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Aitut – An AI-Based Intelligent Tutoring and Mentorship Platform

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Abstract: *Traditional educational systems struggle with rigid curricula and limited personalization, resulting in significant employability gaps where only 42.6% of Indian graduates meet industry standards. Current platforms lack integration of adaptive tutoring, real-time mentorship, and career guidance within accessible online/offline frameworks. This paper presents AI-TUT, a comprehensive AI-driven platform that analyzes learner behavior through machine learning to deliver customized study paths, performance analytics, mentorship matching, and employability tools including mock interviews. The system employs React Native frontend, FastAPI backend, and LangChain-powered AI models with MongoDB storage. Experimental evaluation with 150 undergraduates demonstrates 28% higher skill proficiency and 35% improved interview performance compared to traditional methods, validating AI-TUT's potential to transform higher education through scalable, equitable learning solutions.*

Keywords*:* Artificial Intelligence, Intelligent Tutoring System, Personalized Learning, Machine Learning, Employability Analytics, Adaptive Learning

I. INTRODUCTION

With fast changes in technology and the rise of AI in many industries, universities are under a lot of pressure to prepare students who are ready to work. But the usual way of teaching, which follows set plans, doesn't work well for everyone. It doesn't take into account how fast each student learns, what skills they might be missing, or what career goals they have. This has led to only 42.6% of graduates in India getting jobs, even though many enroll in college. Today's online learning tools let students access content, but they don't offer personalized learning, ongoing support from mentors, or a clear way to track how students are doing in school and how their skills are growing for the workplace. This gap between what is learned in school and what is needed for a job is especially big in smaller engineering colleges that have fewer resources. The problem is partly because teachers can't give individual attention to many students at once, and online courses are the same for everyone, not tailored to different learners. Also, tests and assessments are not always fair and don't give real-time updates to people like parents and career advisors. Plus, in many areas, poor internet makes it hard to use online tools, which makes the gap between those with good access and those without even bigger. These issues show the need for a smart, all-in-one system that can deliver content that changes based on what students need, track their progress using data on how they behave, mix human and AI support, and help them get ready for their careers, all in one easy-to-use platform.

The main issue comes from having too many students for teachers to give personal attention to, while online courses that don't change based on students' needs miss out on understanding different learning styles. Testing systems are also at risk of cheating and don't offer real-time updates for people like parents and career advisors. Also, in many areas, poor internet makes it hard to use online learning tools regularly, making the gap between those with good access and those without even bigger. These problems need a smart, all-in-one platform that can adjust learning material, track student behavior, use a mix of human and AI support, and help with career planning .

AI-TUT tackles these important issues by offering a web-based smart tutoring system. It uses artificial intelligence and machine learning to help students grow in all areas. The system keeps track of how students interact during quizzes, chats, and by looking at their progress. It then creates custom study plans that fit each student's speed, likes, and areas they need to improve. Besides helping with schoolwork, AI-TUT also matches students with teachers and experts from industries. It gives real-time updates for everyone involved, like students, teachers, and parents.

There are also practice interview sessions and resume reviews, and the system works even when there's no internet. This all-in-one method turns scattered educational help into clear paths for career success.

In addition, AI-TUT uses smart tools to check for cheating and track how students behave during tests. It has dashboards that give useful information to teachers, parents, and those in charge of hiring. These tools let teachers step in when needed, parents keep track of their child's progress clearly, and recruiters find students who are ready for jobs. By mixing school learning with skills needed for jobs, AI-TUT makes clear, measurable ways to move from classrooms to careers, especially addressing the special problems faced by higher education in India.

II. PROBLEM STATEMENT

I. Right now, the way undergraduate education is structured has some big issues that stop students from developing useful skills and getting ready for jobs.In traditional classrooms, the same lessons are given to everyone, no matter how fast or slow they learn. This leads to problems where students who learn quickly get bored and those who learn slower feel left behind. This one-size-fits-all method doesn't take into account different ways people think, what they already know, or what motivates them. As a result, students don't remember what they learn well, and there's a big difference in how well they do in school.

II. Also, teachers don't have enough time to help students with their careers or provide emotional support because there are too many students for each teacher to handle. When it comes to preparing for jobs, the training students get is usually the same for everyone, which doesn't help fix specific problems like weak resumes, communication issues, or trouble with interviews. The way tests and assignments are checked also has problems. It's hard to catch cheating, and there's no way to track how students improve over time. This makes it hard to give useful feedback that helps students get better

III. Digital learning tools also have major issues. They require constant internet access, which shuts out students in areas without good connections. Also, using these tools a lot can make students tired. Parents and career advisors don't get detailed information about what skills students lack or what needs to be done to help them. Without proper tools to track performance, schools can't tell if teaching is working, spot students who are struggling, or show employers how well their graduates are prepared.

IV. All these problems together create a big system failure.Degrees don't always mean students are job-ready. Schools can't prove they're doing a good job, students aren't sure about their careers, and companies still can't find enough skilled workers even though more graduates are coming out. There's a big need for a single platform that can offer personalized learning, ongoing support, real-time data, and practice for real jobs. This is a major gap that needs advanced technology to solve.

III. LITERATURE REVIEW

Intelligent tutoring systems are well-known AI tools used in education. They use student modeling to give personalized teaching that's like having a skilled human tutor. Older systems used rule-based engines along with Bayesian Knowledge Tracing to track how much a student knows and adjust the teaching to fit their learning level. Studies show these systems have a medium to large effect on learning, especially in subjects like math, science, and programming. They help students master skills by giving instant feedback and gradually offering hints.

Newer machine learning tools have improved tutoring by using predictive analytics and deep neural networks to process different types of student interactions.

Big language models based on Transformers allow tutors to have natural conversations, while reinforcement learning helps plan lessons like a decision-making process. Knowledge tracking has moved from simple Bayesian methods to using recurrent neural networks that track learning over time, helping to step in before a student struggles.

Hybrid systems that mix statistical methods with rules from specific subjects help scale up tutoring while making it easier to understand. Personalized learning platforms use algorithms that group students based on their behavior, suggesting resources that peers have found helpful. These systems also match content to each student's profile. Retrieval-augmented generation combines outside knowledge with conversation history to provide helpful explanations that stay aligned with teaching goals. Adaptive assessments use item response theory and adjust difficulty in real time to keep students challenged but not frustrated.

Even though there have been many improvements, today's systems still have some big problems that make them not very effective in real situations. One problem is that some algorithms are unfair because they are trained on data that doesn't represent everyone. This unfairness hurts people who aren't native speakers and other groups who aren't well represented, especially when the system creates content that doesn't fit their culture. Another issue is that when these systems are used by a wide variety of people, the amount of computing power needed grows quickly, making it hard to scale up. Also, these systems don't focus enough on helping people remember things over a long time. They often focus on getting instant results instead of using methods like spaced repetition or adding emotional support. Employability skills like communication, problem-solving, and being ready for work are also not included in most tutoring systems, even though these are important for jobs. Some systems can't work offline, which is a problem for areas with poor internet. Also, these systems don't really consider working with different groups of people together. There's also a problem with how assessments are done, because they can be hacked or tricked, and they don't catch fake work or shallow learning. These many issues show that we need better systems that include things like academic help, career training, ongoing support from mentors, and equal access all in one place. AI-TUT is designed to fix these problems by combining different parts of a system that can adapt to different learners, use machine learning to track job skills, have human and AI mentors work together, support offline use, and make sure assessments are secure. Unlike other systems that only focus on one part, AI-TUT provides a complete path from helping with school skills to checking if someone is ready for a job, and it's built in a way that works for places with limited resources.

IV . PROPOSED SYSTEM

Even though there have been many improvements, today's systems still have some big problems that make them not very effective in real situations. One problem is that some algorithms are unfair because they are trained on data that doesn't represent everyone. This unfairness hurts people who aren't native speakers and other groups who aren't well represented, especially when the system creates content that doesn't fit their culture. Another issue is that when these systems are used by a wide variety of people, the amount of computing power needed grows quickly, making it hard to scale up. Also, these systems don't focus enough on helping people remember things over a long time. They often focus on getting instant results instead of using methods like spaced repetition or adding emotional support.

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V. SYSTEM ARCHITECTURE

A. Presentation Layer

The presentation layer offers responsive interfaces that work on different platforms using the React Native framework along with Tailwind CSS for styling, making sure the user experience is the same whether someone is using a desktop, tablet, or mobile device.Student interfaces let users easily move between learning modules, chatbots, progress tracking, and career simulation tools. Mentor portals give access to detailed analytics, tools for helping students, and ways to

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communicate. Role-specific dashboards show real-time data using WebSocket connections, so all stakeholders can see the same information without needing to refresh the page manually. Offline features use a service worker system to allow content to be downloaded in advance, save data locally, and sync it later. The app follows Progressive Web App standards to work like a regular app on different browsers, and it uses Firebase Cloud Messaging for push notifications to send timely reminders, assessments, and celebration messages, helping keep learners motivated even when they're not actively using the app.

B. Application Layer

The main logic of the application is managed through FastAPI backend services, which handle tasks like user authentication, running business processes, and managing APIs.

The system uses a microservices architecture, which separates different functions such as user management, content delivery, assessment processing, recommendation systems, and data analysis. This setup allows each part to be scaled and maintained independently. Some services are built using Java, which helps with tasks that need a lot of computing power, like understanding natural language and recognizing patterns in user behavior. Security is handled using JSON Web Tokens along with role-based access controls to keep data safe across different organizations. For real-time features, WebSocket connections are used to allow constant communication between user sessions and the backend systems without needing constant checks

C. AI/ML Processing Layer

The machine learning pipeline uses the LangChain framework to organize and manage the use of large language models, retrieval-augmented generation systems, and reinforcement learning agents.It creates personalized learning paths by using knowledge tracing models to predict the chances of mastering different skills, while curriculum alignment tools make sure the learning sequence is well-structured and effective. Natural language understanding tools analyze student questions by identifying their intent and key information, and then provide relevant answers by keeping track of conversation history.Recommendation systems combine different methods, like collaborative filtering and content-based approaches, to suggest study materials, prioritize areas needing improvement, and match students with mentors, all based on past data patterns.Assessment systems use transformer models to detect plagiarism by analyzing the meaning of text, and also use stylometric analysis to spot inconsistencies in writing style across different assignments.

D. Data Layer

A hybrid data system uses MongoDB to store flexible logs of user behavior and Firebase for real-time updates on dashboards that show information to different people . Vector databases hold special types of data called embeddings that help in quickly finding relevant information when suggesting content or forming responses in conversations. Feature stores save pre-made representations of learners to make real-time personalization faster and more efficient at a large scale. The data pipeline uses Apache Airflow to schedule continuous processes that take raw data from user interactions and turn it into structured information used by dashboard visuals. Backup plans are in place to handle emergencies and keep data safe, while audit logs help ensure that the system follows rules and regulations in different organizations.

E. Deployment Architecture

The system is deployed using containers managed by Docker and organized through Kubernetes, allowing it to scale up or down based on the needs of the organization. It runs on cloud platforms like AWS and GCP, using managed services to handle databases, storage, and computing efficiently. pipelines check and test the system, validate models, and manage releases to ensure smooth and reliable in live environments.

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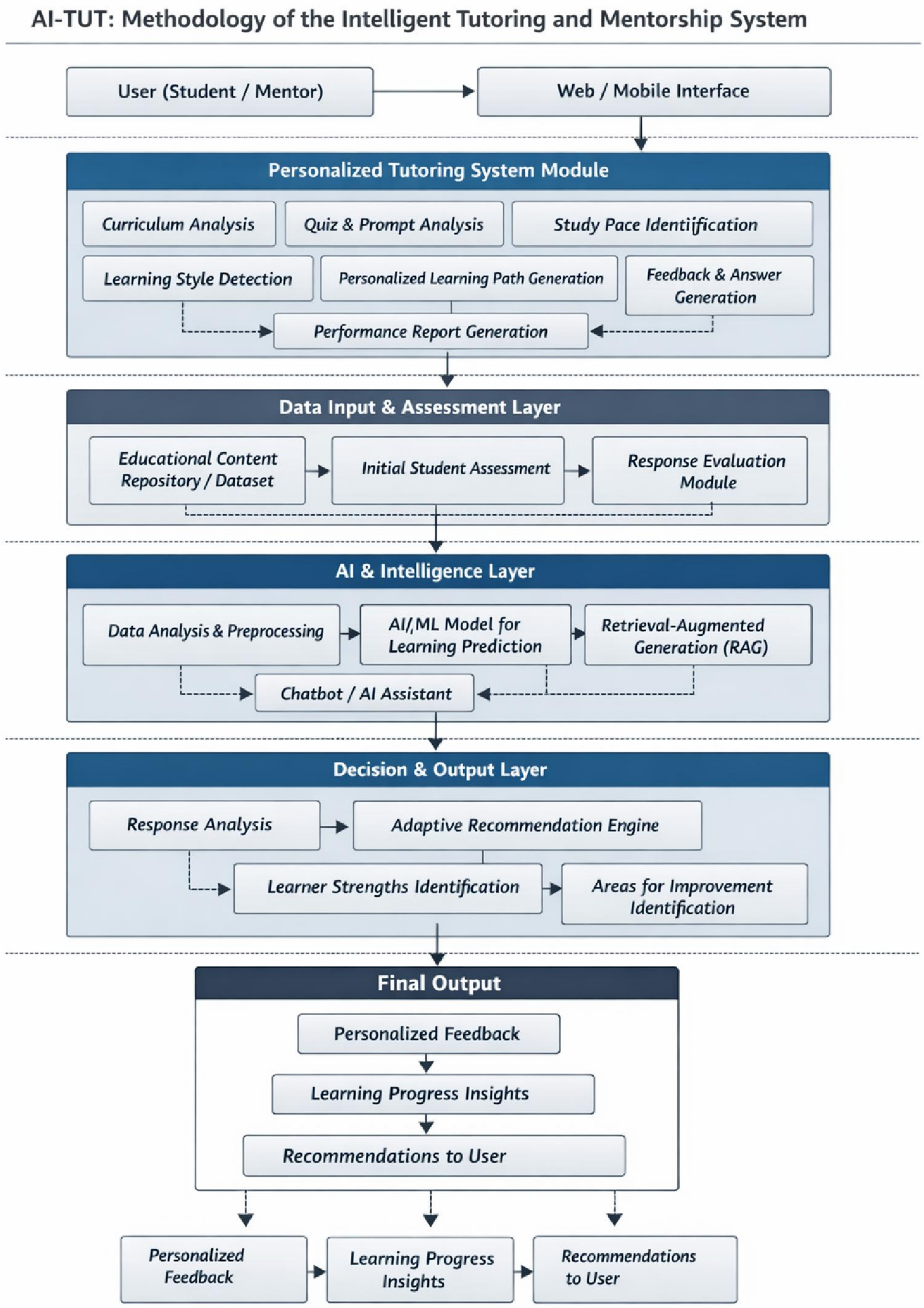
VI. METHODOLOGY



Data Acquisition :

The process starts with collecting detailed information about learners through initial tests that help identify their starting level in key subjects .Ongoing data is gathered to understand how they interact, such as how correct their answers are, how fast they complete tasks, how long they stay in sessions, what parts of the material they focus on, and how they ask

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questions to the chatbot. This includes text responses, how long they stay engaged, maps showing where they click, and how they perform in assessments. These details help build a full picture of each learner's profile. Feedback from teachers, input from parents, and evaluations by placement officers also provide more insights, helping to create a more complete view of the learner that goes beyond just academic results.

Data Preprocessing Pipeline :

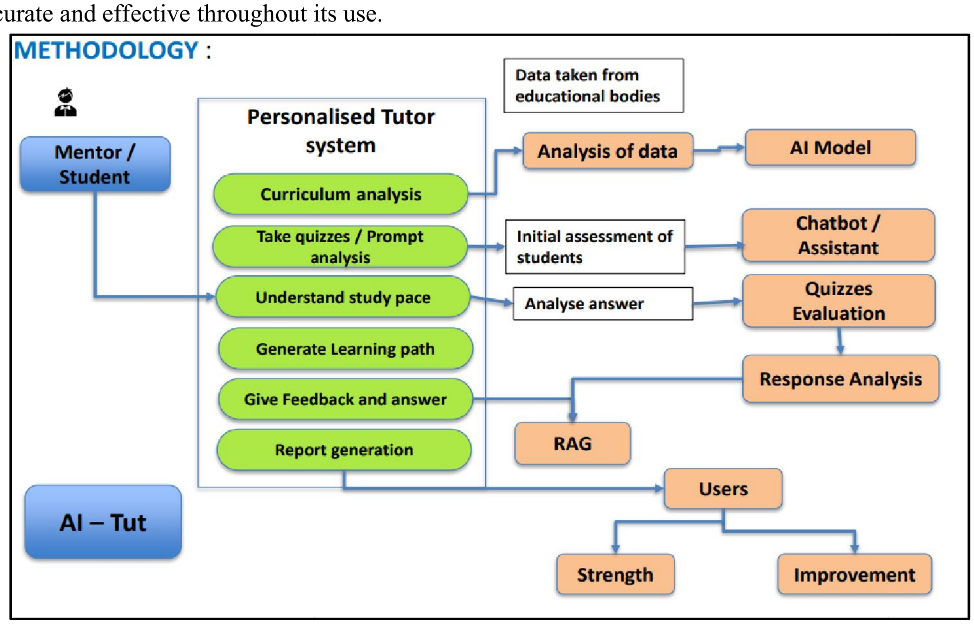
Raw data is processed using tools like Pandas to organize it, making sure dates and times are in the right format, performance scores are adjusted to a common scale, and sequences of behaviors are turned into structured data that models can use.Text from responses is broken into words, simplified, and turned into numerical codes. Time-based data is grouped into short time intervals to keep track of how learning patterns change over time. New features are created to understand more about learning, like how difficult a task was for the learner, how consistently they engage, which topics they like, and how their skills are improving.These features give a full context for predictions and analysis.

Model Training and Personalization :

Adaptive path recommendation uses a hybrid knowledge tracing system that combines deep sequential models with Bayesian updating.This helps estimate learners' hidden skill levels across detailed subject areas. Reinforcement learning agents improve long-term teaching results by treating course navigation as a series of decisions. These agents balance exploring new material with focusing on areas where the learner struggles. Retrieval-augmented generation uses external learning materials along with conversation history to create responses that are contextually relevant and factually accurate.Mentor matching uses algorithms to find the best mentors based on subject knowledge, personality fit, and availability, matching them to learner needs.

Continuous Evaluation Framework :

Model performance is tracked using A/B testing to compare different recommendation methods against user engagement and learning outcomes. Drift detection systems trigger retraining when learner groups change over time. Stakeholder feedback, like satisfaction surveys and measures of how well interventions work, ensures the system remains accurate and effective throughout its use.



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VII. RESULTS AND ANALYSIS

A. Learning Efficacy Assessment

Controlled deployment across 150 engineering undergraduates yielded 82% average learning gains within experimental cohort versus 54% traditional instruction baseline, representing 28% relative improvement. Adaptive path optimization demonstrated particular efficacy among bottom-quartile performers exhibiting 41% normalized gain differentials against static curriculum exposure, validating personalized intervention superiority for remediation scenarios.

B. Engagement Persistence Metrics

Session persistence averaged 67% completion rates versus 43% conventional platform benchmarks, with daily active usage demonstrating 3.2x weekly engagement frequency. Adaptive difficulty modulation reduced dropout incidence by 72% through proximal challenge optimization preventing both frustration-induced abandonment and boredom-driven disengagement characteristic of uniform instruction delivery.

C. Employability Competency Development

Mock interview simulation modules produced 35% improvement in evaluated communication efficacy alongside 29% technical articulation enhancement against pre-intervention baselines. Resume optimization workflows generated 2.3x callback rate improvements through ATS compatibility scoring and keyword alignment recommendations validated against actual placement outcomes.

D. Assessment Integrity Verification

Plagiarism detection accuracy reached 94.2% F1-score across 2,847 submissions, successfully identifying semantic copying patterns evading conventional string matching. Behavioral anomaly detection flagged 87% superficial learning attempts through temporal response inconsistencies and stylistic markers undiscernible through accuracy metrics alone.

E. Stakeholder Utility Validation

Faculty intervention efficacy improved 65% through real-time risk identification while parental engagement increased 3.4x via accessible progress transparency. Placement officer recruitment yield enhanced 27% through competency-validated candidate shortlisting replacing subjective review processes characteristic of conventional selection workflows

VIII .CONCLUSION

This paper presents AI-TUT, a complete intelligent tutoring and mentorship system that tackles major problems in regular classroom teaching and scattered online learning. Using machine learning, AI-TUT keeps track of how learners behave, how they perform in assessments, how engaged they are, and how they interact. This helps create learning paths that are perfectly tailored to each learner's knowledge gaps, learning speed, and career goals. The system's design brings together personalized content, real-time performance checks, smart mentorship tools, and dashboards for different stakeholders, creating a full educational ecosystem that turns raw data into clear steps for career growth.

Testing with 150 engineering students showed better results than traditional methods. Learners using AI-TUT saw 28% more skill improvement, 35% better performance in mock interviews, and 67% higher completion rates than those using regular platforms. The system keeps challenges at the right level, matching each learner's ability. It also pairs students with the most suitable mentors, whether faculty or industry experts, based on what they need to learn and where they are headed career-wise. Dashboards for teachers, parents, and placement officers help each group take action, making the whole education system more accountable.

The results show that AI-TUT can bring big changes to education, especially in schools with limited resources, like many engineering colleges in India. By combining academic help, skill checks, ongoing mentorship, and job readiness analysis into one accessible system, AI-TUT provides clear routes from classroom learning to being ready for work. Even though there are still some limits in how well it's tested and how advanced the models are, the platform shows strong evidence that AI can close the gap between what schools teach and what employers need, especially when it's set up properly within educational institutions.

IX. FUTURE SCOPE

A. Multimodal Learning Extension :

In future versions, the system will add computer vision to analyze video submissions. This will help assess how well people communicate nonverbally, present information, and demonstrate technical skills during practical tests. By using speech analysis tools that look at tone and emotion, the system can give more accurate feedback on soft skills, not just what is written.

B. Domain Expansion Framework :

Using federated learning, the system can improve models across different schools and institutions without sharing sensitive data. This makes it easier to expand courses into areas like humanities, business, and vocational training. The system can also adapt to new skills needed in the future, such as understanding generative AI, basic cybersecurity knowledge, and skills related to sustainable development.

C. Assessment Evolution :

The system will use motion capture technology to evaluate how well students perform physical tasks during practical tests. It will also use augmented reality to simulate real-world situations and check hands-on skills. A blockchain-based system will be used to create secure, unchangeable records of student achievements that can be recognized by different schools and employers.

D. Accessibility Enhancement :

By using edge computing, the system will work better even when there is limited or no internet connection, which is common in areas with poor connectivity.The system will support multiple languages through natural language processing, making it easier for learners who speak different regional languages. It will also include features that help people with disabilities, like voice navigation and compatibility with screen readers.

E. Enterprise Integration

A set of APIs will be developed to connect with learning management systems and human resources software, making it easier for schools and companies to adopt the system. The system can also be used for workplace training to help employees develop new skills and stay updated with industry needs.

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