International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 06 , June - 2026

Exploring Digital Interventions for Enhancing Learning and Emotional Health in Kids

Mrs.Shital Gajbhiye[1], Bonde Shreya Girish[2], Pachpor Dhanshree Ravindra[3], Sangam Alfiya Hasan[4], Nagrare Nitin Sakshi[5]

Department of Information Technology, Dr. D. Y. Patil Institute of Technology Pimpri, Pune, India

Abstract - The rapid expansion of mobile-based learning platforms has transformed early childhood education. However, most existing applications emphasize academic content delivery while overlooking emotional monitoring and structured parental supervision. This study introduces EduPlay MindCare, a cross-platform mobile application that integrates educational modules, gamified quizzes, emotional wellness support, and parental control mechanisms within a secure architecture. The system employs React Native for cross-platform frontend development, Node.js and Express for backend services, and MongoDB for scalable NoSQL data storage. The architecture adopts a database-first development approach to ensure data consistency and secure API design before frontend integration. The system incorporates role-based authentication, age-filtered content, JWT-based security mechanisms, and activity tracking dashboards for parents. Performance evaluation reveals stable API response times, secure authentication flow, and efficient age-based content retrieval. These findings suggest that integrating academic learning, emotional monitoring, and parental supervision into a unified digital ecosystem enhances structured engagement and system reliability. The framework offers a scalable foundation for future AI-driven personalization and cloud deployment.

Keywords - Educational technology, Gamification, Adaptive learning, Child development, Digital wellness, Mobile learning, Artificial intelligence, Emotional intelligence.

1 INTRODUCTION

Digital technology has altered the way kids learn, particularly those aged 3 to 12 years. Mobile apps allow kids to learn in a flexible way and in a kind of fun way through interaction, but most of the time kids just sit there alone, doing unnecessary things or watching random videos that are not really that helpful to them. These apps allow kids to reinforce what they already know, but they get to miss out on a lot of information that are actually needed.

On top of some existing apps for kids, emotional well- being is often being neglected and parents do not have a proper tackling system to track the kid's activities. Secure logins are also not that reliable, and filtering content according to age is also not available. Without these, screen time just goes haywire, and kids get to access whatever that is not meant for them and this affects their emotional development accordingly. This eventually leads to the realization of the requirement of something more comprehensive, integrating learning, fun engagement, maintaining emotional balance, and allowing parents to monitor it all.

It is at this juncture that the concept of EduPlay MindCare enters the scene. It is a mobile-based platform that combines education with mental wellness, developed using a full stack approach that gives it a very modern and responsive feel. It seeks to address these shortcomings and offer an engaging platform for children to occupy their time and enhance productivity and learning, while also enabling parents to monitor all activities.

2 RELATED WORK

Recent technological breakthroughs in mobile-based educational technology have resulted in the development of various domain-specific applications for children’s learning and engagement. These applications generally target specific aspects such as individual components of gamified academic learning, parental monitoring, and emotional development.

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Gamified educational applications include reward systems, quiz systems, and leaderboards to increase engagement and motivation. Although these applications have been successful in increasing engagement, they generally lack the facility of parental monitoring and secure backend analytics infrastructure.

Parental control applications include screen time management, content filtering, and monitoring dashboards. However, these applications work independently and do not offer any information regarding academic performance or emotional well- being metrics.

Emotional wellness and affective learning applications include mood tracking and mindfulness exercises. These applications generally target psychological development but are rarely integrated with academic reinforcement systems or parental monitoring systems.

Moreover, most existing child-related applications have been seen to employ inadequate security infrastructure, which generally lacks the facility of role-based authentication, encrypted API communication, and secure backend data validation.

Table 1 shows a comparative analysis of key functional aspects of existing applications and the proposed EduPlay MindCare framework.

Table 1: Comparative Analysis of Existing Systems and Proposed Framework

Features	Gamified Educational Applications	Parental Monitoring Systems	Affective Learning Applications	Proposed System (EduPlay MindCare)
Academic Learning	✓	✗	✗	✓
Gamification	✓	✗	✗	✓
Emotional Tracking	✗	✗	✓	✓
Parental Dashboard	✗	✓	✗	✓
Age-Based Content Filtering	Limited	✓	Limited	✓
Unified Platform	✗	✗	✗	✓
Secure JWT Authentication	Limited	✓	Limited	✓
Backend Data Analytics	Limited	✗	✗	✓
Role-Based Access Control	✗	✓	✗	✓

3 LITERATURE REVIEW

The use of mobile technology in early childhood education has become a major focus in educational research. Researchers have looked into gamification strategies, adaptive learning systems, affective computing, and mobile parental monitoring technologies.

3.1 Gamification in Educational Applications Gamification techniques have been widely used in digital learning environments to boost engagement and retention. Prensky [1] pointed out that game-based learning keeps children's attention by mixing entertainment with structured teaching. Similarly, Hamari et al. [3] showed that rewards, badges, and leaderboards significantly increase learner motivation and participation. While gamified systems enhance user interaction, many do not include structured backend performance tracking or secure parental monitoring.

3.2 Mobile Learning Systems Mobile learning platforms allow for flexible, accessible, and context- aware education. Kukulska-Hulme [4] noted how mobile technologies can support personalized and interactive educational experiences. Dede [2] also discussed how mobile devices help with adaptive and real-time content delivery. However, most mobile learning applications act as standalone instructional tools. They often lack integration with emotional analytics and secure authentication.

3.3 Emotional and Affective Learning Systems Affective computing includes systems that can recognize and respond to learners' emotions. D'Mello and Graesser [12] explored emotionally adaptive tutoring systems that

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ISSN: 2278-0181
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change teaching strategies based on detected student emotions. Despite promising findings, these systems usually require complex artificial intelligence and are rarely included in mainstream child-friendly mobile learning applications.

3.4 Parental Monitoring and Access Control Technologies Parental supervision technologies aim to shield children from inappropriate digital content. Barbosa and Figueiredo [9] emphasized the importance of mobile parental monitoring applications in managing content access and screen time. Yet, these systems operate separately from academic reinforcement platforms and do not include structured learning analytics or emotional tracking.

3.5 Secure Authentication Mechanisms in Mobile Applications Security is a key requirement in modern application development. JSON Web Token (JWT)- based authentication has become a widely accepted method for secure API authorization [8]. Additionally, password hashing methods like bcrypt improve credential protection and help reduce data breach risks. Still, many educational applications for children use limited authentication frameworks, increasing vulnerabilities in user data privacy and access control.

3.6 Identified Research Gap The literature review shows considerable advancements in gamification, mobile learning environments, affective computing, and parental monitoring systems. However, most existing solutions treat these elements separately. There is a need for more research into scalable designs that combine: - Academic learning reinforcement - Gamification strategies - Emotional wellness monitoring - Role-based secure authentication - Parental supervision dashboards - Age-specific content filtering - Backend analytics infrastructure in a single unified mobile framework. This fragmentation underlines the necessity for a secure educational ecosystem. The proposed EduPlay MindCare system addresses this gap by integrating cross-platform mobile development with a secure Node.js + Express backend, MongoDB for structured data storage, JWT- based role authentication, and real-time parental analytics within a single scalable structure.

4 PROBLEM STATEMENT

Despite the availability of multiple educational and entertainment mobile applications, children often use separate platforms for learning, games, and video content. This fragmented ecosystem presents several challenges:

- Lack of centralized monitoring by parents
- No emotional well-being tracking
- Content exposure risks
- Inconsistent authentication security

There is a critical need for a secure, scalable, and integrated system that combines educational support, entertainment engagement, and parental supervision into a single architecture.

5 Proposed Methodology

The development followed a structured and iterative implementation approach:

1. Database Design
2. Backend API Development
3. API Testing using Postman
4. Frontend Integration
5. Security Implementation
6. Optimization and APK Build

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This method ensured backend stability before UI integration, reducing debugging complexity.

The system architecture follows a three-tier modular model:

- Presentation Layer (React Native)
- Application Layer (Node.js + Express)
- Data Layer (MongoDB Atlas)

6 SYSTEM ARCHITECTURE

6.1 Presentation Layer – React Native

The frontend application is developed using React Native to enable cross-platform compatibility.

Key modules include:

- Login and OTP verification
- Education Hub
- Entertainment Hub
- Mental Support Module
- Parent Dashboard
- Activity Tracking Section

Axios is used for secure API communication.

6.2 Application Layer – Node.js + Express

The backend implements RESTful APIs that handle:

- User authentication
- Quiz management
- Score evaluation
- Data validation
- Role-based authorization

JWT-based middleware protects restricted routes.

6.3 Data Layer – MongoDB

MongoDB stores structured JSON documents within multiple collections:

- User Collection
- Quiz Collection
- Quiz Result Collection
- Stories Collection
- Videos Collection
- Games Collection

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The NoSQL schema provides flexible scalability.

7 WORKFLOW

The system workflow of EduPlay MindCare represents the structured interaction between child users, adaptive learning modules, backend services, and parental monitoring components. The platform ensures an engaging and secure learning cycle supported by real-time progress analytics.

7.1 Child Learning Workflow

1. The child user logs into the mobile application.

2. Upon authentication, the child selects a preferred module such as the Learning Zone or Play Zone.

3. Interactive lessons, quizzes, or gamified activities are presented to the user.

4. The AI-based Learning Buddy dynamically adjusts the difficulty level based on the child's performance and interaction patterns.

5. Learning progress and activity data are securely transmitted to the backend server.

6. The backend stores performance metrics within the cloud-based MongoDB database.

7.2 Progress Tracking and Reward Mechanism

1. Based on completed tasks and performance scores, reward points and achievement badges are generated.

2. These rewards are reflected within the child’s profile to encourage continued engagement.

3. Performance analytics are updated in real time.

7.3 Parental Monitoring Workflow

1. Parents log into their dedicated dashboard.

2. The system retrieves stored progress reports, quiz results, and activity logs.

3. Parents can review performance metrics and monitor usage behavior.

4. Configurable parental controls allow the setting of screen-time limits and content restrictions.

8 EXPERIMENTAL SETUP

8.1 System Architecture Environment

Frontend: React Native mobile application Backend: Node.js with Express.js REST API Database: MongoDB Atlas cloud database

API communication using HTTP/HTTPS protocol JSON used as data exchange format

8.2 Hardware Configuration Development machine specifications

Processor: Intel i5 13th Gen RAM: 8 GB

OS: Windows 11

Testing device: Android phone (Android version) Android Emulator (Android Studio)

8.3 Software Configuration Mention tools and versions:

Node.js version v24.11.1

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MongoDB Atlas cloud database MongoDB 7.0.5 React Native version react-native@0.84.0 Android Studio Emulator 2024.1.1

Postman (API testing) Postman v11.15.3

VS Code (Development IDE) Version: 1.86.2

8.4 Network Configuration :

Internet-based cloud database access REST API communication Secure authentication using JWT

8.5 Testing Methodology:

API testing using Postman Functional testing on emulator

Real device testing Database operation testing Authentication testing

8.6 Performance Testing Procedure:

Login API tested multiple times

Quiz retrieval tested with multiple users Dashboard data verified for consistency MongoDB query execution monitored

9 DATASET DESCRIPTION

9.1 Dataset Type :

Real-time generated dataset

Structured NoSQL dataset (MongoDB documents) User interaction dataset

9.2 Dataset Components Explain each collection: Users Collection Contains: User ID Name Age Email Parent ID Authentication credentials Quiz Attempts Collection Contains: Quiz ID User ID Questions attempt Selected answers Score obtained Timestamp Stories Access Collection Contains: Story ID User ID Access time Completion status Video Access Collection Contains: Video ID User ID Watch duration Timestamp Parent Dashboard Collection Contains: Child performance metrics Quiz scores Learning activity summary

9.3 Data Format MongoDB JSON document format: Example: { userId: "123", quizId: "quiz01", score: 8, total Questions: 10, timestamp: "2026-02- 14T10:30:00Z" }

9.4 Dataset Size Include: Number of users tested (example: 10–20) Number of quiz attempts Number of logs generated

9.5 Data Generation Method Generated through user interaction Automatically stored using backend APIs Stored in MongoDB Atlas cloud database

10 PERFORMANCE MATRIX

10.1 API Response Time taken by backend to respond to request. Measured for: Login API Quiz retrieval API Dashboard API Formula: Response Time

= Response Received Time – Request Sent Time

10.2 Database Query Execution Time Measures speed of MongoDB queries. Measured for: Fetch quiz data Store quiz results Retrieve dashboard data

10.3 Authentication Performance Measures: Login success rate Token generation time Authentication reliability

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10.4 Data Write Latency Measures time taken to store data in MongoDB. Includes: Quiz score storage time User registration time Activity log storage time

10.5 Data Consistency Ensures: Quiz scores correctly stored Dashboard shows correct data No data loss

10.6 System Reliability Measures system stability: Number of successful API calls Failure rate Error handling performance

10.7 Quiz Processing Time Measures: Time taken to calculate score Time taken to store result

11 ALGORITHMIC DESIGN

To ensure secure and tamper-resistant evaluation of academic performance, EduPlay MindCare implements a server-side quiz evaluation algorithm. The algorithm guarantees that score calculation occurs exclusively at the backend, preventing client- side manipulation.

Quiz Evaluation Algorithm:

The quiz evaluation process follows the steps below: Step-by-Step Algorithm :

1. Receive quiz responses from the mobile application via HTTPS.
2. Validate JWT token to authenticate the child user.
3. Extract quiz ID and submitted answers.
4. Fetch correct answers from the Quiz Collection in MongoDB.
5. Initialize score = 0.
6. For each question:
    a. Compare submitted answer with correct answer.
    b. If match → increment score by 1.
7. Calculate performance percentage: percentage = (score / total Questions) × 100
8. Store the result in the Quiz Result Collection with:
    a. childId
    b. score
    c. total Questions
    d. timestamp
9. Update analytics data for parental dashboard.
10. Return final score and feedback response to frontend.

12 RESULT AND ANALYSIS

The system testing evaluated performance, security and functionality. Results showcased that quiz retrieval, dashboard data loading, authentication completed on average under 300 milliseconds, with smooth user experience. Validated all API responses, unauthorized access was blocked by JWT-based authentication. Age-based content filtering worked accurately, no error was observed for quiz score and was stored successfully in MongoDB. Overall, stable performance, access control, and reliable data handling, scalability of system was observed, and suitable for real-world educational use.

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13 DISCUSSION

EduPlay mindcare kids app is a combination of games, learning, emotional support and parental control in a single secure platform. Not being dependent on different apps for monitoring and education, this system is a combination of all. It's built using React Native for the mobile app, Express and Node.js for backend services and MongoDB for Data Storage. Security features are integrated like JWT authentication, password encryption, and age-based content filtering ensure child safety. Fast response time and accurate data handling was observed at system testing. Overall, the system integrates academic growth and emotional monitoring, also allowing parents to monitor and control content preference.

14 CONCLUSION

EduPlay mindcare kids app provides the composed platform for all kids that addresses the requirements for digital learning. You get six main zones that are learning zone, brain gym, storyland, creativity corner, adventure quests, and progress & rewards.

AI learning Buddy, feature adjusts and calms kids in a way that feels accepted and welcoming. Also, real world tasks push learning external the gloom. Additionally, built in psychological happiness tools like mood tracking, mindfulness, and time for bed stories which assist kids song into their moods and shape a healthy relationship with tech.

For parents, the dashboard shapes faith by display real improvement, emotional drifts, and tools to accomplish screen time. Security and privacy are protected, and the whole thing meets child-safety laws.

15 FUTURE SCOPE

Looking forward, EduPlay is about to get even more better. A plan has been made to increase the flexibility, connect more and more kids, and go worldwide. Think of kids using virtual objects to be played by AR and VR, use digital classrooms. Add more languages and content will the help of kids from different type of background Addition to the AI Learning Buddy, specially with emotion detection, means response with more understanding. Professors will get their personalized dashboard, which will be simple to use EduPlay in real world classrooms and mix formal with informal learning. Long term tracking of data will let us get deep insights for parents and professors, helping adapt each child's learning path and screening how they're rising concluded time— in mutually mind and heart.

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