

LearnEdge: An Intelligent Learning Management System

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Abstract — LearnEdge is an intelligent Learning Management System developed to improve the online learning experience and make learning more interesting, organized, and less stressful for students. The system provides separate dashboards for administrators, instructors, and students so that each user can access features related to their role. The platform uses rule-based logic to provide Smart Progress Tracking and Study Schedule Generation for students. These features help students understand their learning status, maintain consistency, and follow a structured study routine. The platform is built using React.js, TypeScript, Tailwind CSS, Vite, and Supabase. Its layered architecture improves maintainability, scalability, and performance. LearnEdge shows how a modern LMS can provide a more engaging and supportive digital learning environment.

Keywords: Learning Management System, Role-Based Access, Smart Progress Tracking, Study Schedule Generation, Learning Analytics, Certificate Generation, Rule-Based Logic

I. INTRODUCTION

Learning Management Systems have become an important part of online learning. They help learners access course content in a structured way and support instructors in delivering material through a digital platform. However, many systems mainly focus on basic content delivery and do not always make learning engaging, easy to follow, and less stressful for students.

Many students lose interest when learning becomes repetitive or difficult to manage. Without enough support, students may fall behind or stop learning regularly. Instructors need simple tools to create and organize content, while administrators need an organized way to monitor platform activity, users, courses, analytics, and reports.

LearnEdge addresses these issues by combining role-based dashboards, structured course management, analytics, certificate generation, and student-focused intelligent support in one system. The main aim is to make learning more interesting and less boring for students while keeping the platform easy to use for instructors and administrators.

II. PROBLEM STATEMENT

Many existing LMS platforms provide basic features such as course access, content viewing, enrollment, and certificate generation. While necessary, these features are often not enough to support students throughout the complete learning process. Students may lose consistency or become inactive when the system lacks guidance, structure, or motivation.

Another issue is that progress data is often shown in a simple form (completion percentage or activity records) without helping students understand how to continue

effectively. There is a need for a platform that keeps regular LMS functions simple while giving students additional intelligent support through rule-based features.

III. OBJECTIVES

The main objectives of LearnEdge are:

- 1) Design and develop a role-based LMS for administrators, instructors, and students.
- 2) Provide separate dashboards with role-specific functionality.
- 3) Enable administrators to monitor platform activity, users, courses, analytics, reports, and revenue.
- 4) Help instructors create, manage, publish, unpublish, draft, and organize courses.
- 5) Allow students to browse, enroll in, purchase, and access courses through a simple and engaging environment.
- 6) Generate digital certificates automatically after successful course completion.
- 7) Provide Smart Progress Tracking for students.
- 8) Generate personalized study schedules for students using rule-based logic.
- 9) Identify at-risk learners and provide timely alerts.

IV. LITERATURE REVIEW

- 1) Bordoloi et al. (2020): Discussed MOOCs in India and found that weak learner engagement and poor progress monitoring are major reasons for low course completion, suggesting better learner support beyond content access.
- 2) Veluvali & Suriseti (2021): Explained that learner-centered LMS platforms improve student engagement in higher education but many systems still lack responsive features supporting individual learners.
- 3) Xin et al. (2021): Found that most LMS platforms provide common features like course delivery and access management, but intelligent monitoring and advanced learner analytics remain limited.
- 4) Altinpulluk & Kesim (2021): Observed that adaptive learning and automation are growing areas in LMS research, highlighting the need for more active and intelligent learner support.
- 5) Bojiah (2022): Found that LMS platforms are effective for content delivery but often have limitations in usability and personalization, highlighting the need for learner-friendly tools beyond basic content access.
- 6) Spreadborough & Glasser (2022): Showed that activity data such as login patterns, material interaction, and assessment behavior can help understand learner progress, but many platforms do not convert this into actionable student support.
- 7) Gamage et al. (2022): Explained that LMS outcomes improve when supported by strong instructional design, while noting deeper personalization and intelligent support are still missing in many systems.

- 8) Lai et al. (2024): Showed that intelligent monitoring can help evaluate learner participation and generate useful academic insights, supporting the integration of analytical intelligence in learning platforms.
- 9) Shinde et al. (2025): Demonstrated that modern web technologies improve the speed, modularity, and usability of online course management platforms, supporting use of modern frontend and backend tools in LMS development.
- 10) Pawar & Dongardive (2025): Found that AI is increasingly used in LMS platforms, but structured, understandable, and student-focused academic guidance is still limited in many current systems.

V. RESEARCH GAP

The following research gaps are identified from the literature review:

- 1) Existing LMS platforms mainly focus on content delivery and standard management functions.
- 2) Many systems do not provide enough support to make learning interesting and engaging for students.
- 3) Progress data is often shown in a simple form and not converted into meaningful guidance.
- 4) Many platforms do not help students stay consistent in their learning process.
- 5) Personalized study planning is missing in most existing systems.
- 6) Student inactivity and learning delays are not properly handled in many LMS platforms.
- 7) Intelligent learner support is still limited in many systems.
- 8) There is a need for a system that keeps general LMS functions simple while giving students additional rule-based support.

VI. PROPOSED SYSTEM

LearnEdge is a modern, intelligent web-based LMS designed to improve the online learning experience and simplify course management. It provides separate dashboards for administrators, instructors, and students so each user can perform activities in a focused and organized way.

Students can browse courses, enroll, purchase access, watch lesson videos, use Smart Progress Tracking, receive personalized study schedules, and download certificates. Instructors can create and manage courses, organize modules and lessons, upload content, and publish or unpublish courses. Administrators can monitor users, courses, analytics, reports, revenue, and general platform activity.

The intelligent part of LearnEdge is based on rule-based logic and is designed specifically for students. Smart Progress Tracking helps students understand their learning status and consistency. Study Schedule Generation helps students plan lessons based on remaining content and available study time. At-risk learner detection identifies students who need support.

VII. SYSTEM ARCHITECTURE

LearnEdge follows a layered architecture to improve maintainability, scalability, and clarity. The architecture comprises four distinct layers:

- 1) Presentation Layer: User interface and role-based dashboards built using React.js, TypeScript, Tailwind CSS, and Vite.
- 2) Application Logic Layer: Handles authentication, role-based routing, course operations, enrollment, analytics, certificate generation, reporting, and system control.
- 3) AI and Smart Modules Layer: Contains student-focused features: Smart Progress Tracking, at-risk learner detection, and Study Schedule Generation, converting raw activity into structured recommendations.
- 4) Backend and Database Layer: Manages authentication, storage, synchronization, and backend services using Supabase with PostgreSQL tables for Users, Courses, Enrollments, Progress, Study Schedules, and Payments.

VIII. SYSTEM WORKING

- 1) Authentication: The user logs in using valid credentials.
- 2) Role Identification: The system identifies whether the user is an admin, instructor, or student.
- 3) Dashboard Redirection: The user is redirected to their role-specific dashboard.
- 4) Student Course Flow: The student browses available courses, completes purchase, and starts learning.
- 5) Instructor Course Flow: The instructor can create courses, add modules and lessons, save drafts, publish, unpublish, or delete the course.
- 6) Admin Monitoring Flow: The admin monitors users, courses, reports, revenue, analytics, and general platform activity.
- 7) Student Smart Support Flow: The student receives Smart Progress Tracking insights and a Study Schedule based on their input and remaining lessons.
- 8) Course Completion Flow: After successful course completion, the system generates a certificate for the student.

IX. UNIQUE FEATURES

A. Smart Progress Tracking

LearnEdge's Smart Progress Tracking gives students a clear view of their learning behavior through rule-based insights. The major components are:

- Progress Dashboard: Displays overall completion percentage, study streak, average quiz score against an 80% target, total enrolled courses, and completed lesson count out of total lessons.
- Study Streak Tracker: A 7-day visual calendar shows daily consistency across three states: studied (orange), today (outlined ring), and inactive (gray), with a running consecutive-day streak counter.
- Smart Insights Panel: Generates up to five rule-based recommendations: quiz revision alert (score below 70%), inactivity warning (course untouched over 7 days), peak study hour from completion timestamps, pace projection with a suggested daily target, and an encouragement message when progress is on track.

- At-Risk Detection: A warning banner appears when an incomplete course has not been accessed for 3 or more days, showing the course name and exact inactivity count. The most neglected course is surfaced first.
- Module Breakdown: Shows lesson-level status per module (completed, in progress, locked, not started) with lesson counts and direct navigation to the course player.
- Quiz Performance Analytics: A bar chart with color-coded bands: green ($\geq 80\%$), amber (60–79%), indigo ($< 60\%$), with tooltips and a per-quiz index showing course name, quiz title, and score.

B. Study Schedule Generation

The Study Schedule Generation feature creates a daily lesson plan based on student preferences and learning progress. The major components are:

- User Input: The student selects weekly study hours, preferred study days (Weekdays, Weekends, Every Day), and preferred study time (Morning, Afternoon, Evening, Flexible).
- Time Calculation: The system checks how many hours the student wants to study and on how many days they want to study. Then it creates a balanced daily study plan without giving too much workload.
- Example: If a student studies 5 days a week, the lessons are divided across those 5 days.
- Lesson Distribution: Pending lessons are arranged in module order and added to the schedule day by day.
- Example: Lessons from Module 1 are scheduled first, then lessons from Module 2.
- Missed Lesson Detection: Incomplete lessons from previous days are highlighted in red with an alert showing the total missed lessons.
- Estimated Completion Date: The system shows the expected course completion date along with pace labels such as Relaxed Pace, Balanced Pace, Fast Track, and Intensive Mode.
- Motivational Layer: Motivational quotes, streak messages, study-time tips, and spaced repetition notes are displayed to encourage regular learning.

X. ADVANTAGES

- 1) Role-based dashboards make the platform easy to use.
- 2) Smart Progress Tracking helps students stay consistent.
- 3) Study Schedule Generation helps students plan lessons in a structured and less stressful way.
- 4) The system combines course management, analytics, certificates, and intelligent student support in one platform.
- 5) The layered architecture improves maintainability, scalability, and system clarity.

XI. DISADVANTAGES

- 1) The system currently uses rule-based logic, so it does not adapt like advanced machine learning systems.
- 2) The quality of recommendations depends on proper and regular student activity data.
- 3) The payment system is still a prototype and needs real payment gateway integration.

- 4) Some advanced features such as live classes, mobile applications, and discussion tools are not yet available.

XII. FUTURE ENHANCEMENTS

- 1) Integrate machine learning for stronger personalization and predictive at-risk learner detection.
- 2) Add live online classes, chat support, and collaborative discussion tools.
- 3) Introduce assignments, quizzes, and automated grading improvements.
- 4) Develop mobile applications for Android and iOS.
- 5) Add online payment gateway integration for real-world deployment.
- 6) Introduce gamification features such as badges, rewards, and achievement milestones.
- 7) Support multilingual interfaces and better accessibility features.
- 8) Add more advanced analytics and adaptive learning paths.

XIII. CONCLUSION

LearnEdge is a user-friendly and intelligent Learning Management System developed to improve online learning while supporting regular platform functions for administrators and instructors. The system combines course access, lesson delivery, analytics, certificate generation, and student-focused intelligent support in one platform.

The main aim of the project is to make learning more interesting, more organized, and less stressful for students. LearnEdge achieves this through Smart Progress Tracking, Automated Study Schedule Generation, and rule-based support features available only to students. At the same time, it keeps admin and instructor functions similar to regular LMS systems. This makes LearnEdge practical, focused, and useful.

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