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An AI-Based Personalized Learning Path Generator for Adaptive Education Systems

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Abstract: - With the increasing use of digital education, there is a growing need for learning systems that can adapt to the individual needs of students. This paper presents *Orion*, an AI-powered personalized learning path generator designed for students from 1st to 12th standard, supporting both English and Marathi mediums. The main problem addressed in this study is the lack of adaptive learning platforms that can adjust content based on a student's learning speed, performance, and curriculum requirements.

The Orion uses machine learning techniques to analyze student data such as academic performance, preferences, and progress. Based on this analysis, it generates customized learning paths for each student. The application includes features like a dashboard, curriculum tracking, assignments, and student profiles, along with an AI-based recommendation system.

The results indicate that personalized learning improves student engagement, understanding, and overall academic performance compared to traditional learning methods. It also helps in effectively monitoring student progress.

In conclusion, Orion offers an efficient and scalable solution for modern education by providing tailored learning experiences. Future improvements may include real-time feedback, voice-based support, and integration with national education systems.

Keywords: - *Personalized Learning, Recommendation System, E-Learning, Adaptive Learning, Education Technology*

INTRODUCTION:

Digital tech has completely changed how students learn these days. Online platforms, apps, and e-learning systems give students a lot more freedom than the actual real world — learning is now way more flexible and accessible. Still, most of these tools stick to the old "one-size-fits-all" method. Doesn't matter who is using them or how fast than they learn; everyone gets the same material. That approach just does not work for everyone. Students may lose interest, feel unmotivated, and honestly, they don't learn as well.

Kids come from different academic backgrounds and boards, like state boards or CBSE, and they often struggle to keep up with standard teaching methods. The language barrier, particularly in multilingual areas, adds another layer of complexity. Therefore, it's clear that we need better educational systems. These systems should be flexible and adapting to each student's needs through personalized and adaptive learning methods like from tracking their paths and performance. Artificial intelligence and machine learning are starting to helps with these issues.

They dig through tons of student data, how they learn, how students perform, how they behave, how they interact with different materials — and they observe what each learner needs help with or where they shine. With that info, these systems build custom learning paths and suggest exactly what a student should focus on. Things like recommendation systems, predictive analytics, and classification algorithms now fuel modern learning platforms and make them work so much better.

In this paper, we introduce Orion, an AI-driven tool that creates personalized learning paths for students from grades 1 through 12, supporting both English and Marathi. Orion is built to bridge the gap between classic teaching and smart digital education by crafting study plans that suit each individual. It's loaded with features — a simple dashboard, curriculum tracking, assignment management, and student performance analysis.

Technically, Orion relies on a modular setup with a frontend, backend services, a central database, and an AI recommendation engine. It keeps collecting and analyzing student data, so the learning paths stay updated and relevant. That way, students always get content that matches their current skill level.The application of AI in the educational sector can have a significant effect on adaptive learning and the development of the learners. It stresses the fact that the integration of artificial intelligence along with

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competent faculty members and adequate institutional infrastructure will enable efficient management of the varied student population and promote equality in education. (Ullah et al., 2025) [1]

It examines the effects of the utilization of artificial intelligence in tutoring secondary education pupils via feedback personalization. As a result of such an approach, improvements are evident both in the academic achievement and motivation of learners, as well as the adoption rate of artificial intelligence on the part of educators. (Bahmani, 2025) [2]

This paper examines the opinions hold by the lecturers regardings the uses of artificial intelligence of technology in providing personalized learning experiences within higher education institutions. The study reveals how AI helps in enhancing teaching processes, offering quality feedback to learners, and making learning an enjoyable experience, all while emphasizing its misuse and ethical considerations. (Mulaudzi & Hamilton, 2025) [3]

LITERATURE REVIEW:

Digital education platforms offer a large amount of content, which could feel overpowering for those studying. This is the point where adaptive learning recommendation engines (PLRS) step in—they select resources that effectively aligns with every learner's preferences. This research examines PLRS-related research in the past ten years (spanning 2013 to 2023), analyzes the key models and algorithms, and explores the difficulties these systems remain subject to. It additionally highlights the direction personalized e-learning has to move forward. (Bin et al., 2024)[4]

Impact of Artificial Intelligence in education includes personalization of learning and serving as an intelligent tutor. Artificial Intelligence offers immediate feedback that can enhance learning and motivation. Yet, problems such as data security, equality issues, and human involvement still exist. (Naayini, 2025)[5]

Now, students get tailored lessons and smart tutoring systems that actually pay attention to how they're doing. It keeps kids more engaged and hands out instant feedback, which really helps them stay on track. But it's not all sunshine — there's stuff like data privacy and bias that needs sorting out if we want AI to really work in schools.(Hariyanto et al., 2025) [6]

AI is shaking up education in some big ways. Teachers and students get instant feedback, so everyone can see what's working—and what's not—and adjust. Results usually get better, too. But, there are some real concerns. People worry about data privacy, ethical issues, and whether these algorithms could be biased. Solving those problems is key if we want AI to really work in schools.(Farhood et al., 2025)[7]

AI technology is revolutionizing educational systems. It's creating a more personalized learning experience, assisting students in maintaining their interest, and motivating them to improve through intelligent systems along with immediate responses. However, genuine issues exist concerning privacy and ethical matters, and such matters require clarification if educational institutions aim to employ AI properly. (Dahal et al., n.d.)[8]

This study looks into how artificial intelligence affects personalized learning—especially through adaptive tech, smart tutoring systems, and learning data analytics. Turns out, students get more involved and actually do better. But there are still some hurdles: people worry about privacy, algorithms don't always play fair, and not everyone gets the same access. (Rayimova & Obidov, 2026) [9]

The paper dives into how AI is reshaping personalized learning. It looks at adaptive systems, virtual tutors, and the way data analytics helps students get more out of their education. Students stay engaged and do better, but the author isn't ignoring the tough stuff—issues like data privacy and bias. (Jian, 2023) [10]

AI tailors the online learning experience through educational psychology and recommendations systems. Through behavioral analysis, personalized resources are provided to enhance engagement and academic success, despite problems such as privacy, discrimination, and flexibility. (Wei et al., 2021) [11]

This paper explores how AI has shaped personalized learning between 2019 and 2025. It covers the most recent breakthroughs, the various approaches, and how they're being used in real classrooms. There's a strong focus on what actually helps students learn more effectively. But it doesn't gloss over the tough spots. The review highlights major challenges, like ethical concerns, data privacy issues, and the difficulty schools face when trying to roll out these new systems.(Khalifeh et al., 2026) [12]

Introduces a recommendation system for distance education that uses deep learning to personalize content. By looking at each learner's data, the system suggests materials and learning paths suited to their needs—helping people stay engaged and learn more efficiently. The results show the system makes better recommendations and tackles real challenges, like dealing with limited data, growing to handle more users, and adapting intelligently as online education keeps changing. (Yang, 2025) [13]

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This systematic literature review examines 89 papers (2000–2024) on Reinforcement Learning (RL) in education. RL shows promise for personalizing instruction and enhancing learning outcomes. However, widespread adoption is hindered by methodological gaps, limited large-scale user evaluations, and the need for improved statistical rigor. (Riedmann et al., 2025) [14]

METHODOLOGY:

This system employs artificial intelligence to design customized learning routes for learners from grade 1 to grade 12. It's built for adaptive, engaging, and inclusive education. Within, includes active machine intelligence, experiential learning modules, and server-side cloud infrastructure which runs flawlessly whether or not children are learning in urban or rural environments. It furthermore supports multiple languages—chiefly English along with local regional ones—so learners from various backgrounds can utilize it comfortably.

1. User Dashboard

The user dashboard brings everything together in one spot and adapts to different age groups. You'll see your personalized learning path, a list of today's tasks, your progress, any achievements you've unlocked, and smart recommendations. It's built to help kids stay engaged and find what they need without any hassle.

2. AI-Based Learning Path Generator

Fundamental to the system represents an artificial intelligence-driven learning path creator. It monitors the way students perform—the speed at which they operate, their behavioral patterns, and their preferences—then designs an educational journey that matches their needs. While students complete quizzes, assessments, or submit feedback, the system continuously adjusts their progression instantly. As a result, each encounter seems tailored and continues to develop together with the learner.

3. AI Tutor

The system contains an intelligent AI tutor which assists students immediately. It addresses their questions, explains complex concepts, as well as guides them through problems gradually. Additionally, it can communicate in Hindi & English languages, which makes it simpler for learners from diverse backgrounds to receive the assistance they require.

4. Video Lessons and Animated Content

This platform offers video lessons which adhere to the school syllabus, and it offers even more. By using tools such as "NotebookLM", it additionally produces animated videos which make lessons more engaging—ideal for younger learners who require some additional involvement. These visualizations simplify complex concepts into more basic components, in order for students to remember what they learn.

5.Gamified Learning

Teachers use engaging and lively games to make learning more engaging, specifically for children covering grades one to five. Such games help kids truly understand the content, take part, and genuinely enjoy acquiring knowledge. The idea is pretty simple—make education feel more like play, and students are way more likely to pay attention and remember what they learn.

6. Screen Time Management

The system keeps an eye on time spent on screens. It tracks how much you use the device you own and makes you aware when you're using it too much. Should things become unmanageable, it will enforce limits to prevent you from spending excessive time being glued to a screen. That way, it assists in maintaining the learning process balanced and healthy.

7. Mentor (Parent) Module

There is a dedicated area meant for parents and mentors to monitor how students are doing. You get clear performance stats, can see what activities students are working on, and look through feedback reports. This provides parents an opportunity to remain more engaged and assists students in learning more effectively.

8. System Architecture and Backend Implementation

The system relies on Supabase Authentication with Google integration to give users a secure and easy login experience. It's a breeze for students and parents to access the platform, plus you get strong security. When it comes to storing data, everything—user profiles,

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learning progress, assessments, and logs—goes into a Supabase PostgreSQL database. Row Level Security makes sure people can only see their own information, so privacy stays tight.

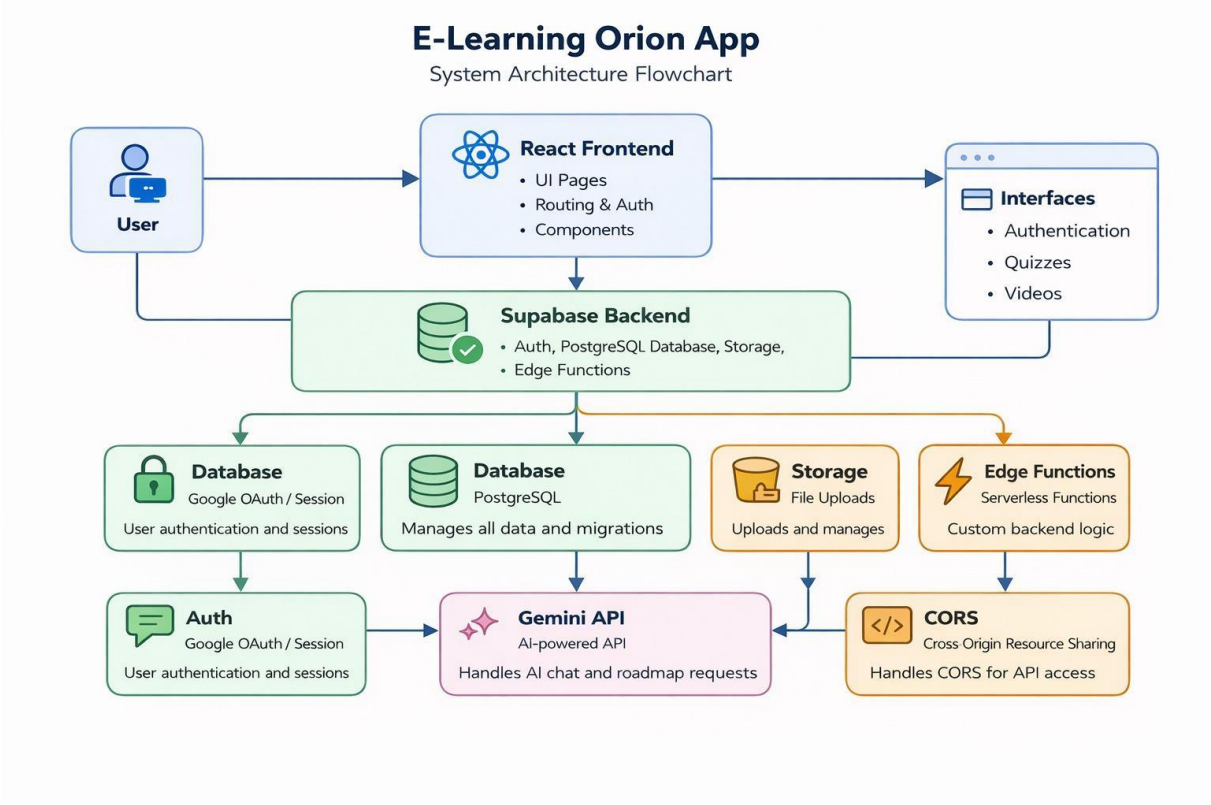

Fig 1: System architecture flowchart of Personalized Learning path generator

On the backend side, the setup's built for both speed and growth. Most of the time, the frontend talks directly to the database using @supabase/supabase-js for safe communication. For tougher jobs, like handling AI workflows, sensitive data, or privileged actions, the system uses Supabase Edge Functions. Sometimes, if you need more flexibility or specific API management, a lightweight Node.js/Express backend does the trick.

Supabase Storage takes care of all the files: certificates, achievements, uploads, you name it. It keeps everything secure and scalable, making sure only the right people have access.

9. Revenue Model (Future Scope)

We can certainly leverages AI-driven advertisements, such as those offered by Meta, but we need to be especially mindful of safety and the well-being of children. These ads won't be intrusive or disrupt the learning environment. Instead, they'll be subtly integrated, complementing the educational experience, which helps students maintain their focus while still allowing for some revenue generation.

RESULTS / FINDINGS:

The proposed solution to develop AI-Based Personalized Learning Path Generator has been evaluated for students studying from 1st standard to 12th standard belonging to CBSE and Maharashtra Board. The outcome is not just based upon comparison but upon the functioning of the system, interaction of user, and features performance of the system itself.

1. Effective Personalization of Learning Paths:

The AI-based learning path generator offers customized learning paths for various types of learners. The poorly performing learners will be given easy-to-understand explanations and additional training sessions. The highly performing learners will be offered hard questions and fast learning paths. It will adapt continuously depending on the learners' behaviors, performance in tests, and quiz scores.

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2. Improvement in Concept Understanding via AI Tutor:

Role of AI Tutor in our system:

AI tutor is an essential component in providing clear understanding and making it possible for the student to learn independently. With such a system, it becomes possible for the students to ask for clarification whenever required without having to depend completely on the teaching faculty. Another advantage of having an AI tutor is that step-by-step solutions to problems become easier. It led to greater clarity of concepts and more self-confidence in students.

3. Increased Engagement through Gamification and Animation:

Integrating elements such as games and animations greatly improved the involvement of the students in the learning process. The lower-level learners (grade 1–5) exhibited more interest and participation in the lessons due to the use of the game approach in the learning process. Animated videos simplified difficult topics for better comprehension and retention by the learners. Learning had become fun and interactive.

4. Age-Appropriate User Interface Design:

There is very much emphasis on the user interface in terms of the various age levels that were taken into consideration when designing the user interface. For younger users, there is an interesting combination of graphics and colors that make it easier for such people to interact with the website. For high-level classes, there is an organized dashboard that offers valuable information. The user interface is very easy to navigate through.

5. Increased Parental Involvement:

The mentoring (parents) module significantly improved the effectiveness of monitoring student activities. It enabled parents to track their child's performance and overall progress in a structured manner. As a result, weaknesses could be identified at an early stage and addressed promptly. The module also contributed to increasing discipline among students by ensuring regular oversight. Overall, it establishes a strong connection between parents and digital learning platforms, enhancing the learning ecosystem.

6. Screen Time Management for Healthy Learning Habits:

Unlike most current technologies, this one ensures proper use of technology by featuring proper screen time monitoring features. These alerts are generated by this technology at the right time to prevent overuse of screens among learners so that they can prevent themselves from being exposed to digital screens for too long. Moreover, it promotes healthy behaviors of learning using technology in a controlled manner.

7. Scalability Across Different Boards and Geographical Locations:

The system designs to caters to students following the CBSE curriculum through a formalized and structured learning approach. It also accommodates Maharashtra Boards students by adapting contents according to state-specific requirements and essential syllabus differences. Moreover, the platform is scalable and can effectively support urban students with access to technical resources, as well as rural students by addressing language diversity and accessibility needs.

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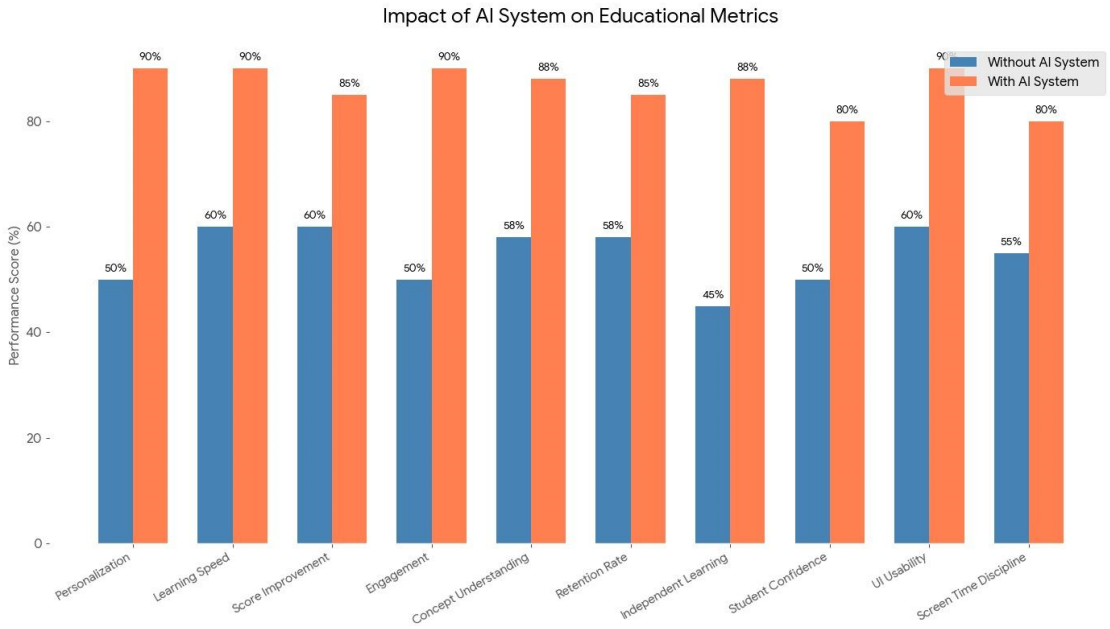
Fig 2:AI-Based Learning System (Student & Learning Impact)



8. Efficiencies Backends Operations (Technical Evaluation):

The use of Supabase that offers efficient backend infrastructure services to the application. Ensures user authentication by incorporating login via Google account in a safe way. Privacy of data is taken care of through the implementation of Row Level Securities. The service also facilitates easy query generation in the database with the help of direct connections between the front end and backend of the platform. AI Processing and Security features are managed using Edge Functions.

Performance Metrics Comparison

Aspect	Without System (%)	With System (%)	Improvement
Multi-Board Support	50%	90%	+40%
Content Adaptability	55%	88%	+33%
Accessibility (Urban + Rural)	52%	88%	+36%
Parental Monitoring	50%	90%	+40%
Security & Privacy	58%	93%	+35%
Backend Efficiency	62%	92%	+30%

Table 1: System Scalability, Monitoring & Technical Performance

Conclusion:

In summary, the proposed AI-Based Personalized Learning Path Generator showcases the potential of using artificial intelligence in modern educational settings. This system addresses several critical problems related to traditional education, including lack of customization, engagement, and accessibility. With its use of AI-powered learning paths, intelligent tutors, gamified material, animated videos, and parental supervision, the platform generates an interactive learning experience for students ranging from 1st to 12th grade in CBSE and Maharashtra Board schools.

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Perhaps the most important contribution made by the system is its capability of offering customized lessons tailored specifically to the needs of each student. It helps the users resolve their doubts instantly and encourages them to learn independently. Furthermore, gamified elements and animations significantly increase engagement and boost retention levels. Besides, the addition of multilingual functionality and an intuitive user interface makes the platform accessible to children from both rural and urban regions.

However, there are several disadvantages of the system. Firstly, the efficiency of an AI system is determined by student data that the AI has access to. Sometimes, low connectivity due to which the user cannot connect to the Internet may be the problem. Furthermore, at present, the system may be incomplete for all subjects or complicated topics, thus requiring updates. Moreover, connecting the system to schools and adding support for additional educational boards will also make the system more useful. Additionally, career advice will be helpful for students. Overall, the suggested system is quite scalable and realistic for the future.

Future Scope:

There are numerous ways through which the recommended e-learning system can be enhanced to create an even more effective learning experience for the users. For instance, the incorporation of artificial intelligence can aid in creating customized learning experiences for each individual student depending on their performance and conduct. Other aspects that the developers can enhance include improving the interaction between the chatbot and the users. This could involve incorporating natural language processing to enable students to get more human-like responses from the chatbot. Other possible improvements include adding more immersive learning features to enhance the learning experience, such as virtual and augmented reality. In addition, the e-learning platform can be enhanced to incorporate other education boards besides just CBSE. It can also allow learning in different languages apart from just English. Predictive analytics is another aspect that can be integrated into the system. It can assist in identifying learners who are having challenges in the learning process.

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