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ClassEdge: AI Assessment and Analytics System of Data-driven Teaching

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Abstract: The study deals with the information asymmetry of the agricultural sector in Kerala where more than 70 percent of the landholdings are marginal. Conventional online advisories are not always successful because of the generic data and language barrier. This paper suggests Krishi Sakhi, which is a personal farming assistant applied using a Malayalam-based Natural Language Processing (NLP) pipeline. The system can offer proactive irrigation, pest management and market timing decision support by synthesizing real-time data of the IMD, ICAR and eNAM. The paper describes the system architecture, multi-source institutional datasets integration, and voice-first interface implementation that makes the system accessible to low literacy users. Findings show that there has been a great enhancement in the maintenance of digital records as well as a shortening of the response time to local threats to crops.

Keywords -Artificial Intelligence; NLP; Teaching; Voice Assistant;

I. INTRODUCTION

Artificial intelligence (AI) has become one of the most potent tools over the last few years, being able to automate more intricate operations and make a practical interpretation of large unrestructured bodies of data. Applied to education, AI presents the prospect of making the teaching process a lot more effective, efficient, and provide a higher objective assessment of the conducted subjective assessment procedures and overall facilitate further data-driven decisions. Machine learning, deep neural networks, and big data analytics technologies can be used to modify the current teaching processes to automate the repetitive ones and help educators concentrate on valuable interactions with learners. Nevertheless, to achieve this potential, cohesive, user-friendly systems are needed that will help in closing the gap between innovative AI systems and the realities of the classroom.

Notwithstanding the development of technology, there are still a number of old issues in education. Manual grading remains to be time-consuming and likely to fatigue particularly when it comes to subjective assessment. To determine deeper gaps in learning, teachers also do not have easy access to integrated tools of analysis. There is also a tendency of fragmentation of data in various systems, and thus cannot be analyzed holistically. Such absence of cohesive information inhibits personalized teaching as the teachers cannot succeed in the strategies of teaching concerning individual requirements of the students.

Moreover, lack of centralization of platforms and managing resources inefficiently will impede the ability to collaborate and access quality teaching materials.

These issues show that an all-inclusive solution that involves automation and meaningful analytics is urgently needed. To solve this, this paper suggests ClassEdge, an AI-based teacher platform that will combine automation, real-time analytics, and intelligent recommendations all within one platform. The platform is expected to support the expansion of administrative overheads, improve effectiveness in teacher performance, and enable teachers to make real-time and informed pedagogical choices.

II. RELATED WORK

The current educational technology has gone past merely just being a glorified data storage to predictive, interactive, and AI-driven systems able to increase the student engagement. The studies emphasize an important role played by real-time analytics in teaching. An example of a quasi-experimental study is that owned using the AI-based dashboard Poll Everywhere in Grade 7 science found that those students who learned with AI support (46 participants) proved to show significantly better learning gains than a control group (43 students) learning by conventional methods. This has been greatly enhanced by the fact that of immediate feedback and interactive learning environments where teachers can dynamically adapt to the instruction.

Also, teacher educational analytics have been indicated to enhance metacognition and reflective behavior. However, challenges remain. Many complex dashboards offer a dense

amount of data, which is hard to read without statistical skills on the part of teachers. To resolve this, more recent research is suggesting explainable AI (XAI) and simpler and narrative-based data summaries to enhance usability and trust.

Assessment has also undergone change owing to AI and specifically the Automated Short Answer Grading (ASAG). The latest techniques encompass both models, such as BERT, with machine learning (e.g., Random Forest), and are more accurate in grading and decrease errors. The Large Language Models (LLMs) also offer increased scalability and the possibility to decrease the time spent on manual grading by more than 80 percent. Nevertheless, there are risks in such problems like criteria drift, situations in which the criteria used to evaluate change over time. Proposed structured forms of prompting, such as Reason-Act-Evaluate (RAE), can be effective in keeping the consistency and aid better consistency with human-graded works.

The use of AI by teachers has increased within a short period. According to 20242025 surveys, estimates are that about 60 percent of educators are currently planning lessons, 33 percent make materials and 28 percent of personalized instruction at the time of planning. The time saved by regular users comes to almost 6 hours in a week, and a large portion of administration work goes to waste. Although, there are still certain issues, such as high learning curves, the necessity to check AI results, and bias and inaccuracy. Teachers report the reduction of workload damaged by around 44 percent and even more increased work is experienced.

Socio-cultural issues also exist. Half of students and parents separate that AI decreases interaction with a human, and teachers are concerned with a decline in professional identity. Reasons why the automation of intellectual labor is increasing are that the pathogenesis of one of the prestigious occupations, teaching, is presently muted to such an extent that perceiving it as a specialty will become significantly harder in the future.

Finally, data-driven decision-making (DDDM) will not be effective without the presence of technology, but it will require institutional support, the cultures of collaboration, and the evolution of the professional growth. Although there are improvements in enhancing data literacy, there is urgent lack of transformation in converting the analysis into practical teaching measures. It is possible to deal with this issue by designing AI systems that are more transparent, interpretable, and are more pedagogically aligned.

III. PROPOSED SYSTEM AND SCOPE

ClassEdge is a proposed system that will support teaching and assessment with the help of various interconnecting features. Its foundation is an Automated Grading System, in which objective questions are interpreted with rule-based logic to achieve the desired accuracy, whereas subjective responses are interpreted with superior NLP models (BERT and T5). These models can be used to have a fine analysis of semantic meaning, contextual elements and content quality in general. It is supported by a Real-Time Performance Analytics module, which includes interactive dashboards that show both individual and group performance in terms of such indicators as average scores, progress trends, and analysis in specific topics.

In order to close the gap between analysis and action, the platform has an AI-based Recommendation Engine that processes student performance data to recommend individual teaching strategies and applicable learning resources. Also, a Collaborative Resource Marketplace enables teachers to share and retrieve teaching resource, facilitating knowledge sharing and institutional becoming. Every feature is consolidated through a Centralized Dashboard, which minimizes the use of disjointed tools.

ClassEdge has the ultimate objectives to automated administrative operations, based on AI and NLP, provide actionable real-time data, build community between instructors, and enhance the reliability and consistency of academic assessment.

The system is technically scalable and adjustable in institutions according to their size. It also facilitates communication with the prevailing Learning Management Systems (LMS) via public APIs as well as standardized data protocols. The role-based access control provides data security to the administrators, teachers, and students. The expected future improvements are predictive analytics, multilingual support and integration with the large-scale cloud-based education systems.

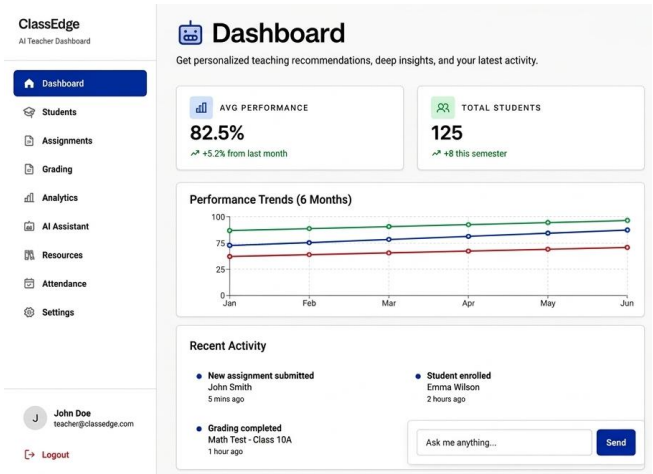

Fig.1: Dashboard

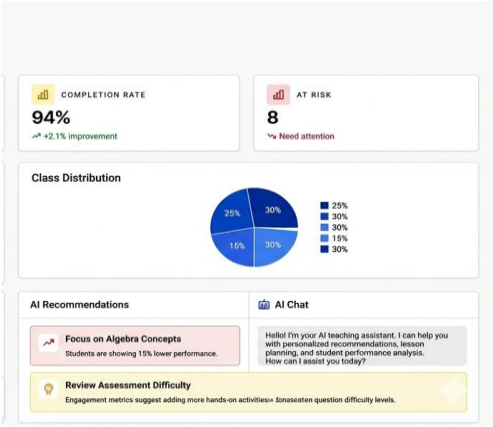

Fig.2: Snapshot of task completion

IV. SYSTEM ARCHITECTURE

The following procedural flowchart would be a conceptualization and tracing of the operational data flow and the interdependent modular architecture of the system:

A. ClassEdge Core System Architecture.

1. Uninterrupted extraction through powerful APIs of legacy LMS.
2. Standardized, and secure CSV batch processing on disconnected environments.
3. First-hand access to student raw text, attendance records, and exam data.

B. Security, Authentication and access control gateway.

1. Cryptographic validation through the use of the JSON Web Tokens (JWT).
2. Intensive encryption of PII and academics through AES Encryption platform.
3. Intense implementation of Role-Based Access Control (RBAC) privileges..

C. Twofold Pronged Automated Evaluation Engine.

1. Objective Sub-Module: Deterministic High speed rule-based algorithms.
2. Intensive encryption of PII and academics through AES Encryption platform.

D. Data Repository & Hot Indexing Layer.

1. MongoDB: Data is stored unformatted and raw text as well as schema of the systems.
2. ElasticSearch: Fast waved upon or aggregation of analytics queries. .

E. Ancient Visualization and Generation of Actionable analytics.

1. Interactive visualization of data (using D3.js, Recharts and Plotly).
2. Structuring of interactive heatmaps, scatter plots, and trend line graphs.

F. Pedagogical Productivity & Extracurricular Interface.

1. On-the-fly creation of the interactive teacher Dashboard.
2. Access to peer to peer Partnership Resource Marketplace.

The system starts with the collection of the data which involves collecting information of the students like attendance, grades and assignments using secure LMS integration using RESTful APIs. Whereas not all data can be integrated, a formatted CSV upload, with smart data map delivers the correct data ingestion.

This information is processed by the Automated Evaluation module. Rule-based algorithms are used in objective measurements of accuracy, whereas subject answers are measured with NLP models such as BERT and T5. Comparing these responses to the rubric standards and production of final scores through Random Forest models are done to guarantee the consistency and decrease biasness.The Data Visualization and Analytics module transforms findings into interactive dashboards with the help of such programming languages as Recharts, D3.js, and Plotly, which allow providing real-time insights, performance tracking, and comparison of cohorts to make data-driven decisions.

A Recommendation Engine is an AI-based program that provides individualized teaching and learning processes and specific learning materials by examining performance and learning patterns.

Lastly, JWT-based authentication, AES encryption and role based access control (RBAC) is implemented to provide security as well as access controls to ensure data protection and control access to user permissions.

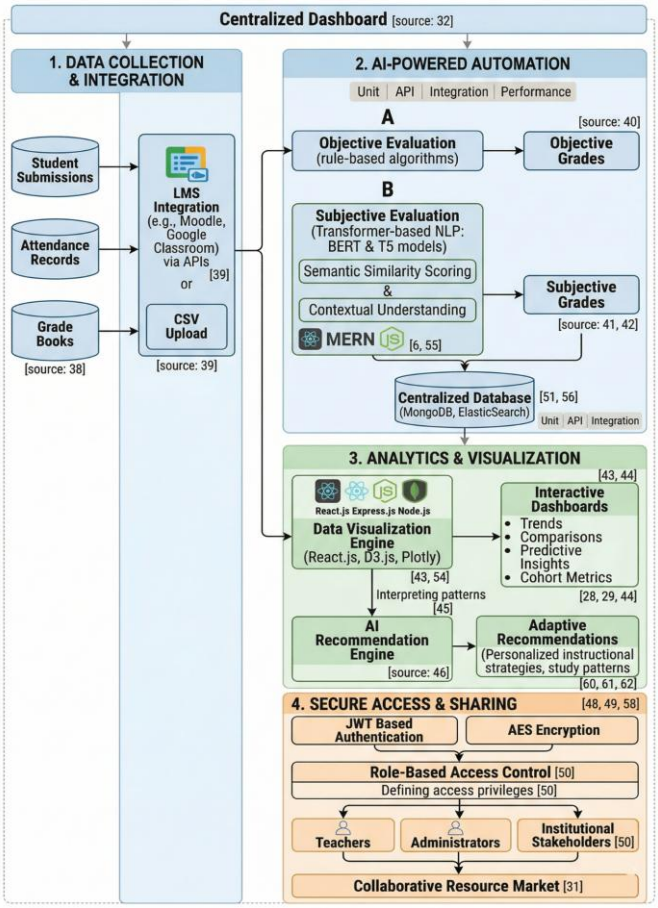

Fig. 3: Architecture of the Centralized Dashboard

V. TESTING TECHNIQUES

Virtuous manual testing of the system is planned to have a fluent and friendly UI/UX. Such makes sure that intricate visualizations are made friendly and their workflows like the upload of CSVs, the rubric manipulations, and browsing their resource marketplace are made seamless to the non-technical customers.

Parallel unit testing at the code level is also done to prove individual components separately. Automated test cases are used to identify and solve errors that occur in core modules such as grading algorithms, JWT-based authentication, and visualization logic within a short period.

The importance of API testing is explained by the fact that the system depends on the external data sources and microservices. It provides safe, dependable, and stable communication with the third-party LMS systems and NLP services.

Last of all is integration and performance testing that test the behavior of the system in real life conditions. Scalability and stability are checked with simulated loads e.g., with thousands of concurrent users lacking in submitting their assignment. These are the tests that indicate that the cloud infrastructure built on Docker can be scaled effectively without any drop in its performance and reliability.

Core Evaluative Metric	**Traditional Process**	**ClassEdge AI Framework**	**Impact.**
Average Subjective Grading Time	Time-intensive, manual subjective grading time	Automated through BERT/T5 + Random Forest	30-50% shorter grading time/lesser fatigue.
Accuracy and Consistency	Subject to bias and inconsistency	algorithms based grading, rubric based grading	Higher accuracy and consistent scoring
Availability of performance data in real time	Humane delays feedback provided by users	Real-time dashboard	instant insights and more immediate intervention .
Instructional Resources Distribution	Dispersed and dispersed	Dispersed resources are centrally-hosted resources	Distribution Enhanced collaboration and sharing.
Quality of Feedback	Generalized by time constraints	AI generated, in-depth feedback	57Percent improvement in the level of feedback.

Table 1: Performance Comparison

VI. RESULT AND DISCUSSION

The outcomes show high levels of efficiency. Results of AI deployment reveal that it lowers the average grading time (30-50 percent), which is consistent with the findings on the national level, revealing that teachers who employ AI can save around 5.9 hours per week. This translates into the saving of time in the processing of large amounts of assessment. Also, AI-based grading enhances the consistency and accuracy by reducing the human bias and exhaustion.

These efficiencies amount to transformational effect on teaching. Through real-time analytics, which are made possible by the use of advanced visualization tools such as D3.js, educators can quickly define their learning gaps, monitor their progress and initiate specific and data-driven instructional strategies. Consequently, both student performance and student engagement demonstrate positive changes, whereas administrative stress is decreased considerably, and it allows teachers to devote more attention to creative and interactive elements of teaching.

These advantages, however, should be taken into consideration together with socio-technical challenges. Although there is an objective reduction in time, approximately 44 percent of teachers themselves mention that their workload does not decrease as they redirect energy going over work on tasks like AI outputs verification, misuse detection, and training on new tools. Furthermore, almost half of the students claim the decreased personal contact with teachers in AI-mediated settings, which is worrying as it brings up the issue of less intense human relationships.

Hence, systems such as ClassEdge are expected to primarily act as a back-up aid rather than substitute human interaction to increase efficiency in any way. This is because the time that is saved due to automation must be specifically channeled into other areas such as student mentorship and personal interaction so that technological progress would not overshadow the human nature of education.

VII. CONCLUSION AND FUTURE WORK

The effectiveness of AI integration is demonstrated by the quantitative results with strong evidence. The data about deploying AI demonstrates a 30-50 percent decrease in the time spent on grading, which coincides with the national literature stating that educators on AI save 5.9 hours per week, which is close to six weeks of teaching time per year. Besides efficiency benefits, AI based scoring is much more efficient and adds to the quality of evaluation due to high

levels of consistency and reduced human bias.

There are significant pedagogical implications that arise out of these improvements. Analytics through the backing of tools such as D3.js provide real-time view of the student performance, determining what they have learned and how they have progressed over a period of time. This will enable teachers to implement accurate and fact-based teaching methods that will improve relative performance as well as student interaction. The system will enable teachers to move back to the creative and human elements of teaching by addressing the reduced administrative burden.

These advantages have to be weighed off though on a socio-technical basis. Compared to time savings that can be quantified, approximately 44% of teachers do not even feel the decrease in workload when the roles of controlling AI output, abusive use, as well as acquiring knowledge of new tools arise. Also, almost half of the students mention decreased interaction in environments supported by AI, which has concerns regarding the lack of close interaction with people and peer contact.

Thus, the position of ClassEdge should be based mainly on one of the administrative support systems. The automation time should be secured and invested into direct student mentorship and face-to-face interaction so that AI will contribute to the process, and no human component still crucial to the educational process will be substituted.

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