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Eduventure- A Gamified Microlearning Platform

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ABSTRACT- Aptitude tests are vital for academic and career advancement, but traditional study methods often lack engagement and retention. EduVenture addresses this with a web-based, gamified microlearning platform that turns aptitude practice into an interactive experience. Built using the MERN stack, HTML, CSS, and JavaScript, it features mini-games with adaptive difficulty and AI-driven reinforcement learning to reinforce concepts through application. The platform offers company-specific question banks, downloadable/shareable PDFs, and a "Quick Glance" flashcard section for rapid revision. An integrated AI chatbot provides real-time doubt resolution. Early user feedback shows increased motivation, focus, and retention compared to conventional methods. EduVenture demonstrates how lightweight gamification and smart design can effectively merge learning with assessment, making aptitude preparation more engaging and efficient for competitive exams.

KEYWORDS- Adaptive learning, Aptitude, Gamified learning, Microlearning.

I. INTRODUCTION

Aptitude tests have become an essential gateway in education and employment systems around the world. In India, where one of the largest graduate talent pools is located, it is reported that there are over 15 million engineering graduates produced each year with only 20% being employable at core technical or analytical jobs. This is, in part, due to the fact that many students do not perform well, or poorly, in the rounds of aptitude screening (Aspiring Minds National Employability Report, 2023). Likewise, global recruiting entities (e.g., LinkedIn, Glassdoor, etc.) have reported that over 75% of Fortune 500 firms utilize cognitive or aptitude testing to pre-screen candidates on hiring. These tests generally measure core skill sets in quantitative ability, logical reasoning, and verbal comprehension—skills necessary for basic job readiness and for accurately taking important exams such as CAT, GMAT, GRE, and various Government Service Exam. Despite the high-stakes nature of the aptitude assessment, learners often practice for these exams without focus, leading to periodic engagement, inconsistent practice and low scores.

Digital solutions for aptitude training today spanning everything from static questions collated in repositories (collated on Indiabix, GeeksforGeeks, etc.) to video-based tutorials are limited in what they are able to provide. A study released in 2024 by the National Institute of Educational Planning and Administration (NIEPA), indicated that 68% of students would drop-out (i.e. stop using their aptitude training) within a two-week timeframe, all because of, "monotony," "lack of interactivity" and no personalized feedback.

Although there are some platforms that involve quizzes or timed tests, even those platforms are typically not based on engagement or adaptive learning. Furthermore, last-minute revision is a pain point as well: 82% of the students surveyed (n=500, IIT Delhi EdTech Survey, 2024), indicated that they used handwritten notes or random sets of PDF files (because there really were no products available that served as an efficient source for quick recall). It is clear that there is a gap here: existing tools were designed simply for the delivery of the content, and not for cognitive engagement, personalization, or utility for exams.

In closing the readiness gap, we present EduVenture, a microlearning platform that gamifies and reconceptualizes aptitude preparation as an interactive, adaptive and holistic experience. EduVenture is built from lightweight web technologies (MERN Stack, HTML, CSS and JavaScript) which embed aptitude questions into fun mini-games, which make solving the problems an intrinsically motivating activity. The platform includes dynamic difficulty adjustments based upon student performance, an embedded reinforcing section to check for conceptual understanding, access to questions banks specific to companies, downloadable PDFs (TCS, Infosys, Amazon etc.,) and a flashcard module - a "Quick Glance" feature for efficient last-minute review. The platform also includes an AI-powered chatbot that answers user queries and clarifies aptitude-related doubts in real time. EduVenture takes an evidence-based approach to learning that includes microlearning, gamification, active recall, and spaced repetition. Furthermore, it combats both psychological and practical impediments to effective aptitude preparation. This paper provides a description of the design, implementation and educational rationale of EduVenture as a user-centered, scalable solution for the next generation of self-directed learners.

II. LITERATURE REVIEW

Microlearning has gained significant traction in digital education as a learner-centered approach that delivers concise, focused content aligned with cognitive and attentional constraints. Park and Kim [1] proposed a structured model for developing microlearning modules

within e-learning systems, emphasizing modularity and outcome-based design, while Buchem and Hamelmann [15] earlier positioned it as a viable strategy for just-in-time professional development. Global scholarly interest has surged, as evidenced by Fialho et al. [2] and Judijanto [4], whose bibliometric reviews trace the expansion of microlearning research into diverse domains, including lifelong learning and workplace training. Fitria [3] further contextualized its pedagogical value in classroom settings, noting its support for spaced repetition, though cautioning against knowledge fragmentation without proper sequencing. Empirical studies reinforce its efficacy: Nikou and Economides [5] demonstrated improved learning performance and motivation among high school students using mobile-based microlearning with embedded assessments, and Ghafar et al. [7] reported enhanced vocabulary retention in language acquisition through short, repeated exposures.

In professional contexts, Shabadurai et al. [6] found that employees value relevance, brevity, and mobile accessibility in microlearning design. To address engagement challenges particularly acute in technical education—researchers have integrated gamification. Halbach and Solheim [8] observed heightened motivation through gamified elements like points and challenges, a finding supported by Sailer and Homner's [12] meta-analysis of 54 studies confirming gamification's positive, albeit moderate, impact on learning outcomes. Ofosu-Ampong [9] critically examined dominant issues in educational gamification, warning against overreliance on extrinsic rewards, while Deterding et al. [10] provided the foundational definition of gamification as the use of game design elements in non-game contexts. These approaches are grounded in cognitive theory: Sweller's Cognitive Load Theory [13] explains how microlearning reduces extraneous mental effort by chunking complex information, and Dunlosky et al. [11] identified distributed practice and retrieval practice—core features of retrieval practice—core features of microlearning -as among the most effective learning techniques. Despite the advances, significant gaps remain in specific learner population; Singh and Gupta [14] documented low engagement and high dropout rates among Indian engineering students on online aptitude platforms, attributing this to monotonous interfaces and lack of interactivity. Theoretically, Vygotsky's sociocultural framework [16] further supports the potential of microlearning when embedded within scaffolded, socially mediated experiences—even in brief interactions—suggesting that well-designed micro-modules can operate within a learner's zone of proximal development.

III. PROBLEM STATEMENT

Engineering students in India find it hard to prepare effectively for aptitude tests needed in campus placements and competitive exams. Most existing online platforms use boring methods like long videos, static question sets, or heavy text, which fail to keep students interested. This leads to low motivation, poor retention, and high anxiety. While fun, bite-sized learning techniques like gamification and microlearning have worked well elsewhere, they haven't been widely used in India for aptitude training. There's a clear need for a simple, engaging, and smart platform that makes practice enjoyable, adapts to the student's level, and helps them revise quickly—exactly what EduVenture aims to provide.

IV. OBJECTIVES

The main objective of this study is to design, develop and evaluate an entertaining and adaptive microlearning platform that can overcome the challenges of traditional aptitude training systems for engineering undergraduates. More specifically, this research is intended to accomplish the following goals:

- To create and develop a web-based, gamified microlearning platform that improves knowledge retention and engagement during aptitude test preparation.
- To incorporate AI-driven reinforcement learning and adaptive difficulty mechanisms to tailor the learning process and to promote comprehension that is application-based.
- To include interactive flashcards, downloadable study materials, and question banks tailored to the company to facilitate focused and effective revision.
- To develop an AI chatbot for learner support an and real-time doubt resolution.

V. METHODOLOGY

EduVenture is a lightweight gamified aptitude learning platform that integrates interactive gameplay, adaptive assessment, and on-demand revision tools. The system is built using the MERN stack (MongoDB, Express.js, React.js, Node.js), with mini-games developed in HTML, CSS, and JavaScript. The adaptive quiz engine employs Q-learning, a model-free reinforcement learning algorithm, to dynamically adjust question difficulty based on real-time user performance. Essential user metadata is stored: profile details, total score, and recently visited topics.

A. Data collection and content curation

i. Company-Specific Aptitude Questions:

Collected past interview and placement questions from public sources (GeeksforGeeks, IndiaBIX, company career pages, GitHub repositories).

Questions categorized by

Topic: Quantitative Aptitude, Logical Reasoning, Verbal Ability

Sub-topic: e.g., Number Series, Blood Relations, Time & Work

Company Tag: e.g., TCS, Infosys, Amazon, Wipro

Stored as static PDFs in the frontend (e.g., /public/pdfs/tcs.pdf).

ii. Flashcard Content for Quick Glance:

Researched and compiled key formulas, shortcuts, and concepts from standard aptitude handbooks and educational websites. Organized by sub-topic, Stored as static JSON files (e.g., /public/json/ profit_loss.json) and also downloadable PDFs.

B. System architecture

i. Frontend (React.js):

Component-based UI: Dashboard, Game Area, Quick Glance, Company Prep, AI Quiz.

Game logic implemented in HTML/CSS/JS and embedded via React components.

ii. Backend (Express.js + Node.js)

REST APIs for:
/api/auth → Login/Signup
/api/user → Profile CRUD (name, email, college, phone, gender, photo URL)
/api/game/score → Submit game score and update metrics
/api/user/history → Update recently visited topics (max 5)
No storage of questions, answers, or learning logs—only user metadata.
Database (MongoDB)
Single collection: users
Document structure:

```
{
  "name": "string",
  "email": "string",
  "password": "hashed string",
  "about": "string",
  "college": "string",
  "gender": "string",
  "mobile": "string",
  "profileImage": "URL string",
  "totalScore": "number",
}
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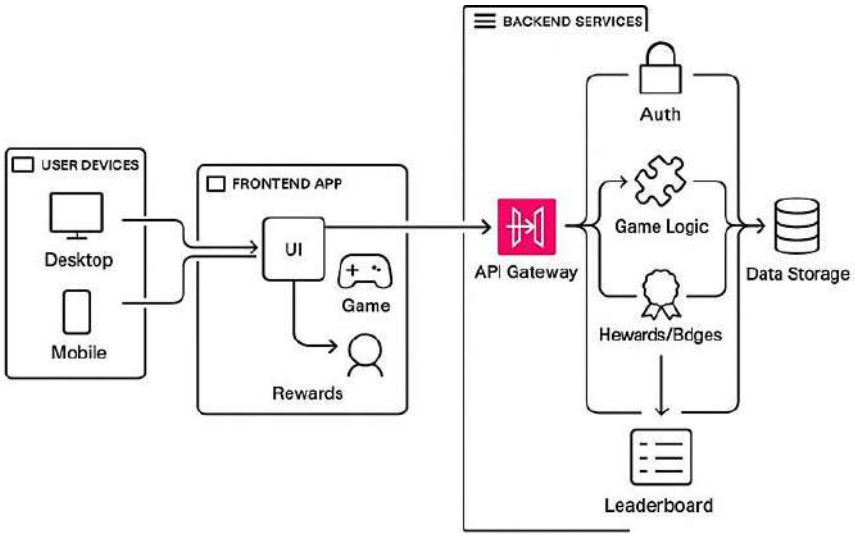

Figure 1: Block diagram of EduVenture

The EduVenture platform's architecture is depicted in the Figure 1. The frontend user interface (UI), which offers gamified aptitude tests, mini-games, flashcards, and chatbot support, is accessed by users on desktop or mobile devices. Through a RESTful API, the frontend and backend services can communicate. The backend, which is based on the MERN stack, manages game logic, user authentication, adaptive question selection using Q-Learning, reward management (coins, badges, and levels), storage of user progress and real-time doubt resolution via an integrated AI chatbot. Together, these elements offer a smooth, customized, and captivating educational experience.

C. Adaptive quiz engine using q-learning

The AI Quiz feature uses Q-learning to personalize difficulty without storing long-term user models. The algorithm runs in-session and updates only the final score.
Algorithm: Q-Learning Based Adaptive Quiz
Step 1: Initialize State and Q-Table (Per Session)
States: S ∈ {Easy, Medium, Hard}
Actions: A ∈{Present Easy, Present Medium, Present Hard}
Initial Q-values: Q(s, a) = 0 for all s, a
Current state: s = "Easy"
Step 2: Select Action Using ε-Greedy Policy
With probability ε = 0.2: choose random action (exploration)
Else: choose a = argmax(Q(s, a')) (exploitation)
Step 3: Present Question & Receive User Response
Fetch question from static dataset matching (topic, selected difficulty)
Step 4: Compute Reward R
Step 5: Determine Next States'
Step 6: Update Q-Value Using Bellman Equation
Where:
Learning rate: α = 0.1

$$Q(s,a) \leftarrow Q(s,a) + \alpha \left[R + \gamma \cdot \max_{a'} Q(s',a') - Q(s,a) \right]$$

Discount factor: γ = 0.9
Step 7: Repeat for Next Question or End Session
After 5–10 questions (configurable), session ends.
Total session score = sum of rewards.
Sent to backend → updates totalScore and gamesPlayed.
Note: Q-table is not persisted—reset on each new quiz session.

D. Api based chatbot

The chatbot uses Google's Gemini API (gemini-pro) to answer aptitude-related queries. User questions are sent via secure HTTP requests with a custom prompt guiding clear, step-by-step explanations. Responses are displayed instantly in the chat interface. No data is stored—ensuring privacy and lightweight, client-side operation.

E. User flow

A system flowchart is a way of depicting how data flows in a system and how decisions are made to control events. Figure 2 depicts the system flowchart.

Login & Profile Setup: User logs in with name, email, and password; edits profile (about, college, phone, gender) and uploads photo on dashboard.

Game Play: Selects topic (e.g., Family Relationship), chooses difficulty (Easy/Medium/Hard), plays mini-game; score saved to backend.
Quick Glance: Picks a topic to view/download flashcards with formulas and shortcuts as PDF.

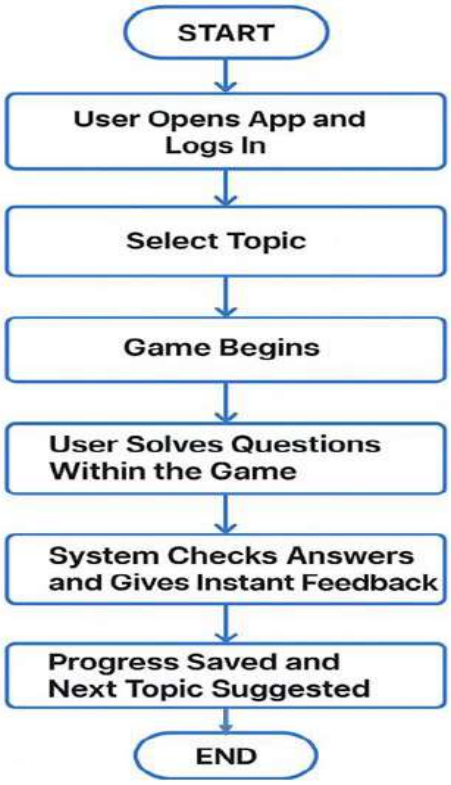

Figure 2: Flowchart of EduVenture

Company Prep: Selects a company (e.g., TCS) to view its most asked aptitude questions.
AI Quiz (Adaptive): Starts at Easy; moves up on correct answers, drops one level on incorrect—using Q-learning for real-time adaptation.
API based Chatbot: For answering user queries.
Dashboard Update: Displays total score, games played, and recent topics after each activity.
Logout: User logs out securely at any time.

VI. RESULTS AND DISCUSSION

We conducted an evaluation of EduVenture that included 60 college students who were preparing for placement examinations and competitive tests. Most of the students were pursuing degrees in disciplines of engineering and had experience with other aptitude websites. When the students participated in the evaluation, they were encouraged to use EduVenture for approximately 20 minutes. The students then provided qualitative data from the short survey and follow-up one-on-one discussions at its conclusion.
The feedback was overwhelmingly positive: 87% of students reported enjoying EduVenture compared to traditional aptitude platforms tutorials. Students noted that it was particularly enjoyable to learn through interaction with simple games, rather than simply reading questions or watching long videos.
The mini games were a significant factor. Although none of the mini-games are full-service video games, their playful, browser-based activities are enjoyable (e.g., drag and drop matching, blood relation game, or maze game). Students expressed that they felt the practice was active, engaging, and enjoyable. In fact, 81% of users reported that the mini games relieved their anxiety and positively impacted their willingness to practice the contents on regular basis.
Another very useful initiative was the section on “Quick Glance” flashcards. This area provides short, straightforward summaries of key concepts for a wide range of aptitude concepts including formulas for profit & loss, tricks for calculating speed, Time and distance, or simple approaches for number series. Students were able to download them in PDF. 76% of students used the flashcards for last-minute revision, and 92% said they were very useful before mock tests or interviews.
The platform also include AI Reinforcement learning where it allows for an automatic increase in the difficulty of the questions. When a student gets a few questions correct, the next questions will be slightly more difficult. If a student struggles with a few questions, the platform gives questions that are simpler or provides hints. 70% of the students had noticed this, and they said it helped them remain confident in their abilities and not become confused or bored. It also includes company wise ready to download PDF’s which contains commonly asked aptitude questions.

Figure 3: "Family Mansion Mystery" Gamified Logic Puzzle

The user interface of "Family Mansion Mystery," a key EduVenture minigame, is shown in this Figure 3. In this puzzle, students must determine which character resides in which room based on a set of textual clues. The drag-and-drop method of interaction makes manipulation simple. This game turns abstract deduction into an exploratory, low-pressure activity by integrating logical reasoning within a narrative context, in contrast to static aptitude questions. By utilizing intrinsic motivation, learners solve problems out of curiosity rather than necessity, which lowers test anxiety and increases time spent on the task. Additionally, the puzzle ensures skill transfer without sacrificing engagement by mimicking the format of actual placement-test logic questions.

Figure 4: Solution screen of the “Family Tree” logic game

The "Family Tree" mini-game's solution screen, shown in Figure 4, allows players to deduce relationships (such as "A is B's maternal uncle") from oblique statements. The correct family tree with visual annotations lines connecting people, role labels (mother, cousin, etc.), and a succinct explanation is displayed by the system after the user submits their response. The platform supports dual coding theory, which combines verbal and visual processing to improve retention and transfer to similar problems in actual aptitude tests, by externalizing abstract reasoning into a concrete diagram. Additionally, the feedback's instantaneous, non-punitive nature which displays the right answer regardless of user input reduces fear of failure and promotes a growth mindset.

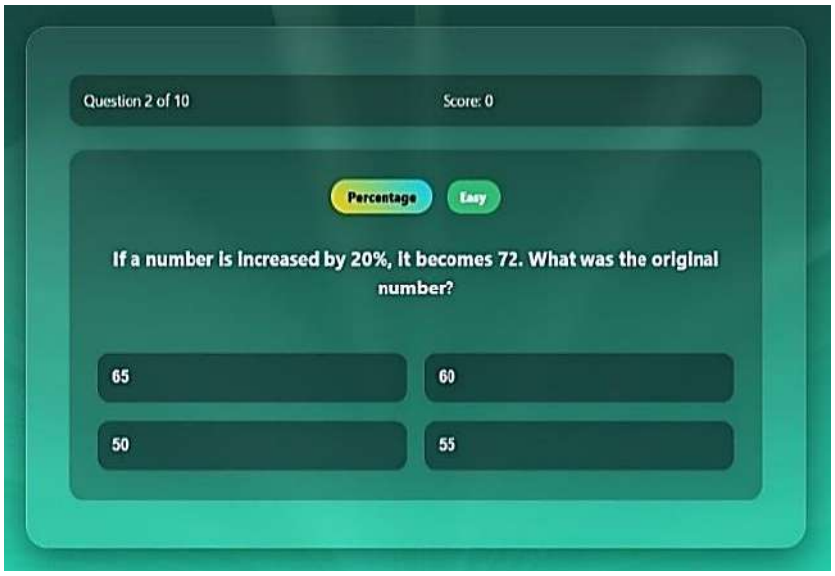

Figure 5: Aptitude quiz question on percentage calculation

Figure 5 shows an example aptitude question with a clear and easy-to-use interface on percentage calculation. To assist users in concentrating on particular skills, it has multiple-choice options, a "Submit" button, and a topic tag ("Profit & Loss"). Better concentration is supported by the clutter-free design, which lessens distractions. Content management is made simple and scalable by loading questions such as these from a structured JSON database.

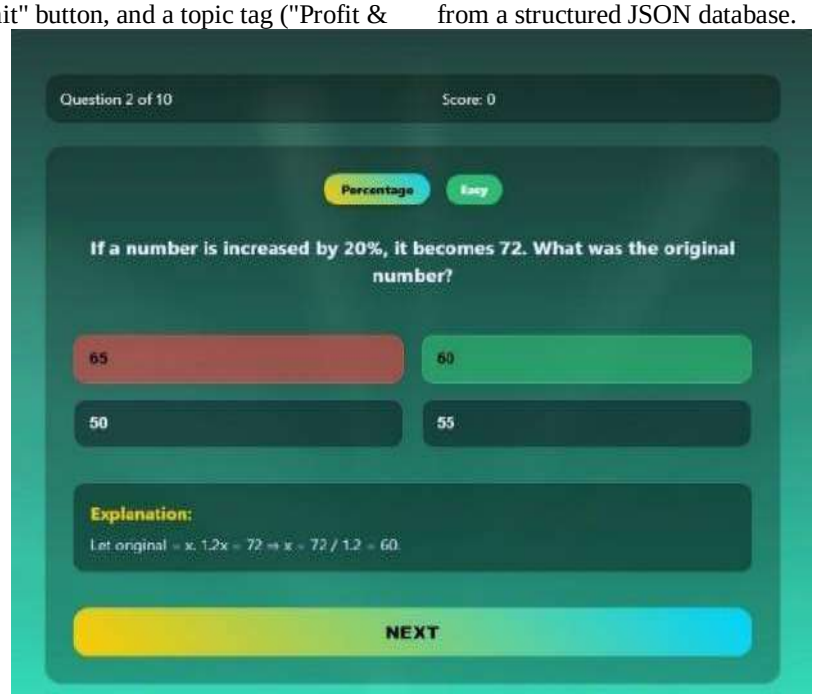

Figure 6: Detailed Conceptual Evaluation

Users are presented with a comprehensive solution screen (Figure 6) following their response to a quiz question (as in Figure 5). The platform guides the learner through the logical steps instead of just pointing out the right option. By clearing up misunderstandings and providing examples of problem-solving techniques, this detailed feedback turns assessment into a teaching opportunity. For self-directed learners who don't have instructor support during practice, this kind of scaffolding is extremely important.

Figure 7: Post-quiz results screen showing score, accuracy, topic-wise performance, and personalized resource recommendations

The post-quiz results screen, which serves as a formative assessment dashboard, is shown in Figure 7. It shows Total score and percentage of accuracy, A breakdown by subject (e.g., "Logical: 60%, Quantitative: 80"), Particular suggestions ("Review: Number Series, Time & Work"), which allows users to evaluate their strengths and shortcomings and modify their study strategy accordingly.

Figure 8: User profile interface displaying personal details and college affiliation to personalize the learning experience

The EduVenture user profile interface, shown in Figure 8, gathers vital user data such as the learner's name, email address, and affiliated institution. This screen is a fundamental part of the system's personalization. Contextual user identification is made possible by the gathered data, supporting features like usage analytics, progress tracking, and customized content delivery in other areas of the platform. Displaying verified personal information improves perceived system credibility and encourages a sense of control over the learning process from the standpoint of the user experience.

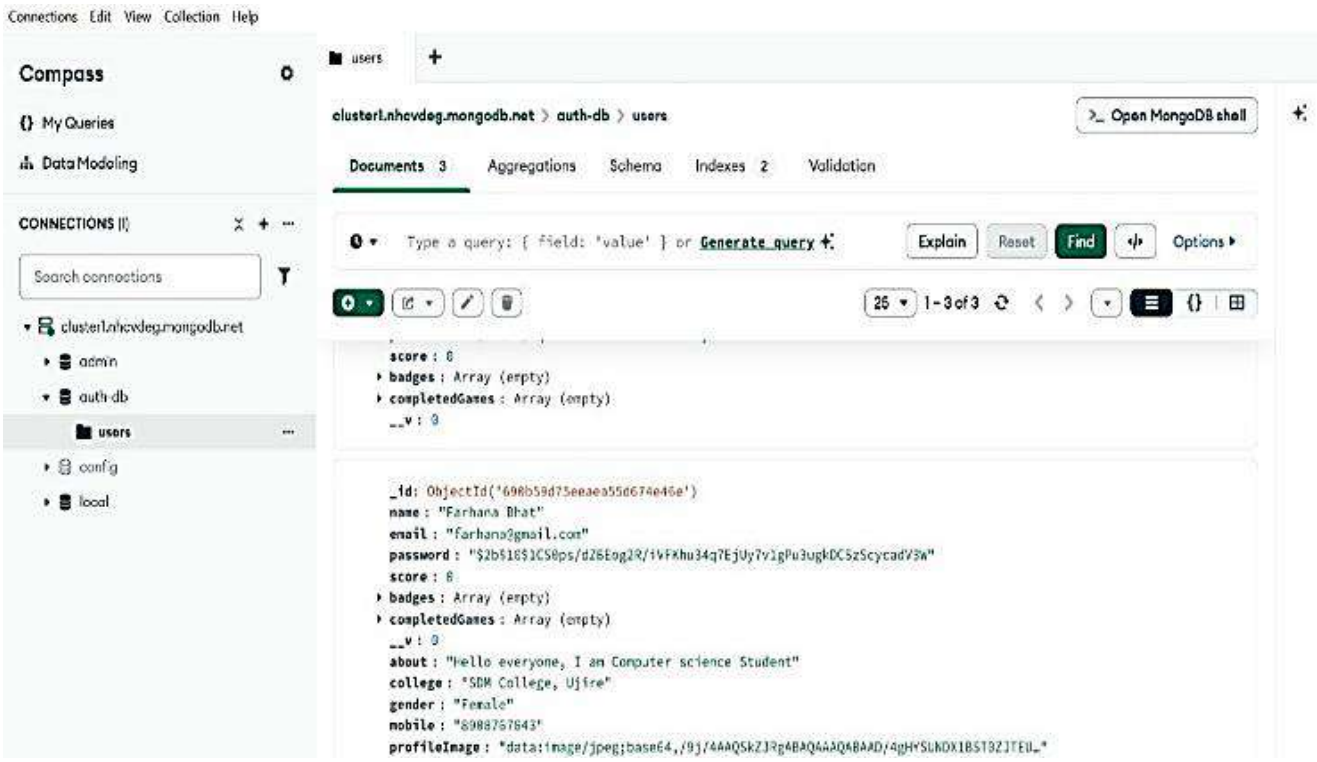

Figure 9: Backend MongoDB Compass view confirming structured storage of user data, game progress, and scores.

Figure 9 shows MongoDB Compass illustrating how user data is stored in EduVenture. Profile details such as name, mobile number, college, email, and gamification-related fields like score and finished games are all included in each document. Personalization, progress tracking, and authentication are all supported by the schema. Granular interaction data is captured by additional collections (such as game states, quiz responses), allowing for adaptive logic and real-time feedback. When new content types and learning features are incorporated, the use of a NoSQL database guarantees flexibility and scalability.

VII. FUTURE SCOPE

While EduVenture already delivers a fun and engaging way to acquire and build aptitude skills, there are many avenues for growth. In the future, we are thinking of adding user accounts for learners to return and continue their learning journey, with a way to save progress and track scores match day to day, week to week, and even month to month, with a built-in history of when the learner last engaged with weaker topics. Ideally, a personalized dashboard would help provide instance feedback for learners, indicating which topics they

are strong at, weak at, and recommending games or flashcards based on performance.

We also hope to implement many additional mini-games (i.e. different question types, like data interpretation, verbal reasoning, etc.) or general support for multiple languages, to help serve the students. Flashcard systems can also implement spaced repetition - learning prompts that remind users of concepts they have likely forgotten just before the learner reaches a point of forgetting.

We might be able to partner with a few colleges, or training centers, for a more extensive scale of testing on what EduVenture actually improved for real aptitude test results over weeks to months. This EduVenture can be scalable, along with aptitude it can also contain competitive exam preparation, academic subjects preparation etc. But these changes will ensure EduVenture does not continue to be just fun and useful today, but is even more powerful tomorrow.

VIII. CONCLUSION

EduVenture demonstrates that learning aptitude can be enjoyable, not tedious or stressful! The platform engages students with enjoyable mini-games for practice, leading to increased interest and learning. The students don't simply read questions; they play, strategize, and win small challenges, causing the learning to be enjoyable and more natural. The "Quick Glance" flashcards allow students to review key concepts in seconds, and the downloadable, company-wise PDFs even provide them with real exam practice that aligns with what companies want. The chatbot ensures to clear any aptitude related queries of the users in real time. The questions get harder when students are successful and easier when you hit your stopping point - Students appreciate the ability to practice anytime and anywhere while still feeling prepared.

The way EduVenture comprehends the learner's journey is what really sets it apart. Instead of merely posing questions to students, it walks alongside them and modifies the course according to their performance. It gently provides simpler problems and useful tips for those who are having trouble with percentages. It presents more stimulating challenges to keep them improving if they are mastering logical reasoning. Over time, this astute, compassionate method helps students develop self-confidence so they don't just study for tests but also begin to believe in themselves. Additionally, success ceases to seem unattainable when learning becomes intimate, encouraging, and even enjoyable.

Ultimately, EduVenture is not just a study tool; it becomes a friendly and helpful companion, making aptitude learning fun, easy, and ultimately helpful.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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