AI-Powered Teacher Assistant And Personalised Feedback

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***Abstract*— The growing pressure on teachers to process high numbers of student assignments has created high demand for automated marking systems. In this paper, the AI Teacher Assistant and Personalized Feedback is conceived, an integrated AI-powered framework that will mark student submission and offer personal feedback automatically. Through the integration of sophisticated Natural Language Processing (NLP), Optical Character Recognition (OCR), and Machine Learning (ML) processes, the system improves the accuracy of marking and significantly minimizes manual effort. The proposed framework can handle different types of response such as multiple-choice questions (MCQs), short answers, essays, and handwritten responses. OCR technology facilitates the transfer of text data from scanned handwriting, while NLP algorithms facilitate more semantic interpretation and contextual analysis of written assignments. The ML models are calibrated to evaluate the relevance, coherence, and completeness of submissions, allowing the system to offer personalized, constructive feedback mapped to prescribed rubrics or learning objectives. This AI-powered solution revolutionizes the learning process from boring, time-consuming grading processes to data-driven mentorship, empowering teachers to concentrate on student development and improving curriculum efficiency. The system can also be configured to accommodate different academic streams, making it versatile across a broad range of schools and education departments. Experimental trials demonstrate that the AI Teacher Assistant and Personalized Feedback system produces grading outputs with high reliability and precision, closely correlating with human grading. Personalized feedback also promotes student engagement, self-improvement, and learning efficiency. This innovation is a major milestone towards intelligent, scalable, and equitable marking systems supporting modern education practices through automation and AI.**

Keywords—Artificial Intelligence (AI), Natural Language Processing (NLP) , Optical Character Recognition (OCR), Machine Learning (ML), Automated Grading, Personalized Feedback, Educational Technology, Assignment Evaluation, Handwritten Text, Recognition, Student Assessment, Constructive Feedback ,Intelligent Tutoring Systems, Learning Analytics, Text Analysis, Academic Automation

INTRODUCTION

Over the past couple of years, the use of artificial intelligence (AI) in learning has become increasingly popular, employed by the growing demand for scalable, efficient, and intelligent learning solutions. One of the very labor-intensive and redundant activities in the educational community is grading student assignments and creating useful feedback. With growing class size and the number of assignments, teachers are finding it increasingly challenging to ensure grading consistency, provide timely feedback, and provide individualized attention to each learner. This kind of situation calls for intelligent systems that can carry out routine educational activities without compromising on quality.

This paper presents an AI Teacher Assistant and Personalized Feedback, a complete AI-driven system aiming to automate marking assignments and provide personalized feedback to students. The suggested framework taps the latest methods in Natural Language Processing (NLP), Optical Character Recognition (OCR), and Machine Learning (ML) to handle different types of responses, such as multiple-choice questions (MCQs), short text answers, essays, and handwritten responses.

By applying OCR for reading handwritten submissions and NLP for interpreting context of students' responses, the system achieves near-human-level grading and

comprehension. Machine learning-based algorithms are conditioned to evaluate quality and relevance of answers based on rubrics built by subject area experts to enable tailored, helpful feedback to each submission.

The objective of this study is two-fold: (1) reduce the workload of teachers through automation of grading and (2) enrich the learning experience of students through timely and customized feedback. Deep assessment confirms that the system possesses the potential to improve grading efficacy, quality of feedback, and student engagement. The approach seeks to revolutionize conventional assessment approaches through intelligence, scalability, and fairness in the academic assessment process.

LITERATURE SURVEY

In the last few years, the confluence of Artificial Intelligence (AI) and education has seen a lot of research on automated grading systems, personalized learning, and intelligent tutoring. There have been experiments showing the potential of AI to enhance conventional education practices, minimize teacher workload, and provide customized learning opportunities.

Initial attempts at automatic marking were towards automatic marking of Multiple-Choice Questions (MCQs) on the basis of rule-based systems [1]. These attempts were, however, inflexible and did not handle subjective and descriptive question types. Sophisticated Natural Language Processing (NLP) has enabled systems to undertake semantic marking of free-text answers, and it is possible to mark short answers and essays with greater accuracy now [2], [3].

Optical Character Recognition (OCR) technology has advanced to the extent that it is possible to recover text content from handwritten paper with accuracy [4]. Integration of OCR and NLP has opened up new avenues in automated grading of handwritten responses, which is a vital component in countries with lean digital infrastructure.

The rise of Machine Learning (ML) and deep learning approaches has revolutionized the situation. Supervised learning techniques have been utilized in training systems on tagged data for automated marking of descriptive responses, which has been found to be as effective as human markers in most situations [5]. Furthermore, transformer models such as BERT and GPT have been found to be more contextually sensitive, hence appropriate in providing personalized feedback and recognizing subtlety in student writing [6].

Even with all these developments, most systems today are unable to generalize to real time and learn a new domain. They also do not have good support for generating personalized feedback to improve the learning outcomes of students. The system built here fills these gaps by combining OCR, NLP, and ML into a single system that has multiple forms of responses and gives personalized, relevant feedback.

Application of artificial intelligence in education technology has been under thorough research in recent research studies. Devlin et al. [7] introduced BERT, a strong language model utilized for semantic analysis, which forms the foundation for the evaluation of descriptive answers in our project. Singh and Kumari [9] introduced an approach to automating the grading of descriptive answers utilizing NLP, identifying the importance of contextual understanding in AI systems utilized in education.

Handwritten text recognition using OCR was demonstrated to be possible by Jain and Pareek [10] using Tesseract and AWS Textract, establishing the viability of our written answer extraction process. The significance of peer and AI-recommended feedback was emphasized by Kulkarni et al. [12], which is in line with our feedback generation module that offers personalized insights.

Pérez-Marín and Pascual-Nieto [11] thought about conversational tutoring systems, highlighting the potential of AI to make interactive learning possible, and Ma et al. [14] verified the beneficial effect of intelligent tutoring systems on students' achievement through meta-analysis. D'Mello and Graesser [15] highlighted the affective dimensions of tutoring, illustrating how engagement supports learning, something taken into consideration in our feedback approach.

Aljohani [8] evaluated adaptive e-learning systems, aligning with the objective of our platform to offer personalized responses to student interactions. Ramanathan and Krovetz [13] investigated AI-based short-answer feedback systems, aligning with the necessity for precise, context-sensitive assessment frameworks like BERT. Finally, Ahuja and Sharma [16] offered a thorough review of AI in education and suggested future research areas for our system to expand upon with improved assessment, accessibility, and engagement.

PROPOSED SYSTEM

The goal of this project is to create an AI-based Teacher Assistant system that automatically grades descriptive responses, provides customized feedback, and improves learning and teaching with smart analysis, efficient grading, and ongoing improvement with user feedback, learning metrics, and adaptive learning methods.

The initiative seeks to design and implement an AI-powered platform to aid instructors in marking descriptive responses, reading handwritten data, and offering tailored feedback. By leveraging the use of natural language processing, optical character recognition, and interactive dashboards, the platform enhances the effectiveness of learning, maintains uniform marking, and enables tailored learning opportunities for educators and learners.

METHODOLOGY

The suggested method for the AI Teacher Assistant and Personalized Feedback system is to utilize cutting-edge natural language processing and machine learning methods to enhance the learning process. The system aims to support teachers in automating the evaluation of descriptive answers, giving feedback, and facilitating personalized learning pathways for students. The method is aimed at smooth communication between the frontend interface, backend operations, AI-driven assessment engine, and data processing

components. Integration of components supports accuracy, scalability, and flexibility in adaptive learning systems.

A. Technology Stack:

For scalability, effectiveness, and precision, the AI Teacher Assistant and Personalized Feedback system is based on a solid and state-of-the-art technology platform. The system leverages a combination of frontend, backend, AI, and cloud technology to develop an efficient and smart feedback environment.

Frontend: Streamlit is used to develop the user interface, an interactive and friendly Python-based framework through which the teachers and students can interact with the system in real-time using a responsive and clean UI.

Backend: Backend processing and logic were implemented using Python Flask, handling the app's core flow, model integration, and communication between system components.

API Management: Fast API is used to enable effective and scalable API processing. It supports optimized asynchronous communication between the frontend, backend, and AI models.

Database: The program employs PostgreSQL, a very sophisticated open-source relational database system, to securely and efficiently store user information, student responses, feedback reports, and performance indicators.

Instruction: In order to be able to understand and evaluate text, the system uses BERT (Bidirectional Encoder Representations from Transformers), a strong NLP model to facilitate context-specific semantic evaluation of student answers.

Handwriting Recognition: The system also provides assistance for the assessment of handwritten responses using OCR (Optical Character Recognition) methods. For high accuracy in text extraction from scanned answer sheets or handwritten data, the AWS Text Extractor Tool is used.

This technology stack enables the system to perform smart assessments, create feedback, and support typed as well as handwritten student assignments, presenting an all-inclusive solution for modern education.

B. Feature Design:

User Interface (UI): The AI Teacher Assistant system has a straightforward User Interface (UI) created with Streamlit, which is simple for teachers and students to use. The interface allows users to upload answer sheets, view feedback, and track performance insights with ease.

Backend Algorithms: Highly sophisticated Algorithms manage the core operations of the system in the backend. With BERT, semantic meaning interpretation of descriptive responses is performed, and OCR and AWS Text Extractor enable accurate validation of handwritten inputs. The system provides real-time personalized feedback for student responses for adaptive learning and ongoing optimization.

C. Scoring System Development:

Keyword Analysis: BERT is used by the system to identify and match appropriate student answer keywords with a provided set of solutions. This assists in identifying the accuracy of content, contextual comprehension, and concept matching, which serves as the basis for the creation of meaningful scores and individual feedback.

Feedback Mechanism: Based on the relevance of the keywords and the structure of the answers, tailored feedback is generated that highlights strengths, areas of confusion, and areas where it needs to be improved. It is tailored for every learner, enhancing comprehension, reinforcing concepts, and allowing instructors to deliver adaptive, student-centered instruction.

D. User Testing and Evaluation:

Frontend Design: Frontend usability, accessibility, and responsiveness were tested based on live student and instructor feedback. Modularity in Streamlit allowed quick UI changes, enabling smooth navigation, effective handling of inputs, and interactive user experience on a wide range of devices and platforms.

Backend Architecture: The backend was tested for scalability, speed, and accuracy. Flask managed the core logic, and Fast API managed efficient API routing. PostgreSQL managed data transactions, and BERT-based analysis maintained stable performance under high-load testing, proving its robustness in various academic environments.

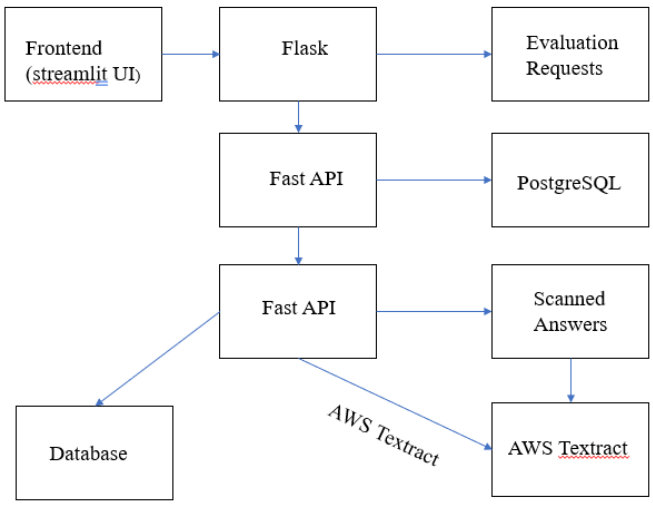


Fig-1 Architecture

IMPLEMENTATION

A. User Login and Signup:

The platform has some pretty solid features, like secure registration and login options for both teachers and students. Depending on their role, users get custom dashboards. This means teachers can easily assess submissions, while students can submit their answers, get feedback, and keep tabs on their academic progress without any hassle.

B. File Upload Functionality:

Users can upload their scanned or handwritten answer sheets right through the interface. It's pretty versatile, supporting different file formats. The platform uses AWS Textract and OCR for processing those documents, pulling out important text for later semantic assessment and evaluation.

C. Grading Functionality:

Once the text is pulled, the system uses BERT to dig into the keywords and context. It then compares student answers to benchmark responses, scoring them based on how relevant the content is, how accurately the keywords are used, and how complete the answers are overall.

D. Feedback Generation:

After the grading wraps up, the system generates detailed feedback that highlights what students did well and where they can improve. This feedback is tailored to match each student's answers, which really helps with personalized learning and lets teachers provide more focused support.

E. Teacher and Student Dashboard:

The Teacher Dashboard gives educators access to submitted answers, grading tools, and feedback records. This way, they can manage and assess student performance effectively. On the flip side, the Student Dashboard lets students submit their answers, check their grades, get personalized feedback, and track their progress over time. It all creates a really engaging and user-friendly environment for both teaching and learning.

RESULTS

We evaluated the AI Teacher Assistant system using user feedback, interaction logs, and performance metrics. Here's a summary of some key findings, focusing on user experience, how effective the features are, and the overall impact on personalized learning and educational support

A. User Experience Metrics :

During real-time evaluations, the system scored high on usability. Users loved how easy it was to navigate, the quick response times, and the clear interface. It seems to cater well to both tech-savvy folks and those who might be a bit less comfortable with technology.

b.

B. Overall User Satisfaction:

Surveys showed that users were pretty happy with the platform. They appreciated the quick feedback and automated grading processes, along with the user-friendly dashboards. Teachers liked that it cut down their manual work, while students enjoyed getting immediate, personalized insights. It's clear the platform really helps boost teaching and learning outcomes.

C. Navigation Efficiency :

Tests on the navigation showed that users could get their tasks done with just a few clicks and without much confusion. The organized layout made it easy for users to switch between submitting answers, checking feedback, and managing educational data.

D. Feature Utilization and Engagement :

Looking at the usage logs, it's evident that users were actively engaging with features like grading, feedback review, and tracking their progress. Teachers frequently accessed evaluation summaries, and students regularly used feedback tools. So, the main features are definitely seen as valuable and effective.

E. Quality Enhancement :

The use of AI has significantly boosted the quality of feedback and consistency in grading. BERT-based evaluations provided deeper semantic insights, while OCR tools helped accurately analyze handwritten responses. This all adds up to better educational value and more precise assessment results.

F. Implementation of Feedback :

We made iterative updates based on user input, which helped refine the user interface and improve performance. These tweaks led to smoother functionality and happier users, showing that the platform can adapt to real classroom needs and what educators require.

G. ATS Compatibility Improvement :

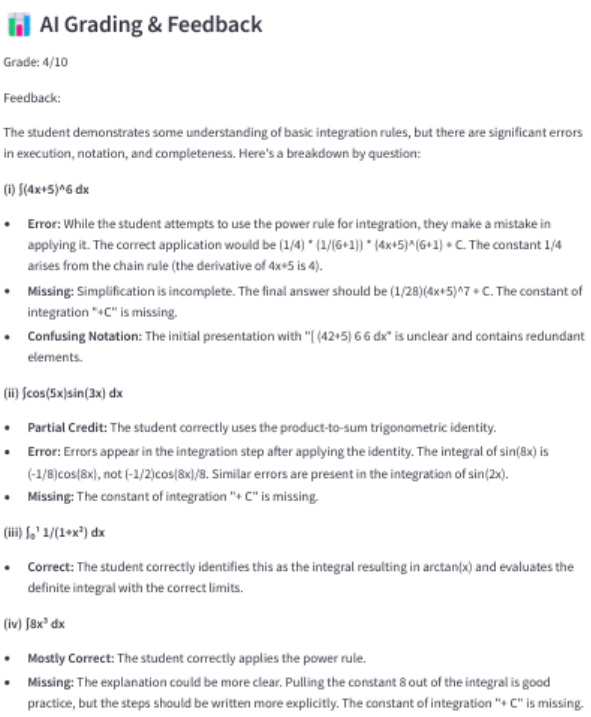
We adjusted the formats for feedback and grading to align with standard Applicant Tracking Systems (ATS). This makes it easier for institutional reporting and academic profiling, increasing the platform's usefulness in formal educational settings and for student portfolios.

H. Accessibility Interest:

Improvements in accessibility, including keyboard navigation, support for screen readers, and a simplified design, were implemented based on user feedback. This broadened inclusivity, making the platform more accessible to users with various needs and learning styles.

I. User Retention and Reuse Intentions :

You know, the numbers really show that people are likely to stick with this platform. Most teachers and students have said they plan to keep using it for future classes. Why? Well, it saves them time, gives useful feedback, and they find the system pretty reliable. Those are some solid reasons, right?



AI Grading & Feedback

Grade: 4/10

Feedback:

The student demonstrates some understanding of basic integration rules, but there are significant errors in execution, notation, and completeness. Here's a breakdown by question:

(i) ∫(4x+5)^6 dx

- **Error:** While the student attempts to use the power rule for integration, they make a mistake in applying it. The correct application would be (1/4) * (1/(6+1)) * (4x+5)^(6+1) + C. The constant 1/4 arises from the chain rule (the derivative of 4x+5 is 4).
- **Missing:** Simplification is incomplete. The final answer should be (1/28)(4x+5)^7 + C. The constant of integration "+C" is missing.
- **Confusing Notation:** The initial presentation with "[(42+5) 6 6 dx" is unclear and contains redundant elements.

(ii) ∫cos(5x)sin(3x) dx

- **Partial Credit:** The student correctly uses the product-to-sum trigonometric identity.
- **Error:** Errors appear in the integration step after applying the identity. The integral of sin(8x) is (-1/8)cos(8x), not (-1/2)cos(8x)/8. Similar errors are present in the integration of sin(2x).
- **Missing:** The constant of integration "+ C" is missing.

(iii) $\int_0^1 1/(1+x^2)\,dx$

- **Correct:** The student correctly identifies this as the integral resulting in arctan(x) and evaluates the definite integral with the correct limits.

(iv) $\int 8x^3\,dx$

- **Mostly Correct:** The student correctly applies the power rule.
- **Missing:** The explanation could be more clear. Pulling the constant 8 out of the integral is good practice, but the steps should be written more explicitly. The constant of integration "+ C" is missing.

Fig-2 Grading and Feedback

(v) $\int(5x^2 - 8x + 5)\,dx$

- **Partial Credit:** The student applies the power rule correctly for each term.
- **Missing:** The question likely intended for definite integration, but the student only provides the indefinite integral. The evaluation shown at the end (188/3 - 8/3 = 60) doesn't connect to the problem and seems arbitrary. The missing limits of integration prevent this part from being fully correct.

General Feedback:

- **Notation:** The student's notation needs significant improvement. Integrals should be written clearly with proper dx notation and limits (when applicable). Steps should be presented logically and neatly.
- **Constants of Integration:** Consistently missing the "+ C" for indefinite integrals demonstrates a lack of understanding of their importance.
- **Show Work:** The student should show more intermediate steps. This helps the grader understand the student's thought process and identify where mistakes occur.
- **Review Basic Rules:** The student should review the basic rules of integration, including the power rule and the handling of constants. More practice is needed to improve accuracy and efficiency in applying these rules.

By addressing these points, the student can significantly improve their understanding and performance in integration.

Fig-3 General Feedback

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DISCUSSIONS

1. Influence on Education and Learning:

The platform really lightens the load for teachers by automating grading and feedback processes. It's not just about making life easier for educators; it also opens up personalized learning opportunities for students, which can lead to some serious self-improvement. Early tests have shown that engagement levels are up, academic performance is improving, and teachers are finding more productivity, all thanks to the system's ability to analyse data in real time and offer evaluations that actually consider the context.

2. Obstacles and Enhancements:

Now, let's talk about some challenges and improvements. Even though the system works really well in structured settings, it still struggles with complicated handwritten answers and messy response formats. So, what's next? Well, continuous training for the model, using feedback from users, and expanding the AI's understanding of different contexts are all vital steps. We want to make this system even more precise, flexible, and inclusive for various educational environments and response styles.

FUTURE ADVANCEMENTS

Looking ahead, there are some exciting upgrades in the pipeline for the AI Teacher Assistant system. One of the big plans is to support multiple languages, which would allow it to evaluate responses in local languages and make it more accessible for different student groups. Integrating it more closely with Learning Management Systems (LMS) will also

help with smoother data transfers and better analytics. Imagine having real-time help for students through conversational AI — that could really boost engagement! Plus, analyzing text sentiment to pick up on students' emotions could help teachers identify those who might be struggling with the material. We're also working on improving Optical Character Recognition (OCR) for messy handwriting and making feedback even better through reinforcement learning. All these tweaks aim to make the platform smarter, more inclusive, and even more supportive of personalized education across different subjects and learning environments.

CONCLUSION

So, the AI Teacher Assistant and Personalized Feedback system is really shaking things up in how we assess descriptive responses in education. In this project, we built an AI-powered Teacher Assistant that automates the assessment of students' descriptive responses and provides customized feedback.

We used a bunch of modern technologies here — Streamlit built with Python for the user interface, Flask for backend functions, PostgreSQL for database management, and cutting-edge Natural Language Processing (NLP) with BERT for understanding meaning. Plus, we incorporated AWS Textract and OCR to recognize handwritten materials, which means the system can deal with various types of input.

The implementation of features like grading, keyword analysis, and smart feedback has shown promising results in streamlining the evaluation process. This automated grading system not only takes some weight off teachers' shoulders but also ensures that grading is fair, accurate, and consistent.

The personalized feedback generated by the AI allows students to think about their performance and focus on areas for improvement, creating a more student-centered learning environment. User testing has shown that both educators and students are really satisfied, with positive comments about how easy it is to navigate, engage with, and understand the results. Things like system responsiveness, clear feedback, and user-friendliness all point to the platform being ready for real-world use in classrooms.

The dashboards for teachers and students were found to be effective, user-friendly, and vital to the overall learning experience. And with the platform's modular design, there's plenty of room for future growth, like potentially integrating with institutional Learning Management Systems (LMS), adding support for multiple languages, doing sentiment analysis, and enhancing data visualization for tracking progress. These improvements could really broaden the system's reach across various educational fields and contexts.

In a nutshell, the AI Teacher Assistant system is a smart and practical solution to the growing need for scalable, effective, and personalized assessment methods in education. It has the potential to transform traditional teaching and evaluation practices, aligning them with data-driven, AI-supported educational approaches that fit perfectly into today's digital landscape.

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