



AI-Based Classroom Lecture Analyzer and ERP System Using Speech Recognition and Natural Language Processing

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ABSTRACT :

Classroom teaching generates a large amount of spoken information that students are expected to understand and record through manual note-taking. During fast-paced lectures, students may miss important concepts, and those who are absent may have limited access to the content discussed in class. Teachers also require efficient methods for maintaining digital lecture records and monitoring academic progress.

This paper presents an AI-Based Classroom Lecture Analyzer and ERP System that combines Automatic Speech Recognition (ASR), Natural Language Processing (NLP), and academic management functionalities in a unified platform. The system converts classroom speech into text, processes lecture transcripts to identify important keywords and topics, and generates concise summaries and structured PDF notes. It also provides centralized lecture storage and role-based dashboards for Students, Teachers, and Administrators.

The proposed system further supports syllabus completion tracking and lecture effectiveness analysis to assist academic monitoring. By integrating lecture processing with ERP functionality, the system aims to reduce manual note-taking, improve access to missed lecture content, and provide an organized platform for managing classroom information and academic activities.

Keywords: Artificial Intelligence, Natural Language Processing, Speech Recognition, Automatic Speech Recognition, Classroom Lecture Analysis, Speech-to-Text, Lecture Summarization, Keyword Extraction, Topic Identification, PDF Note Generation, Educational ERP, Syllabus Tracking, Academic Analytics.

Introduction

Artificial Intelligence (AI) has become an important technology in modern education, supporting automated content processing, personalized learning, and academic management. In a conventional classroom, students are required to listen to the instructor and prepare notes at the same time. This can make it difficult to capture all the important information, particularly when lectures are lengthy or delivered at a fast pace. Students who are absent from a lecture may also face difficulties in accessing the information discussed during the class.

Traditional lecture management generally depends on manual note-taking, recorded classroom sessions, and separate academic management systems. These approaches provide limited support for automatically converting spoken lectures into organized textual content. Teachers may also spend additional time maintaining lecture records, while administrators require appropriate mechanisms for monitoring syllabus progress and academic activities.

Recent developments in Speech Recognition and Natural Language Processing (NLP) have made it possible to process classroom speech automatically. Speech Recognition can convert spoken content into text, while NLP techniques can identify significant terms, topics, and important information from the resulting transcript. Automatic summarization can further reduce lengthy lecture content into a concise form that is easier for students to review.

However, lecture transcription, summarization, note generation, and academic management are often implemented as separate functionalities. There is a need for an integrated platform that combines these capabilities and provides access according to different academic roles. This paper presents an AI-Based Classroom Lecture Analyzer and ERP System Using Speech Recognition and Natural Language Processing. The proposed system captures classroom lectures, converts speech into text, analyses the transcript using NLP techniques, identifies keywords and topics, generates lecture summaries, and produces structured PDF notes. The system also provides centralized lecture management, syllabus completion tracking, lecture effectiveness analysis, and separate dashboards for Students, Teachers, and Administrators.

The primary aim of the proposed system is to reduce the effort involved in manual note-taking while improving the availability and organization of classroom lecture content. By combining AI-based lecture processing with ERP functionalities, the system provides a unified platform for supporting students, teachers, and academic administrators.

Literature Survey

2.1. Natural Language Processing for Educational Content Analysis

Singh [1] discussed the use of Natural Language Processing for extracting useful information from unstructured text. The study shows how NLP techniques can organize textual information for further analysis.

This work is relevant to lecture transcripts, where NLP can identify important information from converted speech. However, it does not provide an integrated classroom lecture and academic management system.

2.2. NLP-Based Keyword Extraction

Narayana and Santoshi [2] studied keyword extraction using NLP techniques. Their work focuses on identifying important words and phrases that represent the main content of a document.

Keyword extraction can help students identify important concepts from lecture transcripts. However, the study does not include lecture summarization, automatic note generation, or ERP-based academic management.

2.3. Keyword Extraction from Speech Transcripts

Liu et al. [3] investigated automatic keyword extraction from meeting transcripts using unsupervised techniques. The study demonstrates that important terms can be identified from speech-generated text.

This approach is applicable to classroom lectures because transcripts contain important subject-specific terms. However, the work mainly focuses on keyword extraction rather than complete lecture analysis.

2.4. Lecture Text Summarization

Miller [4] investigated extractive summarization of lecture content using BERT-based techniques. The approach identifies representative information from lengthy lectures and produces concise summaries.

Automated summarization can help students revise lecture content efficiently. However, the study focuses mainly on summarization and does not integrate transcription, syllabus tracking, PDF notes, or ERP functionality.

2.5. Artificial Intelligence in ERP Systems

Sarferaz [5] examined the integration of Artificial Intelligence with Enterprise Resource Planning systems. The study highlights the potential of AI to improve organizational processes and analytical capabilities.

This concept is relevant to educational ERP systems where AI can support academic activities. However, the study does not specifically address classroom speech processing or lecture analysis.

2.6. AI-Based Educational Systems

Hossain et al. [6] explored the use of AI and IoT technologies for improving classroom interaction and student engagement. The study demonstrates the potential of intelligent technologies in modern educational environments.

However, the work does not specifically focus on converting classroom lectures into structured learning resources. The proposed system extends this concept through speech recognition and NLP-based lecture processing.

2.7. AI-Based Classroom Analytics

Nassou [7] discussed analytical approaches for pedagogy and classroom management in AI-enabled university environments. The study highlights the importance of using analytical techniques to support academic activities.

Such analytics are relevant to lecture effectiveness and syllabus monitoring. However, the study does not combine classroom analytics with automatic lecture transcription and note generation.

2.8. Speech Recognition for Classroom Transcription

Ranchal et al. [8] investigated speech recognition for real-time classroom captioning and lecture transcription. The study demonstrates how spoken classroom content can be converted into text.

This provides a foundation for the Speech-to-Text component of the proposed system. However, transcription alone does not provide NLP analysis, summarization, PDF notes, or ERP management.

2.9. Real-Time Transcription Using ASR and NLP

Anguraj et al. [9] explored classroom automation using Automatic Speech Recognition and NLP for real-time transcription and content processing. The work is closely related to the proposed system. However, the proposed system extends transcription with keyword extraction, topic identification, summarization, PDF generation, syllabus tracking, and role-based dashboards.

2.10. Automatically Generated Lecture Summaries

Gonzalez et al. [10] studied automatically generated summaries of video lectures and their usefulness for students. The research highlights the value of concise lecture summaries for reviewing educational content.

However, the study mainly focuses on lecture summarization. The proposed system combines summarization with transcription, NLP analysis, note generation, and academic management.

2.11. AI-Based Lecture Summarization

Mali et al. [11] reviewed AI-based approaches for lecture summarization. The study highlights the role of Artificial Intelligence in reducing lengthy lecture material into concise and useful content.

The research supports the use of automated summarization in education. However, it does not cover the complete workflow from lecture recording to academic ERP management.

2.12. Whisper-Based Educational Transcription

Rao [12] investigated the use of Whisper for transcribing educational videos. The study demonstrates the applicability of AI-based speech recognition for converting educational audio and video into text.

This approach is relevant to the proposed system because classroom recordings can be transcribed before NLP processing. The proposed system further processes the transcript to generate keywords, topics, summaries, PDF notes, and academic insights.

2.13. Research Gap

The reviewed studies cover important areas such as speech recognition, keyword extraction, NLP, lecture summarization, classroom analytics, and AI-based ERP systems. However, these functionalities are mostly addressed separately.

There is a need for an integrated system that combines lecture recording, Speech-to-Text conversion, NLP analysis, summarization, PDF note generation, syllabus tracking, lecture effectiveness analysis, centralized lecture storage, and role-based ERP dashboards. The proposed system addresses this gap by bringing these functionalities together in a unified educational platform.

Problem Statement and Objectives

3.1. Problem Statement

Classroom lectures contain important academic information that students are expected to understand and record through manual note-taking. However, students may miss important concepts because of fast-paced lectures, incomplete notes, distractions, or absence from the classroom. Traditional methods also provide limited support for automatically organizing and reviewing lecture content.

Existing educational applications generally focus on individual functions such as lecture recording, speech transcription, summarization, or academic management. These functionalities are often available through separate tools rather than through a unified platform. Teachers may also require additional effort to maintain digital lecture records, while administrators need appropriate mechanisms for monitoring syllabus completion and lecture effectiveness.

Therefore, there is a need for an integrated AI-based system that can capture classroom lectures, convert speech into text, analyze lecture content, identify important keywords and topics, generate summaries and structured notes, and support academic management. The proposed system addresses this requirement by combining Automatic Speech Recognition, Natural Language Processing, lecture summarization, PDF note generation, syllabus tracking, lecture effectiveness analysis, centralized lecture storage, and role-based ERP dashboards.

Objectives

The major objectives of the proposed system are:

- To develop an AI-based lecture recording and Speech-to-Text system for converting classroom speech into digital transcripts.

- To apply Natural Language Processing techniques for preprocessing lecture transcripts and identifying important keywords and topics.
- To automatically generate structured PDF lecture notes containing important lecture information in an organized format.
- To provide a centralized lecture repository for storing and accessing transcripts, summaries, notes, and related academic information.
- To implement syllabus completion tracking for monitoring the progress of topics covered during classroom lectures.
- To analyze lecture effectiveness using lecture content, keywords, topic coverage, and syllabus alignment.
- To develop role-based ERP dashboards for Students, Teachers, and Administrators with appropriate academic functionalities.
- To provide academic reports and analytics that assist teachers and administrators in monitoring lecture and syllabus-related activities.

Proposed Methodology

The proposed methodology follows an integrated and modular approach for capturing, processing, analyzing, and managing classroom lecture content. The system combines classroom audio recording, Automatic Speech Recognition (ASR), Natural Language Processing (NLP), lecture summarization, syllabus analysis, note generation, and ERP-based academic management within a unified platform.

4.1. Lecture Capture and Speech-to-Text

The lecture begins with audio captured through the classroom microphone or an uploaded audio file. The recorded speech is processed using an Automatic Speech Recognition model to convert spoken content into a textual transcript.

The system supports:

- Classroom lecture recording
- Audio file upload
- Speech-to-Text conversion
- Transcript generation
- Word and sentence count analysis

The generated transcript is passed to the NLP processing stage for further analysis.

4.2. NLP-Based Lecture Analysis

The generated transcript is processed using Natural Language Processing techniques. The text is cleaned and tokenized to remove unnecessary words and prepare the content for analysis.

The system performs:

- Text preprocessing
- Tokenization
- Stop-word removal
- Keyword extraction
- Topic identification
- Lecture content analysis

The extracted keywords and topics provide a concise representation of the major concepts discussed during the lecture.

4.3. Lecture Summarization

After NLP processing, the system generates an extractive summary from the lecture transcript. Important sentences are identified based on their relevance to the overall lecture content.

The generated summary provides students with a shorter representation of the lecture and helps them review important information without reading the complete transcript.

4.4. Syllabus Mapping and Coverage Analysis

The identified lecture topics are compared with the subject syllabus to determine the level of syllabus coverage.

The system evaluates:

- Topics discussed in the lecture
- Corresponding syllabus topics
- Covered topics
- Remaining topics
- Overall syllabus completion

This information helps teachers monitor academic progress and provides administrators with a broader view of syllabus completion.

4.5. Lecture Effectiveness Analysis

The system evaluates lecture effectiveness using information obtained from the processed lecture content. The analysis considers factors such as lecture content volume, identified topics, extracted keywords, and syllabus coverage.

The effectiveness analysis provides an overall indication of lecture performance and categorizes the result into:

- High
- Moderate
- Needs Improvement

The analysis is intended to provide academic insights based on processed lecture information rather than replace teacher evaluation.

4.6. Automatic PDF Note Generation

The processed lecture information is organized into structured academic notes. The generated content can include lecture metadata, transcript information, important keywords, identified topics, summary, syllabus coverage, and effectiveness information.

The system provides an option to export the processed lecture content as a structured PDF document, allowing students to retain and review lecture notes.

4.7. ERP Integration and Role-Based Access

The lecture analysis components are integrated with the academic ERP system. Role-based access provides different functionalities according to the user's role.

The system supports:

- Student: Access lecture transcripts, summaries, keywords, topics, and PDF notes.
- Teacher: Record lectures, analyze lecture content, monitor syllabus coverage, and review effectiveness.
- Administrator: Monitor academic information, syllabus progress, lecture analytics, and system-level reports.

4.8. Data Storage and Reporting

Processed lecture information is organized for centralized access and reporting. The system maintains lecture-related information such as transcripts, summaries, keywords, topics, syllabus information, and analytical results. The collected information can be presented through role-based dashboards and academic reports, providing a unified view of lecture processing and academic activities.

Overall, the methodology establishes an integrated pipeline from classroom lecture recording and Speech-to-Text conversion to NLP analysis, summarization, syllabus evaluation, PDF note generation, and ERP-based academic management.

This methodology enables the proposed system to transform classroom speech into structured educational resources while supporting students, teachers, and administrators through a unified academic platform.

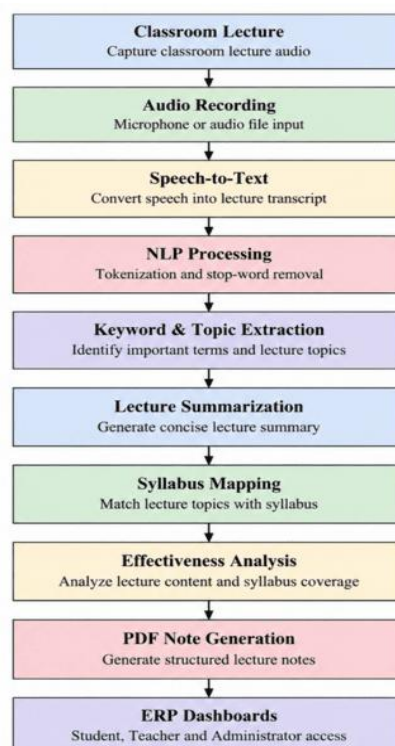


Fig. 1 – Proposed Methodology Workflow

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System Architecture and Implementation

The proposed system follows a layered architecture consisting of the Presentation Layer, Application and Processing Layer, AI/NLP Layer, and Data Layer.

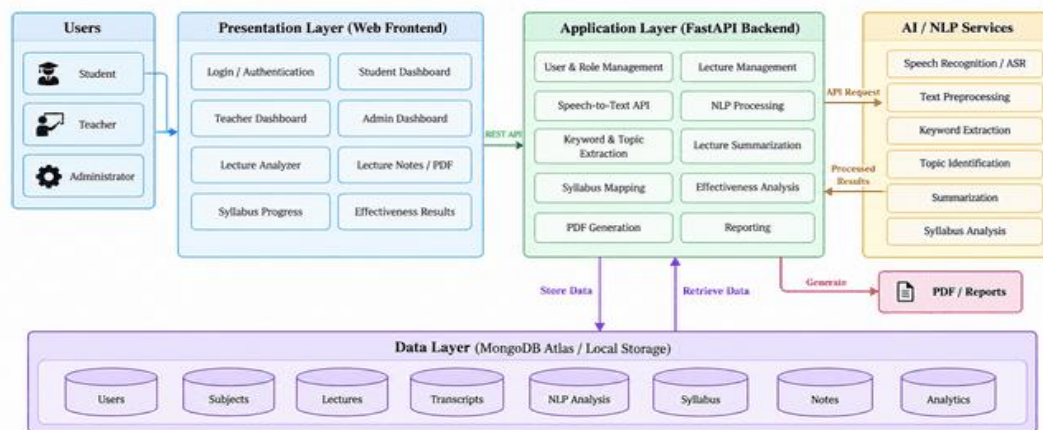


Fig. 2 – System Architecture of the AI-Based Classroom Lecture Analyzer and ERP System

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The Presentation Layer provides web-based interfaces for Student, Teacher, and Administrator users. It includes user login, lecture analysis, dashboards, lecture summaries, syllabus information, effectiveness results, and PDF note access. The Application Layer is implemented using FastAPI and handles lecture management, API requests, user-role access, audio processing requests, and communication between the frontend and AI/NLP components.

The AI/NLP Layer performs Speech-to-Text conversion and lecture content analysis. It includes speech recognition, text preprocessing, keyword extraction, topic identification, lecture summarization, syllabus mapping, and lecture effectiveness analysis.

The Data Layer is designed to maintain lecture-related information such as users, subjects, lectures, transcripts, summaries, syllabus information, notes, and analytical results. The current prototype uses browser-based storage for demonstration, while MongoDB Atlas is considered for centralized persistent storage.

The major functional modules are:

- User Authentication and Role Management
- Lecture Recording and Speech-to-Text
- NLP-Based Lecture Analysis
- Keyword and Topic Extraction
- Lecture Summarization
- Syllabus Mapping and Coverage Analysis
- Lecture Effectiveness Analysis
- PDF Note Generation
- Role-Based ERP Dashboards

The modules communicate through API-based interactions between the frontend and backend. The processed lecture information is returned to the user interface and presented through dashboards, summaries, syllabus information, effectiveness results, and structured lecture notes.

Results and Evaluation

The implemented system was evaluated based on its ability to process classroom lectures, generate Speech-to-Text transcripts, perform NLP-based lecture analysis, provide syllabus and effectiveness information, and generate structured academic notes through role-based ERP dashboards.

6.1. Lecture Processing and Speech-to-Text Results

The system provides a Lecture Studio interface for recording and processing classroom lectures. The lecture processing module supports lecture metadata, subject and syllabus selection, microphone-based recording, and audio upload. The recorded lecture content is converted into text and presented for further NLP analysis.

The Lecture Studio also displays the generated lecture summary, extracted keywords, identified topics, syllabus progress, and lecture effectiveness information. This provides a centralized interface for processing and reviewing classroom lecture content.

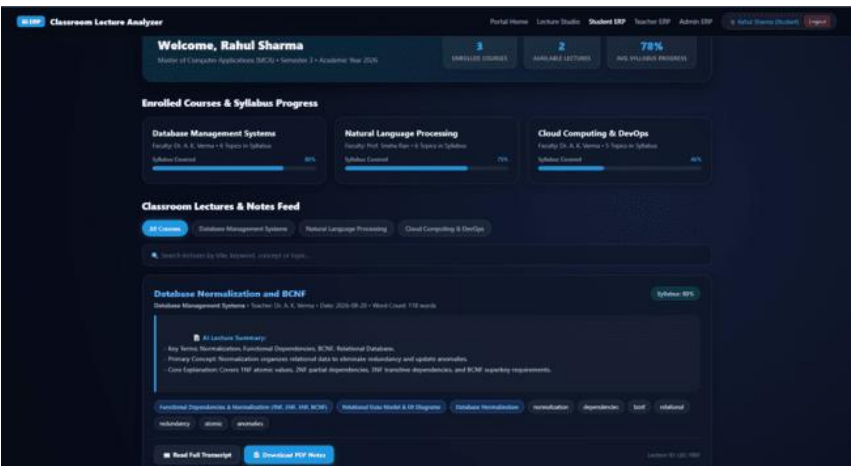


Fig. 3 – Lecture Studio Interface with Real-Time NLP Insights

6.2. Student ERP Dashboard Results

The Student ERP Dashboard provides students with access to enrolled subjects, syllabus progress, processed classroom lectures, summaries, topics, keywords, and PDF notes. The dashboard includes filtering and search options to help students access relevant lecture content.

The lecture cards provide summarized academic information and allow students to review processed lectures and download available PDF notes. This enables students to access lecture resources through a centralized academic interface.

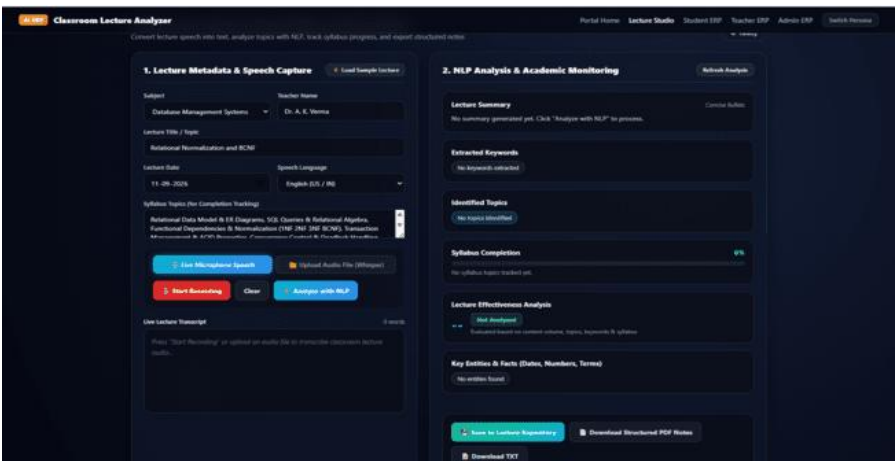


Fig. 4 – Student ERP Portal with Search and PDF Downloads

6.3. Teacher ERP Dashboard Results

The Teacher ERP Dashboard presents assigned subjects, syllabus topic completion, conducted lecture records, and lecture effectiveness information. The dashboard provides syllabus completion indicators and lecture-level analytical results for the teacher.

The interface also provides access to the Lecture Studio, allowing teachers to record and process lectures and review the generated NLP analysis. Effectiveness information is presented using predefined levels such as High, Moderate, and Needs Improvement.

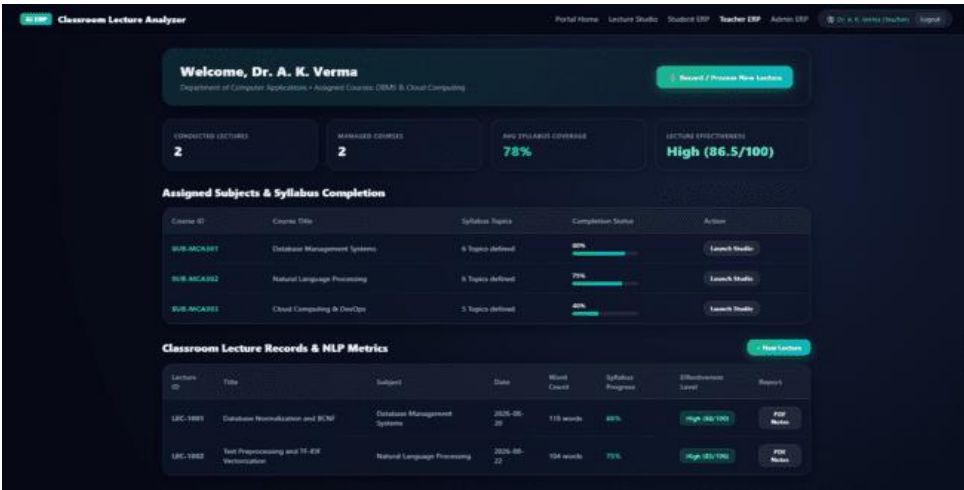


Fig. 5 – Teacher ERP Portal with Syllabus Auditing

6.4. Administrator ERP Dashboard Results

The Administrator ERP Dashboard provides an institutional view of the academic information processed by the system. It presents information such as total users, active courses, processed lectures, syllabus coverage, and lecture-related analytics. The dashboard also includes a syllabus completion audit and academic user directory, allowing administrators to monitor academic information and system-level activities through a centralized interface.

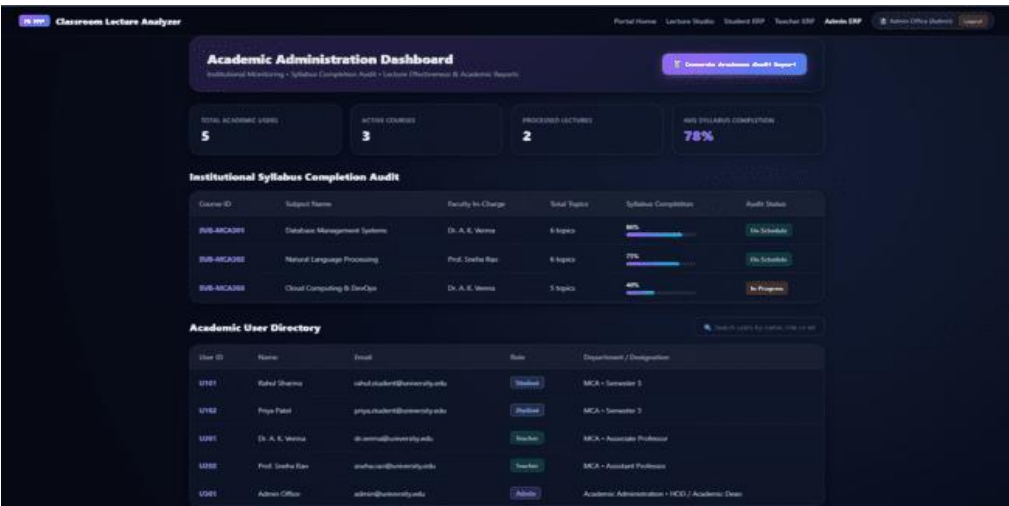


Fig. 6 – Administrator Institutional ERP Monitoring Interface

6.5. Structured PDF Note Generation Results

The system generates structured academic PDF notes from the processed lecture information. The generated PDF contains lecture metadata such as subject, lecture title, teacher, lecture date, syllabus progress, and effectiveness.

The PDF also presents the lecture summary, identified topics and keywords, and the complete lecture transcript. This provides students with an organized document that can be retained for study, revision, and future reference.

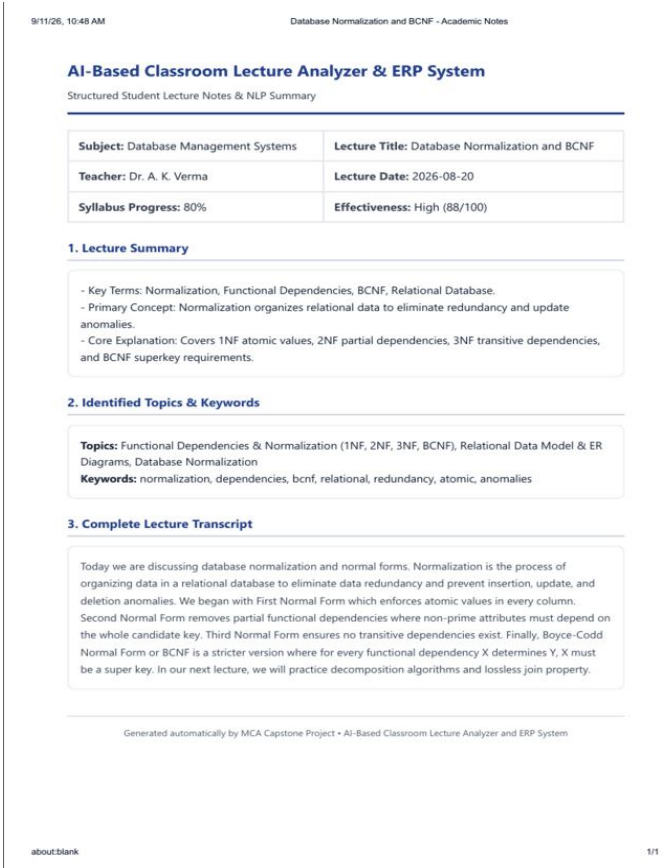


Fig. 7 – Structured Academic PDF Lecture Notes

6.6. Reporting Results

The system presents the processed lecture results through role-based dashboards and generates structured PDF lecture notes containing the major lecture information, including the lecture summary, identified topics and keywords, syllabus coverage, effectiveness results, and complete transcript.

Discussion

The implemented system addresses the identified gap between traditional classroom lecture management and an integrated AI-based lecture analysis platform. Instead of focusing only on lecture recording or transcription, the system combines Speech-to-Text conversion, NLP-based content analysis, summarization, syllabus mapping, effectiveness analysis, PDF note generation, and ERP-based academic management.

The use of Speech-to-Text processing provides a structured digital representation of classroom lectures. The generated transcript acts as the basis for further NLP processing, allowing important keywords and topics to be identified and lecture content to be summarized. This reduces the dependence on manual note-taking and provides students with organized lecture resources. The integration of syllabus mapping and lecture effectiveness analysis adds analytical value to the lecture processing workflow. Rather than providing only a transcript, the system presents information about syllabus coverage and lecture effectiveness. This can help teachers review lecture coverage and provide administrators with academic monitoring information.

The role-based ERP integration further extends the functionality of the system by providing different interfaces for students, teachers, and administrators. Students can access lecture summaries and PDF notes, teachers can review lecture records, syllabus progress, and effectiveness information, and administrators can monitor academic information through a centralized dashboard. The structured PDF note generation component converts the processed lecture information into an organized academic document. The generated notes can contain lecture metadata, summaries, keywords, topics, syllabus information, and the complete transcript, providing students with a reusable resource for study and revision.

Overall, the system demonstrates that classroom lecture processing can be implemented as an integrated academic workflow rather than as a standalone recording, transcription, or summarization tool. The current prototype should be considered an academic decision-support and lecture-management system, with further development required for complete production-level deployment and persistent ERP integration.

Limitations and Future Work

Although the implemented system provides an integrated classroom lecture analysis and ERP platform, several limitations remain.

The current prototype relies on browser-based storage for demonstration purposes, while MongoDB Atlas is considered for centralized persistent storage. Therefore, complete database-backed persistence and enterprise-level ERP functionality require further implementation.

The Speech-to-Text performance can be affected by classroom noise, speaker distance, microphone quality, accents, and overlapping speech. The current system can therefore benefit from further improvement in acoustic processing and speech recognition for different classroom environments. The NLP analysis currently focuses on preprocessing, keyword extraction, topic identification, summarization, syllabus mapping, and effectiveness analysis. More advanced NLP techniques can be incorporated to improve topic understanding, contextual analysis, and lecture summarization.

The syllabus and effectiveness analysis depends on the quality and completeness of the available syllabus information and processed lecture content. Therefore, the analytical results should be interpreted as system-generated academic indicators rather than definitive measures of teaching quality. The current role-based authentication and ERP interfaces are primarily implemented as a prototype. Future development can introduce secure database-backed authentication, stronger authorization mechanisms, and complete persistent user and academic data management.

Future work can focus on multilingual Speech-to-Text processing, speaker diarization, improved classroom noise handling, advanced semantic syllabus matching, automatic quiz and flashcard generation, and integration with existing Learning Management Systems such as Moodle and Google Classroom. Further research can also investigate improved lecture effectiveness metrics, larger-scale classroom testing, personalized learning recommendations, and longitudinal analysis of lecture and syllabus data.

Overall, these improvements could enhance the reliability, scalability, and practical applicability of the proposed AI-Based Classroom Lecture Analyzer and ERP System for educational institutions.

Conclusion

This paper presented an AI-Based Classroom Lecture Analyzer and ERP System designed to capture, process, and organize classroom lecture content using Speech Recognition and Natural Language Processing. The implemented system combines classroom lecture recording and Speech-to-Text conversion with NLP-based keyword extraction, topic identification, lecture summarization, syllabus mapping, and lecture effectiveness analysis.

Beyond basic lecture transcription, the system integrates structured PDF note generation, centralized lecture information, and role-based ERP dashboards for Students, Teachers, and Administrators. These components provide students with organized lecture resources, teachers with syllabus and lecture analysis information, and administrators with academic monitoring capabilities. The key contribution of the system is the integration of lecture processing and academic management within a single platform. Unlike approaches that focus primarily on individual functions such as recording, transcription, or summarization, the proposed system combines these functions with syllabus tracking, effectiveness analysis, PDF note generation, and role-based ERP access.

The system therefore demonstrates the potential of combining Speech Recognition, Natural Language Processing, automated summarization, syllabus analysis, and academic management to support classroom learning and institutional monitoring. Nevertheless, the current platform should be considered a prototype, with further development required for complete persistent database integration, advanced speech processing, and production-level ERP deployment.

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