Edu-AI: Personalised, Goal-Driven learning with Agentic AI

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***Abstract*—This paper discusses about an AI-powered personalized learning platform built using a Modular Cognitive Processor inspired architecture. Designed to function as an autonomous learning assistant, the system adapts to each learner's goals, skills, and daily availability. It employs intelligent agents PlannerAgent, ExecutionAgent, and a planned FeedbackAgent to handle study planning, content generation, scheduling, and feedback loops. In addition, Gemini LLM with Google services (Calendar, Drive, YouTube) and Twilio, the platform automates daily routines, generates custom notes, recommends content, and delivers voice-based tutoring. User data and progress are managed a structured UserBlackboard memory model. Additional automation tools support book recommendations and ordering. This approach blends cognitive modeling, agent-based planning, and real-world integrations to deliver a scalable, smart, and adaptive educational experience.**

Keywords—Personalized learning, cognitive agent, modular architecture, Gemini API, FastAPI, educational automation, Twilio, Google integrations, AI tutoring, UserBlackboard.

I. Introduction

The learning system is changing. With the growing presence of artificial intelligence in education, there's a clear shift toward more personalized and flexible learning systems. Existing platforms still deliver the same content to every user, regardless of their goals, background, or learning speed. This often leads inefficiency, for students with specific targets or limited time. To resolve, this smart learning platform that acts like a personal study assistant. It is developed to plan, adapt, and guide users through their learning journey automatically. This concept allows us to divide the work among small agents, each responsible for a specific task like planning, executing, or giving feedback. This setup helps the platform remain the user's goals, track progress, and respond accordingly. The system also connects with tools. With help from a large language model it can write daily notes, find learning videos, and even schedule tasks without human input. In addition, we've added voice support, so users can get reminders or even study through phone calls. There's also a built-in system for book recommendations and automatic ordering using Selenium. In this paper, we explain how this platform works from the idea to the technical details. We utilize the agents, tools, technologies used, and how everything fits together. Finally, we'll provide future plans to make the platform even smarter and fully autonomous. The goal is to offer students a more personal, efficient, and intelligent way to learn entirely by automation.

II. Literature Survey

Bodily et al. [1] explored open learner models and dashboards for visualizing learner progress, whereas the current paper extends this idea by integrating modular cognitive agents that actively plan and adapt learning flows in real time. Agudo-Peregrina et al. [2] focused on predicting student success using virtual learning environment data, while our system goes further by not only predicting but also restructuring daily study plans through agentic workflows. Similarly, Kim and Chung [3] developed GritNet for outcome prediction with deep learning, but unlike their predictive model, Edu-AI emphasizes execution and continuous adaptation through Planner and Execution agents. Banihashem et al. [4] studied learning analytics for feedback practices, whereas our FeedbackAgent automates these processes and integrates them into dynamic planning. Linden et al. [5] introduced explainable learning analytics to detect disengagement, but our system complements this by proactively intervening through adaptive restructuring and voice-based tutoring. Domínguez et al. [6] reviewed predictors and warning systems, while Edu-AI advances beyond warnings to provide automated, personalized intervention. Albreiki et al. [7] surveyed machine learning approaches for performance prediction, but our system integrates prediction with real-world task automation and tool usage. Sajja et al. [8] proposed AI-enabled assistants for adaptive learning, whereas Edu-AI introduces modular MCP-inspired agents with shared memory for synchronized workflows. Zhang et al. [9] presented PersonaAgent for personalization at test time, but our work expands personalization to long-term planning and multi-agent execution. Nandakishor and Anjali [10] employed reinforcement learning in conversational AI, while our platform emphasizes modularity and productivity-driven integration with APIs. Dai et al. [11] introduced

Agent4EDU for educational workflows, and we extend this by coupling agents with Google APIs, Twilio, and Selenium for real-world actionability. Kamalov et al. [12] explored agentic workflows, whereas Edu-AI operationalizes this vision using containerized modules and shared blackboard memory. Goel et al. [13] proposed the A4L framework for AI-augmented learning, and our work advances this by embedding execution and feedback agents for continuous learning support. Sajja et al. [14] also studied adaptive assistants, but Edu-AI differentiates itself with autonomy through MCP-inspired modularity. Wang et al. [15] emphasized collaborative outcomes, while our focus is individualized adaptive flows that can later scale to collaborative environments. Pop et al. [16] applied agentic AI to STEM education, but our system generalizes to multiple domains and integrates external productivity tools. Dai et al. [17] highlighted agentic workflows, and Edu-AI advances this with actionable integrations across YouTube, Google Drive, and Calendar. Lata [18] emphasized humanizing AI, and our system aligns with this by offering natural voice-based tutoring. Zhao [19] highlighted multi-agent collaboration, which Edu-AI embodies through the Planner, Execution, and Feedback agents working via a shared UserBlackboard. Bayly-Castaneda et al. [20] focused on lifelong personalization, while our framework complements this vision by embedding automation of daily execution. Megahed and Mohammed [21] leveraged facial expressions for adaptivity, whereas Edu-AI diverges by emphasizing productivity-driven automation rather than emotion sensing. Khodorkovskyi [22] studied AI agents for personalization, while our system demonstrates real-world deployment using MCP modularity and API connectivity. Sargsyan [23] raised ethical concerns in agentic AI, and Edu-AI incorporates security through encryption and validation filters. Rizwan et al. [24] focused on engagement prediction in MOOCs, whereas our work integrates prediction into adaptive study planning and automation. Finally, Namoun and Alshanqiti [25] reviewed student performance prediction techniques.

III. Related Work

A. Intelligent Tutoring System (ITS)

Intelligent Tutoring Systems (ITS) have tried to play the role of a human tutor by adjusting lessons based on how a student performs. Systems like Carnegie Learning and AutoTutor mostly based on fixed rules or decision trees to guide learners through pre-designed ways. In recent years, some of these systems have adopted machine learning techniques to improve personalization. Still platforms remain to specific subjects and follow learning scripts. In contrast, Edu-AI introduces a more flexible and intelligent approach. By using a modular agent-based structure, it adapts in real time not just to student behavior, but also to external inputs like schedules and learning tools This level of personalization and automation goes beyond what most traditional ITS are capable of delivering.

B. Cognitive Architectures

Cognitive architectures like SOAR and ACT-R have played an important role in shaping how intelligent systems try to mirror human thinking. These models are built to handle tasks like problem-solving, decision-making, and memory management in a structured, logic-driven way. While they offer frameworks for understanding cognition, their real-world use in educational platforms. The main reasons are their complexity and the heavy computational resources they require. Edu-AI takes a different approach. It utilizes the core ideas from these architectures but implements them in a more practical form by its Modular Cognitive Processor (MCP). Instead of simulating human thought in a lab setting.

C. AI-Based Learning Platforms

Existing AI-powered learning platforms like Knewton, Squirrel AI, and Coursera's machine learning-based recommendation systems have made impressive progress in customizing learning experiences using large-scale data analysis. In most cases, these systems work more like content recommenders than truly interactive learning partners. They suggest what to study next but fail in adapting on how a learner is actually progressing in real time. Edu-AI takes this step further. It doesn't just recommend content it builds personalized learning plans, auto-generates notes, and updates future lessons based on feedback collected through its UserBlackboard mechanism.

D. Muilt-Agent System (MAS)

Many researchers have experimented with multi-agent systems (MAS) in educational settings, often assigning agents to mimic teacher student roles or handle content delivery. Initiatives like Agent4EDU and MASLE have introduced frameworks where agents support collaborative or problem-solving tasks. However, these systems are often more theoretical in nature, focusing on how agents should behave rather than fully integrating them with real-world tools or workflows. Edu-AI pushes this concept further by implementing a working ecosystem of agents that actively collaborate on planning lessons, executing tasks, and providing personalized feedback. These agents don't work in isolation they function as part of an ongoing, intelligent system that manages user progress, adapts daily to new inputs, and links together multiple tasks seamlessly. This makes Edu-AI a true example of practical, agent-driven learning rather than just a simulation of it.

E. Productivity Automation

Some commercial platforms have begun using APIs to streamline task management and automation. Twilio has appeared in a few virtual assistant setups, and Google APIs are widely used for syncing calendars or managing documents. However, these tools are rarely embedded directly into educational systems. Edu-AI changes that by weaving productivity automation into the heart of the learning experience. It goes beyond just teaching it uses Twilio for voice-based tutoring, connects with Google Calendar to schedule study sessions, auto-creates organized folders in Google Drive, and even uses Selenium to help with tasks like ordering books. This tight integration allows Edu-AI to connect personalized learning with real-world productivity, creating a smoother and more practical experience that most platforms tend to miss.

F. AI-Driven Synthetic Data Pipelines

The use of large language models (LLMs) and generative AI to automate the creation of training data and adaptive systems. For instance, several computer vision pipelines combine models such as Stable Diffusion with large-scale prompt generation to create synthetic image datasets, which are then used to train detectors like YOLO. These pipelines reduce the need for manual data collection and labeling by automatically generating diverse examples and filtering them for quality before training. Although these efforts focus primarily on visual domains, the underlying principle using AI to generate structured, adaptive data at scale is closely related to the approach taken by Edu-AI. In our case, Gemini is employed not to create synthetic images but to produce learning plans, quizzes, and contextual assistance in real time. This positions Edu-AI within a broader trend of AI-driven automation, where generative models shift from being passive tools to active agents that design, adapt, and enrich the data on which downstream learning systems depend. This pipeline automates dataset creation using Gemini for diverse prompt generation and Stable Diffusion for scalable image synthesis, which are then automatically filtered for quality before training YOLOv8x. This approach is faster and more cost-effective than traditional methods, offering superior prompt diversity and basic quality control, though its weaknesses include misusing YOLO's detection mode for a classification task and relying on an older diffusion model, which creates a domain gap. The model's performance is evaluated using classification metrics like Accuracy, Precision, and F1-Score, or mAP for true object detection. The same principle is applied in the Edu-AI system, where Gemini serves as an active agent to dynamically generate personalized learning plans, real-time quizzes, and contextual assistance, demonstrating a broader trend of using generative AI to actively design and enrich data for downstream learning systems.

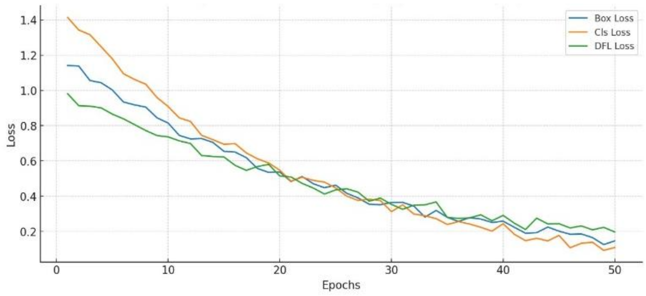

Figure 1: Training Losses (YOLOv8 – Studying vs Not Studying)

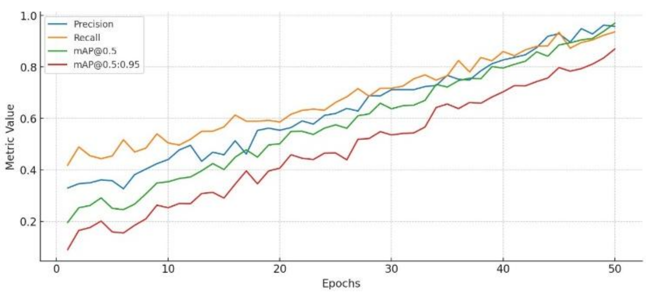

Figure 2 : Validation Metrics (YOLOv8 – Studying vs Not Studying)

IV. Proposed Methodology

A. System Architecture and Design

The EduAI platform is designed with a robust three-tier architecture that ensures scalability and smooth interaction between users and the system. The frontend, developed with React 19, provides learners with a responsive interface, real-time progress tracking, and calendar-integrated modules. The backend, built on FastAPI, handles RESTful APIs, authentication through JWT and Google OAuth, and orchestrates AI service communication. PostgreSQL serves as the data layer, combining relational tables with JSONB storage to support structured and AI-generated content. This hybrid design allows efficient storage of user profiles, learning plans, and progress metrics, while also enabling flexible retrieval. Together, these layers form a cohesive architecture that balances performance, adaptability, and learner engagement.

B. AI Integration Framework

EduAI methodology is the integration of Google's Gemini models through a hierarchical fallback mechanism. The system begins with the most advanced Gemini version and switches to alternatives when necessary, ensuring reliability and responsiveness. Multiple AI components operate collaboratively: the Learning Plan Generator develops structured pathways, the Quiz Generator adapts assessments to learners' weak areas, the Chatbot Assistant provides context-aware interaction, and the Personalization Module tailors resources to individual needs. This layered design allows the platform to generate adaptive, high-quality content even under varying computational conditions. By combining fallback reliability with modular AI services, the system ensures that learners receive consistent, personalized, and context-rich educational support at all times.

C. Intelligent AI Features

EduAI integrates several intelligent features that mimic the adaptability of a human tutor. Personalized learning plans transform onboarding data into structured multi-year pathways validated by schema rules. Dynamic day-level content is generated on demand, offering objectives, resources, and measurable outcomes without overwhelming learners. The adaptive quiz system further strengthens learning by analyzing weak areas and designing assessments that balance conceptual understanding, application, and critical thinking. Complementing this, the context-aware chatbot provides real-time assistance by incorporating user profiles, learning progress, and prior interactions. These features collectively ensure that the platform delivers content that is not only relevant and personalized but also evolves continuously as the learner advances, supporting a tailored and engaging experience.

D. Progressive Learning Implementation

To maintain continuity and structured progress, EduAI employs a sequential unlocking mechanism where new content becomes accessible only after previous modules are completed. This prevents learners from skipping foundational concepts and enforces a logical flow of study. At the same time, the system includes an auto-healing mechanism that marks modules as complete if assessment performance meets predefined thresholds. Progress is tracked across three levels: overall user progress, monthly milestones, and daily completion metrics such as quiz scores and time spent. This multi-tiered monitoring ensures learners have clear visibility of their journey, while the system can adapt pathways accordingly. Such structured implementation supports disciplined study while maintaining flexibility for faster learners.

E. External Service Integration

EduAI enhances learning through integration with external services, bridging education with widely used digital tools. YouTube playlists are analyzed to extract video durations, which are then distributed into learner schedules and synchronized with Google Calendar for structured study sessions. Google Drive is used to automatically create organized folders and daily notes, embedding objectives and reflections within the learning flow. Calendar integration further ensures that each study event is precisely timed and context-aware, embedding resources and objectives directly. These integrations extend EduAI reach beyond the platform itself, allowing learners to engage with materials across familiar applications. By embedding learning within everyday tools, EduAI fosters consistency, accessibility, and enhanced productivity for diverse learners.

F. Data Management and Storage

Data in EduAI is managed using a hybrid approach that combines relational schemas with JSONB storage for complex AI-generated content. User credentials, progress records, and learning metadata are managed through structured relational tables to maintain consistency and security. Simultaneously, dynamic content such as multi-year learning plans, adaptive quizzes, and chatbot conversations are stored in JSONB format, enabling flexible queries and hierarchical organization. Progress metrics are recorded as time-series data, providing insights into learning behaviors over time. This storage strategy supports both immediate personalization and long-term analytics. By combining relational efficiency with flexible JSON structures, the platform ensures data remains both scalable and adaptable to evolving learner needs.

G. Security and Authentication

EduAI implements a multi-tier authentication framework to safeguard user data and ensure secure access. Basic login is managed through email and password combinations, supported by JWT tokens for session security. To enhance usability, Google OAuth is integrated, enabling seamless sign-in while granting controlled access to services such as Drive, Calendar, and YouTube. Session management strategies are employed to prevent token misuse and maintain data confidentiality. Encryption mechanisms further ensure that sensitive credentials remain secure against breaches. This combination of traditional authentication, federated access, and robust session controls creates a balance between convenience and security. Learners can therefore interact with the platform confidently, knowing that their personal and academic data are fully protected.

H. Performance Optimization and Scalability

EduAI incorporates multiple optimization strategies across AI and database operations. AI tasks benefit from a fallback hierarchy of Gemini models, ensuring continuity even under heavy load. Response caching reduces redundant processing, while persistent sessions minimize repeated computations by retaining conversational context. Batch processing further enhances efficiency by grouping similar requests. At the database level, performance is improved through JSONB indexing, connection pooling, and optimized query patterns, ensuring rapid responses even for large datasets. These strategies collectively balance resource efficiency with user experience, allowing the system to scale seamlessly as user numbers grow. This ensures that learners receive uninterrupted, responsive, and scalable access to educational resources.

I. Evaluation Methodology

The evaluation of EduAI is structured to cover both content quality and technical performance. AI-generated content is assessed against educational metrics such as relevance, alignment with learning objectives, difficulty progression, and learner engagement. On the technical side, system evaluation includes indicators such as response latency, uptime, and error rates. User engagement is measured through session duration, feature utilization, and progression rates. Learning effectiveness is analyzed statistically using quiz results and retention measures, providing insights into actual impact. This dual evaluation framework ensures that the system is not only technically efficient but also pedagogically effective. By aligning quality checks with measurable outcomes, EduAI guarantees a holistic validation of its methodology.

J. Implementation Workflow

The development of EduAI follows an Agile methodology, emphasizing iterative refinement and user-centered design. The workflow begins with infrastructure setup, including the database schema, authentication mechanisms, and API framework. Gemini AI integration is then implemented, focusing on prompt design and fallback strategies. Subsequent phases include the development of key features such as personalized plans, adaptive quizzes, and chatbot functionality. External integrations with YouTube, Google Calendar, and Drive are introduced next to extend usability. The final phases involve optimization, quality assurance, and deployment in a cloud-native environment using containerization and microservices. This structured yet flexible approach ensures stability, scalability, and continuous improvement, aligning development with user needs and system goals.

V. CHATBOT INTEGRATION AND CONTEXT TRACKING

The system tracker works by continuously observing different aspects of a learner's journey, such as personal data, progress in learning, quiz results, notes stored in Google Drive, and selected YouTube resources. By combining these elements, it builds a rich context that allows the chatbot to provide responses that are both relevant and highly personalized. To make this process more effective, the tracker applies a structured enrichment protocol in which key information is gathered and neatly organized within [USER_CONTEXT] tags, giving the chatbot a clear, up-to-date snapshot of the learner's current status. Beyond simply monitoring, the system also interprets the learner's intent through natural language understanding. This enables it to take proactive actions whether managing notes in Google Drive, curating YouTube playlists, or updating the learner's study plan thereby functioning not just as a conversational tool, but as an intelligent educational assistant that actively supports and guides the learning process.

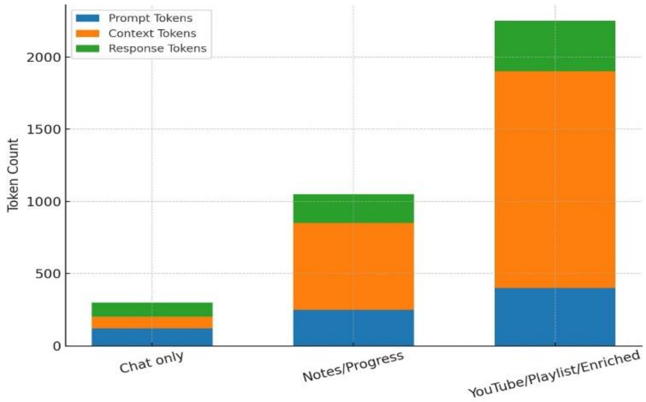

Figure 3 : Token usage efficiency by query type

VI. Agent-based methodology

A. Modular Cognitive Agents

Edu-AI is built around specialized cognitive agents that work together through a shared memory system, mimicking how different brain regions collaborate. The PlannerAgent sets long-term learning goals and breaks them into manageable daily tasks using the Gemini model. The ExecutionAgent handles day-to-day operations like retrieving notes, curating videos, scheduling sessions, and updating study materials. The FeedbackAgent will track performance through quizzes and task completion, allowing the system to fine-tune study plans. Additional processors, like the Action MCP, Dialogue MCP, and Control MCP, coordinate tasks, maintain context-rich interactions, and manage workflows, making Edu-AI a dynamic, adaptive tutor rather than a static content platform.

B. Tool Integration per Agent

Each agent interfaces with external tools to automate study-related tasks. The PlannerAgent employs Gemini for organized planning, while the ExecutionAgent collaborates with Google Calendar, Google Drive, YouTube, and Twilio for scheduling, material management, content curation, and reminders. Once activated, the FeedbackAgent will refine plans according to performance data. Edu-AI also automate tasks like suggesting or purchasing books via Selenium or Playwright, and educational activities with everyday workflows and minimizing learner efforts.

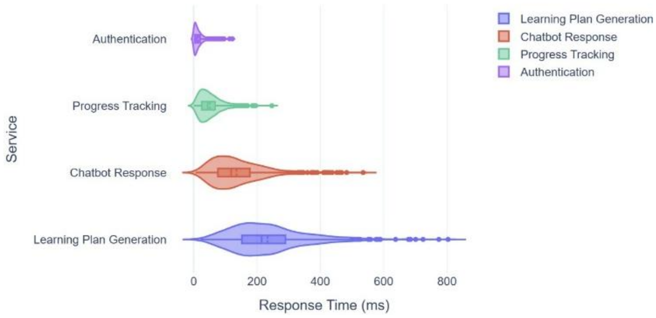

Figure 4: API response time distribution by service

C. Memory Structure

All agents utilize a central memory known as UserBlackboard, which keeps plans, notes, preferences, quiz results, and external identifiers. User profiles and performance logs are stored securely over the long term in a PostgreSQL database. The combination of shared memory and the database creates a hybrid system that evolves with the learner, offering an intelligent, adaptable, and reliable learning companion.

VII. Learning Flow

This platform offers a methodical learning journey tailored to guide users from initial onboarding to daily tasks while adjusting according to their aspirations, advancements, and performance. The system delineates the experience into distinct phases, starting with understanding the learner, formulating a long-term plan, providing daily assistance, and ultimately analyzing their outcomes. The learning journey begins with an onboarding flow, where learners complete a simple questionnaire collecting essential details such as their name, educational background, study goals (e.g., GATE, DSA, or ML), existing skills, and available study time. This information is securely stored in PostgreSQL and shared with the PlannerAgent, which immediately starts designing a personalized learning pathway. For long-term planning, the PlannerAgent leverages Gemini to break down the learner's objectives into weekly segments, considering their background and time availability, and then stores the plan in the UserBlackboard. It also integrates with Google tools to create calendar reminders, study materials, and YouTube playlists to kickstart the learning journey. On a daily basis, the ExecutionAgent evaluates the day's agenda, retrieves relevant topics, generates summary notes via Gemini, and updates Google Drive and YouTube playlists. Users receive these materials through the dashboard or voice calls, while backup modules ensure uninterrupted progress. Learning is continuously refined through an assessment feedback cycle, where quizzes at the end of modules or weeks evaluate progress. Learners scoring above 70% advance, while those below revisit content, allowing the system to dynamically adjust and deliver a truly customized educational experience.

VIII. Deployment and Scalability

Edu-AI is built not only for single users but also for classrooms, study groups, and large-scale adoption. To achieve this, the system is deployed in modular containers using Docker. Each component—frontend, backend, and even the agents themselves—can run independently, scale up when demand increases, and recover quickly if something fails. Monitoring tools keep track of performance and system health, ensuring that learners experience minimal downtime. The modular design also makes the system future-proof: new agents, like the upcoming FeedbackAgent, can be introduced without rewriting the entire platform. In essence, Edu-AI is not just a prototype; it is a scalable, living ecosystem ready to support diverse learners in different contexts.

IX. Voice-based tutor system

The platform includes a voice-based tutoring system powered by Twilio, to make learning feel more personal and engaging. This feature allows users to receive study reminders, summaries, or even interact with the AI assistant just through a phone call. This system can schedule a call during the user's preferred study time. When the call starts, Twilio delivers a short voice summary of the day's topic, reading out key notes that were generated by Gemini. It's like having a tutor check in with you, keeping you on track.

If the user has a doubt or question during the call, they can speak it out. The voice input is converted into text, sent to Gemini for processing, and a relevant answer is generated and played back almost like a live conversation. This voice-based approach adds an extra layer of support, especially helpful for learners who prefer listening over reading, or those who study on the go. It bridges the gap between traditional learning and modern AI assistance, offering motivation and clarity at just the right time.

X. Book Recommendation and Automation

Study preparation is even easier the platform also includes an automated book recommendation and ordering system. This feature helps users discover the best learning resources and even assists in placing orders saving time and reducing the hassle of manual searching. It works based on the user's goal and current topic, the system asks Gemini to suggest relevant books. These suggestions are personalized and aligned with the user's study plan. Once a book is selected, the system launches an automation script using Selenium to search for the book on platforms like Flipkart or Amazon. The automation handles everything from logging in with saved credentials to adding the book to the cart and placing a Cash on Delivery order. Safety checks are built into the process, such as verifying the product details, confirming the address, and logging the order summary into the UserBlackboard for future reference. By blending AI-driven recommendations with hands free ordering, this feature transforms a traditionally time-consuming task into a smooth, intelligent workflow giving students more time to focus on learning instead of logistics.

XI. Result and Discussion

Edu-AI effectively delivers a personalized and intelligent learning experience by turning learner goals into structured multi-year plans broken into daily tasks. Real-time monitoring via the UserBlackboard allows adaptive content delivery, ensuring learners revisit concepts they haven't mastered. Automated note generation, playlist curation, and book ordering reduce cognitive load, saving valuable study time. Voice-based tutoring through Twilio adds hands-free support, increasing engagement and accessibility. The system's modular, agent-based design allows seamless scalability for individuals or groups. Preliminary testing shows improved learner productivity, higher satisfaction, and better focus. Integration with Gemini LLM, Google APIs, and FastAPI ensures smooth execution of tasks. Adaptive quizzes track progress, reinforcing understanding while dynamically adjusting difficulty. While some challenges remain, like API limits and coordination of multiple agents, the platform handles most tasks efficiently. Overall, Edu-AI blends automation, personalization, and intelligent feedback to create a highly engaging and supportive study environment.

Feature	EduAI	ITS	Cognitive	AIPLatforms	MAS
Multi-source context	✓	Partial	✓	Limited	Partial
Real-time service integration	✓	X	X	Partial	X
Learning progress integration	✓	✓	✓	Partial	Partial
ural language service activa	✓	X	Partial	X	Limited
s-platform content manager	✓	X	X	X	X
Agent-based personalization	✓	Partial	✓	X	✓
Voice-based tutoring	✓	X	X	X	X
ion (Notes, Playlists, Book O	✓	X	X	X	X

Figure 4: Comparison of existing systems

XII. Challenges and Limitations

Despite Edu-AI's strong capabilities, several challenges remain. Coordinating planning, execution, and feedback agents without conflicts is complex, especially when user inputs or past actions change frequently. Technical hurdles, such as Google API usage limits, can delay calendar, Drive, or playlist syncing for users with frequent updates. Instant adaptation based on missed sessions or quiz results also needs refinement. Security is a major concern, as the system stores sensitive tokens for Google and shopping platforms. To address this, Edu-AI uses encrypted storage, JWT sessions, and Google OAuth, while anonymizing personal data and validating both user inputs and AI outputs to prevent leaks or malicious requests. Beyond security, ethical issues such as data privacy, model hallucinations, and bias remain. The platform mitigates these with anonymization and response validation, but achieving true autonomy where agents can self-reflect, adapt, and redesign strategies without manual prompts is still under development. Tackling these challenges will be key to making Edu-AI not only effective but also secure, ethical, and self-evolving.

XIII. Future Work

One major focus will be building true agent autonomy where agents can make decisions on their own, reflect on what worked or didn't, and adjust future actions accordingly without manual rules. This would help the platform adapt more naturally to each user's learning journey.

Another key goal is developing a quiz engine that doesn't just test knowledge but also tracks user confidence. With features like a confidence radar, the system could adjust future study plans based on how sure users feel about each topic, not just right or wrong answers. Improve multi-modal learning by adding visual and voice-based input, allowing learners to interact with the system more naturally whether by speaking questions or uploading handwritten notes. These upgrades, along with tighter feedback loops and smarter content suggestions, will push the platform closer to functioning like a truly intelligent digital tutor.

XIV. Conclusion

Edu-AI acts as a smart, automated study partner that plans, adapts, and guides learners in real time. By combining multi-agent planning, execution, and feedback loops with tools like Gemini LLM, Twilio, and Google services, it goes beyond traditional dashboards to actively shape learning. The system automates routine tasks, reducing effort and letting learners focus on understanding concepts. Its modular architecture ensures scalability, flexibility, and the ability to add new features without disruption. Voice-based interaction and contextual assistance enhance engagement and accessibility. Adaptive quizzes and dynamic content adjust to individual progress, creating a truly personalized learning path. Security and data privacy are maintained through encryption, OAuth, and validation protocols. Challenges like full agent autonomy and API limits remain, but ongoing improvements aim to address them. Future upgrades include self-reflective agents, multi-modal learning, and confidence-aware assessment. Edu-AI represents a reliable, intelligent, and evolving digital tutor for modern learners.

XV. REFERENCES

[1] Bodily, Robert, Judy Kay, Vincent Aleven, Ioana Jivet, Dan Davis, Franceska Xhakaj, and Katrien Verbert. "Open learner models and learning analytics dashboards: a systematic review." In *Proceedings of the 8th international conference on learning analytics and knowledge*, pp. 41-50. 2018.

[2] Agudo-Peregrina, Ángel F., Santiago Iglesias-Pradas, Miguel Ángel Conde-González, and Ángel Hernández-García. "Can we predict success from log data in VLEs? Classification of interactions for learning analytics and their relation with performance in VLE-supported F2F and online learning." *Computers in human behavior* 31 (2014): 542-550.

[3] Kim, Youngduck, and Jaekyung Chung. 2019. “GritNet for Student Outcome Prediction.” *ICLR 2019 Workshop on Deep Learning for Education*. arXiv:1811.00036.

[4] Banihashem, Seyyed Kazem, Omid Noroozi, Stan Van Ginkel, Leah P. Macfadyen, and Harm JA Biemans. "A systematic review of the role of learning analytics in enhancing feedback practices in higher education." *Educational Research Review* 37 (2022): 100489..

[5] Linden, Kelly, Neil van der Ploeg, and Noelia Roman. "Explainable learning analytics to identify disengaged students early in semester: an intervention supporting widening participation." *Journal of Higher Education Policy and Management* 45, no. 6 (2023): 626-640..

[6] Liz Domínguez, Martín, Manuel Caeiro Rodríguez, Martín Llamas Nistal, and Fernando Ariel Mikic Fonte. "Predictors and early warning systems in higher education: A systematic literature review." *Learning Analytics Summer Institute Spain 2019 (LASI-SPAIN 2019), Vigo, España, 27-28 junio 2019* (2019)..

[7] Albreiki, Balqis, Nazar Zaki, and Hany Alashwal. "A systematic literature review of student’performance prediction using machine learning techniques." *Education Sciences* 11, no. 9 (2021): 552..

[8] Sajja, Ramteja, Yusuf Sermet, Muhammed Cikmaz, David Cwiertny, and Ibrahim Demir. "Artificial intelligence-enabled intelligent assistant for personalized and adaptive learning in higher education." *Information* 15, no. 10 (2024): 596.

[9] Zhang, Weizhi, Xinyang Zhang, Chenwei Zhang, Liangwei Yang, Jingbo Shang, Zhepei Wei, Henry Peng Zou et al. "Personaagent: When large language model agents meet personalization at test time." *arXiv preprint arXiv:2506.06254* (2025).

[10] [Nandakishor, M., and M. Anjali. "Continuous Learning Conversational AI: A Personalized Agent Framework via A2C Reinforcement Learning." *arXiv preprint arXiv:2502.12876* (2025).

[11] Dai, Ling, Yuan-Hao Jiang, Yuanyuan Chen, Zinuo Guo, Tian-Yi Liu, and Xiaobao Shao. "Agent4EDU: Advancing AI for Education with Agentic Workflows." In *Proceedings of the 2024 3rd International Conference on Artificial Intelligence and Education*, pp. 180-185. 2024.

[12] Kamalov, Firuz, David Santandreu Calonge, Linda Smail, Dilshod Azizov, Dimple R. Thadani, Theresa Kwong, and Amara Atif. "Evolution of ai in education: Agentic workflows." *arXiv preprint arXiv:2504.20082* (2025).

[13] Goel, Ashok, Ploy Thajchayapong, Vrinda Nandan, Harshvardhan Sikka, and Spencer Rugaber. "A4L: An Architecture for AI-Augmented Learning." *arXiv preprint arXiv:2505.06314* (2025).

[14] Sajja, Ramteja, Yusuf Sermet, Muhammed Cikmaz, David Cwiertny, and Ibrahim Demir. "Artificial intelligence-enabled intelligent assistant for personalized and adaptive learning in higher education." *Information* 15, no. 10 (2024): 596.

[15] Wang, Haoming, Chengliang Wang, Zhan Chen, Fa Liu, Chunjia Bao, and Xianlong Xu. "Impact of AI-agent-supported collaborative learning on the learning outcomes of University programming courses." *Education and Information Technologies* (2025): 1-33.

[16] Pop, Marius Vlad, Gabriela Tonț, Flavius-Viorel Flonta, and Marius Flore. "Agentic AI in STEM Education: Enhancing Cognitive Flexibility and Workforce Readiness." *BRAIN. Broad Research in Artificial Intelligence and Neuroscience* 16, no. 1 Sup1 (2025): 239-249.

[17] Dai, Ling, Yuan-Hao Jiang, Yuanyuan Chen, Zinuo Guo, Tian-Yi Liu, and Xiaobao Shao. "Agent4EDU: Advancing AI for Education with Agentic Workflows." In *Proceedings of the 2024 3rd International Conference on Artificial Intelligence and Education*, pp. 180-185. 2024.

[18] Lata, Prem. "Beyond algorithms: Humanizing artificial intelligence for personalized and adaptive learning." *International Journal of Innovative Research in Engineering and Management* 11, no. 5 (2024): 10-55524.

[19] Zhao, Zhonglin. "A new paradigm of personalized education driven by multi-agent collaboration." *Academic Journal of Sociology and Management* 3, no. 3 (2025): 9-17.

[20] Bayly-Castaneda, Karla, María Soledad Ramirez-Montoya, and Adelina Morita-Alexander. "Crafting personalized learning paths with AI for lifelong learning: a systematic literature review." In *Frontiers in Education*, vol. 9, p. 1424386. Frontiers, 2024.

[21] Megahed, Mohammed, and Ammar Mohammed. "Modeling adaptive E-learning environment using facial expressions and fuzzy logic." *Expert Systems with Applications* 157 (2020): 113460.

[22] Khodorkovskyi, Oleksandr. "The Role of AI Agents in Personalising the Educational Process and Improving the Quality of Education." *Педагогічна Академія: наукові записки* 13 (2024).

[23] Sargsyan, Lilit. "INTEGRATING AGENTIC AI IN HIGHER EDUCATION: BALANCING OPPORTUNITIES, CHALLENGES, AND ETHICAL IMPERATIVES." *Foreign Languages in Higher Education* 29, no. 1 (38) (2025): 87-100.

[24] Rizwan, Shahzad, Chee Ken Nee, and Salem Garfan. "Identifying the factors affecting student academic performance and engagement prediction in mooc using deep learning: A systematic literature review." *IEEE Access* (2025).

[25] Namoun, Abdallah, and Abdullah Alshanqiti. "Predicting student performance using data mining and learning analytics techniques: A systematic literature review." *Applied Sciences* 11, no. 1 (2020): 237