Testing the Game: Gamma Finance as a Design-Based Prototype for Financial Literacy in Higher Education

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Abstract: This study presents Gamma Finance -GF, a high-fidelity instructional game designed to explore the potential of gamification in enhancing financial literacy among university students. Grounded in gamification and experiential learning principles, GF enables participants to engage in active decision-making, problem-solving, and strategic thinking within simulated financial scenarios. The study followed a design-based research approach, employing a quasi-experimental methodology without a formal control group, which limits the ability to infer causality. The findings should therefore be interpreted as exploratory and formative. Data were collected through expert validation, pilot testing, focus groups, and iterative design refinements. The study offers initial insights into how students interact with the game and perceive its educational value. Participants reported increased engagement and motivation, with 91% expressing strong interest in learning financial concepts through gameplay. Additionally, qualitative feedback and performance indicators suggest the game may help develop analytical, mathematical, and financial decision-making skills. These findings position GF as a promising prototype and an example of how gamified learning tools can complement traditional approaches to financial education. Future research should further investigate its impact through controlled studies and assess its scalability across diverse educational contexts.

Keywords: Financial education, Gamification, Instructional game, Experiential learning, Financial literacy

1. Introduction

Financial education has become an essential skill in the 21st century, enabling individuals to make informed decisions about saving, investing, credit management, and budgeting. Despite its recognized importance, global financial literacy levels remain alarmingly low, even in advanced economies (Lusardi & Mitchell, 2011; Lusardi & Messy, 2023). This knowledge gap is particularly critical among university students, who often transition into the workforce and assume financial responsibilities without a solid understanding of key financial concepts (Stepnova, Starchikova & Kurashova, 2024). Poor financial literacy can lead to excessive debt, poor financial planning, and missed economic opportunities.

In Colombia, the situation is no different. According to Asobancaria (2021), the national Financial Education Index has shown a decline, underscoring the urgent need to strengthen financial education. Higher education institutions are uniquely positioned to address this challenge, offering a platform for students to develop critical financial skills before entering the professional world. However, traditional methods of teaching financial literacy, often focused on theoretical content, struggle to capture students' interest or promote long-term retention.

To address this gap, innovative teaching strategies such as gamification have gained prominence. Gamification, defined as the use of game elements in non-game contexts, has shown promise in enhancing student motivation, engagement, and learning outcomes (Pashaei et al., 2024; Lotter & Okoro, 2023). In financial education, gamified tools provide an opportunity for students to experience financial decision-making, manage resources, and solve problems in a risk-free environment.

This study introduces Gamma Finance -GF, a physical, high-fidelity board game designed as a proof of concept to explore the potential of gamification for improving financial literacy. The game engages students in negotiation, decision-making, and problem-solving tasks across three difficulty levels, each aligned with different levels of financial knowledge and age groups. By doing so, GF seeks to bridge the gap between theoretical instruction and experiential learning.

Rather than aiming to produce validated evidence of effectiveness, this study introduces GF as a design-based research initiative, one that iteratively develops and refines an educational tool while gathering insights into its perceived educational value, usability, and alignment with learning goals. Specifically, the research seeks to address the following questions:

- How do students experience and interpret the educational value of GF?
- What design elements contribute most to engagement and perceived learning?
- What insights can be drawn to guide future iterations or broader implementations of gamified financial education?

The study employed a quasi-experimental framework involving 45 undergraduate students and drew upon expert validation, pilot testing, focus groups, and iterative design refinements. While the results are exploratory, the findings suggest that GF offers meaningful learning experiences and design insights for the development of gamified financial literacy tools.

Ultimately, this study contributes to the growing body of design-based educational research, particularly within the context of emerging economies. GF, developed in Colombia, offers a locally grounded yet globally relevant perspective on the role of games in financial education. Its development process underscores the importance of iterative, user-centered design and positions the game as a springboard for further innovation and cross-cultural dialogue in game-based learning.

2. Theoretical Background

In the 21st century, higher education institutions are expected to fulfil a transformative role, not merely transmitting knowledge but fostering active, experiential learning. This involves adopting innovative pedagogical methods such as gamification, which can revitalise traditional instruction. Financial education has emerged as a key competence, enabling students to develop analytical, systemic, and critical thinking for responsible economic decision-making (Pashaei et al., 2024; Reddy and Taj, 2024)

The digitalisation of society and the expansion of fintech services have altered how individuals engage with financial management, promoting financial inclusion through improved access to digital tools (Lyons and Kass-Hanna, 2021). Yet, despite these technological strides, financial literacy remains critically low worldwide (Lusardi and Mitchell, 2011; Lusardi, 2019; Lusardi and Messy, 2023), necessitating stronger educational initiatives.

Robust financial education not only supports personal wellbeing but also strengthens economic stability by empowering individuals to make informed decisions about savings, debt, and investment (Péter and Ambilikumar, 2020; Stepnova, Starchikova and Kurashova, 2024). Gamified interventions like GF exemplify how experiential learning can reinforce financial competencies while maintaining student engagement.

Universities are thus called to adopt teaching strategies beyond traditional models. Gamification offers clear potential, particularly when aligned with rigorous design and measurable learning outcomes (Kurnianti et al., 2023; Kraitzek and Förster, 2023; Ambuehl, Bernheim and Lusardi, 2021).

Literature widely recognises the link between financial education and financial wellbeing. Munisamy, Sahid and Hussin (2022) found that financial knowledge influences responsible credit use and economic resilience. Their study in Malaysia showed that financial education promoted healthy habits and improved household financial stability, particularly in low-income groups.

In the digital era, financial illiteracy is further complicated by the rise of online banking and the risk of digital fraud. A recent Russian study (Stepnova, Starchikova and Kurashova, 2024) demonstrated that targeted financial literacy programmes improved students' understanding of interest rates and financial markets between 2020 and 2023. These findings support the integration of financial education as an elective within university curricula.

Financial education also intersects with entrepreneurship and strategic decision-making. Pashaei et al. (2024) highlight how economics education enhances students' entrepreneurial skills, suggesting broader applications of financial literacy beyond personal budgeting to include enterprise management.

The OECD (2011) defines financial education as the process through which individuals improve their understanding of financial products and risks, developing the skills necessary for informed decision-making. A lack of such knowledge can undermine household economic security. Lusardi (2019) notes that financially literate individuals are more likely to save, invest efficiently, and avoid excessive debt, especially among youth and economically vulnerable populations.

Klapper and Lusardi (2020) and Tahir, Richards and Abdullah (2021) similarly found that stronger financial education correlates with reduced credit card debt. Ludlum et al. (2012) revealed that fewer than 10% of students knew basic credit terms, and Allgood and Walstad (2013) showed that older students are less likely to repay debt in full, highlighting the ongoing need for financial education throughout life.

Developing financial literacy requires more than technical skills, it also involves emotional awareness and strategic foresight. Embedding these components into university courses can equip students with holistic financial management skills.

Recent innovations demonstrate that digital tools and planning exercises can improve financial literacy (Kurnianti et al., 2023). Kraitzek and Förster (2023) propose assessing competencies through emotional recognition systems and practical evaluations, reinforcing the importance of immersive learning.

Game-based learning (GBL) has gained attention post-pandemic due to its effectiveness in increasing learner engagement and decision-making capacity (Lotter and Okoro, 2023). While gamification in financial education remains under-researched, scholars such as Reisdorfer et al. (2025) underline the importance of addressing three core dimensions: financial knowledge, attitudes, and behaviours. These can be enhanced through contextual and experiential learning models tailored to youth.

To respond to these challenges, universities must design structured, technology-enhanced programmes that integrate gamified tools and real-world applications. Initiatives like GF at the Universidad Tecnológica de Bolívar serve as promising models, bridging academic content and practical financial competence for long-term student wellbeing.

3. Methodology

This study adopts a design-based research (DBR) approach to explore the development, implementation, and refinement of GF; a high-fidelity educational board game aimed at strengthening financial literacy among university students. DBR is particularly suited to educational innovation, as it enables iterative cycles of design, testing, and revision in real-world learning environments, while generating both practical solutions and theoretical insights (Design-Based Research Collective, 2003).

The research was conducted at the Universidad Tecnológica de Bolívar (Cartagena, Colombia), a higher education institution committed to the integration of experiential and active learning within its pedagogical model. The study involved 45 undergraduate students enrolled in social science and engineering programmes, selected through purposive sampling to ensure diversity in academic backgrounds and financial knowledge.

Participants were divided into guided and unguided groups to observe the potential role of instructional support in gameplay-based learning. All participants were informed of the study's aims and gave their consent in accordance with ethical standards for educational research.

3.1 Design and Development of GF

GF was conceived as a physical board game incorporating core elements of financial education, such as income management, budgeting, savings, investment, and debt. The game is structured into three progressive levels of difficulty, allowing for adaptability across varying levels of financial literacy and age groups. Its mechanics integrate negotiation, risk assessment, problem-solving, and strategic decision-making.

The design process followed iterative prototyping cycles, involving expert reviews, pilot testing with students, and ongoing refinement based on feedback. This ensured both pedagogical alignment and user engagement. Content validation was conducted by three subject-matter experts in finance and education, who assessed the accuracy, relevance, and clarity of game scenarios and rules.

3.2 Data Collection Methods

Multiple qualitative and quantitative techniques were employed to gather data across different stages of the intervention:

- Focus groups were conducted before and after gameplay sessions to explore students' expectations, perceptions, and reflections.
- Observation protocols were used to document student interaction, decision-making processes, and collaborative behaviours during gameplay.

- Post-session questionnaires measured self-reported changes in motivation, perceived learning, and financial confidence.
- Satisfaction surveys employed a 10-point Likert scale to assess student engagement and enjoyment.
- Comparative analysis between guided and unguided groups provided exploratory insights into the role of facilitation in learning outcomes.

3.3 Data Analysis

Data were analysed using a mixed-methods approach. Quantitative data from surveys and questionnaires were processed using descriptive statistics to identify patterns in motivation and satisfaction. Qualitative data from focus groups and observations were coded thematically to capture emergent insights on learning dynamics, engagement, and concept assimilation. This multi-method strategy enabled a comprehensive understanding of the educational value and design implications of GF within a university setting.

Process Description

- *Content validation:* Experts assessed the coherence of the financial content, the clarity of the instructions, and the alignment with the educational objectives. Recommendations from experts were integrated to improve the game's precision and applicability.
- *Pilot testing in classroom contexts:* The game was implemented in two class sessions, each lasting 40 minutes. These courses were selected intentionally to represent different levels of financial competency and academic progression (implemented in an introductory-level course -first semester and an advanced-level course -ninth semester), thus supporting the robustness of the quasi-experimental design. Students participated in small groups and played GF following the established rules. Observers documented student interactions, their financial decision-making abilities, and their level of engagement.
- *Focus groups:* 12 students were selected intentionally to participate in guided discussions. Using the FESTIN protocol (Easy, Attractive, Social, Timely + Fun) (Chaparro et al, 2020), their perceptions of the experience, challenges encountered, and the learning outcomes achieved were explored.
- *Iterative design improvements:* Feedback from students and experts was consolidated into a feedback matrix. Adjustments were made to the game's rules, the complexity of financial questions, and the clarity of instructions. Four independent classroom observers, and four co-designers who participated in both formative development and iterative refinement stages. The final design of GF incorporated these changes to optimise its educational effectiveness.

The process outlined above is summarised in Table 1.

Table 1: Summary of validation phases and instruments

Phase	Methodological Technique	Participants	Instrument/Tool	Purpose
Content validation	Expert Review (See Figure 1)	3 experts (finance and pedagogy)	Checklist	Ensure theoretical and educational coherence of the game.
Pilot testing	Classroom observation (See Figure 3 and 4)	45 students	Observation sheets and questionnaires	Evaluate playability and understanding of concepts.
Focus groups (See Figure 2 and 5)	Semi-structured discussion	12 selected students	FESTIN protocol	Gather qualitative feedback.
Iterative improvement	Collaborative analysis	Design team and experts	Feedback matrix	Optimise the gaming experience

Figure 1: Expert Review

Figure 2: Focus group discussions (research team)

Figure 3: Pilot Application

Figure 4: Pilot Application (control)

Figure 5: Focus group discussions (users)

4. Results and Discussion

4.1 Gamma Finance

GF is structured into three levels of difficulty; each tailored to varying levels of prior knowledge and age groups. At each level, participants are required to negotiate, solve problems, and make decisions through managing a game board, thereby creating a controlled and secure environment for experimentation. Additionally, the reward and challenge system played a key role in sustaining motivation and engagement, encouraging active participation and continuous feedback. The complete game board at the advanced level is presented in Figure 6 and Table 2. The hexagonal board design represents a significant departure from traditional financial education games, which often rely on linear or square formats. Its spiral paths and triangular cells promote non-linear navigation and strategic decision-making, thereby fostering critical thinking. Each cell is embedded with thematic symbols related to financial literacy, while the coloured zones at the centre and edges suggest thematic territories, enabling players to begin from different starting points and pursue unique learning trajectories. This personalised and decentralised structure reinforces the notion that there is no single path to success, an

important pedagogical shift that acknowledges the complexity and diversity of real-life financial experiences. Moreover, the network-like layout fosters cooperative interaction rather than zero-sum competition, aligning with more progressive and inclusive educational approaches. The modular and symbolic nature of the design further allows for physical or digital adaptation and thematic expansions, reinforcing its potential as an innovative and flexible tool in contemporary financial education.

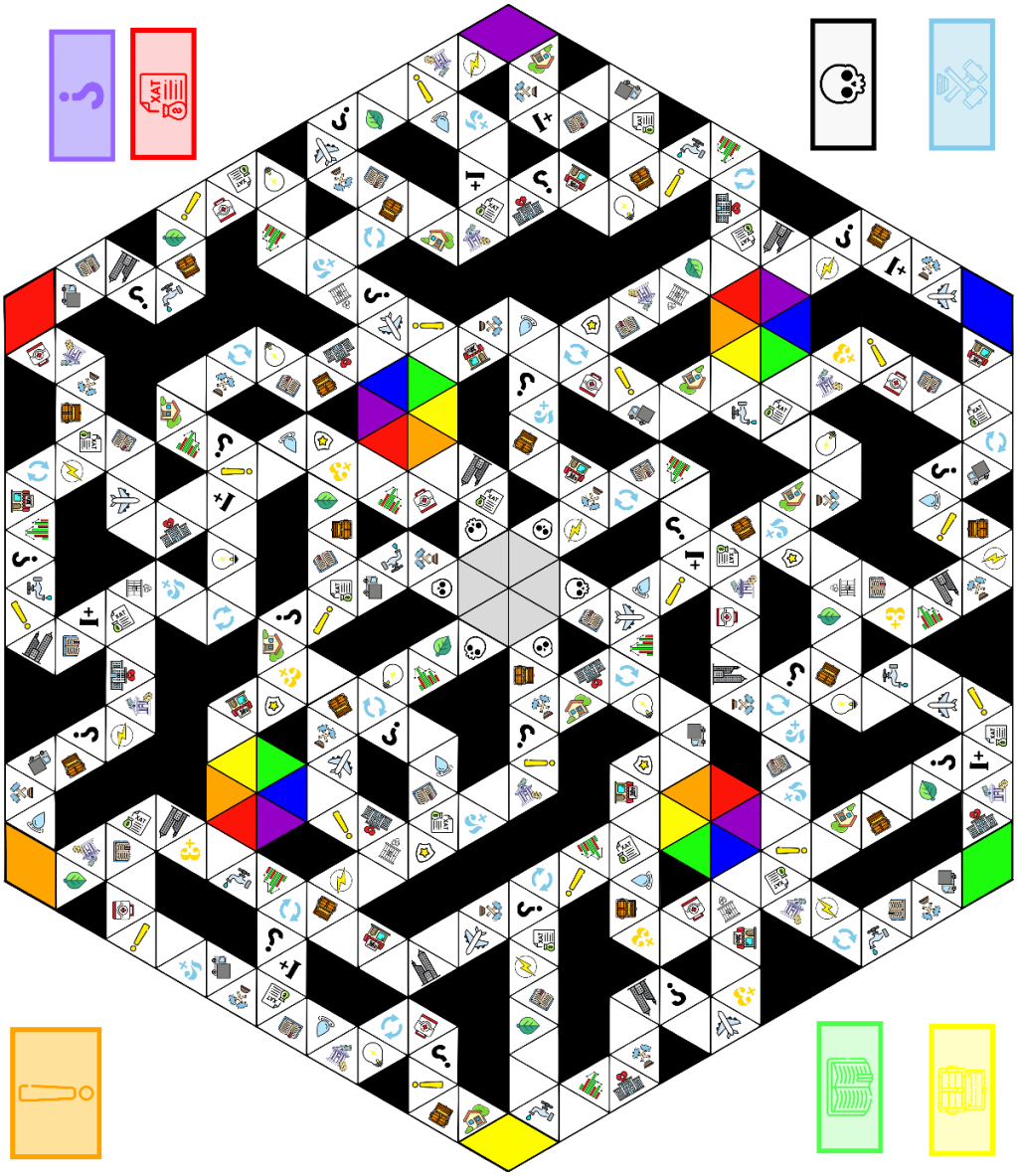

Figure 6: Game Board GF (Advanced Level)

Table 2: Symbols and iconography

Symbols and iconography	Description
	Starting the game: Each player begins on a coloured starting point with an initial balance of 500 units
	Roulette tiles: Upon landing on a roulette tile, roll the colour die.
	Purchasing properties
	Types of cards: There are seven types of cards, each with unique effects: Financial Bonds (Yellow), Concepts (Green). Penitentiary (Blue), Question (Purple), Taxes (Red), Missions (Orange), Financial death (Black): Severe penalties that may lead to bankruptcy.

Symbols and iconography	Description
	Gamma Market
	Movement-related spaces
	Immunity Tile
	Confinement rules

The comparative evaluation of GF against other gamified financial learning tools (See Table 3) reveals a clear strength in its multilevel design, physical engagement, and research-based approach. While digital platforms like FinAI and CashCoach excel in accessibility and scalability, they often lack the immersive roleplay and scenario-based strategy embedded in GF. Similarly, although games such as FinPlan and ISCA Family Game provide engaging simulations, they tend to focus on narrow segments of financial literacy, either planning or budgeting, whereas GF addresses a broader conceptual spectrum, including negotiation, analytical reasoning, and financial ethics. The inclusion of adjustable difficulty levels, reflection of real-world financial roles, and alignment with pedagogical principles such as self-determination and goal orientation mark GF as a potential comprehensive educational tool. This positions it not only as an innovative game but as a structured academic intervention capable of reinforcing curricular objectives in financial education.

Table 3: Comparative analysis of financial education games

Name	Country	Target Population	Methodology	Objective	Format	Results	Key Differentiator	Citation
FinAI	India	University students and financially literate youth	Google-based course selection, quizzes, chatbot, real-time data	Evaluate platform's effectiveness in simplifying financial concepts	Digital interactive platform	Increased student interest in finance through gameplay	AI integration and quiz-based progression	Deshmukh (2025)
ISCA Family Game	Portugal	Students aged 12–18 from primary to university levels	Kahoot quiz, budgeting simulations, reflective exercises	Raise financial awareness and responsible consumption	Physical board game with character tokens	Increased awareness and engagement	Pre/post assessments and reflection	Estima and Peguinho (2024)
META-Z	Indonesia	Gen Z youth (18–26 years)	Role-based financial simulations	Improve Gen Z financial literacy	Hybrid physical-digital	Higher satisfaction and motivation	Wealth multiplier goal mechanic	Lisana (2025)
Moonshot	Germany	Secondary school students	Scenario cards for financial transactions	Empower responsible daily financial choices	Physical card-based game	Enhanced perceived value of financial literacy	Personal life project alignment	Platz and Zauner (2025)
CashCoach	Germany	Secondary school students	Quizzes, missions, knowledge duels	Gamified digital financial literacy	Digital animated app	Awarded 'Best Scientific Analysis'	Strong digital engagement and competition	Ambacher et al. (2023)
FinPlan	Malaysia	Lower secondary students (15–16 years)	AR-enhanced board game simulating incomes and expenses	Improve personal financial planning	Board game with AR	Enhanced financial planning knowledge	Focus on planning, AR feature	Yin et al. (2025)

4.2 Experience

4.2.1 Participant profile and engagement

The study involved 45 (NS=45) undergraduate students (53% female, 47% male) from the Universidad Tecnológica de Bolívar, aged 18-26, enrolled in two finance-related courses (implemented in an introductory-level course -first semester and an advanced-level course -ninth semester: ITC for business and Finance I) together with their teachers (NT=2). The participants were divided into guided and unguided groups to assess

the impact of instructional support on gameplay and learning outcomes. A detailed overview of participant characteristics is provided in Table 4.

Table 4: Participant Demographic

Characteristic	Percentage (%)
Gender	Female: 53% Male: 47%
Age range	18-26 years
Academic background	Business: 56% Engineering: 27% Other: 17%
Group distribution	Guided: 52% Unguided: 48%

4.2.2 Student perceptions of GF

Participants' perceptions of the game were assessed through a post-session questionnaire and focus group discussions.

- *Interest in Financial Education*: 91% expressed strong interest in learning financial concepts through the game.
- *Self-perceived Financial Knowledge*: Basic: 44%, Intermediate: 44%, Advanced: 4%, No prior knowledge: 7%
- *Keywords used to describe the game (Positive, Cognitive and Financial): Positive:* "Fun" (16 mentions), "Educational" (5), "Good" (4), "Interesting" (3), "Didactic" (3), "Innovative/Creative/Different" (3), "Enriching", "Complete", "Cool" (1 each). *Cognitive:* "Strategy", "Analytical", "Reasoning". *Financial:* "Accounting", "Investment", "Finance"
- *Overall satisfaction:* On a 10-point scale, the game received an average score of 8.78, indicating high satisfaction.
- *Impact of gameplay experience:* Participants reported engaging with a range of simulated financial tasks, most notably: property acquisition (91%), calculating interest, rent, or taxes (74%), answering financial questions (70%), managing money (70%). Facing business dilemmas (48%) the lowest, likely due to randomness in gameplay mechanics (e.g., dice rolls and tile landings)
- *Iterative Decision-Making:* 72% of students reported that they changed their strategies during gameplay, indicating active reflection and adaptation. The variability in exposure to activities reflects the intentional game design incorporating chance, allowing players to simulate real-life unpredictability in economic decision-making. This feature, while introducing asymmetry in experience, mirrors authentic financial environments, reinforcing the learning objectives.
- *Cognitive and affective learning outcomes:* Participants were asked to rate their agreement with six learning outcomes (Analytical capacity, Problem-solving skills, financial decision-making, Mathematical skills, Motivation to learn financial concepts, Development of financial knowledge) on a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). All responses clustered within the top two agreement levels (Agree/Strongly Agree). These exploratory findings suggest that the game effectively supported both cognitive and affective dimensions of learning. Its format promoted situated problem-solving and engaged multiple intelligences (logical-mathematical, interpersonal, and strategic reasoning), thus aligning with pedagogical theories underpinning experiential and constructivist learning.
- *Qualitative insights, student feedback:* a thematic analysis of focus group discussions revealed four key themes: (a) Engagement and motivation: *"I never thought finance could be this fun.", "The game made me think about money in a completely different way.";* (b) Practical learning: *"Understanding interest rates became much easier because I saw how they worked in the game.", "It was like managing a small company, but with no risk.";* (c) Strategic thinking: *"I had to plan my moves carefully, just like in real life.", "The decisions we made had real consequences in the game.";* (d) Peer interaction: *"It was fun to negotiate with other players.", "We learned a lot by discussing strategies with our classmates."*

GF as a design-based research initiative is a viable educational tool for enhancing financial literacy in higher education. Preliminary findings from the pilot implementation are summarised as follows, demonstrate that students do not merely learn through the game, they enjoy and internalise the experience. This confirms the central tenet of game-based learning: cognitive immersion through meaningful play. Moreover, the analysis reveals that the game succeeds in bridging theoretical knowledge with practical simulation, encouraging students to make decisions under constraints, negotiate, and reflect on outcomes, all essential elements of real-world financial behaviour. The inclusion of both guided and unguided groups also opens possibilities for further comparative analysis of instructional scaffolding in gamified environments. Future studies could employ pre- and post-intervention measures to quantify knowledge gains or examine longitudinal retention of concepts introduced during gameplay.

4.3 Discussion

It is important to note that, although quasi-experimental in nature, this study did not include a separate control group. As such, the design is best interpreted as an exploratory educational intervention rather than a validated test of efficacy. The results of this study suggest that GF holds promise as a design-based educational prototype for enhancing financial literacy among university students. By integrating gamification and experiential learning principles, the game offers a dynamic, interactive environment in which learners actively engage with financial concepts rather than passively consuming information.

These preliminary findings resonate with existing literature on gamified learning, which emphasizes the value of active environments in promoting higher-order thinking skills (Kiili, 2005; Lotter & Okoro, 2023). Through real-world-inspired financial scenarios, GF enabled students to apply theoretical knowledge in practice, especially regarding complex topics such as interest rates and investment strategies. The game mechanics encouraged risk analysis, strategic planning, and adaptive thinking, which simulate authentic financial behaviour.

Qualitative feedback frequently included terms such as "Fun," "Educational," "Strategy," and "Analytical", suggesting a meaningful blend of enjoyment and cognitive stimulation. The game's negotiation-based structure fostered peer learning and collaborative reflection, enriching the overall learning environment.

In terms of the OECD's financial literacy framework, encompassing knowledge, skills, and attitudes (OECD, 2011) GF showed potential to contribute in the following areas:

- Knowledge acquisition: Students demonstrated improved comprehension of core financial concepts such as interest, taxes, and investment.
- Skill development: Gameplay encouraged practical behaviours like budgeting, negotiation, and risk evaluation.

In comparing GF with other gamified financial education initiatives such as FinAI, ISCA Family Game, and META-Z, several distinguishing features emerge:

- Tactile learning: Unlike digital platforms, GF emphasizes physical interaction, encouraging face-to-face social learning and teamwork.
- Adaptability: The three-tiered difficulty structure allows the game to accommodate diverse levels of financial literacy, from beginners to advanced learners.
- Design-based development: The iterative prototyping process ensured pedagogical coherence and continuous improvement through user feedback and expert input.

While GF has shown encouraging potential as a learning tool, several areas warrant further exploration:

Building on the current development of a digital version, future iterations of GF could explore hybrid implementations combining physical gameplay with digital interfaces. Potential avenues include developing a web-based or app-based platform for remote or asynchronous participation, integrating analytics to track player decisions, and incorporating adaptive difficulty through algorithmic feedback. These advances would support broader accessibility, especially in low-resource or distance-learning environments, while enabling scalable data collection for future evaluation and refinement.

4.4 Limitations

This study presents several limitations. First, the lack of a formal control group restricts the ability to draw causal conclusions from the observed outcomes. Second, reliance on self-reported measures, such as perceived learning and motivation, may introduce bias and limit the objectivity of the findings. Third, the study was conducted within a single institutional setting, which may affect the generalisability of results to other contexts

or populations. Future research should address these limitations through controlled trials, longitudinal assessments, and multi-institutional comparisons.

Overall, this study offers a proof of concept for the use of gamification in financial education within higher education settings, particularly in emerging contexts. Further studies, including those with control groups and longitudinal data, are recommended to evaluate long-term learning outcomes and scalability.

5. Conclusion

This study presents GF as a design-based research initiative aimed at exploring innovative approaches to financial education through gameplay. By integrating gamification, experiential learning, and strategic decision-making, the game offers a more dynamic educational experience than traditional methods.

Preliminary findings suggest that students perceived improvements in their understanding of financial concepts and analytical skills, while reporting motivation and satisfaction. Facilitator support appeared to enhance the learning experience, highlighting the potential value of guided implementation in game-based environments.

Although GF remains at an early stage of validation, the initial results provide a solid foundation for further, more rigorous investigation. Future research should consider longitudinal studies to assess long-term behavioural impact, explore its adaptability across diverse educational contexts, and advance the development of a digital version to increase scalability and access.

In sum, GF is more than an instructional game, it is an emerging pedagogical tool with the potential to transform how financial literacy is taught in higher education, particularly in contexts that demand more engaging and applied learning experiences.

Ethics declaration: This research was conducted in accordance with the ethical and regulatory guidelines of the Technological University of Bolívar, with institutional approval for its execution. All participants involved in the study provided informed consent after receiving a detailed explanation of the research objectives, methodology, confidential use of data, and their right to withdraw at any time without consequences. Collected data were anonymized and stored under strict security protocols, in compliance with Colombian personal data protection regulations (Law 1581 of 2012).

AI declaration: Regarding the writing and linguistic adaptation process, AI-powered tools were employed to support the translation of content from English to Spanish. Machine-generated translations underwent critical review and manual adjustments by the authors to ensure technical accuracy, contextual coherence, and cultural appropriateness. This hybrid approach (AI + human oversight) preserved academic integrity and enhanced the document's communicative clarity.

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