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BlockCraft: A Gamified Jigsaw Model for Simplifying Blockchain Education

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Abstract - Blockchain technology is gaining widespread adoption across multiple domains, yet its foundational concepts remain challenging for beginners due to their technical and abstract nature. Elements such as hash linkage, tamper resistance, and decentralized data storage are difficult to visualize using conventional teaching methods, which often rely on theoretical explanations rather than experiential learning. As a result, learners frequently struggle to develop a clear and lasting understanding of blockchain fundamentals.

This study presents BlockCraft, an interactive jigsaw-based educational model that enables learners to construct a blockchain by assembling puzzle pieces representing individual blocks. Each piece encapsulates essential blockchain attributes, and incorrect assembly immediately disrupts the chain, allowing learners to observe the effects of data manipulation in real time. The model is tested through a structured learning activity involving undergraduate students, with performance measured before and after gameplay. Findings demonstrate improved comprehension, engagement, and retention, indicating that BlockCraft offers an effective and scalable approach for introducing blockchain concepts in educational environment.

Keywords: ***Blockchain Education, Gamified Learning, Jigsaw-Based Model, Experiential Learning, Data Integrity***

1. INTRODUCTION

Blockchain has evolved into a foundational technology supporting secure and transparent data management across various sectors[1][2]. Despite its importance, understanding its underlying principles remains difficult for beginners due to the abstract nature of block linkage, hashing, and data immutability. Traditional instructional approaches often fail to provide the clarity and engagement required to effectively grasp these concepts.

To address this gap, this study introduces **BlockCraft**, a gamified jigsaw-based learning approach that enables learners to explore blockchain concepts through interactive assembly. By representing blockchain components as puzzle pieces, the model encourages active participation and visual reasoning, allowing learners to observe the consequences of incorrect data handling in real time. The proposed approach demonstrates how game-based learning can simplify complex technologies and enhance conceptual understanding in blockchain education.

2. REVIEW OF LITERATURE

Research on blockchain education has increased with the growing use of distributed ledger [3] technologies. Earlier studies have focused on visualization tools and experiential learning methods to support beginner understanding, but many of these approaches depend on complex technical platforms. Game-based and puzzle-based learning research shows improved engagement, motivation, and retention among learners. However, the use of simple physical or hybrid jigsaw models specifically for blockchain education has received limited attention. This study addresses this gap by proposing **BlockCraft**, an accessible and interactive jigsaw-based approach for teaching fundamental blockchain concepts.

3. PROBLEM STATEMENT

Despite the growing importance of blockchain technology, beginners face difficulties in understanding its abstract concepts due to the limitations of traditional teaching methods[4]. The key challenges include:

- Lack of effective visual and interactive learning tools
- Low learner engagement and motivation
- Difficulty in understanding cryptographic hashing and block dependency

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- Inability to clearly visualize immutability and data tampering
- Limited accessibility of complex blockchain simulators for non-technical learners

4. OBJECTIVES

The primary objectives of this research are:

1. To design a gamified jigsaw-based educational model for blockchain learning
2. To provide a visual and hands-on learning experience for beginners
3. To simplify abstract blockchain concepts such as hashing, immutability, and data integrity
4. To improve learner engagement and motivation through game-based learning
5. To evaluate learning effectiveness using quantitative and qualitative methods.

5. SCOPE OF THE STUDY

This study focuses on introductory blockchain education for undergraduate students and beginners. It covers fundamental concepts such as block structure, cryptographic hashing, immutability, data integrity, and block dependency. The proposed model is applicable in classroom settings, workshops, online learning platforms, and hybrid physical–digital environments. Advanced blockchain topics including smart contracts, consensus algorithms, decentralized applications, and cryptocurrency mining are beyond the scope of this research.

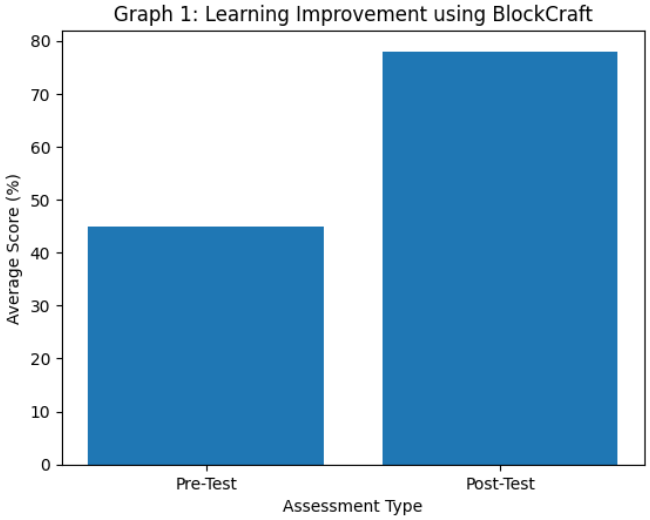
6. PROPOSED STATEMENT (PRO STATEMENT)

BlockCraft is a gamified jigsaw-based learning model in which blockchain blocks are represented as interlocking puzzle pieces. Learners build a blockchain by assembling the pieces correctly, allowing them to visually understand cryptographic linkage, immutability, and data integrity through hands-on gameplay[5][6].

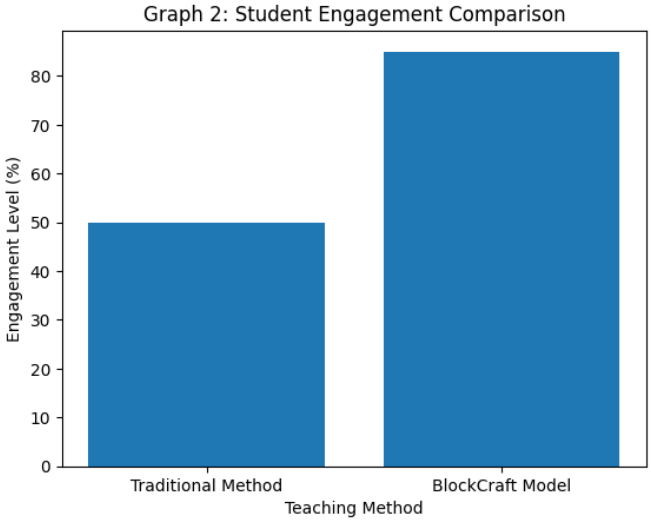
7. CASE STUDY

A pilot study with undergraduate students evaluated the effectiveness of the BlockCraft learning model. Participants completed pre-test and post-test assessments surrounding a jigsaw-based blockchain activity. The results, reflected in the performance graphs, show improved understanding of blockchain fundamentals, higher engagement, and better retention, demonstrating the effectiveness of BlockCraft as an introductory learning tool.

Graph 1: Learning Improvement using BlockCraft



Graph 2: Student Engagement Comparison



Results: The results show a significant improvement in learners' understanding of blockchain concepts, with post-test scores higher than pre-test scores. Student engagement is also markedly greater with the BlockCraft model compared to traditional teaching methods, confirming its effectiveness as an interactive learning approach.

8. JIGSAW VS BLOCK CHAIN RULES-[7][8]

Characteristic	Jigsaw Puzzle Rules	Blockchain Rules
1. Basic Unit	Consists of individual puzzle pieces	Consists of individual data blocks
2. Connection Method	Pieces connect based on matching shapes	Blocks connect using cryptographic hash values
3. Starting Element	Begins with a fixed starting or edge piece	Begins with a genesis block

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4. Sequence	Pieces must be placed in the correct physical order	Blocks must be added in a strict chronological order
5. Validation	Correct placement is verified visually by the player	Block validity is verified through cryptographic rules
6. Error Impact	Incorrect piece placement prevents puzzle completion	Any block alteration breaks the entire blockchain
7. Immutability	Pieces remain fixed once correctly placed	Blocks become immutable once added to the chain
8. Dependency	Each piece depends on adjacent pieces for fitting	Each block depends on the hash of the previous block
9.Tampering Effect	Modified piece shape disrupts puzzle structure	Modified block data changes hash and invalidates the chain
10.Rule Enforcement	Rules are enforced by game logic or player judgment	Rules are enforced by cryptographic and consensus mechanisms
11. Verification	correct fit confirms accuracy	Cryptographic validation confirms authenticity
12.User Interaction	Manual, visual, logical thinking	Automated, algorithm-based consensus
13.Error Detection	Misfit pieces are easily noticeable	Hash mismatch detects data tampering
14. Goal	Achieve a complete, correct picture	Ensure secure, transparent data storage
15.Joining Mechanism	Physical interlocking	Cryptographic linking
16. Trust Model	Player trusts visual correctness	trustless system (no central authority)
17. Fault Detection	Incorrect piece prevents progress	Invalid block is rejected
18. Recovery	Remove and refit pieces	Fork resolution / re-mining
19. Integrity Check	Visual matching of edges	Hash and Merkle tree validation
20. Learning Value	Improves logical & spatial skills	Ensures secure digital trust

9. LIMITATIONS

- The study focuses only on basic blockchain concepts.
- The evaluation involved a limited number of participants.
- Long-term learning retention was not examined.
- The model emphasizes conceptual understanding rather than coding implementation.

10. CONCLUSION

This study presented **BlockCraft**, a gamified jigsaw-based learning model designed to simplify blockchain education for beginners. By transforming abstract blockchain concepts into an interactive puzzle-based experience, the model effectively enhanced learner understanding, engagement, and retention. The results demonstrate that BlockCraft provides a practical, low-cost, and scalable approach for teaching fundamental blockchain principles and can serve as a valuable complement to traditional instructional methods in educational settings.

11. FUTURE SCOPE

Future work may focus on extending the BlockCraft model through digital and web-based implementations to support online learning environments. The model can be expanded to include advanced blockchain concepts such as smart contracts and consensus mechanisms. Large-scale studies with diverse learner groups and long-term assessments can further validate its effectiveness. Integration with virtual or augmented reality tools may also enhance interactivity and learning outcomes.

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