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Learning Analytics Framework for STEM Education: MERN Stack Implementation

Sandya Rani[1], Uva Shakthi[2]

[1]MCA Final Year, Department of Computer Science and Applications, Vivekanandha College of Arts and Sciences for Women (Autonomous), Tiruchengode, Namakkal. Tamilnadu. India.
sandya0067@gmail.com
ORCID iD:0009-0003-5183-5047
LinkedIn: www.linkedin.com/in/vela-annamalai

[2]Controller of Examinations, Vivekanandha College of Arts and Sciences for Women (Autonomous), Tiruchengode, Namakkal. Tamilnadu. India.
uva75@gmail.com
ORCID iD: 0009-0006-0360-0418

Abstract: ***The MSPHE is an online Web Application, App, and Software Application designed to improve the management of academic activities within educational institutions. It aims to provide administrators, educators, and students with a perceptive interface that facilitates interactions and manages data efficiently. To accomplish this, the system is created using a modern technology stack. The Frontend is developed with React.js, allowing a dynamic and responsive user experience, and Node.js and Express are utilized for the Backend, providing a server-side framework that handles requests and processes data efficiently. The database, MongoDB, provides scalable and adaptable data storage. Numerous capabilities are included in the AMS to support crucial operations. Such as Student and Faculty Data management, Attendance monitoring for students, monitoring student's marks, course management, event management, and mentorship tracking for monitoring students. A robust RESTful API provides access to these features, guaranteeing smooth front-end and back-end interactions.***

Keywords: Academic, MIS, Node.js, Express, MongoDB, React, API, Authentication, Course Management, Attendance, Events, Mentorship, Security, Scalability.

1. Introduction

In Today's fast educational environment, effective management of academic activities is important for the achievements of both institutions and students. In Conventional techniques managing academic processes often leads to miscommunication and a lack of accessibility to information. To Overcome these challenges, I built an MSPHE System, through a web application to enhance the management of academic activities within institutions.

It acts as a centralized platform to enable smooth interaction among administrations, Faculty, and Students.BY leveraging modern web technologies, including MongoDB, Express, and React (MERN Stack), the system provides a user-friendly interface that simplifies various academic processes. It includes user authentication for Admin and Faculty, Course Management, Attendance Tracking for Students, Maintaining Marks for Students Event Management, and Mentorship Tracking for Students. It is designed to enhance accessibility and security, the Project gives users the ability to effectively handle their academic obligations while protecting the confidentiality and integrity of sensitive data.

2. Literature Survey

The Project has emerged as a critical tool for educational institutions, facilitating the management of various academic processes. This literature review highlights key findings from existing research on MSPHE, focusing on their evolution, features, challenges, and future trends.

a) Evolution of Academic Management Systems

Digital-based systems have radically changed the ways of managing academia. The original systems were simple and focused only on administrative aspects, whereas today's AMS embraces features that boost user experience and interaction (Alharbi et al., 2020).

b) Challenges

Despite the advancements, there are still several challenges that exist in the implementation of MSPHE. Data security and privacy issues, resistance to user adoption, and integration issues with existing systems are some of the common problems that institutions face (Khan et al., 2020; Mishra & Singh, 2021). These challenges need to be addressed for the successful deployment of MSPHE.

c) Future Trends

The immediate future of MSPHE is going to come from advancements in artificial intelligence (AI) and machine learning (ML), which are capable of providing predictive analytics on student performance, alongside providing personalized learning experiences (Zhang et al., 2021). Moreover, advancements in mobile applications and improved user interfaces will continue to make access more convenient for the user and provide higher engagement.

3. System Architecture

The architecture of the MSPHE is designed in such a manner that it allows for a strong, scalable, and maintainable framework for handling academic processes at educational institutions. The architecture adopts a multi-tier approach,

involving three main layers: Presentation Layer, Application Layer, and Data Layer. The components and respective responsibilities of the layers ensure proper separation of concerns.

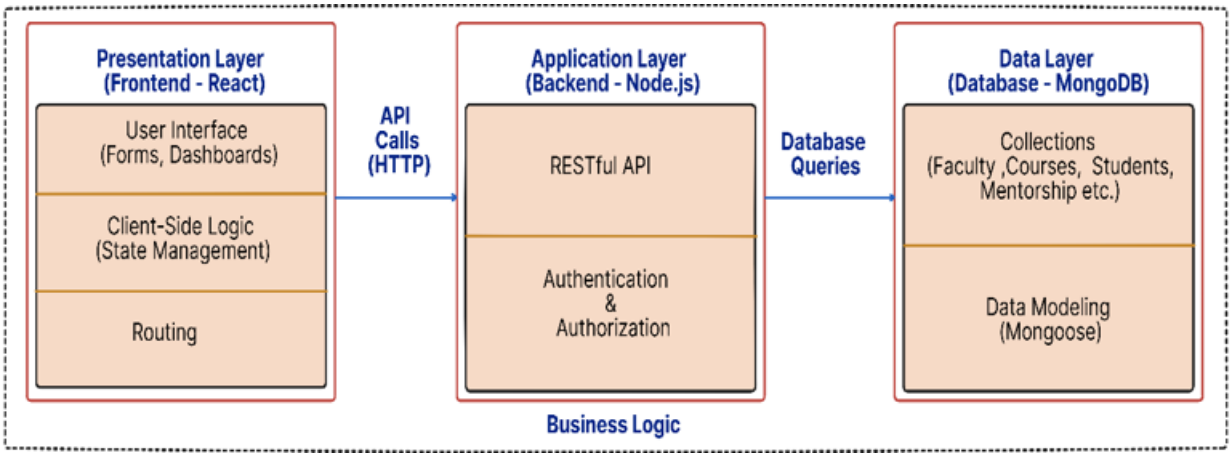


Figure 1: Digital Based Student Higher Education Performance Architecture

Architecture Components

a) Presentation Layer (Frontend)

In Frontend of the AMS is built using React which is used for dynamic and responsive user-friendly. The UI includes Login Forms for user Authentication same login form for both admin and Faculty login while an admin adds new faculty automatically login generated for faculty it could be staffid as username and Date of Birth as Password for Faculty Login, Separate Dashboard for Admin and Faculty, Course Management enable only for particular Faculty to Create, update and manage course effectively, Then Attendance Tacking Interface allows faculty to mark student attendance in particular period then faculty can get attendance report, Event Management Interface is used to maintain academic events and can generate events Report, The crucial interface in my project is Mentorship Tracking important for every Faculty to maintain their student progress it can see only by their mentor.

b) Application Layer (Backend)

The Backend is developed using Node.js and Express, providing a serve-side environment for handling requests and responses, The Request is sent from the frontend to the server through the routes, to perform CRUD operations I use RESTful API endpoints.

User Authentication is implemented by using JWT (JSON Web Tokens) for secure API endpoints to avoid unauthorized access, By using the middleware function to verify tokens and restrict access to protect routes based on user roles like faculty or admin.

Business logic is a core part of MSPHE logic organized into a controller for handling specific functionalities to different resources (e.g., Mentorship Controller, Mark Controller, Attendance Controller).

c) Data Layer (Database)

MSPHE makes use of the MongoDB Database for flexibility, it allows for handling unstructured data, The Database consists of several Collections including Student, Faculty, Courses, Attendance, Events, and Mentorship, and Data Modeling is done by usage of Mongoose to define schemas and interaction with MongoDB Database.

4. Functional Requirements and Non-Functional Requirements

The Functional Requirements of AMS are to meet the needs of users so that in Student Enrolment a Student detail can be uploaded by Excel Sheet the MSPHE can read the .xls format file, read the data from Excel and it will store it in a Database, A Student Details can Update, Delete and Generate PDF (19 KB), In this system a user can generate Excel for all student in one Excel (e.g.,65 students details download in Excel 41.5 KB), can also be done the same thing for Faculty Enrollment, Mark Entering Process.

The Non-Functional Requirements are for quality attributes and system performance, The system responds to the user within 2 seconds except for bulk uploading response, it is also designed to scale horizontally to accommodate an increasing number of users and data volume without performance loss.

5. Outcomes

Figure 1: Mark Entry form Can the user enter marks manually or upload marks through an Excel sheet

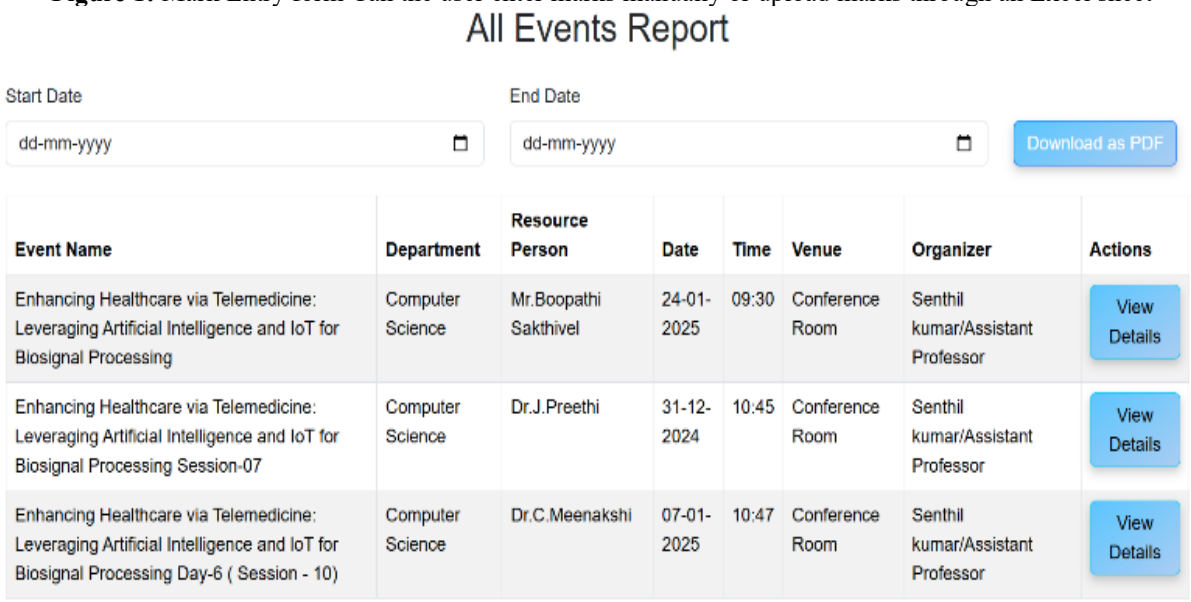


Figure 2: Event Report Screen A user can get an event report for an individual event or an overall event report.

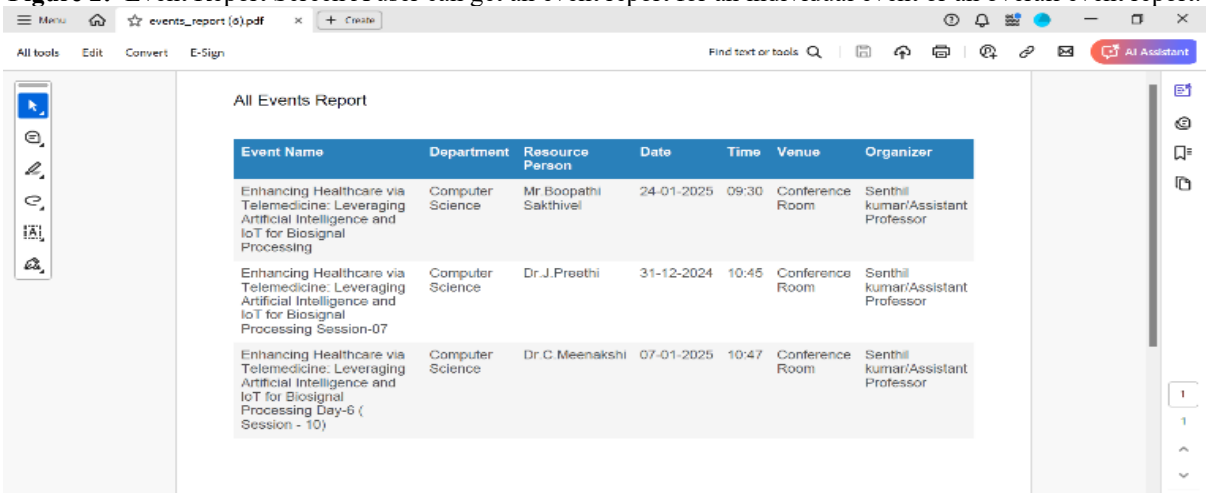


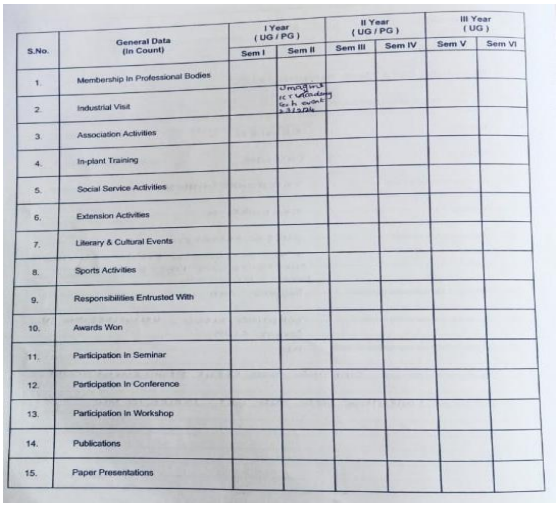
Figure 3: Report of Event in PDF (9.18 KB)

6. Future Trends

An Education System continues to develop, so MSPHE must adopt emerging technology for the best user experience, like Automated Administrative Tasks for real-time support to students and faculty, MSPHE will adopt a mobile-first design, MSPHE will continue to grow in cloud-based adoption.

7. Contribution

Since every college student in the modern world needs appropriate guidance from their mentor, more colleges are using the Mentor-Mentee System, which was previously completed manually. To avoid the paper concept, I created a digital version of the system that will be used by mentors to monitor their mentees. It will have submodules such as the Student Mentorship Report, Student Performance, Evaluation Report, and General Data of Student.



S.No.	General Data (In Count)	I Year (UG / PG) Sem I	I Year (UG / PG) Sem II	II Year (UG / PG) Sem III	II Year (UG / PG) Sem IV	III Year (UG) Sem V	III Year (UG) Sem VI
1.	Membership In Professional Bodies						
2.	Industrial Visit						
3.	Association Activities						
4.	In-plant Training						
5.	Social Service Activities						
6.	Extension Activities						
7.	Literary & Cultural Events						
8.	Sports Activities						
9.	Responsibilities Entrusted With						
10.	Awards Won						
11.	Participation In Seminar						
12.	Participation In Conference						
13.	Participation In Workshop						
14.	Publications						
15.	Paper Presentations						

Figure 5: Manual Report of Mentor-Mentee

Figure 6: Mentor-Metee in Digitialized format.

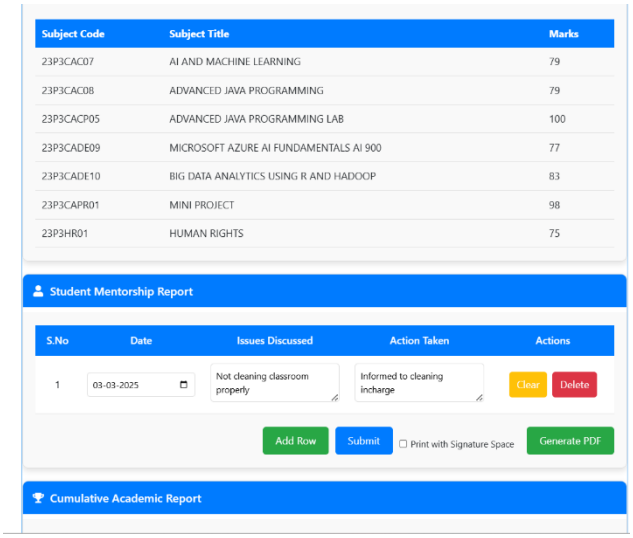


Figure 7: Evaluation Form and Mentorship Report Form

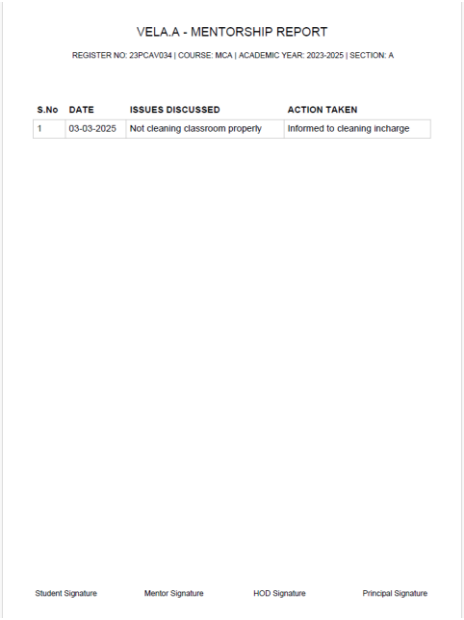


Figure 8: Genrating into PDF 5.55 KB

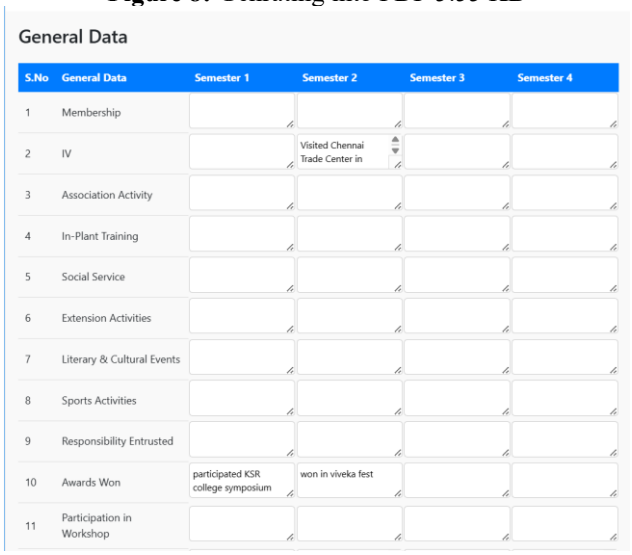


Figure 8: Cumulative Form for Students

8. Conclusion

An important development in the administration of academic procedures within educational institutions is the MERN Solution for Improving Student Performance in Higher Education (MSPHE). The MSPHE aims to streamline communication, fast-track processes, and generally upgrade the educational experience for administration, staff, and students by applying modern technologies and user-centric design. The MSPHE offers a complete solution to satisfy the various needs of its customers by putting elements of course management, student enrolment, attendance tracking, and event management into practice. As it evolves, the system will adjust to new developments such as the incorporation of cloud-based solutions, artificial intelligence, and improved data security.

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