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Learn Mate:-AI powered study assistant

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Abstract: *In the modern educational environment, mobile learning applications provide students with flexible and convenient access to educational resources. However, maintaining student engagement, tracking learning progress, and evaluating knowledge effectively remain important challenges. This paper presents **LearnMate**, a mobile learning application developed using Flutter and Firebase technologies. The application provides a centralized platform where students can access lectures, track video progress, participate in quizzes, and earn experience points (XP) through learning activities.*

Learn Mate uses Firebase Authentication for user authentication and Cloud Firestore for storing and managing application data. The application is designed with learning progress tracking, quiz submissions, administrative grading, and leaderboard functionality. Video progress is recorded to help determine whether students have met the required viewing threshold before proceeding to associated quizzes. Quiz evaluation and reward allocation are designed to use trusted backend operations to improve data integrity and prevent unauthorized changes.

The primary objective of LearnMate is to make digital learning more interactive, organized, and motivating. This paper describes the system design, major modules, development methodology, testing approach, limitations, and future enhancements of the application.

Key Word: *Mobile Learning, LearnMate, Flutter, Firebase, Cloud Firestore, Gamification, Quiz Management, Progress Tracking.*

I.INTRODUCTION

Digital technology has transformed the way educational content is created, distributed, and consumed. Students increasingly use mobile devices to access video lectures, practice questions, and other learning materials. Despite the availability of digital resources, students may face difficulties in maintaining consistency, monitoring their progress, and staying motivated throughout the learning process.

Traditional learning platforms may provide educational content without sufficiently integrating progress tracking, quizzes, rewards, and performance-based motivation into a single learning experience. A well-organized mobile application can help address these challenges by bringing essential learning activities together.

To address this need, the LearnMate project focuses on developing a mobile learning application using Flutter and Firebase. Flutter provides the framework for building the mobile user interface, while Firebase supports authentication and cloud-based data storage.

The application is designed around a structured learning process. Students can access published lectures, view educational videos, track their watching progress, and attempt associated quizzes when the required completion conditions are satisfied. XP rewards and a leaderboard are intended to encourage participation and recognize learning achievements. Administrative functionality supports quiz evaluation and the management of learning-related records.

The main aim of LearnMate is to provide an accessible, interactive, and motivating digital learning environment. By integrating learning content, progress monitoring, quiz assessment, and gamification, the application seeks to improve the organization and usability of mobile learning.

II.LITERATURE REVIEW

Digital learning systems have evolved from basic electronic content repositories into interactive platforms that support assessment, communication, and learner progress monitoring. Mobile learning allows students to access educational materials beyond the physical classroom and offers flexibility in terms of time and location.

One important aspect of digital education is **learner engagement**. Gamification introduces elements such as points, achievements, and leaderboards into learning activities. These elements can provide feedback and encourage participation, although their effectiveness depends on implementation and learner needs.

Another important area is learning analytics and progress tracking. Recording student activity can help learners understand their progress and help educators identify areas that may require attention. For video-based learning, progress measurements can provide a basis for determining whether a learner has watched the required portion of a lecture.

Cloud-based application development also supports the creation of systems that require authentication, shared data, and access from multiple devices. Firebase provides services that can be integrated with Flutter applications for user authentication and cloud data management.

LearnMate brings these concepts together in a mobile application that combines lecture access, video progress tracking, quiz submissions, administrative grading, and gamification. The application is designed to connect learning activity with assessment and reward mechanisms within one platform.

III. OBJECTIVES AND SCOPE

Objectives: The primary objectives of LearnMate are:

1. To develop a mobile application that provides organized access to educational lectures.
2. To implement user authentication using Firebase Authentication.
3. To record lecture-watching progress using Cloud Firestore.
4. To associate quizzes with relevant lectures and apply eligibility checks before quiz submission.
5. To support administrative grading of quiz submissions.
6. To provide XP rewards and leaderboard functionality as gamification features.
7. To maintain structured learning records and apply appropriate access restrictions.

Scope: The scope of the project includes the Flutter mobile application, Firebase-based authentication, cloud data storage, lecture progress management, quiz submission workflows, administrative grading, and reward-related data management.

The project also considers data integrity and authorization. Sensitive actions, such as confirming lecture completion and assigning trusted quiz results or rewards, should be handled by secure backend logic rather than relying entirely on values submitted by the mobile client.

The current implementation status of individual features should be verified before describing the application as fully deployed or production-ready.

IV. SYSTEM MODULES

User Authentication Module: This module uses Firebase Authentication to support user sign-in and identity verification. Authentication provides a basis for associating learning records with the appropriate user account.

Authenticated identity is used when recording lecture progress and submitting quizzes. Access to administrative operations must be restricted to authorized accounts.

Student Learning Module: The student learning module provides access to published lectures and their associated information. Lecture records may contain the title, description, subject, video URL, thumbnail, duration, required viewing percentage, XP reward, and associated quiz identifier.

The module is intended to help students locate learning materials and follow a structured learning path.

Lecture Progress Tracking Module: This module records lecture-watching measurements such as watched seconds, total duration, and calculated watch percentage. Progress records are associated with the student and lecture.

A lecture can define a required viewing threshold, such as 90 percent. Meeting this threshold can be used as one condition for quiz eligibility. However, the mobile application should not be solely responsible for confirming trusted completion status. A secure backend should validate the recorded measurements and update the authoritative completion state.

Quiz Submission Module: The quiz module allows students to submit answers to quizzes associated with lectures. Before accepting a submission, the system is designed to check whether the quiz is published, whether it is associated with a valid lecture, and whether the student has satisfied the required lecture progress conditions.

The submission workflow should validate the submitted answers and store the submission with an appropriate status. Administrative grading can then be performed according to the configured quiz rules.

Admin Grading Module: The administrative grading module supports the evaluation of pending quiz submissions by authorized administrators. It is designed to verify the administrator's permissions, retrieve the relevant quiz and answer key, calculate the result, and record the grading outcome.

Where applicable, the module can calculate XP rewards based on the grading result. Grading, result creation, and reward allocation should be performed by trusted backend logic to reduce the risk of unauthorized modifications.

XP and Leaderboard Module: Gamification is included to encourage continued participation in learning activities. Experience points can represent rewards associated with eligible learning achievements or quiz performance.

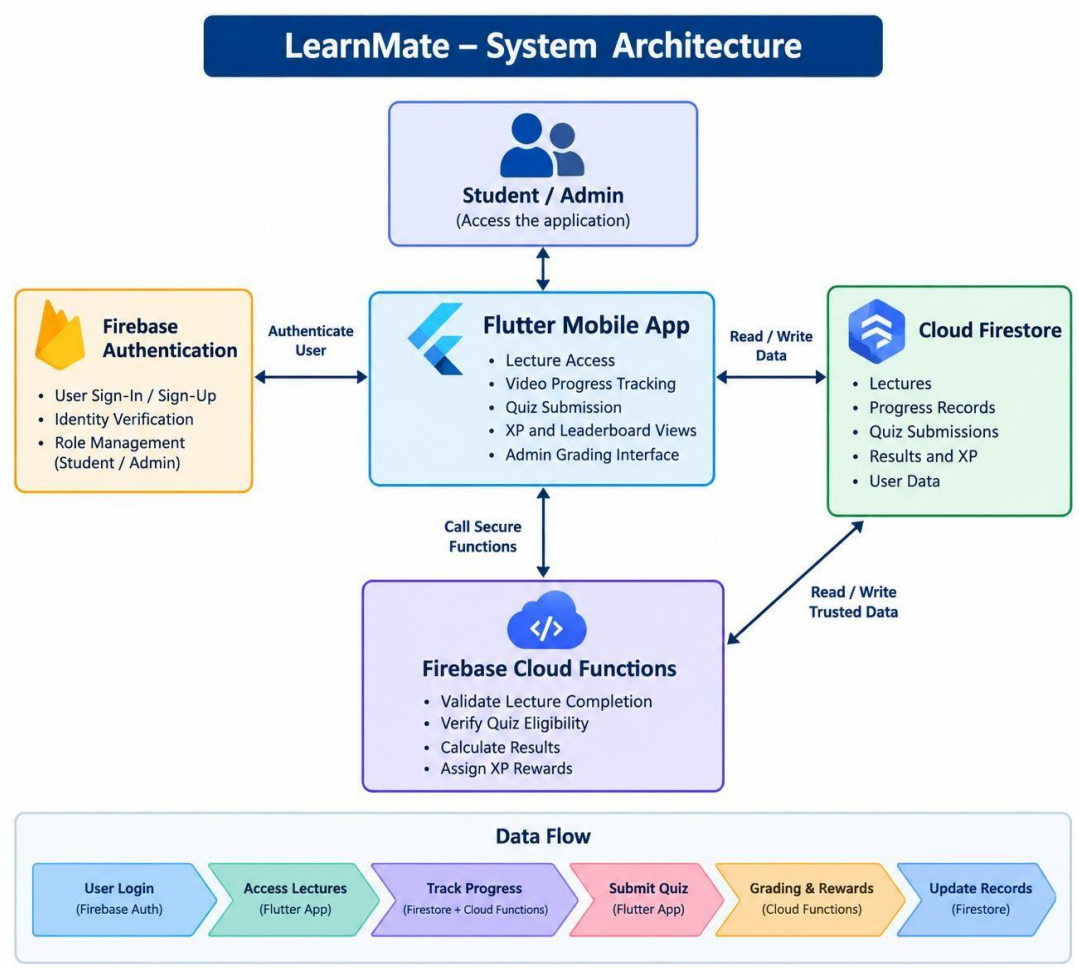
The leaderboard can present comparative XP information for users. Reward allocation must follow consistent rules so that points are not granted repeatedly for the same activity or modified directly by unauthorized clients.

Cloud Data Management Module: Cloud Firestore is used to store application data such as lecture information, progress records, quiz submissions, quiz results, and reward-related information, according to the application's data model.
Firestore security rules are important for enforcing access restrictions and protecting sensitive fields. Backend operations should validate data before changing trusted completion, grading, and reward records.

V.SYSTEM ARCHITECTURE

Learn Mate follows a client-and-cloud architecture. The Flutter mobile application provides the user interface, Firebase Authentication manages user identity, Cloud Firestore stores application data, and Firebase Cloud Functions can execute trusted server-side operations.
The intended architecture is illustrated below.

System Architecture:



The diagram represents the intended logical architecture. Operations shown under Firebase Cloud Functions depend on the corresponding secure backend functions being implemented and deployed.

The Flutter application communicates with Firebase services to authenticate users and access permitted data. Firestore security rules control which records and fields users can read or modify.

Trusted backend functions are intended to validate completion, process grading, and allocate rewards.

VI.DEVELOPMENT METHODOLOGY

The development of LearnMate follows a modular approach in which the user interface, data models, progress services, quiz workflow, and administrative operations are developed as separate components.
Requirements Analysis: The initial stage involves identifying the needs of students and administrators. Students require access to lectures, progress information, and quizzes.
Administrators require controlled access to grading and related management operations.
These requirements are translated into application modules and data structures.

Mobile Application Development: Flutter and Dart are used to develop the mobile application. The interface is organized around learning activities and the information required for each workflow.

Separate models and services help organize lecture information, progress measurements, and quiz submissions. This modular structure supports maintenance and future enhancements.

Firebase Integration: Firebase Authentication is used for user authentication, while Cloud Firestore stores relevant application records.

Progress and quiz services interact with Firestore while checking the authenticated user's identity and the conditions required for each operation. Security rules provide an additional layer of protection for client-accessible data.

Progress Validation: The progress tracking workflow records viewing measurements and calculates the watch percentage using the watched duration and total lecture duration.

A client-side progress measurement is not, by itself, sufficient proof that a lecture has been completed. A trusted backend operation should validate the measurement and update the authoritative completion status before a quiz is considered eligible.

Quiz Evaluation and Rewards: The quiz submission workflow checks eligibility conditions before storing a submission for evaluation. The grading workflow is designed to validate the submission, calculate the result, and update the associated result and XP records.

These operations should be protected by administrator authorization and backend validation. Duplicate submissions, repeated reward allocation, and unauthorized changes must be considered during implementation.

Testing and Deployment: The final stages involve functional testing, security-rule validation, integration testing, and deployment preparation. Testing should cover successful workflows as well as invalid inputs, unauthorized access, and incomplete learning progress.

Deployment status and test results should be documented based on actual execution rather than assumed outcomes.

VII.TESTING AND VALIDATION

Testing is essential for verifying the correctness, security, and reliability of Learn Mate.

Authentication Testing: Authentication tests should verify successful sign-in, invalid credentials, session handling, and access restrictions for unauthenticated users.

Lecture Progress Testing: Progress tests should verify the calculation of watch percentage, recording of watched duration, handling of invalid measurements, and preservation of previously confirmed completion status.

Boundary cases should include zero duration, invalid durations, and progress values that fall below or meet the required threshold.

Quiz Eligibility Testing: Quiz tests should confirm that unpublished quizzes cannot be submitted and that students who have not satisfied the required lecture completion conditions are prevented from proceeding.

The system should also handle missing progress records, invalid quiz identifiers, and repeated submissions according to the defined application rules.

Administrative Grading Testing: Grading tests should verify that only authorized administrators can grade submissions, that the appropriate answer key is used, and that the result and XP calculations follow the configured rules.
The system should also be tested for repeated grading attempts and duplicate reward allocation.

Firestore Security Testing: Security testing should verify that users cannot modify other users' records or directly alter protected completion, grading, and reward fields. Tests should also cover access to administrative data and operations.

Integration Testing: Integration testing should examine the interactions between the Flutter application, Firebase Authentication, Firestore, and the trusted backend functions.

The final test report should include the test cases executed, expected outcomes, actual outcomes, and any defects identified. No numerical success rate should be claimed without recorded test results.

VIII.EXPECTED RESULTS AND DISCUSSION

Learn Mate is intended to provide a structured mobile learning experience by bringing together lecture access, video progress tracking, quizzes, administrative grading, XP rewards, and leaderboard functionality.

Progress tracking can help learners understand how much of a lecture they have watched. Quiz eligibility checks can connect learning activity with assessment, while administrative grading provides a controlled process for evaluating submissions. XP and leaderboard features are intended to add a motivational element to the learning process.

Firebase-based authentication and cloud data storage provide a foundation for managing user identities and learning records. However, the reliability of the overall system depends on correct security rules, backend validation, and consistent reward-processing logic.

The expected benefits should be evaluated through functional testing and, where possible, user feedback. Claims about improved academic performance or increased engagement would require evidence from actual use and evaluation.

IX.LIMITATIONS AND FUTURE SCOPE

Limitations: The effectiveness of LearnMate depends on the completeness and reliability of its implementation. Video progress measurements may not establish that a learner has genuinely watched or understood every part of a lecture. Secure validation is therefore important when progress is used to unlock quizzes or grant rewards.

The application also depends on network connectivity and the availability of its cloud services. In addition, Firebase security rules and backend authorization require careful configuration and testing.

Gamification features such as XP and leaderboards may encourage participation, but they do not independently measure understanding or academic achievement.

Future Scope: Future improvements may include:

1. Personalized lecture and quiz recommendations.
2. Additional learning analytics and progress reports.
3. Expanded quiz formats and assessment options.
4. Notifications for new lectures, pending quizzes, and learning goals.
5. Achievement badges and configurable reward policies.
6. Improved accessibility and offline learning support where technically feasible.
7. More comprehensive administrative reporting.
8. Stronger backend validation, monitoring, and automated security testing.

These enhancements could extend the usefulness of LearnMate while maintaining a focus on data integrity, usability, and secure learning workflows.

X.CONCLUSION

Learn Mate is a Flutter-based mobile learning application designed to combine educational content, progress monitoring, quiz assessment, and gamification in a single platform. Firebase Authentication and Cloud Firestore provide core services for user identity and data management, while the application modules organize lecture access, progress records, quiz submissions, administrative grading, and reward-related information.

The project emphasizes the importance of linking learning progress with quiz eligibility and protecting trusted results through appropriate backend validation. XP and leaderboard functionality are intended to make learning activities more engaging, while structured data management supports consistent handling of student records.

The proposed system provides a foundation for a more organized and interactive mobile learning experience. Its reliability and educational value should ultimately be assessed through implementation verification, security testing, and feedback from actual users. Future development can further enhance personalization, analytics, accessibility, and the overall learning experience.

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