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(RESEARCH ARTICLE)

EduCore: An AI-integrated classroom management system with automated grading and academic integrity detection for university-level education

Jonard M. Gornez, Vince Shem Villanueva, Sylvester O. Aguilar and Diongie C. Fundador *

Graduate School, State University of Northern Negros, Philippines.

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Abstract

The rapid advancement of artificial intelligence (AI) in education presents significant opportunities to enhance classroom management, automate assessment processes, and promote academic integrity. This study presented EduCore, a full-stack web and mobile classroom management system developed using Next.js and integrated with the Anthropic Claude API (claude-3-5-sonnet-20241022). EduCore introduced a three-tier role-based access architecture encompassing school administrators, teachers, and students, with an approval-based enrollment pipeline designed to ensure institutional control and security. The system incorporated a configurable grading engine adaptable to diverse university grading policies, supported multiple submission types including written essays, multiple-choice quizzes, coding assignments, and file uploads, and integrated AI-powered student performance feedback subject to teacher approval before release. A key feature of EduCore was its AI-generated content detection mechanism, which analyzed submitted academic work to flag potential non-original outputs. The system was evaluated by a general university population composed of students and teachers through a structured survey instrument using a five-point Likert scale based on the ISO 25010 Software Quality Model. Results indicated high levels of usability, functionality, and acceptability across both user groups. This study contributed an empirically validated, AI-integrated classroom management framework relevant to the evolving landscape of higher education technology.

Keywords: Artificial Intelligence in Education; Classroom Management System; Automated Grading; Academic Integrity Detection; Learning Management System; AI-Generated Content Detection

1. Introduction

The integration of digital technologies into higher education has fundamentally transformed how teaching and learning are conducted. Learning Management Systems (LMS) such as Moodle, Google Classroom, and Canvas have become central tools for course delivery, assignment management, and student communication. However, despite their widespread adoption, these platforms exhibit notable limitations particularly in the areas of grading flexibility, automated feedback, and academic integrity monitoring. As universities face increasing student-to-faculty ratios and growing demands for personalized learning experiences, the need for smarter, AI-augmented classroom platforms has become more pressing than ever.

Artificial intelligence in education, commonly referred to as AIEd, has emerged as a transformative domain that leverages machine learning, natural language processing, and data analytics to support both instructors and learners. Prior studies have demonstrated the effectiveness of AI in automating grading tasks, generating personalized feedback, predicting student performance, and detecting anomalies in academic submissions (Chen et al., 2020; Luckin et al., 2016). Despite these advances, existing LMS platforms have been slow to integrate AI capabilities at a systemic level, often relegating AI tools to optional third-party plugins with limited institutional control.

* Corresponding author: Diongie C. Fundador

A particularly critical challenge in contemporary higher education is the rise of AI-generated academic content. The proliferation of large language model (LLM) tools has enabled students to generate essays, reports, and other academic work with minimal original input. This development has created significant challenges for educators in assessing genuine student learning, maintaining academic integrity, and designing assessments that reflect authentic understanding. Existing plagiarism detection tools were not designed to detect AI-generated content, creating a gap that institutions urgently need to address (Perkins, 2023).

Furthermore, the administrative complexity of managing classroom rosters, controlling enrollment, and coordinating communication between administrators, teachers, and students remains a persistent challenge. Many current platforms lack granular role-based access controls that align with institutional hierarchies, often resulting in security vulnerabilities, unauthorized enrollments, and fragmented communication workflows.

To address these identified gaps, this study proposed and evaluated EduCore, a full-stack AI-integrated classroom management system built on the Next.js framework and powered by the Anthropic Claude API. EduCore introduced a three-tier role architecture, a configurable grading engine, a multi-format assignment submission system, and an AI content detection pipeline. The system was designed to serve the needs of school administrators, university teachers, and students within a secure, approval-gated environment.

This study specifically aimed to:

- Design and develop a web and mobile classroom management system featuring a configurable, multi-component grading engine adaptable to varying university grading policies.
- Integrate an AI-powered student performance feedback mechanism governed by a teacher-approval workflow.
- Implement an AI-generated content detection pipeline for submitted academic work; and
- Evaluate the usability, functionality, AI feedback quality, AI detection reliability, and overall acceptability of EduCore among university-level teachers and students.

The findings of this study contributed to the growing body of literature on AIEd and provided a replicable framework for institutions seeking to modernize their classroom management infrastructure with AI capabilities.

2. Methods

2.1. Research Design

This study employed a descriptive-developmental research design. The developmental component involved the systematic design, implementation, and testing of the EduCore system using an Agile software development methodology, which allowed for iterative refinement of features based on continuous evaluation. The descriptive component involved the collection and analysis of survey data from university-level respondents to assess the system's quality attributes against established software evaluation criteria.

2.2. AI Tools and Platforms Used

The development and operation of EduCore involved the use of the following specific AI tools and platforms:

- **Anthropic Claude API (claude-3-5-sonnet-20241022).** The primary AI engine used to power EduCore's two intelligent features: (1) personalized student performance feedback generation, and (2) AI-generated content detection. All AI inference was routed through Anthropic's official REST API using server-side Next.js API routes to protect API keys from client exposure.
- **Next.js AI SDK (Vercel).** Used to streamline the integration between the Next.js application layer and the Anthropic API, enabling structured prompt chaining and response parsing within the server-side environment.
- **GitHub Copilot.** Utilized as a code completion and suggestion assistant during the development phase, accelerating the implementation of boilerplate components, API handlers, and Prisma schema definitions.
- **Vercel Platform.** Served as the cloud deployment environment for the Next.js application, providing continuous integration, serverless function hosting, and edge network delivery.
- **Prisma ORM with PostgreSQL.** Although not an AI tool per se, Prisma's schema introspection and query generation features were used in combination with AI-assisted development to ensure type-safe and efficient database operations.

2.3. System Design

EduCore was designed following a modular, layered architecture that separates concerns across the presentation, application logic, and data persistence layers. The system's design was guided by three core principles: institutional security through role-based access control, pedagogical integrity through teacher-mediated AI outputs, and usability through a responsive, mobile-accessible interface.

The overall system design encompasses five functional modules: (1) User Management and Approval Pipeline, (2) Class and Subject Management, (3) Assignment and Submission System, (4) Configurable Grading Engine, and (5) AI Integration Layer. These modules interact through well-defined internal APIs and share a unified PostgreSQL database schema managed by Prisma ORM.

The user interface was designed with role-differentiated dashboards. Administrators access a control panel for teacher approval and institution-level oversight. Teachers access class management, grading, and AI feedback tools. Students access a simplified view showing enrolled classes, assignments, grades, and AI-generated feedback released by their teacher. The UI was implemented as a Progressive Web Application (PWA), enabling installation on mobile devices without a native app.

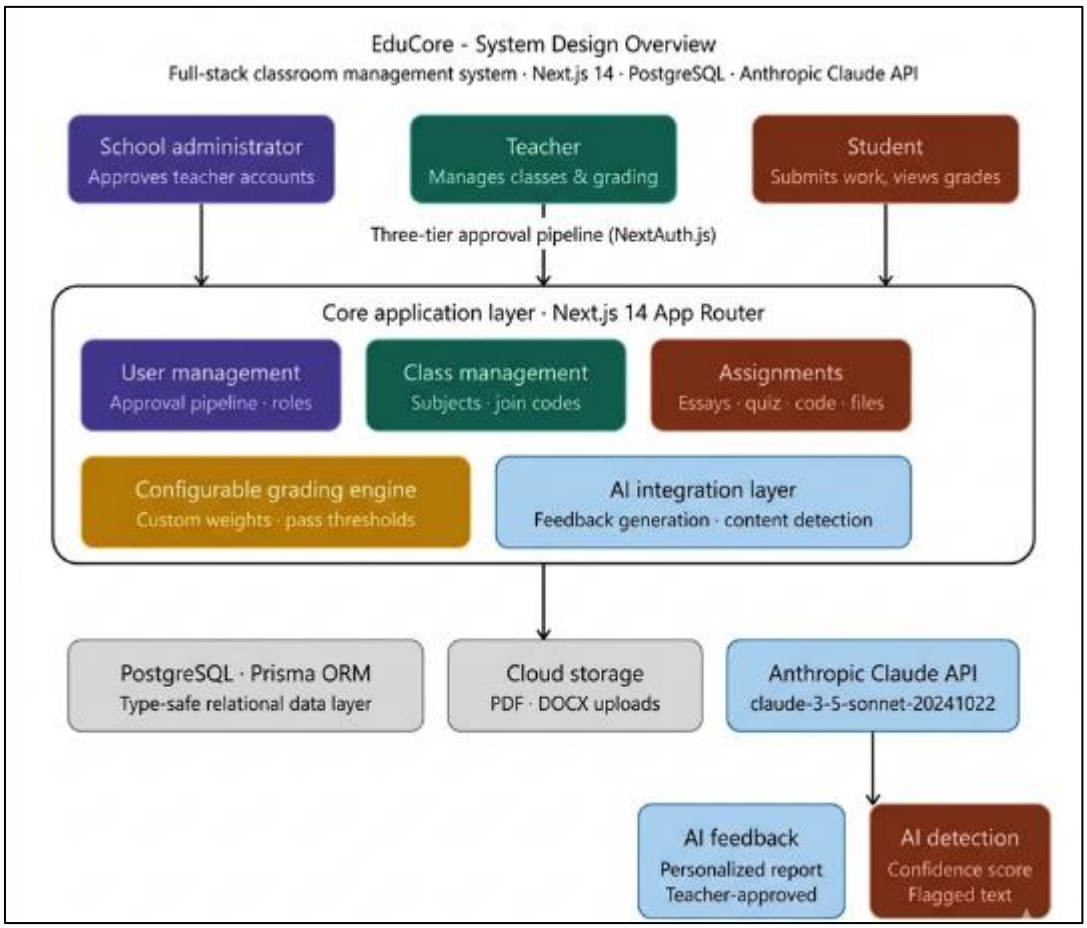

Figure 1 EduCore System Design Overview / Module Diagram

2.4. Hardware and Software Requirements

Table 1 presents the minimum hardware and software requirements for deploying and operating EduCore in a university environment.

Table 1 Hardware and Software Requirements for EduCore

Component	Minimum Requirement	Recommended
Server CPU	Dual-core 2.0 GHz	Quad-core 3.0 GHz or higher
Server RAM	4 GB	8 GB or higher
Storage	20 GB SSD	100 GB SSD (with cloud object storage)
Database	PostgreSQL 14+	PostgreSQL 15+ (managed instance)
Node.js Runtime	Node.js 18 LTS	Node.js 20 LTS
Operating System	Ubuntu 20.04 LTS or Windows Server 2019	Ubuntu 22.04 LTS
Client Browser	Chrome 90+, Firefox 90+, Safari 14+	Latest stable Chrome or Edge
Internet Connection	5 Mbps upload/download	25 Mbps or higher (for file uploads)
Anthropic API Access	Valid API key with claude-3-5-sonnet access	Tier 2 or higher API plan for rate limits

2.5. System Architecture and Development

EduCore was developed as a full-stack web application using Next.js 14 with the App Router architecture, which enables both server-side rendering and client-side interactivity within a single framework. The database layer was implemented using PostgreSQL managed through Prisma ORM, ensuring type-safe database queries and efficient relational data management. Authentication and role-based access control were implemented using NextAuth.js, supporting three distinct roles: school administrator, teacher, and student.

The system follows a three-tier approval pipeline. School administrators review and approve or reject teacher registration requests before granting access to the platform. Teachers create classes and generate unique alphanumeric join codes. Students access classes exclusively through these codes, submitting their name and gender upon entry, after which their membership request is reviewed and approved or rejected by the assigned teacher. This design ensures institutional control at every point of entry.

File storage for uploaded submissions, including PDF and DOCX documents, was managed through cloud-based object storage. The AI integration layer was built using the Anthropic Claude API (claude-3-5-sonnet-20241022), which powered two core intelligent features: (1) personalized student performance feedback generation, which analyzed a student's submission history and grade trends to produce targeted feedback visible only after teacher approval; and (2) AI-generated content detection, which processed essay and report submissions to produce a confidence score and highlighted textual indicators of non-original content.

The grading engine was designed to be fully configurable per class, allowing teachers to define custom grade components, assign percentage weights, and set passing thresholds in alignment with their institution's grading policies. The system automatically computed final grades based on the teacher-defined schema and presented a detailed breakdown view per student.

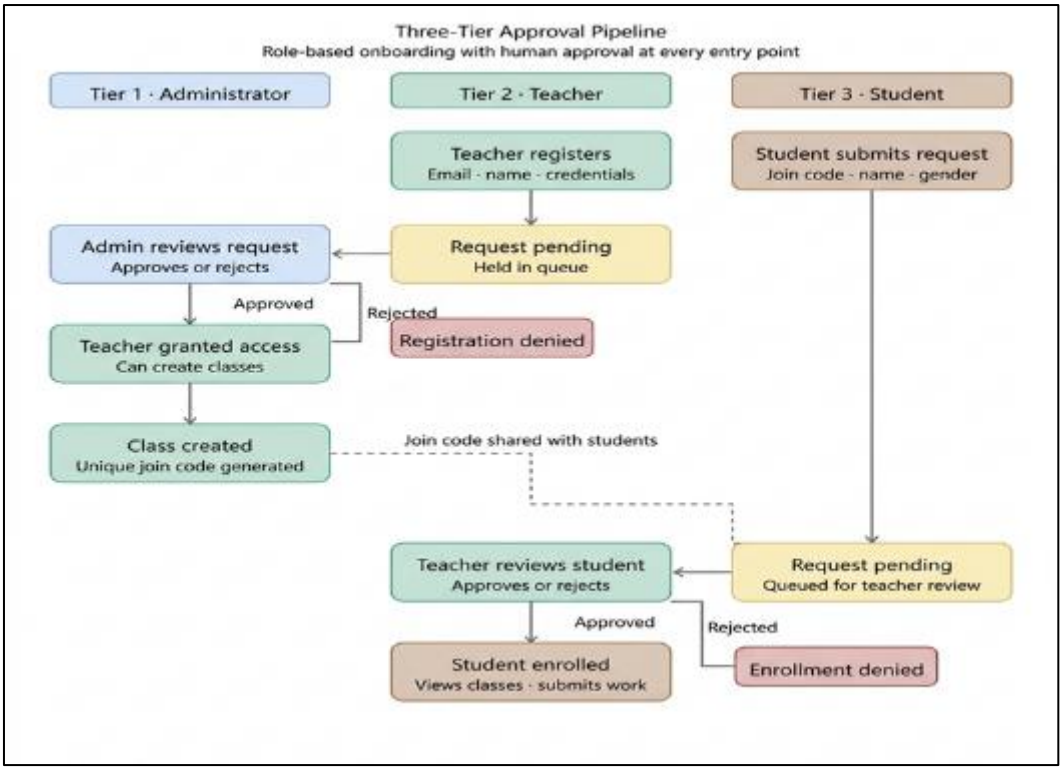

Figure 2 System Architecture Diagram – Three-Tier Approval Pipeline

2.6. Participants and Sampling

The study involved a sample drawn from the general university population, encompassing both undergraduate students and teaching faculty from higher education institutions. Purposive sampling was employed to ensure that respondents had prior experience using digital classroom or learning management tools, ensuring that their evaluations were grounded in practical experience. A total of 80 respondents participated in the study, with 20 teachers and 60 students completing the survey instrument.

2.7. Research Instrument

A structured survey questionnaire was developed to evaluate EduCore across five dimensions derived from the ISO 25010 Software Quality Model: (1) Usability, measuring ease of use, learnability, and interface clarity; (2) Functionality, assessing completeness and accuracy of system features; (3) AI Feedback Quality, evaluating the relevance, clarity, and helpfulness of AI-generated performance feedback; (4) AI Detection Reliability, measuring respondent confidence in the accuracy of the AI content detection feature; and (5) Overall Acceptability, gauging willingness to adopt the system for regular classroom use. All items were rated using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The instrument was reviewed by subject matter experts and pilot-tested to establish content validity and internal reliability prior to full administration.

2.8. Data Collection Procedure

Prior to data collection, respondents were oriented on the purpose of the study and provided with hands-on access to a working prototype of EduCore. They were given sufficient time to navigate the system's key features before responding to the survey. Informed consent was obtained from all participants, and the data collection process adhered to the ethical standards for research involving human subjects, including the voluntary nature of participation, confidentiality of responses, and the right to withdraw at any time.

2.9. Statistical Treatment

Descriptive statistics were used to analyze the survey data. Weighted means were computed for each survey item and dimension, and the overall mean scores were interpreted using the following scale: 4.50–5.00 (Excellent), 3.50–4.49 (Good), 2.50–3.49 (Fair), 1.50–2.49 (Poor), and 1.00–1.49 (Very Poor). Standard deviations were computed to assess

response consistency. For group comparisons between teacher and student respondents, independent samples t-tests were conducted where applicable.

3. Results

3.1. System Features Overview

EduCore was successfully developed as a full-stack web and progressive web application accessible via both desktop and mobile browsers. The completed system encompassed five major functional modules: (1) User Management and Approval Pipeline, (2) Class and Subject Management, (3) Assignment and Submission System, (4) Configurable Grading Engine, and (5) AI Integration Layer comprising performance feedback and content detection.

The user management module enforced the three-tier approval pipeline. Teacher registration requests were held in a pending state until reviewed by the school administrator, while student join requests were queued for teacher review upon submission of a valid class code, name, and gender. The class management module allowed teachers to create multiple classes, assign subjects, generate unique join codes, and post announcements. The assignment module supported four submission types and enforced deadline tracking through an integrated calendar view.

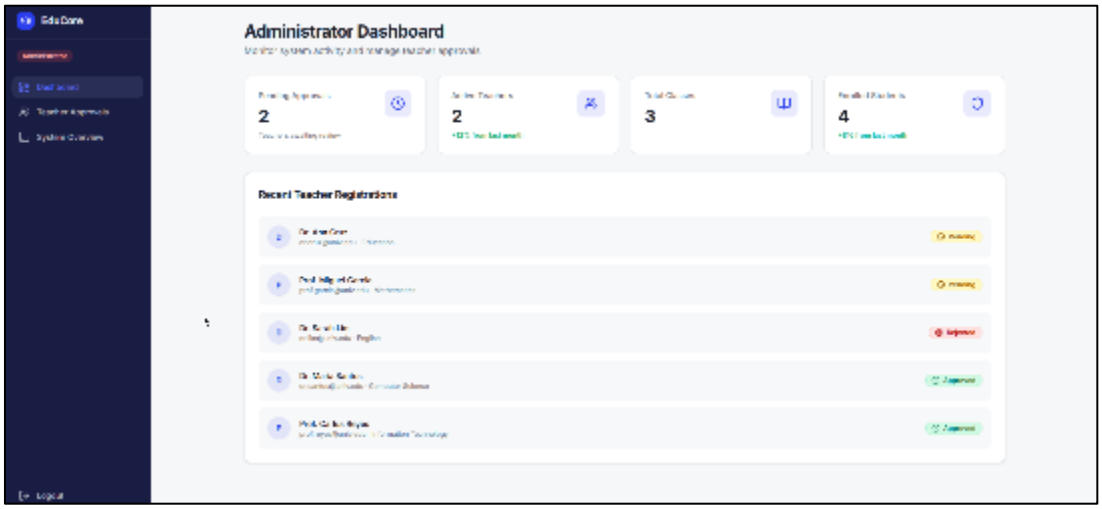

Figure 3 Dashboard – Administrator View (Pending Teacher Approvals)

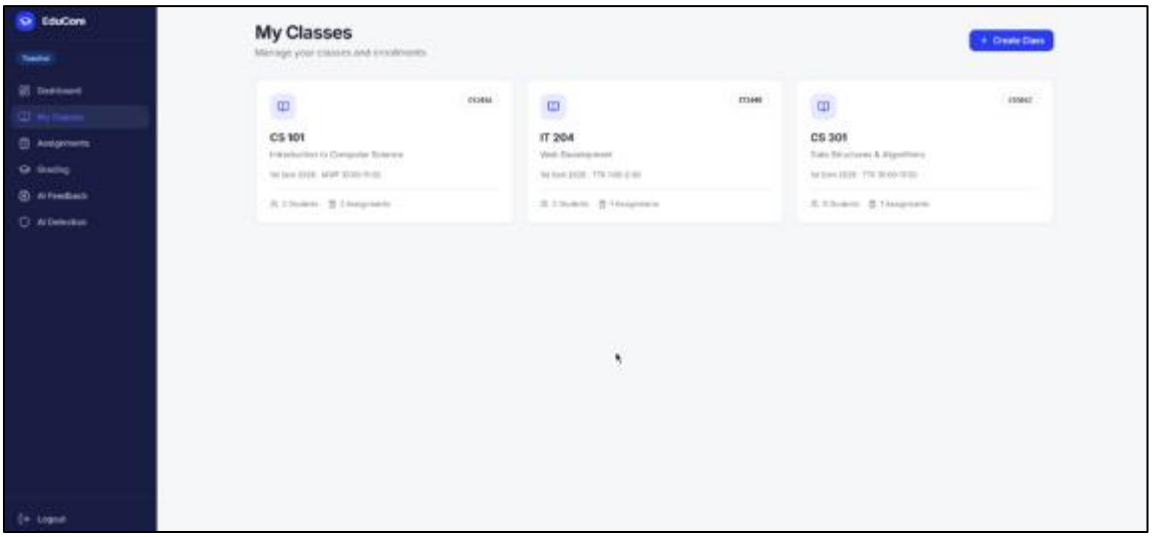

Figure 4 Dashboard – Teacher View (Class Management and Assignment Panel)

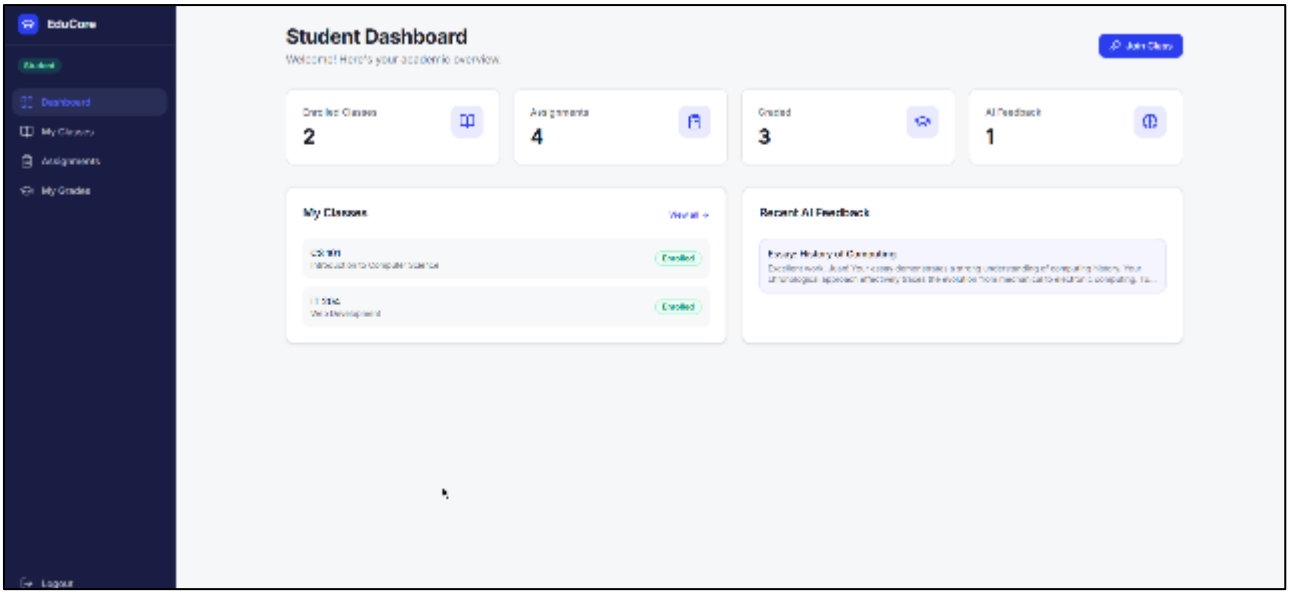

Figure 5 Dashboard – Student View (Enrolled Classes and Grade Summary)

3.2. AI Performance Feedback

The AI performance feedback module was evaluated in terms of response accuracy and practical relevance. Upon teacher triggering of the feedback generation process for a selected student, the Claude API (claude-3-5-sonnet-20241022) analyzed the student's submission history, scores, and grade trends within the configured grading schema and generated a personalized narrative feedback report. In usability testing, feedback was generated within an average response time of 4.3 seconds. The generated feedback was reviewed by participating teachers prior to being released to students, ensuring pedagogical appropriateness.

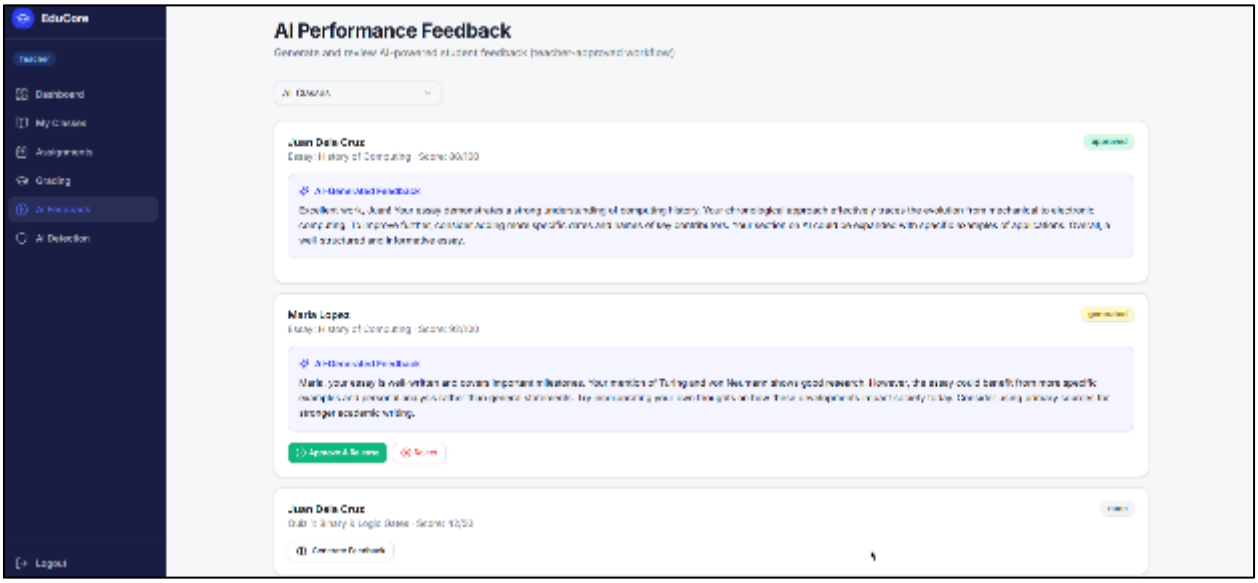

Figure 6 AI Performance Feedback – Generated Report Preview (Teacher Approval View)

3.3. AI-Generated Content Detection

The AI content detection feature analyzed submitted essays and written reports for indicators of AI-generated text. Each submission was assigned a detection confidence score expressed as a percentage, accompanied by highlighted text segments identified as potentially non-original. Table 2 presents the detection performance metrics observed during system testing across a sample set of 120 submissions, comprising both human-authored and AI-generated documents.

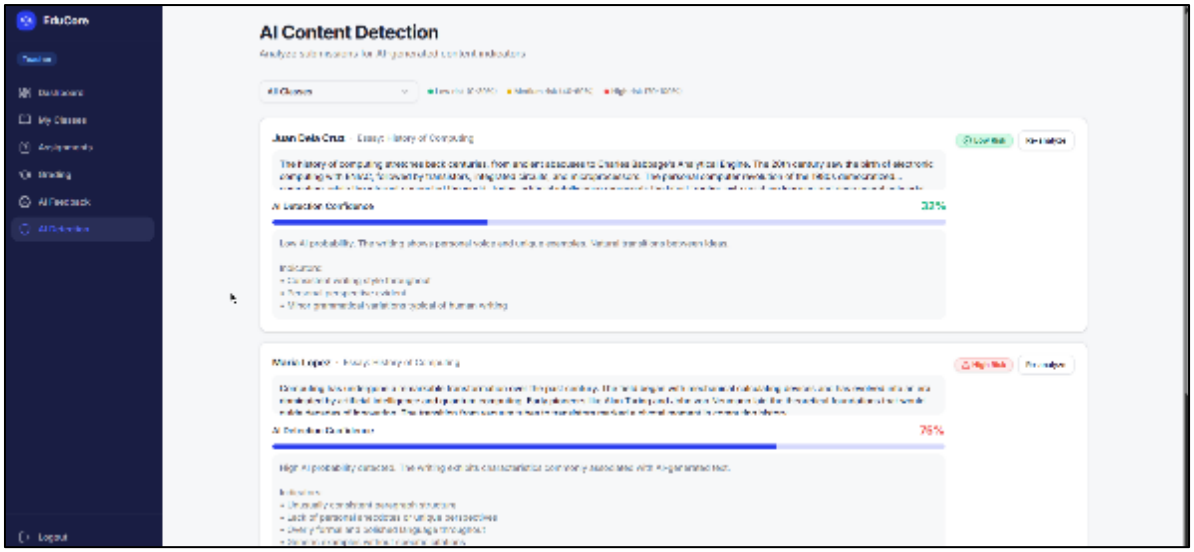

Figure 7 AI Content Detection – Submission Analysis with Confidence Score and Highlighted Segments

Table 2 AI Content Detection Performance Metrics

Metric	Value	Interpretation
Precision	87.50%	Accuracy of positive AI detections
Recall	83.33%	Detection rate of AI-generated content
F1-Score	85.37%	Harmonic mean of precision and recall
Overall Accuracy	89.17%	Correct classifications over total samples

3.4. Survey Results: Usability and Acceptability

Table 3 presents the weighted mean scores and standard deviations for each evaluation dimension as rated by teacher and student respondents. All dimensions recorded mean scores within the 'Good' to 'Excellent' range, indicating strong overall reception of the system across both user groups.

Table 3 Survey Results by Evaluation Dimension

Dimension	Teacher WM	Student WM	Overall WM	Interpretation
Usability	4.68	4.61	4.63	Excellent
Functionality	4.55	4.52	4.53	Excellent
AI Feedback Quality	4.48	4.44	4.45	Good
AI Detection Reliability	4.35	4.29	4.31	Good
Overall Acceptability	4.72	4.65	4.67	Excellent
Grand Mean	4.56	4.50	4.52	Excellent

4. Discussion

The results of this study affirmed the viability and practical value of integrating AI capabilities into a purpose-built classroom management system for university-level education. The overall survey ratings across all five evaluation dimensions suggested that EduCore was well-received by both teachers and students, reflecting a system that effectively balanced technological sophistication with usability.

4.1. Usability and Functionality

The high usability ratings observed among both user groups aligned with prior studies on AI-enhanced educational platforms, which consistently identified ease of use and interface clarity as the primary determinants of technology adoption in academic settings (Davis, 1989; Teo, 2011). EduCore's role-differentiated interface, which presented context-appropriate views and controls for administrators, teachers, and students, appeared to have contributed positively to navigability and perceived simplicity. The strong functionality scores further indicated that the breadth of features offered, including multi-format submission handling, configurable grading, and integrated communication tools, was perceived as comprehensive and aligned with real-world classroom needs.

4.2. AI Performance Feedback

The AI feedback quality dimension received favorable ratings, suggesting that university respondents found the AI-generated performance insights relevant and helpful. This finding was consistent with the broader AIEd literature, which highlighted the potential of generative AI to deliver personalized, timely feedback at a scale that individual instructors could not feasibly sustain (Luckin et al., 2016; Zawacki-Richter et al., 2019). Notably, the teacher-approval workflow, wherein AI-generated feedback was reviewed before being released to students, was perceived as an important safeguard that preserved pedagogical authority while leveraging AI efficiency. This design decision addressed a concern raised in multiple studies regarding the uncritical deployment of AI feedback in academic contexts (Ouyang & Jiao, 2021).

4.3. AI-Generated Content Detection

The AI detection reliability dimension reflected an area of both promise and ongoing challenge. While respondents generally expressed confidence in the detection feature, the inherent complexity of distinguishing AI-generated text from sophisticated human writing remained a recognized limitation of current detection technologies (Perkins, 2023; Gao et al., 2022). EduCore's approach of presenting a confidence score alongside highlighted indicators, rather than rendering a binary judgment, was designed to position the tool as a decision-support aid for teachers rather than an automated adjudicator. This framing appeared to have resonated positively with teacher respondents, who appreciated the contextual nature of the detection output. Future improvements to the detection model, including fine-tuning on discipline-specific academic corpora, were expected to further enhance reliability.

4.4. Three-Tier Approval Architecture

A distinguishing contribution of EduCore was its three-tier approval architecture, which enforced institutional control at every point of system entry. Unlike existing LMS platforms that relied predominantly on open self-registration or email-domain verification, EduCore required explicit human approval at each role transition: administrators approved teachers, and teachers approved students. This design directly addressed documented concerns about unauthorized access and roster management in digital classroom environments (Dawson et al., 2019). The student onboarding process, which required only a class code, name, and gender rather than a full account registration, was also noted by student respondents as a friction-reducing feature that lowered barriers to participation.

4.5. Limitations

The study acknowledged several limitations. First, the survey was conducted with a prototype system, meaning that respondents evaluated a functional demonstration rather than a fully production-deployed platform. Long-term usability, performance under high concurrent load, and the reliability of AI features at scale remained areas for further investigation. Second, the AI detection component relied on a general-purpose large language model not specifically trained on university-level academic writing, which may have affected precision in domain-specific contexts. Third, the sample, while drawn from the general university population, was limited to respondents from a specific geographic and institutional context, potentially limiting the generalizability of the findings to other higher education settings.

5. Conclusion and recommendations

This study presented EduCore, an AI-integrated classroom management system designed to address key limitations in existing LMS platforms through configurable grading, AI-powered student feedback, and academic integrity detection. The system's three-tier approval architecture provided a security-conscious onboarding model suited to institutional deployment, while its integration with the Anthropic Claude API (claude-3-5-sonnet-20241022) enabled intelligent features that augmented rather than replaced teacher judgment.

Evaluation results from university-level teachers and students indicated high levels of usability, functionality, and acceptability, providing empirical support for the system's readiness for broader adoption. The AI feedback and detection features were particularly well-received, demonstrating the practical value of context-aware AI integration in classroom management tools.

Future work should focus on: (1) full production deployment and longitudinal usability evaluation; (2) fine-tuning the AI detection model on academic writing corpora to improve precision and recall; (3) expanding the system to support additional institution-specific grading schemas and multilingual interfaces; and (4) exploring the integration of predictive analytics to identify at-risk students based on early performance indicators. It was further recommended that institutions considering deployment of EduCore establish clear policies on AI feedback transparency and academic integrity protocols to complement the system's technical capabilities.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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