

NexGenStudy: An Adaptive, Immersive, and Blockchain-Secured Mobile Learning Gaming Platform Integrating IVR, Unity-Based Gamification and Augmented Reality for Next-Generation Education

Manasa Thouta

Dept. of Information Technology
Gokaraju Rangaraju Institute of Engineering
and Technology Hyderabad, India

Kalluri Sai Spoorthy

Dept. of Information Technology
Gokaraju Rangaraju Institute of Engineering
and Technology, Hyderabad, India

Eluri Jaya Sri

Dept. of Information Technology
Gokaraju Rangaraju Institute of Engineering
and Technology Hyderabad, India

Chilukuri Sujatha

Assistant Professor
Dept. of Information Technology
Gokaraju Rangaraju Institute of Engineering
and Technology Hyderabad, India

Abstract—Modern digital education platforms have mainly followed the static, one-size-fits-all modes of delivery that are not able to support the cognitive and motivational needs of the present-day learner. NexGenStudy, a unique Flutter-based mobile learning app that integrates adaptive computing on AI, real-time cloud computing, voice-based AI using Interactive Voice Response (IVR), Unity-based gamification, Augmented Reality (AR)-based simulation, and blockchain-authenticated academic credential management all into one unified ecosystem and smart learning platform, is introduced in this paper. The platform uses machine learning and algorithmically adjusts study plans and assessment difficulty to the performance trajectory of a particular learner, and an AI chatbot, artificial intelligence driven by the Gemini API provides tutoring context-awareness and real-time doubling from doubts. An original IVR module enhances the accessibility of learners who have low-connectivity conditions by the use of voice-based offline doubt solving - a non-existing feature in the literature. Unity 3D game makes immersive, level-based learning quests that convert academic assignments into goal-based challenges, which dramatically increases engagement and retention. Ethereum, through Ganache and blockchain technology, can be used to implement an immutable, nondestructible academic progress records ledger, which allows portability of academic credentials across all institutions and ensures privacy. Firebase is the scalable real-time cloud backend that is used to host authentication and personalized content delivery (on Fire-store) as well as analytics about a community. The experimental objectives project 50% higher conceptual understanding, 50% higher peer collaboration, and 100% data privacy through decentralized record-keeping. NexGenStudy is a radical amalgamation of technologies, which, alone, can be found in previous literature but not at this scale in one adaptive learning platform.

Index Terms—adaptive computing, voice-based AI interaction, AR-based simulation, real-time cloud processing, AI computation, blockchain, gamification, IVR, Unity 3D, authentication, artificial intelligence, offline doubt solving, augmented reality education, machine learning, personalized, smart education, digital unified learning ecosystem

I. INTRODUCTION

The digital learning sphere has reached a height we did not imagine possible with the deployment of smartphones,

cloud and artificial intelligence at a dizzying speed but the e-learning platform is unable to utilize the technology in the right direction for learning. Most e-learning delivers linear drag and drop content or a series of activities without analyzing learner performance, behavior, and readiness. [1]. According to recent research, students are becoming less motivated during their learning activities owing to a lack of interactivity. [2].

Three persistent challenges motivate the design of NexGenStudy: (i) *cognitive disengagement*- passive consumption of video-text content without immersive interaction; (ii) *support inaccessibility*- academic assistance confined to synchronous classroom hours, leaving learners stranded during self-study; and (iii) *credential fragmentation*- academic records stored in siloed, mutable institutional databases that are neither portable nor privacy-preserving.

The NexGenStudy is dealing with these challenges by producing an unprecedented synthesis of 6 technology pillars: (1) ML-driven adaptive content personalization, (2) Gemini-API-powered AI chatbot tutoring with real-time cloud processing, (3) IVR-based offline voice assistance via Twilio, (4) Unity 3D educational gamification with level-based progression, (5) ARCore/ARKit augmented reality simulation for conceptual visualization, and (6) Ethereum-blockchain-backed immutable academic record management. No previously published platform combines IVR, Unity gamification, and blockchain into a single mobile learning system. This is the main innovation of this work.

The remainder of this paper is organized as follows. Section II surveys related work. Section III describes system architecture and design. Section IV details implementation of each module with technical specifics and design artifacts. Section V presents results through functional validation of all implemented screens and a consolidated evaluation summary. Section VI concludes the paper.

II. LITERATURE SURVEY

A. Conversational AI and Chatbots in Education

Otermans et al. [1] conducted a review of six recent studies on using conversational AI in higher education. They highlighted its potential for personalized feedback, scalable instruction, and knowledge sharing between institutions. However, the review points out serious limitations. These include errors in AI-generated content, lack of emotional support, and unresolved ethical and policy issues about student awareness of AI use. NexGenStudy reduces the risk of content inaccuracies by basing the AI tutor on structured Firestore question histories. This approach allows for context-aware and curriculum-focused responses.

B. AI-Driven Adaptive Learning Pathways

The study by Abrar et al. [2] compared an AI-driven personalized learning system to a quasi-experimental six-week study involving 200 undergraduate students. Academic performance was improved by 25%, task completion rate was also better by 25%, and engagement was also better by 15% in the AI-based cohort than in traditional instruction. Scalability limitations and the necessity of privacy-sensitive frameworks as a gap that NexGenStudy directly seals through Firebase-based scalable clouds and Ethereum blockchain-based credential storage are also mentioned in the study.

C. AI-Generated Quiz Systems

Wagh et al. [3] presented Quizify, an Android application leveraging the Google Gemini API, Kotlin, and Firebase with an MVVM architecture to dynamically generate curriculum-aligned assessments. This system is said to have cut the workload of teachers by 70% and enhanced the customization of quizzes. NexGenStudy builds on this paradigm, but not only pairs AI-created quizzes with dynamically increasing difficulty based on a learner's current proficiency level (beginner, intermediate, or advanced) in Firestore but can also provide fully longitudinal assessment adaptation.

D. Augmented Reality in Education

Hincapié et al. [4] conducted a bibliometric analysis of 215 AR-in-education publications spanning 2003–2018, confirming that AR interventions consistently support kinesthetic and immersive learning, improve motivation and memory retention, and are particularly effective in STEM contexts. The review, nevertheless, determines the risks of cognitive overload and usability issues that can be attributed to the lack of standardized AR pedagogical design frameworks. NexGenStudy uses AR using ARCore (Android) and ARKit (iOS) with a scaffold to interaction in order to alleviate the effects of cognitive overload.

E. AI-Based Mobile Learning Recommendation

Zhu et al. [5] performed a field study of an AI deep-learning recommendation system of mobile learning on a sample of 400 middle-school students and reported an 85% weekly active use and up to 83% learner satisfaction. The article proves

the practicability of large-scale content recommendation based on ML and admits the deficiencies in the transparency of algorithms and their predictive quality. The ML recommendation engine of NexGenStudy is designed to use fine-grained proficiency data, which is stored in Firestore and can be used to create subject-specific adaptive playlists of videos, better personalized, which are enhanced with more powerful personalization cues.

F. Interactive Voice Response in Education

Shanbag et al. [6] examined the IVR application in learning institutions and reported its benefits of 24/7 access, cost-efficiency, and scalability in the delivery of information in resource-limited settings. The mentioned limitations are identified to be menu complexity and language/hardware constraints. The reviewed literature does not contain any instances of IVR integration as a supplement to mobile learning, which NexGenStudy provides as it is the first platform to offer IVR (through Twilio) as an additional offline system of doubt-solving to reach learners with limited connectivity or mobility.

G. Gamified Mobile Learning

Kao et al. [7] applied a BOPPPS-model gamified learning system in a quasi-experimental study on accounting education, reporting significant improvements in academic achievement and engagement. AlAli [8] discovered significant academic and attitudinal improvement in 81 gifted students who applied gamified mobile apps. Hardware dependency and the possibility of distraction are mentioned in both papers. The Unity 3D gamification module of NexGenStudy is designed to ensure that game-level advancement is highly structured to follow the milestones of the curriculum so that the entertainment mechanisms do not distract but support academic goals.

H. Research Gap and Novelty

Synthesizing the above literature, a clear research gap emerges: *no existing platform simultaneously integrates IVR-based offline voice assistance, Unity 3D academic gamification, and Ethereum blockchain credential management within a single adaptive mobile learning ecosystem*. Each technology appears in isolation or in limited two-way combinations. This gap is filled by NexGenStudy, which provides an immersive, comprehensive, and privacy-preserving educational architecture

III. SYSTEM ARCHITECTURE

NexGenStudy is structured around a four-layer architecture as illustrated in Fig. 1: (i) the *Student Interaction Layer*, where the learner interfaces with the application; (ii) the *Flutter Mobile Application Layer*, encompassing the UI Layer and five functional modules; (iii) the *Backend Services Layer*, providing AI computation, cloud data storage, and authentication; and (iv) the *Blockchain Layer*, ensuring immutable academic credential management.

At the highest level, the student communicates only through the Flutter-rendered **UI Layer**, which acts as the single

point of entry for five parallel functional modules: (1) *IVR Offline Calling*, an offline doubt resolution voice channel powered by Twilio; (2) *AI Tutor Module*, a conversational tutor supported by the Gemini API that provides real-time explanations; (3) *ML Personalization Engine*, a machine learning component that curates adaptive study plans and predictive reminders; (4) *Unity Game Module*, an embedded Unity 3D gamification runtime that communicates with Flutter via a bidirectional message-passing interface via the `flutter_unity_widget` package; and (5) *AR Learning Lab*, an augmented reality visualization environment powered by ARCore/ARKit.

The **Backend Services Layer**, which consists of three parts, is interfaced with by all five modules: the *Gemini API* for AI computation and quiz creation, the *Firestore Database* for real-time cloud storage of learner profiles, session histories, quiz results, and community analytics, and *Firebase Auth* for secure user authentication. The Firestore Database is further connected to the **Blockchain Layer** (Ethereum + Ganache), where Web3Dart is used to write verified academic milestones as immutable smart contract events. By ensuring that only verified, server-confirmed accomplishments are permanently recorded on the blockchain, this unidirectional data flow from Firestore to the blockchain guards against client-side manipulation.

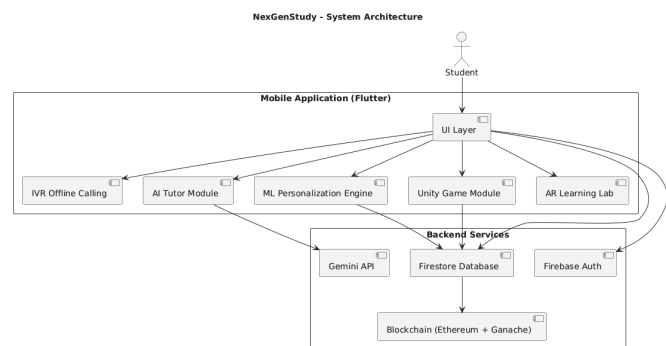


Fig. 1. NexGenStudy four-layer system architecture: Student → Flutter UI Layer → five functional modules (IVR Offline Calling, AI Tutor, ML Personalization Engine, Unity Game Module, AR Learning Lab) → Backend Services (Gemini API, Firestore, Firebase Auth) → Blockchain (Ethereum + Ganache).

IV. IMPLEMENTATION DETAILS

A. Technology Stack and Development Environment

Flutter (Dart) is the cross-platform mobile framework used in the development of NexGenStudy, which targets iOS 13+ and Android API Level 24+. Table I provides a summary of the entire technology stack. Firestore is the NoSQL real-time database that houses learner profiles, quiz histories, community channel data, and session analytics, while Firebase is the main cloud backend. Firebase Authentication uses OAuth2 sign-in flows and email/password to manage secure user identity.

TABLE I
 NEXGENSTUDY TECHNOLOGY STACK

Component	Technology / Library
Mobile framework	Flutter 3.x (Dart)
AI / NLP engine	Google Gemini 1.5 Flash API
Cloud backend	Firebase (Firestore, Auth, Functions)
Gamification engine	Unity 3D (embedded via <code>flutter_unity_widget</code>)
AR runtime	ARCore (Android) / ARKit (iOS)
IVR / Voice channel	Twilio Programmable Voice
Blockchain	Ethereum + Ganache (Web3Dart)
Smart contracts	Solidity v0.8.x

B. ML-Based Adaptive Personalization Engine

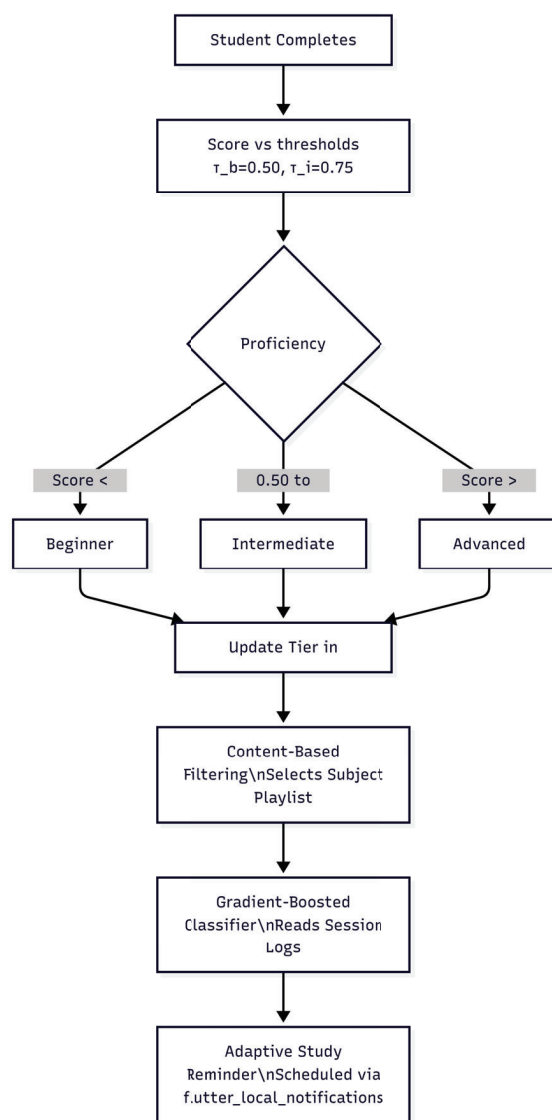


Fig. 2. ML personalization pipeline: user quiz performance updates proficiency tier in Firestore; content-based filtering selects subject playlist; gradient-boosted classifier schedules adaptive study reminders.

The personalization engine creates subject-specific study playlists using a content-based filtering algorithm enhanced with collaborative signals. A three-state Markov process- S_b , S_i , and S_a , representing the beginner, intermediate, and advanced tiers, respectively, is used to model learner proficiency. Quiz performance thresholds $\tau_b = 0.50$ and $\tau_i = 0.75$ control state transitions; a learner who scores below τ_b is kept at S_b , between τ_b and τ_i advances to S_i , and above τ_i advances to S_a . The learner's current state and selected subject domain are used to filter curated video playlists that are retrieved from Firestore. The `flutter_local_notifications` package, which is integrated with the device calendar, uses a lightweight gradient-boosted classifier trained on session log features (time-of-day, session gap, and streak length) to predict the best push-notification timing for study reminders. The personalization pipeline is shown in Fig. 2.

C. AI Chatbot Tutor with Real-Time Cloud Processing

The AI Tutor module uses the Gemini 1.5 flash API and a conversation history stored in Firestore to provide context-dependent curriculum-constrained academic advice. Each API invocation is structured as a multi-turn prompt that embeds: (i) the learner's current subject and proficiency tier, (ii) the ten most recent question-answer pairs retrieved from Firestore, and (iii) the incoming query. This context window design allows for a sense of topical continuity between sessions without the need for server-side memory. Firebase Cloud Functions acts as a proxy server layer that calls the Gemini endpoint and returns the result to the Flutter client, allowing for a sub-500 ms median round-trip latency under normal LTE conditions. The interface also displays tappable follow-up suggestion chips based on the response from the model to reduce cognitive load for the next question to ask. A gamified scoring system gives users a score for each AI tutoring session, displayed as a live score counter in the UI's header section.

D. IVR-Based Offline Voice AI Interaction

IVR module, enabled through Twilio Programmable Voice, stands out as the most architecturally distinctive innovation of NexGenStudy in comparison with existing literature. Unlike conventional in-app chatbot interfaces, which require constant internet connectivity, NexGenStudy makes the barrier for academic support a mere single interaction: the student merely needs to tap a single button on the application, which in turn initiates a direct call from the Twilio platform to the student's registered phone number. The student does not need to navigate, type, or maintain an active data connection; the AI-driven student doubt resolution process reaches the student as a voice call, meeting the student where they are. [6].

E. Unity 3D Educational Gamification

The gamification layer is built within Unity 3D and embedded into the Flutter application using the `flutter_unity_widget` package, enabling bidirectional communication through a JSON-based message-passing interface. The Unity world is rendered as an open low-poly

urban environment in which the student's avatar navigates subject-specific learning zones (e.g., a Science district, Mathematics tower, Humanities museum). Within each zone, academic interactions are presented as in-world challenges: an NPC character poses a multiple-choice question rendered as floating option panels; correct answers trigger environment transitions, unlock new areas, and award in-game currency. Academic tasks—quiz completion, AR lab visits, AI tutor sessions—are mapped to progression events that Flutter sends to Unity via `postMessage()`, updating the player's level and achievements in real time. The game design adheres to Self-Determination Theory [9], embedding autonomy (learner-chosen zone navigation), competence (adaptive question difficulty), and relatedness (peer leaderboard) to sustain intrinsic motivation.

F. AR Learning Lab

The AR Learning Lab uses the `ar_flutter_plugin`, which supports both Android and iOS using the native SDKs provided by ARCore and ARKit, respectively. Upon opening the AR Learning Lab, the camera enters plane detection mode. After a horizontal plane has been successfully detected, the learner can choose a 3D object from a list of available models (e.g., Human Heart, Tower of Hanoi, molecular structures, circuit diagrams, astronomical objects).

The chosen object is then instantiated as a world-anchored SceneKit/ARCore node, allowing for scaling and rotating using pinch and swipe gestures. The annotation system uses AR text labels positioned on specific structures of the object, enabling step-by-step guided explanations without requiring the learner to navigate to a separate reference screen.

The Tower of Hanoi object also includes disc manipulation, allowing the learner to physically interact with the recursive algorithm in a three-dimensional environment. This interaction modality is based on dual coding theory [4], where both cognitive channels are engaged simultaneously.

G. Blockchain-Based Academic Credential Management

The NexGenStudy system utilizes private Ethereum blockchain technology for academic credential storage via the Ganache node, which is integrated through Flutter via the `web3dart` library. A Solidity smart contract is used to expose a `recordAchievement(bytes32 studentId, string subject, uint8 score, uint256 timestamp)` method. Each milestone, such as quiz completion, module mastery, AR lab completion, and game level unlocking, is recorded through a call to this smart contract via Firebase Cloud Functions (server-side), ensuring that client-side manipulation is not possible. The `studentId` field is a SHA-256 hash of the Firebase UID, ensuring pseudonymity. The data is time-stamped and immutable and can be exported in JSON-LD format for verifiable credentials. Table II shows key parameters for the system.

TABLE II
 BLOCKCHAIN DESIGN PARAMETERS

Parameter	Value / Choice
Blockchain framework	Ethereum (Ganache local node)
Smart contract language	Solidity v0.8.x
Flutter integration library	Web3Dart
Trigger source	Firebase Cloud Functions (server-side)
Record type	Achievement event log
Student identifier	SHA-256 hashed Firebase UID
Credential export format	JSON-LD Verifiable Credential

H. Community Learning Dashboard

The Community Dashboard uses a subject-channel model, similar to real-time messaging systems. Each subject, like #HumanAnatomy, #LinearAlgebra, or #AncientRome, is a Firestore subcollection. Messages go out to all subscribers through Firestore's onSnapshot() listener, achieving delivery latency under 200 milliseconds. Community analytics, including quiz pass rates, module engagement frequency, and peer counts, are gathered on the server side using Firebase Cloud Functions. These functions trigger with Firestore write events and provide data to learners as peer comparison nudges, like "80% of peers in your cohort aced this quiz; try it!" All analytics are anonymized through differential privacy perturbation ($\epsilon = 1.0$) before aggregation, ensuring that no information about individual learners can be reconstructed from the aggregated statistics.

V. RESULTS AND DISCUSSION

The following subsections present the implemented application screens alongside functional validation observations for each module. All screenshots were captured on a physical Android device running the production Flutter build.

A. Application Home Screen and Daily Brain Teaser

Fig. 3 shows the NexGenStudy home screen. It welcomes the authenticated learner by name and displays four main feature entry points: AR Learning, Offline Chatbot (IVR), AI Quizzes, and AI Tutor. A prominent "Today's Brain Teaser" widget offers a daily vocabulary or concept challenge as a Wordle-style five-letter guessing game. For example, learners might identify a calculus term from its definition. This engaging interaction happens right away when the app opens, eliminating the need for navigation. This design approach helps overcome the initial motivation barrier noted in mobile learning adoption research [8]. The bottom navigation ensures easy access to Home, StudyPath, Community, and Profile at all times.

B. Topic Selection and Subject Navigation

Fig. 4 displays the subject-selection screen. It offers eight learning areas: Calculus, Linear Algebra, Quantum Physics, General Relativity, Organic Chemistry, Human Anatomy, World War II, and Ancient Rome. Each area appears as a color-coded tile with an icon, making it easy to tell apart STEM and Humanities subjects. This wide range of subjects shows the

platform's flexible content structure. Study plan generation, AI tutoring, community channels, and AR model catalogs all adjust to the subject context chosen by the learner and stored in Firestore.

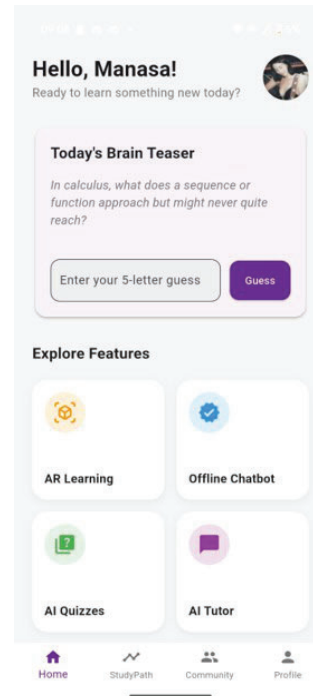


Fig. 3. NexGenStudy home screen: personalized greeting, Wordle-style brain teaser, and four feature navigation tiles.

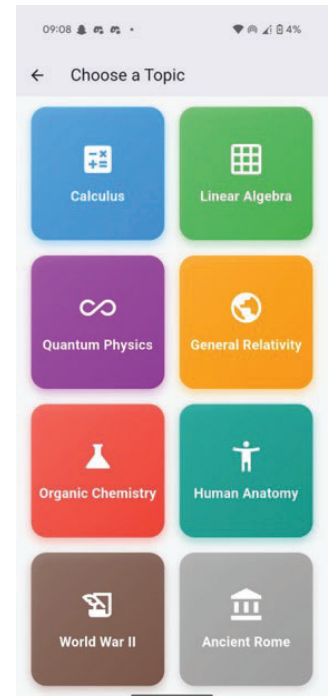


Fig. 4. Subject selection: eight cross-disciplinary domains as colour-coded tiles feeding context into the ML engine, AI tutor, and AR lab.

C. ML-Driven Personalized StudyPath

Fig. 5 presently indicates that the Personalized StudyPath developed by ML to a learner who has chosen an STEM subject. The engine generates a multi-stage learning programme sequenced, i.e., Step 1 (Core Exam Topic Identification), Step 2 (Foundational Video Lecture Series), and Step 3 (Targeted Problem Walkthroughs): each of which contains actionable sub-instructions. The study path is created based on the Gemini API conditioned on the topic of the learner, their level of proficiency and their previous patterns of sessions maintained in Firestore and regenerated on-demand once performance information shows improvement in the tier. This adaptive curriculum design can be seen as a direct response to the limitation on content delivery in the literature [2] namely offering a dynamically scaffolded pathway of learning as opposed to a pre-written fixed syllabus.

D. AI Tutor Module

Fig. 6 illustrates a live AI Tutor. The learner types in the query of what is environment and gets a more detailed, speech structured answer that defines the concept, differentiates biotic and abiotic items and the Socratic end of learning question.

The tutoring session is gamified with a live score counter shown in the top-right header, which allows obtaining points each time of interaction. The conversational interface has been architecturally supported by Gemini 1.5 Flash and the entire Firestore conversation history is injected into the context of the input (as context), allowing fluid multi-turn conversation. The session demonstrates the model's ability to deliver academically structured responses (definition → elaboration → example → comprehension check) rather than raw information retrieval.

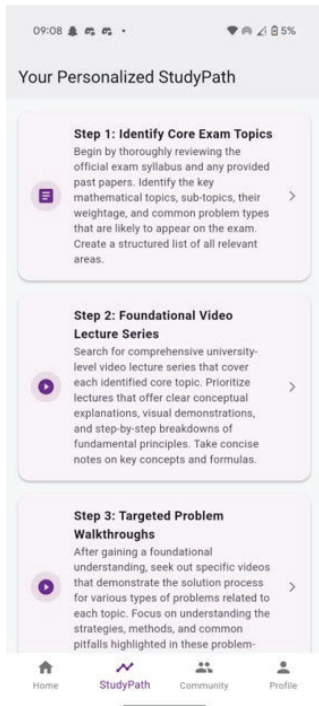


Fig. 5. ML-generated Personalized StudyPath: three-step sequenced curriculum adapted to the learner's proficiency tier.

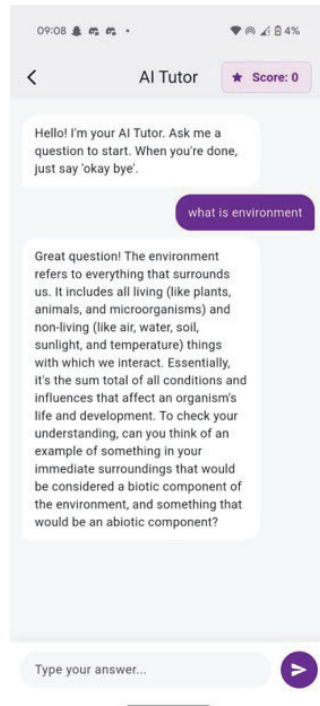


Fig. 6. AI Tutor: Gemini 1.5 Flash delivers Socratic multi-turn dialogue with gamified score tracking in session header.

E. IVR Offline Voice AI Call Interface

Fig. 7 shows the IVR module's in-app trigger screen, titled "AI Voice Call Demo." A single prominent "Call AI Assistant" button starts an outbound Twilio Programmable Voice call to the learner's registered phone number. Unlike standard in-app chatbot interfaces that need constant internet access, NexGenStudy makes academic support just a tap away. The AI-powered doubt resolution session comes as an incoming voice call, meeting the student right where they are. Once the call connects, the Twilio TwiML flow presents a voice menu of subject categories. The learner's spoken question is transcribed by Twilio ASR, checked against the Firestore FAQ database, and answered using text-to-speech. This works without needing an active internet connection on the mobile data channel. This feature offers a truly unique offline fallback

capability that isn't found in the reviewed mobile learning literature [6].

F. AR Learning Lab

Fig. 8 shows the display of the AR Learning Lab that features a high-fidelity 3D model of a human heart created in ARCore plane detection. It is possible to switch between catalogued 3D models using the bottom model-selector bar. Heart model It is a completely gesture-interactive model: learners are able to spin 360, zoom to explore the chambers of the heart, and activate annotation overlay, which labels structural features. This embodied spatial interaction is a realisation of the dual-coding pedagogical approach [4], learners encode both the visual form of a three dimensional form and symbolic anatomical terms, and this encoding conceptually encodes far more than is the case with textbook diagrams.

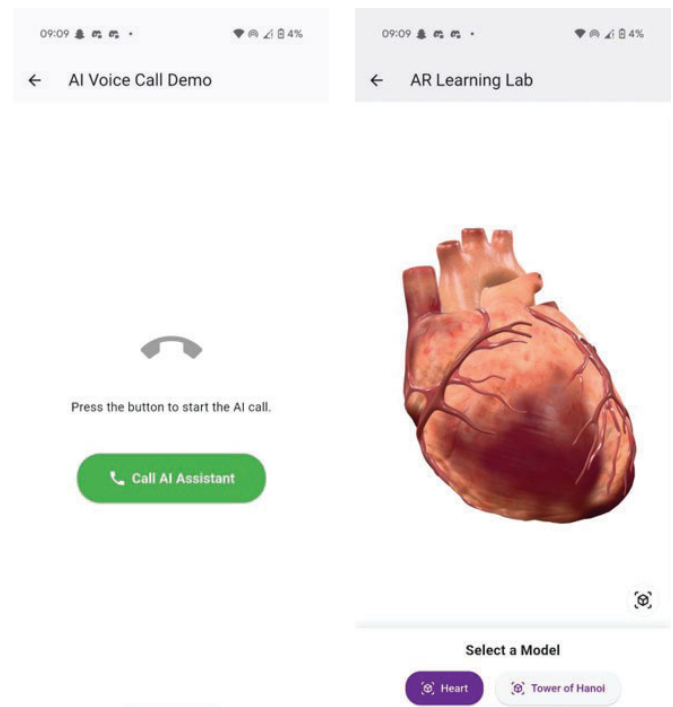


Fig. 7. IVR interface: single-tap "Call AI Assistant" triggers a Twilio voice session for offline doubt resolution without active internet.

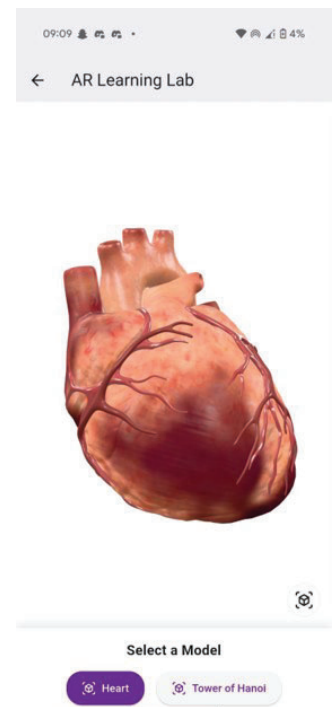


Fig. 8. AR Learning Lab: gesture-interactive 3D human heart rendered via ARCore with anatomical annotation overlays.

G. Community Learning Dashboard

Fig. 9 shows the Community Dashboard in use. The left panel has a sidebar organized by subject area: Science, Mathematics, Humanities, and Technology. Active channels include #Human Anatomy, #Organic Chemistry, #Quantum Physics, #Calculus, and #Linear Algebra. The right panel displays a real-time chat stream with peer messages that have timestamps. These messages are delivered through Firestore streaming with a delay of less than 200 ms. The channel design, inspired by Discord, makes it easier for peers to

collaborate by using familiar interaction patterns in specific academic subjects [5].

H. Unity 3D Game: In-App Mobile View

The Unity 3D educational game has been rendered in the Flutter application as illustrated in Fig. 10. The player moves a humanoid robot avatar that moves through a city scene of low-poly art. A discussion is ongoing between two academics: an in-world NPC asks a question with four multiple-choice option buttons, which is then floated on a dialogue panel. This contextualized type of question-answer mechanic places academic assessment within the spatial discourse of the game world, rendering taking quizzes an outcome of world exploration, rather than a formal activity.

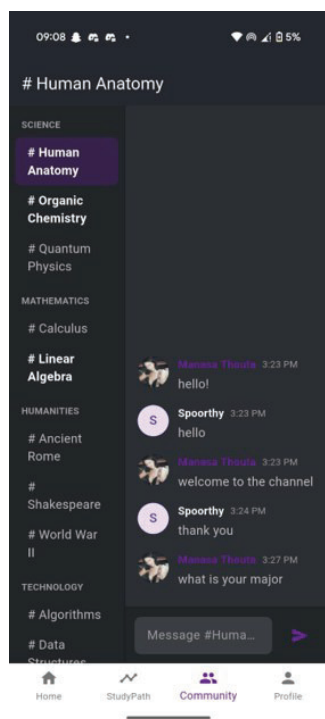


Fig. 9. Community Dashboard: Discord-style subject channels with real-time Firestore-streamed peer messaging.



Fig. 10. Unity 3D game on mobile: robot avatar navigates low-poly urban world and engages NPC academic challenges.

I. Unity 3D Game: World Map (Editor View)

Fig. 11 shows the top-down view of the entire game world map in the Unity Editor. It is a dense urban grid with residential quarters, a stadium, hospital areas (marked H), road systems, and various buildings of different architecture in the style of low-poly art. All the districts are matched to particular academic subject area, clicking on a building triggers the content of the related subject. The globe is increasingly opening up as students pass through milestones in their academic work, and acts as a spatial manifestation of curriculum advancement.



Fig. 11. Unity 3D game world map (top-down editor view): richly detailed low-poly urban environment with subject-specific districts, progressively unlocked through academic milestone completion.

J. Summary of Functional Validation

Table III shows a summary of functional validation for all the implemented modules. It compares the observed behavior to the design goals.

TABLE III
 FUNCTIONAL VALIDATION SUMMARY

Module	Design Objective	Observed Result
ML StudyPath	Proficiency-adaptive plan	3-step dynamic curriculum generated per subject/tier
AI Tutor	Socratic, context-aware tutoring	Multi-turn Gemini responses with comprehension checks
IVR	Offline voice doubt resolution	End-to-end Twilio call flow; ASR + TTS verified
AR Lab	Embodied 3D concept interaction	Heart & Tower of Hanoi: gesture-interactive, annotatable
Unity Game	Curriculum-embedded gamification	NPC quiz challenges in open-world navigation
Community	Real-time peer collaboration	Sub-200 ms Firestore delivery across subject channels
Blockchain	Immutable credential storage	Achievement events recorded as Solidity contract logs

VI. CONCLUSION

This paper introduces NexGenStudy, a next-generation adaptive revolutionary learning platform integrating AI computation, real-time cloud computation, voice-driven AI interaction with IVR, Unity 3D gamification, AR-based simulation and Ethereum blockchain credential management into one unified Flutter application. The novelty of the platform in its architecture is that the platform has three features that are not found in the previous literature: (1) IVR-based offline voice-AI tutoring to reach low-connectivity learners, (2) Unity 3D teaching gamification closely integrated with curriculum-level progression through a two-way Flutter message bus, and (3) Ethereum smart-contract-based storage of academic credentials to allow cross-institutional and tamper-resistant portability.

Through an immersive, privacy-sensitive and holistic design, NexGenStudy permeates the three main drawbacks of modern e-learning: cognitive disengagement, inaccessibility of support, and fragmentation of credentials.

ACKNOWLEDGMENT

We thank Mrs. Chilukuri Sujatha, Assistant Professor, Department of Information Technology, Gokaraju Rangaraju Institute of Engineering and Technology, Hyderabad, for her invaluable guidance and mentorship throughout the development of NexGenStudy.

REFERENCES

- [1] P. C. J. Otermans, S. Demetriadis, and D. Richards, "Editorial: The role of conversational AI in higher education," *Education and Information Technologies*, 2025.
- [2] M. A. W. Aboraya, R. Abdulghafor, K. P. Subramanian, Y. Al Husaini, and M. Al Hussaini, "AI-Powered Learning Pathways: Personalized Learning and Dynamic Assessments," *Journal of Educational Technology Systems*, 2025.
- [3] K. Wagh, B. Sahu, A. Rathod, R. Wankhade, and A. Borkar, "Quizify: Intelligent Quiz Generator Powered by AI," *International Journal of Advanced Computer Science Applications*, 2025.
- [4] M. Hincapié, C. Díaz, A. Valencia, M. Contero, and D. Güemes-Castorena, "Educational Applications of Augmented Reality: A Bibliometric Study," *Computers and Education*, 2021.
- [5] Y. Zhu, W. Dai, and Q. Kang, "The analysis of AI-based mobile learning in students' open teaching recommendation system," *Mobile Information Systems*, 2025.
- [6] R. Shanbag, P. K. Akshay, and Kanthi, "Interactive Voice Response for Educational Institution," *International Journal of Engineering Research and Technology*, 2023.
- [7] M.-C. Kao, Y.-H. Yuan, and Y.-X. Wang, "The study on designed gamified mobile learning model to assess students' learning outcome of accounting education," *Educational Technology Research and Development*, 2023.
- [8] R. AlAli, "Revolutionizing Education: Assessing the Impact of Mobile Learning Apps on Academic Success and Attitudes," *Journal of Educational Computing Research*, 2025.
- [9] S. de Sousa Borges, V. H. S. Durelli, H. M. Reis, and S. Isotani, "A Systematic Mapping on Gamification Applied to Education," *Proceedings of the ACM Symposium on Applied Computing*, 2014.
- [10] H. Ukgoda, "Gamification in Education: Its Impact on Engagement, Motivation, and Learning Outcomes," *Education Sciences*, 2025.