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BEAT THE CLOCK: ANDROID APPLICATION TO MEASURE THE LEVEL OF LOGICAL THINKING AND DEVELOP THE SPEED OF MATH RULES OF ELEMENTARY STUDENTS

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ABSTRACT
Integrating digital technology into the educational process has significantly transformed traditional teaching and learning paradigms, offering more engaging and interactive methods. However, many young learners face challenges balancing academic responsibilities with extracurricular activities and often find conventional book-based learning unappealing. This paper proposes an innovative Android-based educational game, Beat the Clock, designed to enhance the teaching-learning process by merging education with entertainment. The game incorporates multiple levels targeting logical reasoning, mathematical proficiency, and general knowledge, supported by a robust performance measurement algorithm. Unlike existing educational games, Beat the Clock diversifies its scope to include languages, general knowledge, and other cognitive skills, thereby fostering holistic development. Additionally, the game provides performance summaries to assist parents in identifying their child's strengths and weaknesses, enabling personalized learning strategies. By gamifying education, Beat the Clock aims to make learning an enjoyable and effective experience, revolutionizing traditional methods.
KEYWORDS: *Logical Thinking, Gamified Learning, Android Game, Mathematics Education, Toddlers*

1. INTRODUCTION

Technology's quick development has revolutionized education currently and created chances to greatly improve the teaching and learning process. The goal of this project is to create an educational game application for Android that will evaluate kids' logical thinking skills and help them get better at arithmetic. The game will have several stages, each concentrating on a different subject, guaranteeing young students an interesting and participatory experience.

The primary objective of this study is to integrate entertainment with education, creating a platform that motivates children to learn through enjoyable and interactive methods. The application will cover diverse subjects, including mathematics, general knowledge, language skills, and logical reasoning. While numerous educational games exist with similar objectives, this research seeks to introduce innovative features, such as multi-themed levels and a comprehensive performance summary, to distinguish the game from its counterparts.

The proposed application will be convenient to use and let children study and play in the privacy of their own homes while being watched over by their parents. The research being conducted aims to promote children's greater engagement and excitement for learning by fusing entertainment with educational content, which will ultimately lead to better academic achievement.

1.1. Problem Statement

Many educational applications lack multidisciplinary approaches or fail to provide personalized performance insights. Furthermore, the absence of engaging, gamified tools targeting logical thinking and mathematics hinders their effectiveness.

1.2. Purpose

This research introduces *Beat the Clock* as a solution, blending interactive gameplay, error feedback, and performance analytics to bridge the gap between education and entertainment.

1.3. Objectives

- Develop game levels to enhance logical and psychological thinking.
- Design an Android-based game to improve children's mathematical knowledge.
- Create an algorithm to measure children's performance.
- Provide a learning environment that is gamified to help kids enjoy studying.

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2. LITERATURE REVIEW

Mathematics instruction according to the new educational M-learning tool This article suggests and assesses a smartphone app to support teachers of elementary mathematics. The goal is to present a game that covers math course material by the Para Metros Curriculum Nacionais. This research has a drawback because it solely examines the material covered in math courses. As a result, parents won't receive precise outcomes from the game. Therefore, parents can only assess their children's mathematics skills.

[1]This study focuses on implementing the mathematics curriculum in primary education using traditional children's games. Learning objectives are tailored to K–9 students in rural and urban areas, considering their cognitive capacities. However, the research remains in its early stages and lacks developmental levels. The repetitive nature of the games, delivered via a projector, risks disengaging students due to monotony.

[2]Android educational games target elementary and high school students to enhance basic skills such as solving simple mathematical problems. Although accessible and user-friendly, the games primarily emphasize mathematical content without offering varying levels or dynamic elements. The lack of diversity, akin to repeated "snakes and ladders" levels, limits their effectiveness in sustaining engagement.

[3]This study introduces games designed to develop children's analytical and problem-solving skills by identifying deviations in patterns. While innovative in its approach, the game suffers from limitations such as insufficient levels and repetitive random figure displays, which fail to challenge the children consistently.

[4]Research on digital game-based learning for 3–4-year-olds highlights developmentally appropriate design focusing on cognitive, psychomotor, and socio-emotional growth. By integrating problem-solving activities, these games enhance mathematical skills, memory, and technological aptitude. The research emphasizes algorithmic design as a key factor in creating effective educational games.

[3]This study explores cloud-based multiplayer video games aimed at improving children's logical reasoning and cognitive skills. Using a variety of topics and stages, the games enhance academic achievement and include entertaining yet informative content. The design incorporates theories of cognitive development, computational intelligence, and tools like OOHDM and photon cloud, utilizing keywords such as artificial intelligence and cloud computing.

[5]This research investigates imaginative play and logical reasoning in toddlers, observing 4-year-olds to measure creativity and problem-solving skills. The framework incorporates symbolic use, encouraging inventiveness while involving parents through consent processes. Although insightful, the study lacks a clear pathway for further applications.

[6]This game aims to develop logical thinking in children by using block-shaped stained-glass pieces to assess color discrimination. However, repetitive levels without progression risk disengaging users. A more dynamic approach with varied challenges would enhance its educational impact.

[5] A tablet-based game designed for autistic children integrates three stages: two-dimensional gestalt designs (Rails), logistic complexity (Pipes), and three-dimensional visuals (Snakes). The methodology involves prototype creation, usability testing, and user evaluations. This structured approach provides valuable insights into designing games tailored to specific needs.

[7]Carmona and Millan's research integrates formative evaluation to enhance the effectiveness of a Spanish orthography game. The system currently tracks students' scores but could benefit from advanced user modelling to adapt difficulty levels dynamically, motivating learners to improve spelling and comprehension.

[4]This game focuses on enhancing logical thinking through progressively challenging levels. Players connect three or more magnets of the same color to succeed. The inclusion of varied levels improves engagement and performance among young learners.

[8]Research into the integration of ICT in preschool education highlights its formal and informal applications. While tools like tablets are portable and cost-effective, toddlers often struggle with devices requiring mouse operations. Effective games need to balance usability with cognitive challenges tailored to this age group.

[9]Mind games analyzed in this study aim to enhance children's cognitive processes. However, the lack of interactivity and fun limits their effectiveness. Incorporating engaging features, such as those found in "Beat of the Clock," would significantly improve the learning experience.

[10]A mobile application designed for reading, spelling, and math skills in infants and preschoolers demonstrates high functionality but faces challenges due to its cost. The research emphasizes evaluating system efficacy to justify the investment compared to traditional methods.

3. METHODOLOGY

The proposed application was developed using the prototype technique, an iterative process comprising planning, analysis, design, implementation, and testing stages. This methodology emphasizes continuous refinement, where each cycle incorporates user feedback and introduces new features. By focusing on iterative development, the prototype evolves into a fully functional system that meets user requirements effectively.

3.1 Planning

The project followed the Software Development Life Cycle (SDLC) framework, with a six-month timeline for systematic execution. Key tasks were defined, assigned deadlines, and monitored rigorously. The project's concept—a mobile application to enhance

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logical reasoning skills in children aged 8 to 12—was refined through a comprehensive review of related studies and applications. This informed the creation of a Gantt chart, establishing timelines for all functions and ensuring methodical progression.

3.1.1 Identifying Business Values

Parents and educators, key stakeholders, shaped the application's values: fostering a love for learning, enhancing math skills, and providing an engaging, user-friendly experience that blends entertainment and education to empower students.

3.2 Analysis and Requirement Gathering

3.2.1 Analysis

To define the requirements for *Beat the Clock*, data collection involved parents, educators, literature reviews, observations, and interviews. This systematic approach ensured the application aligned with user needs and educational goals effectively.

3.2.2 Requirement Gathering

Observation was the primary data collection method to address the limitations of traditional surveys with young students. A study at Reggie Ranatunga College, Minuwangoda, involved Grades 3, 4, and 5 students performing lattice method exercises in addition, subtraction, multiplication, and division under teacher supervision. Completion times were recorded and analyzed: addition (2.33 minutes), subtraction (2.58 minutes), multiplication (2.97 minutes), and division (1.41 minutes). These insights emphasized time-based activities to foster logical and analytical thinking. By incorporating these findings, *Beat the Clock* delivers an engaging educational tool tailored to improve student skills while aligning with curriculum goals effectively.

3.3 Designing

The design phase focused on client-side programming and system architecture, crucial for prototype development. The architecture consisted of two main components: the mobile interface and the game database. Players access games by downloading the app, with a one-way data flow from the database to the device, ensuring simplicity and user-centric functionality.

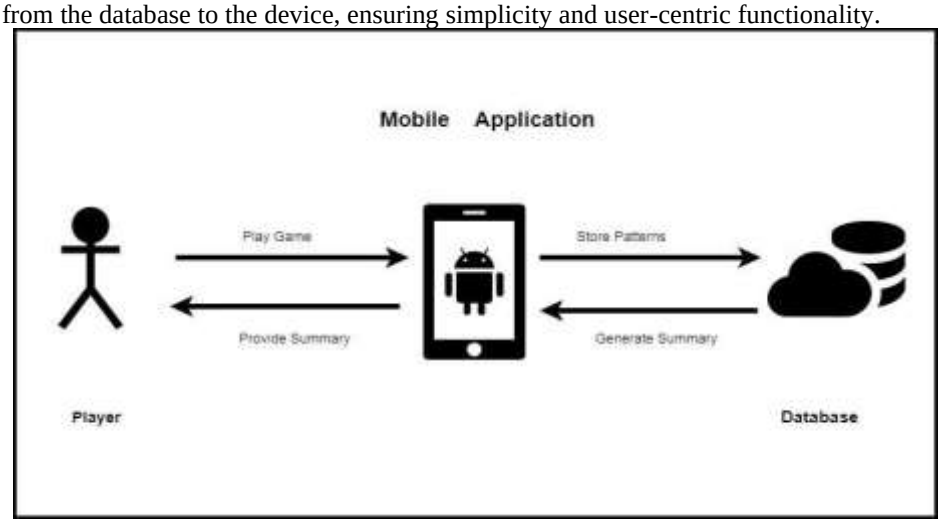

Figure 1: System Architecture Diagram

3.4 Implementation

The "Beat the Clock" Android application was developed using Android Studio, SQLite, Balsamiq Wireframes, and Microsoft Project. Its framework consists of a Title Screen, Operation Selection Screen, and Gameplay Screen, offering an intuitive user experience. SQLite managed data storage, while Android Studio provided a reliable development environment. A deployment diagram outlined hardware and software requirements, including Android SDK and Gradle. Promotional videos were created with a video editor, and documentation was prepared using Microsoft Word and PowerPoint. The development process ensured the application met its goal of enhancing students' analytical and mathematical skills.

3.5 Testing

Unit testing validated individual code components, addressing challenges like threading complexities. Integration testing ensured seamless component interaction, including login and gameplay. Non-functional testing assessed performance, responsiveness, and usability, while system testing confirmed compliance with all requirements. Ultimately, "Beat the Clock" emerged as a reliable, engaging, and user-friendly educational app for elementary students.

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4. RESULTS AND DISCUSSION

"Beat of the Clock" Mobile Game Application

The user-centric interface of the "Beat the Clock" mobile game application is intended to improve the educational experience for young learners. The Addition, Subtraction, Multiplication, Division, and Score Screens are among the important screens, as are the Login, Select Grades, Play Option Selection, and Operation Selection displays. These elements collectively provide a seamless navigation structure, engaging gameplay, and effective progress tracking. Users begin by authenticating through the Login Screen, tailored to ensure security. They then proceed to select their grade level, choose play options, and engage in operations aligned with their skills. Each operation culminates in a Score Screen, offering detailed performance insights.

- ***Login Screen***

By asking users to enter their username and password, the Login Screen guarantees safe access to the program. While returning players can see a gaming demonstration film, new users can register using the Register Screen. This screen emphasizes user authentication and application security.

Figure 2: Login Screen

- ***Select Grades***

After logging in, users access the Select Grades screen, where they choose their grade level (Grades 3–5). This customization tailors content difficulty, ensuring an age-appropriate experience aligned with curriculum needs.

Figure 3: Select Grades

- ***Play Option Selection Screen***

Users can choose between typing and selecting options on the Play Option Selection Screen. This flexibility accommodates varying skill levels and enhances user engagement.

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Figure 4:Play Option Selection Screen

- ***Operation Select Screen***

The Operation Select Screen offers four mathematical operations—Addition, Subtraction, Multiplication, and Division. Users select one to proceed, fostering targeted learning and skill improvement.

Figure 5: Operation Select Screen

- ***Playing Screens***

After completing an operation, users receive a score summary screen showcasing their performance. This feedback promotes progress tracking and motivation for skill enhancement.

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- ***Selection Option***

Figure 6: Selection Option

- ***Typing Option***

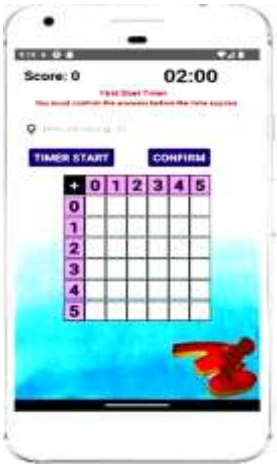

Figure 7: Typing Option

5. CONCLUSION

This research highlights the potential of "Beat the Clock," an Android application, to transform primary mathematics education. Iterative development, informed by user feedback and rigorous testing, ensured reliability. Observations and interviews affirmed its effectiveness in enhancing engagement, mastering math concepts, and fostering logical thinking among students.

5.1 Limitation

The research faced limitations, including a small sample size restricted to government primary schools, time constraints, limited prior research, and challenges linking game content to real-life applications, emphasizing teacher involvement for better integration.

5.2 Future Work

Future research should expand the sample size, involve educators and developers, adapt the app for higher grades, incorporate advanced features, and use feedback to ensure sustained engagement and educational relevance.

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