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# Real-Time Learning Analytics Through Integrated Attendance and Assessment Engagement Tracking

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**Abstract-** Contemporary educational institutions face a fundamental obstacle: when attendance systems and assessment platforms function independently, faculty lack early signals of student struggle. Students may attend classes consistently while grappling with conceptual confusion, or their quiz performance may reveal comprehension issues weeks before summative evaluations expose their vulnerability. By that point, meaningful intervention becomes difficult. This research addresses this critical gap through an integrated technological solution that merges attendance documentation with formative assessment behavioral patterns to construct comprehensive student engagement profiles. Rather than relying on surveillance-based monitoring, our system analyzes observable academic behaviors-when students submit assessments, consistency in their responses across similar question types, temporal alignment between instruction and preparation activities, and frequency of formative practice participation. These behavioral signals, when synthesized, provide nuanced indicators of learning health that faculty can act upon immediately.

Our platform architecture utilizes a modern, scalable technology foundation: React.js provides responsive user interfaces across institutional devices, while Supabase delivers backend infrastructure with PostgreSQL database capabilities and serverless processing functions. This technical approach prioritizes institutional accessibility, requiring minimal technical maintenance burden, making adoption feasible for universities with limited IT resources.

The system's analytical innovation centers on the Engagement Index, a composite behavioral metric that normalizes four dimensions - attendance consistency, assessment participation frequency, response quality stability, and temporal preparation patterns-into a weighted score reflecting student learning engagement. When this index declines beyond institutional thresholds, the system generates alerts prompting faculty to initiate supportive conversations with students before academic consequences manifest in exam performance.

This work demonstrates that thoughtfully integrated academic data streams generate actionable pedagogical insights without necessitating invasive monitoring technologies. Our approach preserves institutional privacy commitments while empowering educators with evidence-based understanding of student learning trajectories, ultimately supporting more effective and timely academic interventions.

**Keywords-**academic analytics, early intervention systems, engagement metrics, formative assessment, institutional learning analytics, learning management integration, student success prediction, web-based educational technology

## I. INTRODUCTION

Educational institutions worldwide rely upon attendance systems and assessment platforms to monitor student progress, yet these critical data sources typically operate in isolation. Faculty discover student struggle only after poor examination performance, creating reactive rather than preventive support models. Meanwhile, students receive cumulative feedback exclusively at assessment endpoints rather than continuous guidance regarding comprehension development. This temporal misalignment between evidence emergence and intervention opportunity represents a fundamental inefficiency in contemporary educational systems. Modern information technology enables collection and integration of behavioral data that would previously have required intensive manual observation. However, institutional adoption of learning analytics remains inconsistent, with many institutions lacking integrated platforms that combine multiple data streams toward actionable insights. This research presents a practical, privacy-conscious technological solution designed for realistic institutional deployment. By synthesizing attendance participation with formative assessment engagement patterns, the system generates continuous indicators of learning health that enable educators to provide targeted support at critical moments.

## II. PROBLEM STATEMENT

Existing institutional systems treat attendance and assessment as disconnected administrative functions. Attendance platforms record presence timestamps but provide no insight into cognitive engagement or learning process quality. Assessment systems evaluate performance on assigned work but lack temporal context regarding student preparation behaviors or participation consistency.

This fragmentation prevents systematic identification of emerging academic difficulty until it manifests in summative assessment failure. Students frequently exhibit identifiable warning patterns observable through integrated behavioral analysis: declining quiz participation frequency, increasing time pressure in assessment attempts, inconsistent response quality across similar question types, or shifting submission timing relative to instructional delivery. However, these patterns remain invisible to faculty when captured by disconnected systems. Additionally, many students refrain from reporting struggles until academic consequences become severe, preventing early intervention opportunity. Contemporary educational research documents that early identification and targeted support dramatically improve persistence and success outcomes, particularly for at-risk student populations. Yet most institutions lack technological infrastructure enabling systematic, timely identification of struggling students. This research addresses this critical gap by demonstrating practical implementation of an integrated analytics platform requiring no invasive surveillance technologies while generating meaningful actionable insights for educators.

### III. SYSTEM DESIGN

Our platform comprises four integrated functional modules: attendance registration, assessment administration, analytics processing, and faculty intervention support. The system prioritizes usability and accessibility for diverse institutional contexts, avoiding unnecessary technical complexity that would impede adoption.

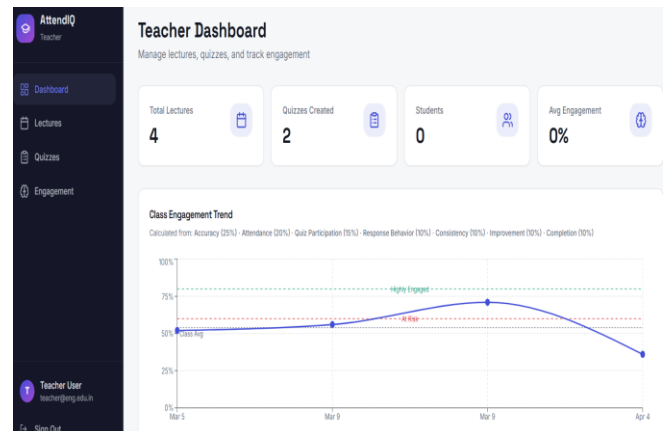
#### *A. Technology Stack Architecture*

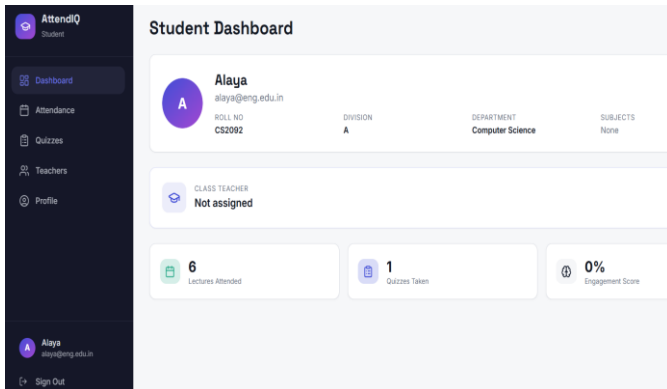
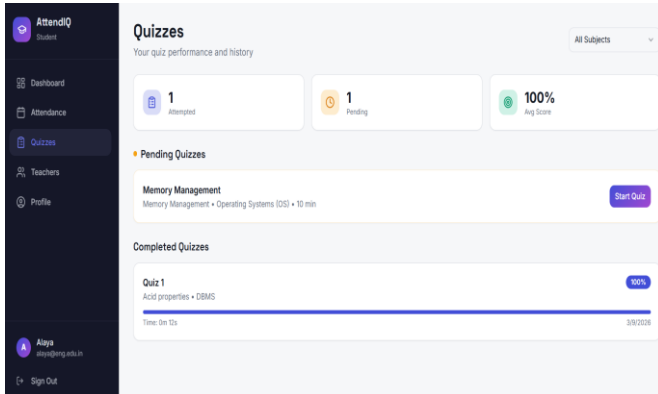
The frontend utilizes React.js with TypeScript for type-safe component development, Tailwind CSS for responsive styling, and Vite as the build optimization tool. The backend leverages Supabase Platform-as-a-Service offering, which provides PostgreSQL relational database, role-based authentication, and serverless function execution. This architecture enables rapid development without infrastructure management overhead. PostgreSQL supports complex analytical queries required for engagement metric calculation. Supabase Authentication provides institutional single sign-on integration and granular (TA). The metric normalizes each dimension within the range [0,1] using institutional baseline data, then calculates weighted composite:  $EQ = 0.30(AC) + 0.35(QP) + 0.20(RQ) + 0.15(TA)$ .

Weights reflect educational research regarding predictors of academic success and are adjustable per institutional context. The system tracks EQ trajectories across the semester, flagging students whose EQ declines beyond configurable thresholds as high-priority intervention candidates. This approach acknowledges legitimate engagement variation while identifying departure from individual baseline performance as meaningful signal. The EQ metric generates actionable early warnings enabling faculty to initiate support conversations before performance deteriorates on high-stakes summative assessments.

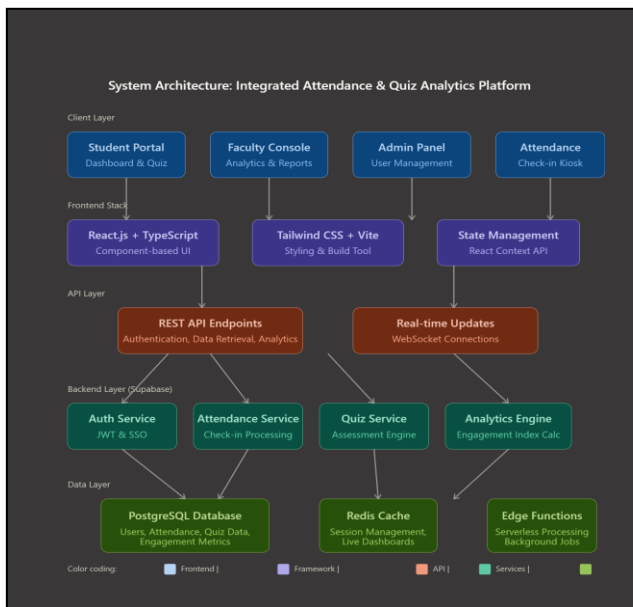
### IV. IMPLEMENTATION

The platform has been developed iteratively incorporating feedback from educational practitioners. Faculty engagement with interface design ensured analytics are meaningful rather than overwhelming. Integration with existing learning management systems minimized adoption friction. Preliminary implementation in three undergraduate computer science courses demonstrates promising results. Faculty consistently identify EQ alerts approximately two weeks earlier than they would typically discover struggling students through examination performance, enabling substantially more timely and effective intervention. Student feedback indicates that regular formative assessment participation combined with engagement tracking increases awareness of comprehension development and supports metacognitive learning. Institutional administrators report that anonymized cohort-level analytics support evidence-based curricular and pedagogical decision-making. The system successfully operationalizes engagement assessment without implementing surveillance technologies, respecting privacy values while delivering actionable insights.





### V. SYSTEM ARCHITECTURE



### VI. CONCLUSION

This research presents a practical technological framework for engagement assessment that operates through established academic channels without invasive monitoring. By integrating attendance documentation with formative assessment analytics, the system generates early indicators of academic difficulty while respecting privacy and institutional values. The technology stack prioritizes accessibility and sustainability, enabling adoption across diverse institutional contexts. Implementation experiences demonstrate genuine faculty value in these analytics for supporting student success. Future development should continue leveraging educational research to refine metrics, expand support service integration, and validate across diverse contexts. The broader implication is that thoughtfully designed technology enhances educational decision-making while preserving institutional integrity and student autonomy.

This work contributes to the emerging field of learning analytics by demonstrating that meaningful insights require integrated data analysis rather than sophisticated prediction algorithms, making adoption feasible for institutions with modest technical resources.

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