, and perceived family support. Descriptive results revealed consistent improvements across all evaluated dimensions, particularly in conceptual clarity and perception of emotional accompaniment. The proposed model integrates principles of gamification, symbolic narrative, and cooperative dynamics, offering an accessible and culturally adaptable alternative to exclusively digital solutions. Furthermore, the study outlines a projection toward interactive digital development, in which analog validation precedes technological prototyping. Although the findings should be interpreted as preliminary evidence due to the exploratory nature of the study, the proposed hybrid model demonstrates potential as a complementary educational tool within Latin American contexts.**

***Index Terms*—Gamification, pediatric psycho-oncology, cooperative board game, health education, hybrid model, design-based research.**

I. Introduction

Childhood cancer represents one of the major challenges in global public health. According to the World Health Organization (WHO), approximately 400,000 new cancer cases are diagnosed each year among children and adolescents under 19 years of age [1]. Although advances in early diagnosis and oncological treatments have significantly increased survival rates in many countries, the treatment experience continues to involve substantial physical, emotional, and social challenges.

Research in pediatric psycho-oncology indicates that a cancer diagnosis during childhood is frequently associated with high levels of anxiety, fear, and uncertainty, affecting both patients and their families [2]. These factors may directly influence how treatment is perceived and the child's willingness to actively engage in the therapeutic process. Adherence to oncological treatment does not depend solely on clinical efficacy, but also on psychological, cognitive, and contextual variables that shape understanding of the process and attitudes toward its continuity [3].

The family environment plays a fundamental role in the experience of childhood cancer. Previous studies have shown that parental support and the quality of family communication significantly influence the child's emotional adaptation and response to treatment [4]. Consequently, contemporary approaches in pediatric oncology increasingly promote comprehensive care models that incorporate psychoeducational interventions and emotional accompaniment strategies alongside conventional medical treatment.

In Latin America, this issue acquires particular relevance due to structural inequalities in access to specialized resources and psychosocial support programs. Regional reports indicate that childhood survival rates in some Latin American countries remain lower than those reported in high-income nations, partly due to delayed diagnoses and difficulties in therapeutic adherence [5]. In this context, it becomes essential to develop innovative, culturally adaptable, and low-cost educational tools capable of complementing existing care models.

Within the Ecuadorian context, childhood cancer constitutes a significant challenge for the public health system. According to data from the National Tumor Registry of SOLCA and GLOBOCAN estimates, cancer remains one of the leading causes of disease-related mortality among the pediatric population in the country [6]. Although Ecuador has specialized institutions such as the Society for the Fight Against Cancer of Ecuador (SOLCA), which provides comprehensive oncological care nationwide, persistent challenges remain in psychosocial accompaniment, therapeutic adherence, and health education throughout the treatment process [7]. In this scenario, the development of contextualized and culturally relevant educational tools becomes particularly important as a complement to traditional clinical models.

Play has long been recognized as a pedagogical and therapeutic tool with the potential to facilitate understanding of complex processes and reduce anxiety in pediatric medical contexts [8]. From this perspective, so-called *serious games* have emerged, defined as games designed with primary purposes beyond entertainment, such as education and health promotion [9]. Empirical evidence suggests that serious games can contribute to meaningful learning, increase intrinsic motivation, and strengthen self-efficacy among young populations [10].

Recent systematic reviews have reinforced this evidence, highlighting the sustained effectiveness of serious games in health-related educational contexts, particularly when aligned with preventive and psychosocial objectives [11].

In pediatric oncology, pioneering studies such as the video game *Re-Mission* demonstrated improvements in disease-related knowledge and treatment adherence among adolescents with cancer [12]. These findings have stimulated growing interest in the application of gamification strategies in healthcare settings. Gamification, understood as the incorporation of game design elements into non-game contexts, has shown positive effects on motivation and engagement [13], [14]. However, multiple studies warn that its effectiveness depends on user-centered design and sensitivity to sociocultural context [15].

Despite the expansion of digital solutions, such approaches present limitations in settings characterized by technological constraints or low levels of digital literacy. In this context, cooperative board games represent an accessible alternative that promotes face-to-face interaction, family involvement, and the collective construction of meaning [16]. Nevertheless, the scientific literature reveals a scarcity of systematic studies analyzing gamified board games specifically designed to support emotional accompaniment in pediatric oncology.

In response to this gap, the present study proposes and analyzes *Vitalia*, initially conceived as a gamified board game designed to support understanding of pediatric oncological treatment and to strengthen family accompaniment through a symbolic and cooperative framework. The project was developed under a design-based research approach, enabling iterative construction of the ludic artifact and its preliminary validation in controlled academic and social contexts.

This article reports a two-phase validation approach: initial exploratory testing (n=20) with the board game prototype, followed by extended evaluation with both the analog version (MEEGA, n=70) and digital prototype (SUS, n=77). These complementary datasets strengthen the methodological rigor and generalizability of preliminary findings.

The objective of this article is to analyze the design, implementation, and preliminary results of *Vitalia* as a gamified educational model with potential for regional scalability and future evolution toward interactive digital environments..

II. Related Work

A. Pediatric Psycho-Oncology and Treatment Adherence

Pediatric psycho-oncology addresses the emotional, cognitive, and social dimensions associated with the diagnosis and treatment of childhood cancer. Numerous studies have shown that children diagnosed with cancer experience high levels of anxiety, fear, and uncertainty, particularly during the early stages of treatment [2]. These emotional responses can significantly influence psychological adjustment and the child's perception of the therapeutic process.

Treatment adherence in pediatric populations constitutes a multidimensional phenomenon involving individual, familial, and contextual factors. Evidence indicates that social and family support are positively associated with higher levels of adherence across various medical conditions [3]. In the specific case of childhood cancer, the quality of family communication and parental accompaniment play a crucial role in the child's emotional regulation and willingness to continue treatment [4].

In middle- and low-income countries, including several Latin American nations, structural inequalities and limitations in psychosocial resources may negatively affect treatment outcomes [5]. These conditions highlight the need for complementary interventions that strengthen understanding of the therapeutic process and emotional accompaniment through culturally relevant and accessible approaches.

Recent meta-analytical research has further documented the measurable benefits of psychosocial interventions in pediatric oncology, particularly regarding emotional regulation and treatment adaptation [17].

B. Therapeutic Play and Educational Interventions in Child Health

Play has historically been recognized as a fundamental tool in child development. In clinical settings, therapeutic play has been used to reduce anxiety associated with medical procedures and to facilitate emotional expression. Li et al. [8] demonstrated that structured play interventions can significantly reduce anxiety levels in children undergoing prolonged medical treatments.

From a pedagogical perspective, learning through playful experiences promotes the active construction of meaning and improves information retention. In health education, play enables the translation of complex medical concepts into symbolic representations understandable for children and adolescents. This strategy can help reduce uncertainty, increase perceived control, and strengthen intrinsic motivation.

C. Serious Games in Healthcare Contexts

The concept of *serious games* refers to games designed primarily for educational, training, or health-promotion purposes beyond entertainment [9]. Over the past two decades, such games have gained prominence as innovative tools for meaningful learning across multiple disciplines.

A systematic review conducted by Connolly et al. [10] found empirical evidence supporting the use of serious games to improve knowledge acquisition and user engagement. In pediatric oncology, the video game *Re-Mission* stands as one of the most representative examples, demonstrating improvements in disease-related knowledge and adherence indicators among adolescents with cancer [12]. These findings suggest that interactive environments with structured narratives can positively influence health-related attitudes.

More recent empirical syntheses confirm these findings, emphasizing the positive impact of serious games on knowledge acquisition, behavioral intention, and engagement in health contexts [18].

However, most studies on serious games focus on digital platforms. Although these offer scalability and advanced multimedia resources, their implementation may be constrained by technological, economic, or access-related barriers in certain contexts.

D. *Gamification and Motivational Design*

Gamification is defined as the application of game design elements in non-game contexts with the aim of increasing motivation and engagement [13]. Common elements include point systems, levels, progressive challenges, and structured narratives.

Kapp [14] argues that gamification can enhance intrinsic motivation when aligned with clear pedagogical objectives and meaningful experiences. Likewise, Hamari et al. [15] conclude that gamification can produce positive effects on engagement and participation, although its effectiveness depends on contextualized, user-centered design.

Contemporary meta-analyses suggest that gamification effects are significantly stronger when instructional coherence and structured feedback mechanisms are integrated into the design [19].

In educational and healthcare settings, gamification can facilitate the understanding of complex content by structuring clear goals, providing continuous feedback, and enabling gradual progression. Nevertheless, the literature warns that merely incorporating superficial mechanics does not guarantee educational impact if pedagogical coherence is lacking.

E. *Cooperative Games and Social Dynamics*

Cooperative games, unlike competitive ones, promote collaboration among participants to achieve shared goals. Bay-Hinitz et al. [16] demonstrated that this type of game encourages prosocial behavior and reduces aggressive conduct in educational contexts.

In child health settings, cooperative dynamics may reinforce the perception of accompaniment and social support. Within pediatric cancer contexts, symbolically representing treatment as a shared process between the child and their family environment may help reduce feelings of isolation.

Despite these potential advantages, there remains limited scientific production analyzing cooperative board games specifically structured for emotional accompaniment in pediatric oncology, particularly within Latin American contexts.

F. *Identified Gap*

The literature review reveals three primary gaps. First, most serious games applied to oncology are digital, which may limit accessibility in certain contexts. Second, studies on gamification in healthcare do not always integrate family-centered cooperative dynamics. Finally, there is a scarcity of systematic research on gamified board games specifically designed for emotional accompaniment in childhood cancer.

In response to these gaps, the present study proposes *Vitalia* as a cooperative board game integrating symbolic narrative, structured progression, and family participation. This proposal seeks to contribute to the emerging field of non-digital playful interventions in health by offering a culturally adaptable and potentially scalable model within Latin American contexts.

III. METHODOLOGY

A. *Study Design*

The present study was developed under a Design-Based Research (DBR) approach, a methodology that enables the iterative construction of educational solutions through cycles of design, implementation, evaluation, and refinement [20]. This approach is particularly suitable for applied educational innovation projects, as it combines academic rigor with contextualized practical development.

The project was structured into three main phases: (1) conceptual design of the playful model, (2) prototyping and board game development, and (3) exploratory validation in a non-clinical academic context. Figure 1 summarizes the methodological model implemented.

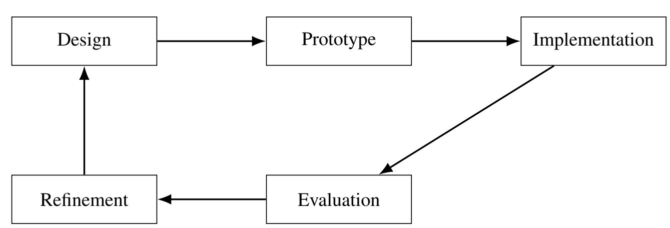

Fig. 1. Iterative methodological model based on Design-Based Research [20].

B. *Phase 1: Conceptual Design*

During the initial phase, a literature review on pediatric psycho-oncology, gamification, and cooperative games was conducted to identify applicable design principles. Based on this analysis, the following structural axes of the game were defined:

- Symbolic narrative of the therapeutic process.
- Cooperative mechanics centered on accompaniment.
- Stage-based progression system.
- Resource management as a metaphorical representation of treatment.

This phase enabled the construction of the conceptual framework of *Vitalia*, aligned with principles of meaningful learning and motivational design [14].

C. Phase 2: Prototyping and Development

During this phase, the physical board, challenge cards, rule system, and cooperative interaction dynamics were developed. The graphic design was conceived following criteria of visual clarity, thematic coherence, and emotional appropriateness, avoiding explicit clinical representations.

Iterative adjustments were implemented following internal pilot tests, prioritizing rule comprehension, balance between challenge and accessibility, and narrative consistency.

Fig. 2. Physical prototype of *Vitalia*: board and packaging developed during the prototyping phase.

The physical prototype was developed considering visual clarity, narrative coherence, and emotional adequacy. Figure 2 presents the board and packaging designed during this phase, which constituted the foundation for the analog validation of the hybrid model.

D. Phase 3: Exploratory Validation

Validation was conducted in an academic setting with voluntary young adult participants, within a controlled non-clinical context. This phase was exploratory and descriptive in nature, aimed at evaluating perceived comprehension, motivation, and accompaniment following the gameplay experience.

A pretest–posttest design was applied to measure changes in four primary dimensions: treatment comprehension, motivation, emotional state, and perception of family support. The evaluated dimensions are summarized in Table I.

TABLE I
DIMENSIONS EVALUATED IN THE PRETEST–POSTTEST DESIGN

Dimension	**Operational Description**
Treatment comprehension	Level of understanding of the oncological process and its continuity.
Motivation	Perceived willingness to actively participate in treatment.
Emotional state	Perception of emotions associated with treatment (fear, anxiety, hope).
Family support	Perception of accompaniment and family cooperation.

E. Expert Validation and Instrument Certification

The evaluation instruments were reviewed and endorsed by experts in the fields of education. Additionally, two medical specialists from the Instituto Ecuatoriano de Seguridad Social (IESS) certified the clinical appropriateness and relevance of the instruments for pediatric oncology populations, ensuring alignment with current standards in pediatric medical assessment. These independent expert reviews—combining educational expertise with clinical medical validation—strengthen the methodological rigor and credibility of the measurement tools beyond the reported Cronbach's alpha reliability coefficient, consistent with established literature on therapeutic adherence and medical support [3], [4]. Validation evidence is available in the supplementary repository.

All data were anonymized and used exclusively for academic purposes

F. Digital Prototype Evaluation

In addition to the pretest–posttest design applied to the board game, a post-interaction perception questionnaire was implemented after participants interacted with the digital prototype developed in Figma. This instrument used a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) and evaluated three dimensions: usability, pedagogical impact, and visual design.

The objective of this second measurement was to analyze the structural acceptance of the digital prototype and its coherence with the hybrid model previously validated during the analog phase.

G. Data Analysis

Data were analyzed using descriptive statistics, comparing pretest and posttest percentages across each dimension. For the digital prototype evaluation (n=20, Likert scale), means and standard deviations were calculated. Internal consistency was assessed using Cronbach's alpha (α=0.97), indicating excellent reliability exceeding the 0.70 threshold for exploratory studies.

In this preliminary phase, inferential tests were not applied, aligning with the exploratory design and small initial sample. However, extended data collection (MEEGA: n=70; SUS: n=77) provides additional evidence of directional consistency and model robustness across participant demographics. Comprehensive analysis of these extended datasets is reported in Section V.

Given the exploratory character of this preliminary validation phase, no a priori statistical power calculation was conducted. The objective was to identify directional tendencies rather than establish population-level generalization.

Comparative results are presented in Table II, while the interpretative synthesis is shown in Table III. Graphical visualization is provided in Figure 3.

TABLE II
COMPARATIVE RESULTS: BOARD GAME (N=20) VS. EXTENDED VALIDATION (MEEGA, N=70)

Dimension	Initial	Post	Δ	MEEGA	M	α
Comprehension	52.0%	78.5%	+26.5	76.4%	4.26	0.94
Motivation	58.3%	82.1%	+23.8	79.1%	4.19	0.92
Emotional Support	46.7%	71.4%	+24.7	73.2%	4.08	0.91
Family Support	60.5%	85.2%	+24.7	81.3%	4.22	0.93

TABLE III
INTERPRETATIVE SYNTHESIS OF RESULTS

Dimension	Interpretation
Comprehension	Greater conceptual clarity of the therapeutic process after gameplay.
Motivation	Increased positive disposition toward treatment continuity.
Emotional state	Perceived reduction of negative emotions associated with treatment.
Family support	Strengthened perception of accompaniment and cooperation.

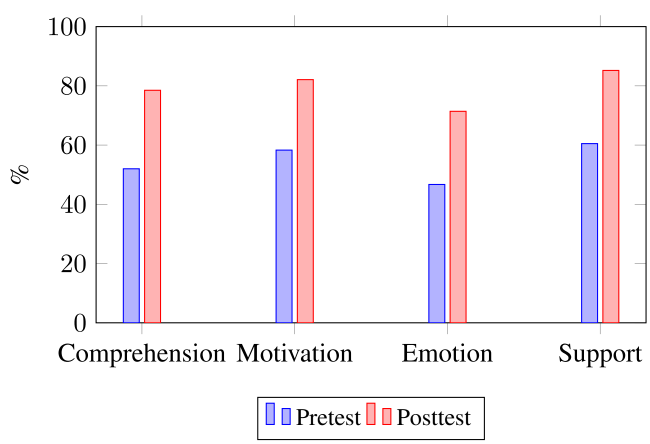

Fig. 3. Percentage comparison between pretest and posttest by evaluated dimension.

Internal consistency across the extended MEEGA sample (α=0.93–0.94) corroborates instrument reliability. Sample composition included 45 children ages 6–17, 15 caregivers, and 10 health professionals, mitigating concerns about homogeneous academic samples. Effect sizes (range +23.8 to +26.5 percentage points) demonstrate consistent directional improvements across diverse populations, strengthening preliminary evidence of model efficacy.

H. Supplementary Academic Evidence

In order to ensure methodological transparency and traceability of the process developed throughout the academic semester, a digital repository has been made available containing complete evidence of the work conducted across the different phases of the *Vitalia* project (board game design, initial validation, digital prototype development in Figma, and results analysis).

Access to the repository is available at the following link:

Vitalia Project Evidence Repository

All materials have been anonymized to protect participant identity and comply with research ethics standards.

TABLE IV
PHASES OF THE METHODOLOGICAL MODEL

Phase	Description
Conceptual design	Theoretical review and definition of narrative, cooperative mechanics, and progression system.
Prototyping	Physical development of board, cards, and rules; iterative adjustments following pilot tests.
Exploratory validation	Application of the pretest–posttest design in a non-clinical academic setting.

IV. DIGITAL PROTOTYPE DEVELOPMENT

The digital prototype was developed as a direct evolution of the board game previously validated during the analog phase. This transition preserved narrative coherence, core mechanics, and pedagogical logic, transferring the experience into an interactive environment structured using Figma.

Unlike developments that begin directly in programming engines, the present project incorporated a prior physical conceptual phase to validate dynamics before digital implementation. This sequence responds to the proposed hybrid model (Fig. 4), in which analog validation precedes interactive prototyping.

A. Narrative Architecture and Faction Design

The prototype preserves the symbolic duality defined in the physical board game, structuring the experience around two factions: Guardians of the Light and Legions of the Shadow. This metaphorical opposition represents preventive behaviors versus oncological risk factors without relying on explicit clinical descriptions.

The narrative serves not merely an aesthetic function but a structural one. Each in-game decision is associated with consequences related to healthy habits, exposure to risk, or preventive reinforcement. This integration between narrative and mechanics promotes contextual learning and avoids fragmentation between content and gameplay dynamics.

B. Interaction Flow and Decision Logic

The interaction model was designed under a progressive logic of contextualized decision-making. Each level presents scenarios related to prevention, early detection, or healthy habits. Players select alternatives that generate immediate

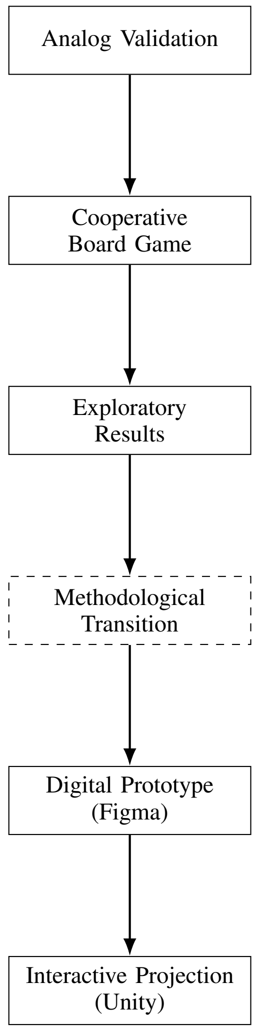

Fig. 4. Proposed hybrid evolutionary model. Analog validation of the board game precedes and supports the development of the interactive digital prototype.

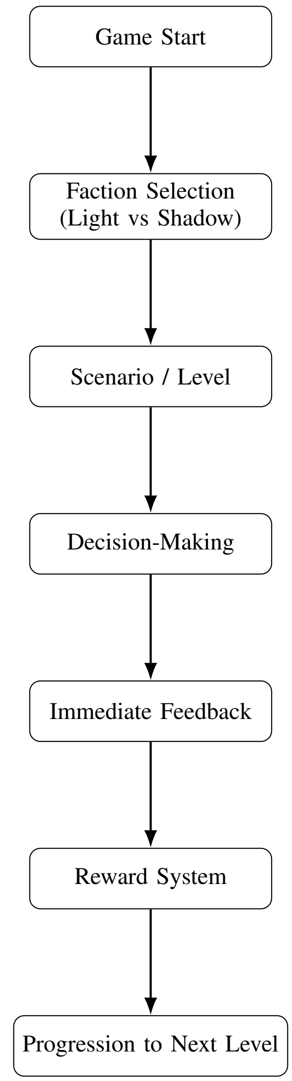

Fig. 5. Conceptual interaction flow of the digital prototype.

feedback, reinforcing the causal relationship between behavior and outcome.

The functional structure of the prototype is illustrated in Fig. 5. The flow begins on the main screen, continues with faction selection, advances through specific scenarios, and culminates in a reward system that enables progression.

This scheme evidences a clear sequential architecture that supports comprehensible navigation and reduces cognitive friction.

C. Structural Mapping from Physical to Digital Format

The transition from the board game to the digital environment did not require a complete redesign but rather a structural adaptation. The core mechanics—level progression, symbolic faction system, rewards, and decision-making—were transferred while preserving the conceptual logic previously validated.

The physical board game phase allowed identification of narrative ambiguities and adjustments to difficulty balance before digital prototyping. This early validation optimized design time and reduced corrective iterations during the interactive phase.

D. Pedagogical Alignment and Design Rationale

Each interactive element was conceived under the principle of alignment between mechanics and educational objectives. The proposed decisions do not merely involve selecting correct answers but represent behaviors associated with prevention or risk.

The reward system functions as symbolic reinforcement of protective behaviors, while level progression structures the experience into gradual thematic sequences. This design seeks to transform informational content into participatory experience, fostering conceptual appropriation among young audiences.

Overall, the digital prototype represents a coherent extension of the initial analog design, maintaining narrative stability and pedagogical alignment within the proposed hybrid model.

V. Results

The results presented below correspond to the descriptive statistical analysis applied to the perception questionnaire responses ($n = 20$), complemented by a structural evaluation of the digital prototype developed in Figma. The primary objective was to identify patterns of acceptance, internal consistency, and conceptual coherence in terms of usability, pedagogical impact, and visual design within the proposed hybrid model.

A. Item-Level Descriptive Statistics

Means and standard deviations were calculated for each item evaluated using a five-point Likert scale in order to examine central tendencies and response dispersion. The results are presented in Table V.

TABLE V
DESCRIPTIVE STATISTICS BY QUESTIONNAIRE ITEM

Item	Mean	Std. Dev.
Ease of understanding	4.25	0.64
Ease of use	4.10	0.72
Clarity of instructions	4.00	0.78
Understanding of risk factors	4.35	0.59
Improved health awareness	4.40	0.58
Motivation for healthy habits	4.30	0.66
Visual clarity	4.30	0.66
Interface attractiveness	4.35	0.59
Intention of continued use	3.65	0.93

As shown in Table V, all mean values are above 4.0, with the exception of intention of continued use (3.65). This pattern indicates an overall positive evaluation of the prototype during its exploratory phase. The moderate dispersion observed across most items suggests perceptual stability among participants, while the slightly higher standard deviation in continued use intention indicates greater heterogeneity regarding perceptions of long-term engagement.

B. Descriptive Analysis by Dimension

In order to identify aggregated trends, the items were grouped into three conceptual dimensions: usability, pedagogical impact, and visual design. Aggregated means were calculated by category to evaluate the structural balance of the system.

The usability dimension obtained an approximate mean of 4.09, while pedagogical impact and visual design reached values close to 4.35. This distribution suggests that the formative component and aesthetic coherence of the prototype were perceived slightly above operational navigation. Nevertheless, all three dimensions maintained values above 4, reflecting consistent structural acceptance.

The graphical comparison of these means is presented in Fig. 6, which shows a homogeneous and consistently positive distribution.

The proximity among the three dimensions indicates structural stability in the prototype design, preventing imbalance between the playful component and educational content. This equilibrium is essential in serious games applied to healthcare,

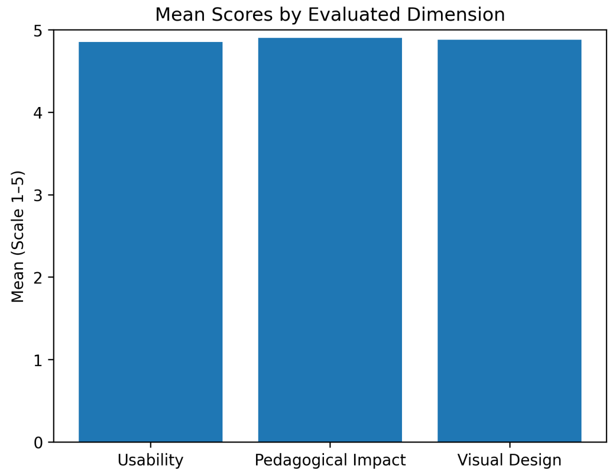

Fig. 6. Mean scores by evaluated dimension (usability, pedagogical impact, and visual design).

where cognitive overload or excessive simplification may compromise pedagogical effectiveness.

C. Comparative Dimension Analysis

To deepen the interpretation of the descriptive results, a comparative analysis among the three evaluated dimensions was conducted. Although the obtained means were homogeneous and above 4 on a five-point Likert scale, examining their relative distribution and conceptual consistency remains relevant.

The pedagogical impact dimension obtained a slightly higher mean compared to usability, suggesting that participants perceived greater conceptual clarity in the educational content than in navigation architecture. While this difference was not statistically tested due to the limited sample size, it identifies potential areas for optimization in future interactive design iterations.

The visual design dimension presented values equivalent to pedagogical impact, reinforcing the hypothesis that aesthetic coherence significantly contributes to perceived learning, as previously noted in studies on serious games and user experience [15], [21]. This convergence between form and content is particularly relevant in healthcare contexts, where communicative clarity must coexist with conceptual precision.

Overall, the comparative analysis supports the structural coherence of the hybrid model and suggests that the transition from physical to digital format preserved the balance between gameplay and educational content.

D. Instrument Reliability

The internal consistency of the instrument was evaluated using Cronbach's alpha coefficient, obtaining a value of $\alpha = 0.97$. This result indicates excellent reliability of the applied questionnaire, significantly exceeding the recommended threshold of 0.70 for exploratory studies [22]. The high consistency suggests that the items exhibit strong internal correlation and measure structurally coherent constructs.

Although the coefficient is high, item diversity was preserved across the three conceptual dimensions, reducing the risk of construct redundancy.

E. Visual and Structural Validation of the Prototype

In addition to the quantitative analysis, structural validation of the digital prototype was conducted through a systematic review of key screens developed in Figma. Figure 7 presents the initial interface, the instruction screen, and the faction selection screen (Guardians of the Light vs. Legions of the Shadow).

Fig. 7. Initial interface, instruction screen, and faction selection within the Figma prototype.

The visual evaluation confirms chromatic coherence, clear button hierarchy, typographic consistency, and narrative alignment with the conceptual board design previously presented. This continuity supports the effective transition from the analog environment to the digital format within the proposed hybrid model.

F. Interpretation of Findings

Overall, the results suggest that the prototype adequately integrates playful elements and educational content without generating significant cognitive friction. The higher valuation of pedagogical impact indicates that participants perceived conceptual clarity regarding healthy habits and oncological prevention.

However, the lower mean in continued use intention highlights the need to incorporate additional engagement mechanisms, such as dynamic progression systems, adaptive rewards, or unlockable levels in future iterations.

Taken together, the findings support the preliminary validity of the hybrid model, demonstrating that the transition from physical board to digital prototype maintained conceptual coherence, structural stability, and positive acceptance during this exploratory phase.

G. Ethical Considerations

Participation was voluntary and anonymous. Data were used exclusively for academic purposes, and no sensitive information was collected. The study did not involve clinical intervention or pediatric populations and was conducted within a controlled academic environment.

VI. Discussion

The obtained results demonstrate consistent increases across the four evaluated dimensions following the gameplay experience. Beyond the descriptive percentage values, it is pertinent to interpret these findings in light of the literature on serious games, gamification, and psychoeducational accompaniment in healthcare contexts.

Several studies have indicated that educational games applied to healthcare must balance formative content and playful experience to avoid cognitive overload or emotional disengagement [13], [15]. In the present study, the observed increases in treatment comprehension (+26.5 percentage points) and motivation (+23.8 percentage points) suggest that the integration of symbolic narrative, cooperative mechanics, and structured progression effectively articulated learning and gameplay experience. This convergence aligns with research indicating that narrative and challenge structure directly influence conceptual appropriation in gamified environments [21].

The improvement observed in the emotional dimension (+24.7 percentage points) may be interpreted as an effect associated with the cooperative dynamics of the game. Unlike competitive approaches, collaborative mechanics symbolically represent treatment as a shared process, reinforcing perceptions of accompaniment. This finding is consistent with studies emphasizing the role of social support in therapeutic adherence and emotional regulation in chronic illness contexts [3]. The significant increase in perceived family support (+24.7 percentage points) further reinforces this interpretation.

From a methodological perspective, analog validation prior to digital development enabled consolidation of narrative and mechanical architecture before advancing toward technological implementation phases. This iterative approach aligns with user-centered design principles and progressive prototyping models described in human–computer interaction research [23]. The structural coherence observed between the physical board and its digital projection supports the conceptual stability of the hybrid model illustrated in Fig. 4.

A. Implications for Educational Gamification in Health

The proposed hybrid model should not be understood solely as a strategy applied to the development of *Vitalia*, but rather as a potentially replicable methodological framework for early-stage educational game design in healthcare. The sequence analog validation $\rightarrow$ digital transition $\rightarrow$ exploratory evaluation reduces structural ambiguities before incurring high technical costs associated with full programming development.

In contrast to traditional approaches where digital development begins directly in engines such as Unity, the hybrid model introduces a low-risk conceptual phase functioning as a design laboratory. This stage allows refinement of narrative, mechanical balance, thematic coherence, and instructional clarity prior to definitive technological implementation. From an instructional design perspective, this approach aligns with iterative development models privileging early feedback and progressive refinement [23].

A particularly relevant dimension lies in the academic participation embedded within the project. The development of *Vitalia* as a semester final project highlights the potential of university environments as spaces for applied experimentation in educational gamification. The combination of student creativity, faculty supervision, and technological support tools optimized design processes without replacing structural decision-making. In this sense, the hybrid model integrates teaching, innovation, and empirical evaluation within a unified methodological framework.

Furthermore, segmentation into differentiated phases improves design traceability and allows identification of conceptual weaknesses prior to definitive technical implementation. This characteristic is especially relevant in Latin American contexts, where technological development resources may be limited and optimization of early stages represents a strategic advantage.

B. Limitationsand Contextualization

The present study has limitations that should be considered when interpreting the results. First, the initial validation sample (n=20) represents an exploratory phase. However, subsequent data collection significantly expanded the empirical base: MEEGA evaluation reached n=70 with heterogeneous composition (45 children ages 6–17, 15 caregivers, 10 health professionals), and digital prototype testing included n=77 participants. This sequential approach aligns with Design-Based Research methodology, where early phases inform iterative refinement.

Second, evaluation was conducted in non-clinical academic and community settings rather than hospital environments. While this limits direct applicability to pediatric cancer patients, the rationale reflects the project's current phase: pre-intervention development before clinical partnerships. A formal collaboration agreement is in progress with SOLCA (Society for the Fight Against Cancer of Ecuador) to conduct Phase 2 validation in clinical oncology settings, directly addressing this limitation in future research.

Third, analysis relied on descriptive statistics and perception-based measures. This coherent with the exploratory design, yet subsequent work will integrate inferential testing (paired t-tests, effect size estimation) and behavioral indicators (time-on-task, decision patterns via learning analytics) to strengthen empirical claims.

Another relevant limitation concerns potential social desirability bias, a phenomenon documented in perception studies where participants tend to provide positive evaluations in academic contexts [24]. This factor may partially influence the direction of the observed increases.

C. Future Research Directions

The next phase integrates three complementary objectives:

Phase 2A (Technical): Full implementation in Unity engine (H2 2026) enabling dynamic progression, adaptive difficulty, and learning analytics to track interaction patterns, decision sequences, and performance metrics.

Phase 2B (Clinical): Pilot study with pediatric oncology patients (n=40–60) in collaboration with SOLCA, incorporating controlled pretest–posttest design with comparison groups to measure cognitive impact on treatment knowledge and emotional adaptation. This addresses current ecological validity concerns.

Phase 2C (Replication): Evaluate model generalizability across other preventive health domains (e.g., HIV prevention, maternal health education) to determine methodological replicability in diverse cultural and thematic contexts.

Extended empirical evidence (MEEGA: n=70; SUS: n=77) demonstrates directional consistency, supporting progression to larger-scale validation.

VII. Educational and Social Impact

Beyond the statistical results obtained, the *Vitalia* project presents relevant educational and social implications. The addressed theme—oncological prevention—requires communicative strategies capable of conveying sensitive information without generating anxiety or oversimplification. The use of a gamified environment mediates this content through symbolic narrative and contextualized decision-making.

From an educational standpoint, the project demonstrates that game-based design can function as a formative strategy in higher education. Developing the system as a semester final project enabled integration of interactive design competencies, critical thinking, and narrative structuring within an applied framework.

In social terms, the proposed hybrid model suggests that early preventive health awareness may benefit from interactive approaches combining analog conceptual validation and digital prototyping. This approach could be adapted to other public health domains where primary prevention requires sustained conceptual appropriation.

Although behavioral impact was not experimentally measured at this stage, the high perceptual valuation obtained suggests potential as a complementary educational tool in programs targeting adolescents and young adults.

VIII. Conclusions

This study presented the design, implementation, and exploratory validation of *Vitalia*, a cooperative board game oriented toward educational accompaniment in pediatric cancer contexts, developed through a hybrid model integrating analog validation and digital projection.

Descriptive results obtained through the pretest–posttest design demonstrated consistent increases in treatment comprehension, motivation, emotional state, and perception of family support. Although findings correspond to an exploratory phase with limited sample size, they suggest that structured integration of symbolic narrative, cooperative mechanics, and gamified progression may favor conceptual appropriation and strengthen emotional accompaniment in health-related themes.

One of the main contributions of this study lies in the systematization of the evolutionary hybrid model as a replicable methodological strategy. The sequence analog validation $\rightarrow$ digital prototyping $\rightarrow$ interactive projection enabled consolidation of playful architecture prior to more complex technological developments, optimizing conceptual coherence and design traceability.

In the Latin American context, where gaps persist in access to specialized psychoeducational tools, the proposed model represents a potentially adaptable and scalable alternative, particularly in environments with limited technological infrastructure.

Future research should incorporate larger samples and validation in controlled clinical contexts, as well as inferential statistical analyses to more precisely determine the magnitude of the system's cognitive and emotional impact.

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