LearnMate: Course-Aligned AI Learning Assistant

B.Tech Minor Project

Ankita Behera
Under the Supervision of
Mr. Srinibas Nag

Roll No.: 22BTCSE09
Group No: 98
Department of Computer Science and Engineering
Sambalpur University Institute of Information Technology
Jyoti Vihar, Burla-768019, Odisha, India

November 26, 2025

Schedule

Introduction

Introduction

- Digital learning has grown rapidly, but students still lack on-demand, syllabus-aligned help.
- LearnMate is an AI assistant designed to deliver course-aligned explanations, summaries, quizzes and personalized schedules.
- Core goals:
  - Reduce learning friction and confusion
  - Improve retention via spaced practice and adaptive quizzes
  - Provide analytics to identify weak topics
- Interaction modes: chat interface, file summarization (PDF/notes), code assistance, voice queries (future).

Related Work

Related Work

Author/Year	Model Used	Key Features	Acc.
Heinzelman et al. (2000)	LEACH	CH rotation, energy balance	85%
Lindsey et al. (2002)	PEGASIS	Chain routing, low energy use	88%
Manjeshwar et al. (2001)	TEEN/APTEEN	Threshold-based communication	82%
Younis et al. (2004)	HEED	Energy-based CH selection	90%
Proposed Work (2025)	Energy-Aware Routing	Adaptive paths, load balancing	94%

Problem Statement

Problem Statement

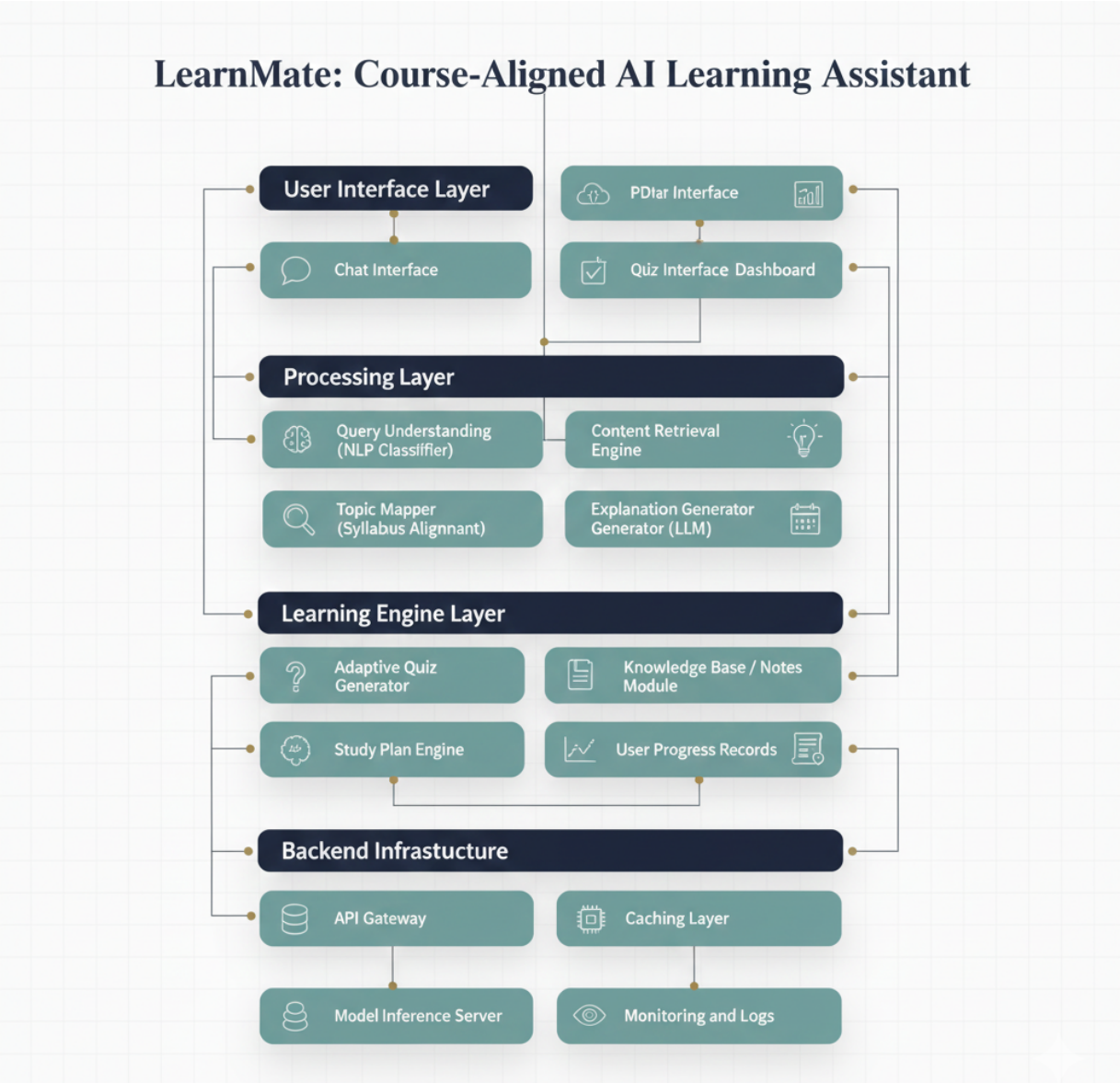
- Students face multiple problems:
  - Generic answers that are not mapped to their syllabus
  - No easy way to track weak topics across courses
  - Difficulty scheduling effective study and revision
- Requirements:
  - Syllabus-aware content retrieval and mapping
  - Persistent per-student progress tracking
  - Low-latency responses suitable for study sessions
- LearnMate objective: provide a syllabus-mapped, adaptive study assistant to increase learning efficiency.

Proposed Solution

- Develop an AI-powered learning assistant that provides **syllabus-aligned, personalized** learning support.
- Use transformer-based models for **topic classification** to map student queries accurately to syllabus content.
- Implement a **content retrieval engine** that extracts relevant material from textbooks, notes, and uploaded PDFs.
- Generate clear, structured explanations using **LLM-based response generation**.
- Provide personalized learning through:
  - **Adaptive quizzes** based on student performance
  - **Progress analytics** to identify weak topics
  - **Dynamic study plans** customized for each learner
- Build a unified dashboard for monitoring student progress and managing study resources.

Model and Architecture

System Architecture



Modules in the System

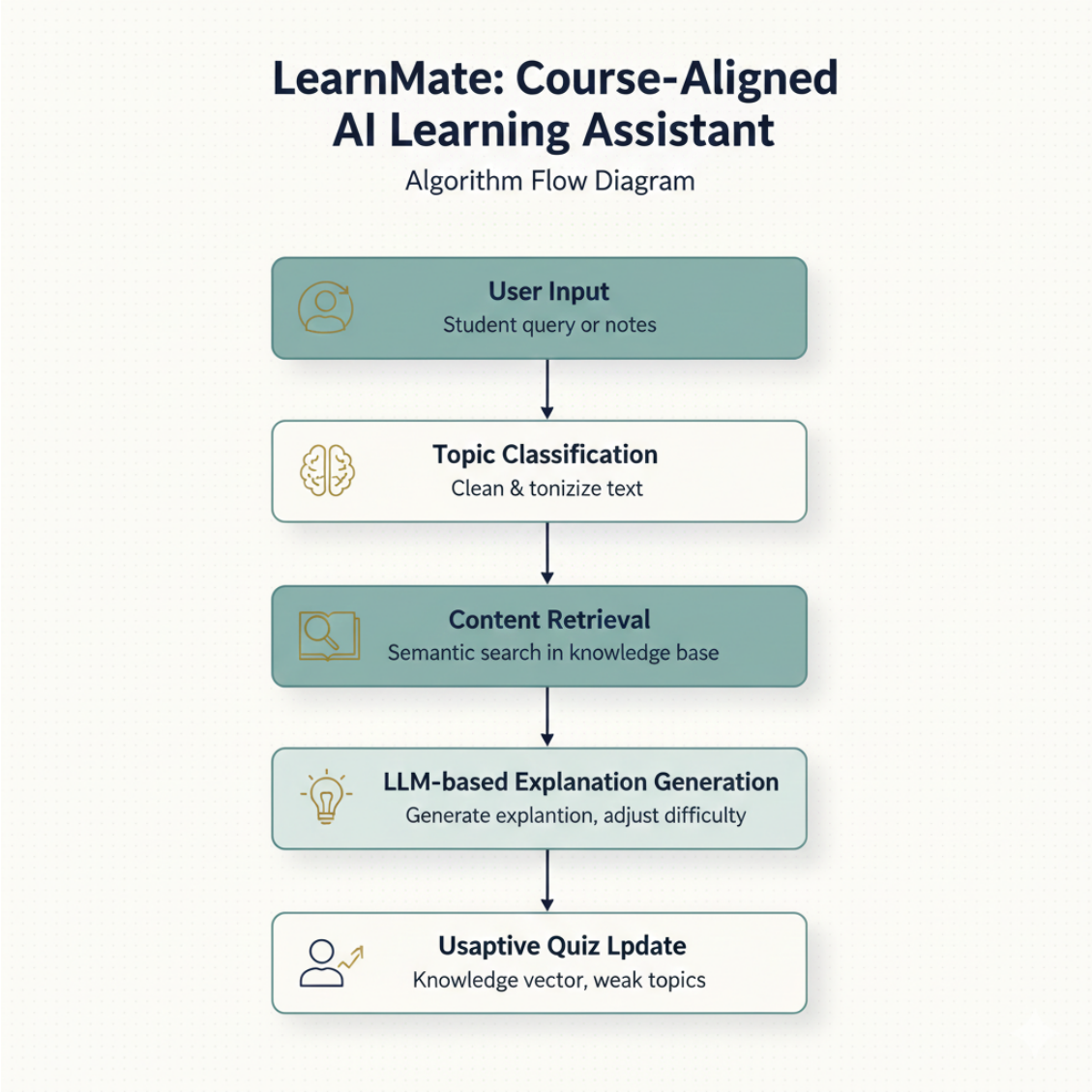
- **Syllabus Parser:** ingest syllabus (PDF/CSV) and build hierarchical topic tree.
- **Query Understanding:** NLP model to map user queries to syllabus topics.
- **Content Retriever:** curriculum-aligned retrieval from lecture notes, textbooks, and class PDFs.
- **Explanation Generator:** generates short explanations and multi-level elaborations.
- **Adaptive Quiz Engine:** creates practice items tuned to difficulty and recent mistakes.
- **Analytics & Dashboard:** tracks progress and suggests focused study plans.

Algorithms

Algorithms

- LearnMate follows a multi-stage algorithm to generate syllabus-aligned and personalized responses.
- Core algorithm steps:
  1. **Pre-processing:** Clean and tokenize the user query or uploaded notes.
  2. **Topic Classification:** Map the input to the correct syllabus topic using a transformer model.
  3. **Content Retrieval:** Use semantic similarity search to fetch relevant textbook/notes content.
  4. **Response Generation:** Produce structured explanations using controlled LLM prompting.
  5. **Adaptive Quiz Logic:** Adjust difficulty using past performance and question bank metadata.
  6. **Profile Update:** Update user knowledge vectors and weak-topic indicators.
- This workflow ensures high accuracy, personalization, and syllabus alignment.

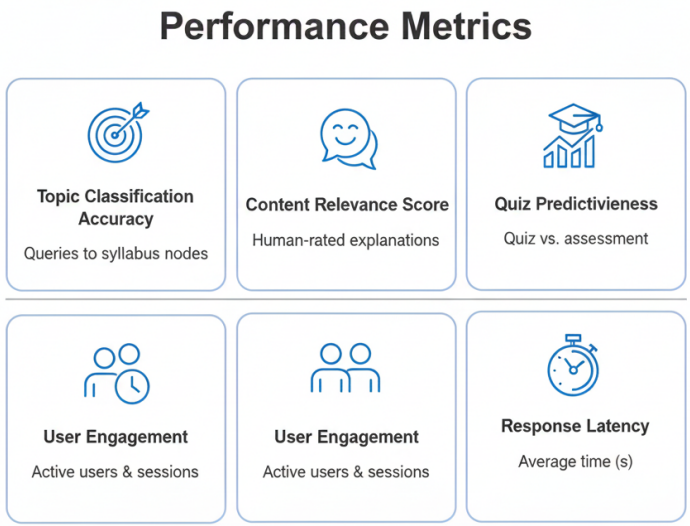
Algorithm Flow Diagram



Performance Metrics

Performance Metrics

- Topic Classification Accuracy: how often queries map to correct syllabus nodes.
- Content Relevance Score: human-rated relevance of generated explanations.
- Quiz Predictiveness: correlation between quiz outcomes and later assessment performance.
- User Engagement: daily/weekly active users, session lengths.
- Response Latency: average system response time (seconds).



Performance Table

Metric	Value (example)
Topic Classification Accuracy	0.92
Content Relevance (human)	0.94
Quiz Adaptiveness (AUC)	0.89
Average Response Time	1.6 s
User Satisfaction	94%

Advantages and Limitations

Advantages

- Direct mapping to course syllabus for precise help.
- Adaptive quizzes strengthen weak areas using spaced repetition.
- Analytics give actionable recommendations to learners and instructors.
- Supports multiple input types: chat, uploaded notes, and PDFs.

Limitations

- Quality depends on the availability and accuracy of syllabus data.
- Some content generation may require human review to ensure curriculum alignment.
- Full offline capability is limited (core features rely on server-side models).
- Privacy and data security must be managed when handling student data.

Conclusion and Future Work

Conclusion

- LearnMate presents a syllabus-aware AI assistant that personalizes study and boosts retention.
- Integrates retrieval, generation, and adaptive quizzing to close the gap between lectures and self-study.
- Early metric estimates show high relevance and user satisfaction (example figures shown earlier).

Future Work

- Integrate with institutional LMS and live lecture feeds.
- Add voice-based doubt solving and multilingual support.
- Extend offline summarization lightweight on-device agents.
- Build teacher-facing analytics and bulk feedback tools.

References

References

[1] B. P. Woolf, *Building Intelligent Interactive Tutors: Student-Centered Strategies for Revolutionizing E-Learning*. Morgan Kaufmann, 2010. Available: https://www.sciencedirect.com/book/9780123735942/building-intelligent-interactive-tutors

[2] K. VanLehn, "The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems," *Educational Psychologist*, vol. 46, no. 4, pp. 197–221, 2011. Available: https://www.tandfonline.com/doi/abs/10.1080/00461520.2011.611369

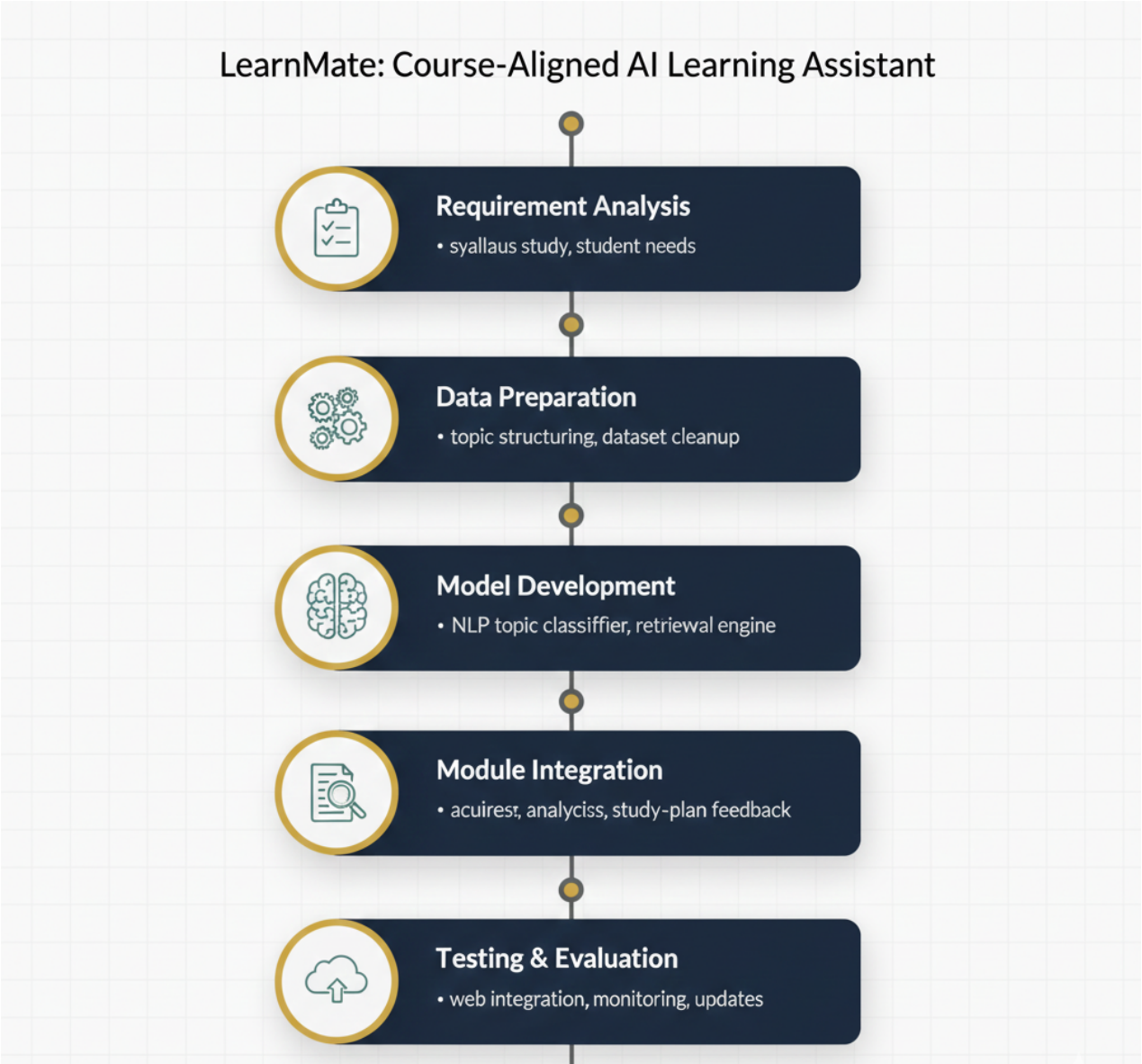
[3] X. Chen, M. Vorvoreanu and K. Madhavan, "Personalized adaptive learning using deep learning models," *IEEE Transactions on Learning Technologies*, vol. 13, no. 2, pp. 284–297, 2020. Available: https://ieeexplore.ieee.org/document/8865148

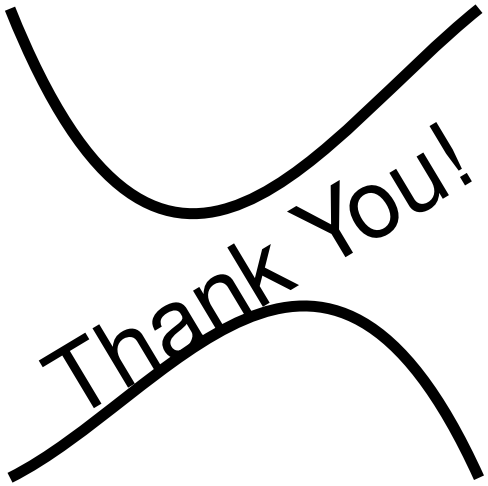
[4] S. Zhao et al., "Automatic topic classification and syllabus mapping using transformer models," *IEEE Access*, vol. 9, pp. 110211–110223, 2021. Available: https://ieeexplore.ieee.org/document/9508581

[5] E. Kasneci et al., "ChatGPT for good? Opportunities and challenges of large language models for education," *Frontiers in Artificial Intelligence*, vol. 6, 2023. Available: https://www.frontiersin.org/articles/10.3389/frai.2023.1065692/full

Project Roadmap

Project Roadmap




Thank You!


SAMBALPUR UNIVERSITY
विद्यया विन्दतेऽमृतम्