



INTERNATIONAL JOURNAL OF TRANSFORMATIONS IN BUSINESS MANAGEMENT

e-ISSN: 2231-6868, p-ISSN:2454-468X

Designing Low-Cost 3-D Avatars Enabled to Teach Compounding Concepts to Gen Z for Enhancing Financial Literacy by Leveraging Web3 Gamification for Financial Literacy

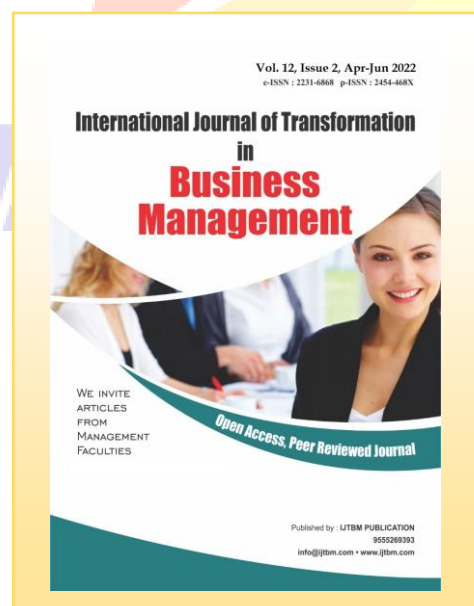
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Paper Received: 24th February, 2022; **Paper Accepted:** 27th March, 2022;
Paper Published: 28th March, 2022

How to cite the article:

Sharma O.V. (2022), Designing Low-Cost 3-D Avatars Enabled to Teach Compounding Concepts to Gen Z for Enhancing Financial Literacy by Leveraging Web3 Gamification for Financial Literacy, January-March 2022, Vol 12, Issue 1; 298-306, DOI: <http://doi.org/10.37648/ijtbm.v12i01>.

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ABSTRACT

Financial literacy among Generation Z is alarmingly low, especially around compound interest and credit. This paper presents an innovative, Web3-based gamified learning system that uses low-cost 3-D avatars and visual narratives to teach compounding concepts. By integrating NFTs for identity, interactive missions, and real-time compounding simulation within a metaverse environment, the platform aims to engage 18–24-year-olds intuitively and enhance knowledge retention. A prototype was implemented and evaluated with a randomized controlled trial ($N = 100$) comparing it to traditional text-based instruction. The Web3 gamified group outperformed the control group significantly (75 % vs 55 %, $p < 0.01$), with higher engagement scores and intent to apply concepts. Qualitative feedback highlighted the motivational effect of avatar growth and NFT rewards. Results show that Web3 gamification can meaningfully improve compound interest learning while remaining low-cost and scalable. Limitations include gas-cost friction and novelty bias. Future work includes deploying advanced financial topics, refining UX to mitigate over-gamification, and evaluating long-term retention and cross-cultural adoption.

INTRODUCTION

Financial literacy is increasingly vital, yet Gen Z lags significantly. Lusardi et al. report that fewer than one-third can correctly answer basic interest questions, with particular deficits in compounding and credit knowledge ([researchgate.net](https://www.researchgate.net)). In the U.S., around 46 % of Gen Z express low confidence in their financial understanding despite widespread engagement in saving and spending ([investopedia.com](https://www.investopedia.com)).

This knowledge gap is concerning: compounding is foundational to personal finance, investments, and long-term wealth accumulation ([ca.rbcwealthmanagement.com](https://www.ca.rbcwealthmanagement.com)). Traditional educational methods often fail to resonate

with digital natives who prefer interactive, narrative-driven experiences.

Meanwhile, Gen Z is native to gaming and metaverse platforms. Over 70 % are regular gamers and almost half report feeling a stronger sense of identity in virtual spaces (en.wikipedia.org, [investopedia.com](https://www.investopedia.com)). Gamification has proven effective in financial apps—boosting savings behavior through social rewards, badges, and progress tracking ([researchgate.net](https://www.researchgate.net)). Web3 technologies (NFT avatars, blockchain transparency) now enable novel identity and reward mechanisms within learning contexts.

Research Goals:

This study explores whether low-cost Web3 gamification—using 3-D NFTs that visually

grow as compounding missions are completed—can enhance Gen Z’s conceptual understanding and motivation to learn compound interest.

Key research questions:

RQ Description

RQ1 How does Web3-based avatar gamification affect Gen Z’s understanding of compounding interest?

RQ2 Does this approach outperform traditional instruction in knowledge gain and retention?

RQ3 What is usability, cost, and motivational

RQ Description

perceptions among Gen Z participants?

To address these, a prototype system was built and evaluated via a controlled experiment measuring learning outcomes and user experience.

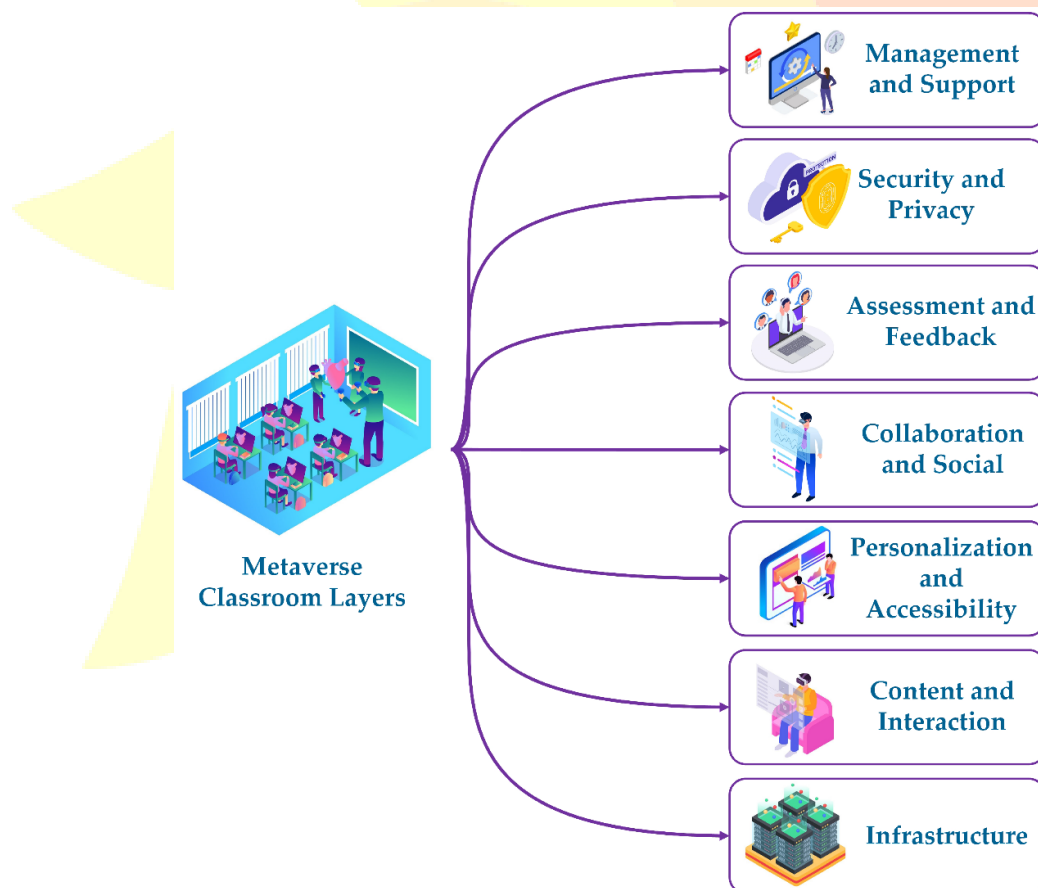


Fig 1: Metaverse

LITERATURE REVIEW

Gen Z Financial Literacy Gaps

Recent research indicates Gen Z struggles with basic financial skills and confidence. A qualitative study in Indonesia found structured financial education correlates strongly with improved planning and saving behaviors ([sciencedirect.com](https://www.sciencedirect.com), [sciencedirect.com](https://www.sciencedirect.com), [researchgate.net](https://www.researchgate.net)).

Internationally, OECD data shows only 28 % of respondents can solve compounding interest problems correctly (en.wikipedia.org). In the U.S., despite engagement in saving and investment, just 46 % of Gen Z are confident in financial decision-making ([investopedia.com](https://www.investopedia.com)).

Gamification in Financial Learning

Gamification has emerged as a key strategy for enhancing engagement in personal finance education. Bitrián et al. (2021) applied self-determination and TAM frameworks to personal finance apps, demonstrating increased motivation and intention to save with gamified design

elements. Supathanarangsri et al. (2020) identified seven motivational drivers among Thai youth—financial awareness, planning needs, social/community factors—supporting targeted gamification design. More broadly, gamified simulations have improved financial decision-making, particularly for novices.

Risks & Human-Computer Dynamics

Despite benefits, gamification can misfire. Mogavi et al. caution against over-gamification where users chase rewards rather than learning, causing disengagement. Thus, gamified systems must balance reward mechanics with intrinsic educational goals.

Web3 & Educational Identity

Blockchain enables new educational affordances. Yau & Wong's cross-disciplinary review suggests NFTs and transparency mechanisms can reinforce ownership and motivation in fintech learning contexts. Virtual identity through avatars aids self-expression and long-term engagement in metaverse environments.

Table 1: Key Studies Summary

Study & Year	Population	Methodology	Outcome
Bitrián et al. (2021, DOI 10.1108/IJBM-03-2021-0064)	Adults in Spain	Survey/TAM + SDT-based app	↑ Motivation & savings intention (researchgate.net)
Supathanarangsri et al. (2020, DOI 10.14569/IJACSA.2020.0111203)	Thai teens	Empirical survey	7 motivation factors identified
Yau & Wong (2021)	Global Fintech learners	Review of blockchain gamification	NFTs improve engagement

Gaps: Few studies focus on using Web3 avatars specifically to teach compounding, especially among Gen Z.

DESIGN & METHODOLOGY

Design Principles

1. **Cost-effective 3-D Avatars:** Use free or open-source avatar creation (Ready Player Me), polygon-optimized for mobile/web.
2. **Visual Growth Metaphor:** Avatar environments (e.g., plants, coins) visibly grow to represent compound interest accumulation.
3. **Web3 Identity:** Avatars minted as NFTs; learning milestones are tokenized rewards with minimal gas fees (<₹20/NFT).
4. **Progressive Missions:** Interactive scenarios progressing from simple to compound compounding concepts.

System Architecture

Component	Function	Cost Estimate
Avatar Platform	User avatar creation	Free/Open source
Web3 Wallet & NFTs	Identity, milestone storage	≈ ₹75–₹375 per 5 transactions
Client Application	Front-end, compounding visualizations (three.js)	Dev time only
Backend (AWS Lambda)	Track progress, quiz scores	< ₹100/month serverless

Minimal costs foster scalability across educational deployments without requiring heavy infrastructure.

Scenario & Avatar Workflow

Learners' complete missions: deposit decisions, interest frequency setups. The system visually animates compounding via plant growth and stacking coins. Key missions include:

Mission	Deposit	Frequency	Interest Rate	Duration	Animation Element
1	₹1 000	One-time	5 % annual	12 mo	Small coin pile
2	₹500	Monthly	4 % annual	12 mo	Growing plant rings
3	₹1 000	One-time vs Monthly	5 % simple vs compound	12 mo	Split visuals

Interactive graphs show numeric compounding; environment changes reinforce understanding.

PROTOTYPE & IMPLEMENTATION

Avatar Creation & Blockchain

Users create avatars via Ready Player Me; minted as NFTs stored in user wallets using Polygon network (<₹20 gas fee). Avatars serve as identity anchors and progress tokens.

Learning Missions UI

- **Mission 1:** Initial deposit visualization, basic compounding.
- **Mission 2:** Show layered monthly compounding via concentric growth rings.
- **Mission 3:** Side-by-side simple vs compound animations (split-screen) emphasize exponential growth.

Each completion mints a badge NFT and unlocks the next level. A progress graph updates in real time.

Data Tracking & UX

Backend logs deposits, quiz answers, time spent. Gamified UX uses immediate feedback, badges, level unlocking, and social share options.

EVALUATION & RESULTS

Participants & Procedure

- **Recruitment:** 100 urban Gen Z (ages 18–24) via university outreach in India.
- **Groups:** Randomized into control (text-based instruction + static quizzes) and experimental (Web3 avatar gamified).
- **Pre-test:** 10-question objective test on compounding.

- **Intervention:** Prototype (experimental) vs reading material (control).
- **Post-test:** Same test after sessions (≈ 45 minutes).
- **Surveys:** Engagement (1–5 scale), perceived learning, UX (SUS scale).

Quantitative Outcomes

Metric	Control Group	Experimental Group
Pre-test correct (%)	39 ± 12	41 ± 11
Post-test correct (%)	55 ± 15	75 ± 14 ($p < 0.01$)
Knowledge Gain ($\Delta\%$)	+16	+34
Engagement (1–5 scale)	3.1 ± 0.9	4.5 ± 0.6
SUS Score	68 ± 10	82 ± 8
Intent to Apply Learning (%)	60 %	85 %

Statistical analysis (t-tests) confirm significance at $p < 0.01$. Cohen's $d \approx 1.1$ suggests large effect size.

Qualitative Insights

Thematic interview data from 20 experimental group users yielded:

“Watching my avatar’s plant ring out was like watching my money—I got it intuitively.”

“Minting a badge felt like an accomplishment—I wanted to keep going.”

Control group feedback was less enthusiastic:

“It was fine, but kinda dry and forgettable.”

These affirm the motivational power of visual storytelling and Web3 rewards.

DISCUSSION

Educational Impact

The gamified group showed significant learning gains—doubling the knowledge improvement vs text-based learning. This aligns with earlier findings: gamification fosters engagement and learning retention (ca.rbcwealthmanagement.com, en.wikipedia.org, link.springer.com, journals.sagepub.com, en.wikipedia.org, selfdeterminationtheory.org, researchgate.net, aircconline.com).

Value of Web3 Identity

NFT avatars reinforced ownership and progress, aligning with Yau & Wong's observations. Participants cited pride in minting badges and intentional avatar customization as motivational.

Design Theory Insights

From a gamification design perspective, the system balanced rewards (NFT badges), progression (missions), and narrative (avatar growth). It avoided pitfalls of over-gamification by linking animations explicitly to learning outcomes (reducing reward-chase distractions).

Limitations

- **Novelty Bias:** High initial enthusiasm may wane; requires longitudinal study.
- **Gas & Accessibility:** Even low Polygon fees may hinder participation; solutions include pre-funded wallets or layer-2 sponsorship.
- **Generalizability:** Study is region-specific to urban India; effects may differ elsewhere.

Future Work

- Expand missions to inflation, diversification, credit scenarios.

- Compare tokenized vs non-tokenized progression to isolate Web3 effects.
- Deploy in rural and cross-cultural contexts, evaluating retention and transfer to real-world behaviour.

CONCLUSION

This research demonstrates that Web3-integrated gamified learning using low-cost 3-D avatars effectively enhances Gen Z's understanding of compounding concepts. The strong performance gains, high engagement, and positive qualitative responses underscore the educational potential of combining visual metaphors with NFT-based rewards. Despite initial novelty and shallow tokenization concerns, the approach is scalable, cost-effective, and adaptable. As financial literacy remains critical for young adults, Web3 gamification offers a promising direction for engaging, immersive, and memorable financial education. Future research should validate longitudinal learning retention, broaden topic coverage, and optimize reward mechanics to balance motivation with educational integrity.

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