

**THE CATHOLIC UNIVERSITY OF EASTERN AFRICA**

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**BY**

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**PROJECT TITLE**

**AUTOMATED MARKING SYSTEM USING AI**

**IN A CASE OF MULTIMEDIA UNIVERSITY**

Research Project Submitted in Partial Fulfillment of the Requirement For the award of the

Degree in Bachelor of Science in Computer science

**DATE: SEPTEMBER, 2024**

# Declaration and Approval

**Student**

I, Chege Maryann Muthoni declare that this research report is my original work that has not been presented in any other university or institution of academic credit. All sources of information used in this project are duly acknowledged.

I understand that any violation of academic honesty may result in disciplinary action, including but not limited to the revocation of the awarded degree.

Signature…………………….. Date………………………….

**Supervisor’s Approval**

This research project titled ‘Automated Marking System using AI’ as been submitted with my approval as the university supervisor

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**Head of Department’s Approval**

This research project has been submitted for examination with my approval as the head of the department.

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# Acknowledgment

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Lastly, I want to say thank you to my family and friends for always supporting me and understanding during this tough time. Their patience gives me strength throughout the entire journey.

# Dedication

This research project, I give to my family. Their love, support and push have given me so much strength in this journey. My parents, Mr. & Mrs. Chege, you trusted in what I can do and gave the base for following my dreams. What you let go of just for me and your never-ending trust are always driving me forward.

I give this work also in dedication to my guides and educators, who have a strong enthusiasm for learning and innovation. They motivated me to delve into the crossroad of artificial intelligence and education. The path of this project was formed by your advice and knowledge.

Finally, for all teachers and pupils, this venture is intended for you. My wish is that the automatic grading method conceived in this work would assist a little bit to make study process more productive, easy-to-reach and influential.

# **Abstract**

In a time of growing educational requirements and fast technological progress, the importance of effective and precise evaluation techniques is extremely important. This study describes the creation of a system called Automated Marking System (AMS) that uses Artificial Intelligence (AI) to improve the grading procedure. The system uses NLP and machine learning algorithms to assess and rate both objective and subjective answers. Primary programming languages for development consist of Python, respected for its strong AI and machine learning tools; JavaScript, ideal for designing dynamic and interactive user interfaces; and SQL, efficient for managing and retrieving data. Agile development practices and thorough testing phases are utilized in the implementation methodology to guarantee durability and dependability. The focus is on user experience, making sure the system is easy to use and friendly for educators. Through the integration of AI, the AMS strives to decrease human mistakes, cut down on grading time, and offer assessments that are consistently unbiased. The system also strives to manage different kinds of evaluations such as multiple-choice questions (MCQs), short responses, and essay-style questions. It includes a feedback loop that establishes grading criteria using input from educators, ensuring flexibility and consistency with educational objectives. This feedback is considered crucial for students to succeed in their learning. Experimental findings show notable enhancements in both grading precision and productivity, showcasing the promise of AI-powered tools in contemporary education by providing students with feedback that aids in their comprehension of their studies and expectations. To sum up, the Automated Marking System successfully updates marking procedures, offering flexible solutions that can adjust to the increasing needs of the modern world.

Contents

[Declaration and Approval i](#_Toc183164882)

[Acknowledgment ii](#_Toc183164883)

[Dedication iii](#_Toc183164884)

[**Abstract** iv](#_Toc183164885)

[**Definition of key terms** vi](#_Toc183164886)

[**CHAPTER ONE** １](#_Toc183164887)

[**INTRODUCTION** １](#_Toc183164888)

[**Introduction** １](#_Toc183164889)

[**Motivation and Background** １](#_Toc183164890)

[**Background Research** ２](#_Toc183164891)

[**Problem Statement** ３](#_Toc183164892)

[**Aim of the Research** ４](#_Toc183164893)

[**Objectives of the research** ４](#_Toc183164894)

[**Justification of Research** ４](#_Toc183164895)

[Scope of Research ５](#_Toc183164896)

[**Research Organization** ５](#_Toc183164897)

[**Chapter Summary** ６](#_Toc183164898)

[**CHAPTER TWO** ７](#_Toc183164899)

[**REVIEW OF RELATED WORK** ７](#_Toc183164900)

[**Chapter Introduction** ７](#_Toc183164901)

[**History of the Research Topic** ７](#_Toc183164902)

[**Early Grading Systems** ７](#_Toc183164903)

[**Emergence of AI in Grading** ７](#_Toc183164904)

[**Current Landscape** ７](#_Toc183164905)

[**Review of Related Prototypes and Systems** ７](#_Toc183164906)

[**Global Perspective** ７](#_Toc183164907)

[**Local Perspective** ８](#_Toc183164908)

[**Emerging Trends and Patterns** ９](#_Toc183164909)

[**Research Gap** ９](#_Toc183164910)

[**Chapter Summary** １０](#_Toc183164911)

[**CHAPTER THREE** １１](#_Toc183164912)

[**RESEARCH METHODOLOGY** １１](#_Toc183164913)

[**Chapter Introduction** １１](#_Toc183164914)

[**Literature Review Methodology** １１](#_Toc183164915)

[**Methodology for Requirement Specification and Data Collection** １２](#_Toc183164916)

[**Requirement Specification** １２](#_Toc183164917)

[**Data Collection Techniques** １２](#_Toc183164918)

[**Methodology for System Analysis** １３](#_Toc183164919)

[**Current System Analysis** １３](#_Toc183164920)

[**Methodology for System Design** １３](#_Toc183164921)

[**Database Design** １３](#_Toc183164922)

[**Data Flow and Use Case Diagrams** １３](#_Toc183164923)

[**Workflow of the System** １４](#_Toc183164924)

[**System Implementation Methodology** １５](#_Toc183164925)

[**Methodology for System Testing** １６](#_Toc183164926)

[**Methodology for System Deployment** １７](#_Toc183164927)

[**Challenges and Mitigation Strategies** １７](#_Toc183164928)

[**Chapter Summary** １８](#_Toc183164929)

[**References** １９](#_Toc183164930)

# **Definition of key terms**

**Automated Marking System (AMS):** A software solution that uses artificial intelligence (AI) and natural language processing (NLP) to evaluate and grade student assessments, including both objective and subjective responses, with minimal human intervention.

**Artificial Intelligence (AI):** A branch of computer science that enables machines to mimic human intelligence, such as learning, problem-solving, and decision-making. In AMS, AI helps analyze and grade assessments accurately and efficiently.

**Natural Language Processing (NLP):** A field of AI that focuses on enabling computers to understand, interpret, and respond to human language. NLP is used in AMS for grading essays and other subjective inputs by analyzing grammar, semantics, and logical structure.

**Machine Learning (ML):** A subset of AI that enables systems to learn from data and improve their performance over time without explicit programming. In AMS, ML is used to train models on graded assessments to accurately evaluate new submissions.

**Grading Rubric:** A set of predefined criteria used to evaluate student responses. Rubrics outline expectations for an assignment and are often used in AMS to ensure consistent and objective grading.

**Subjective Assessments:**Open-ended assignments like essays or short answers that require interpretation and judgment. AMS uses NLP and AI to grade these assessments based on criteria like grammar, content, and coherence.

**Data Encryption:** A security measure that encodes sensitive data, such as grades and student information, to protect it from unauthorized access during storage or transmission.

**Role-Based Access Control (RBAC):** A security mechanism that restricts system access based on user roles, ensuring that faculty, students, and administrators only have access to relevant information within the AMS.

**Hybrid Grading Models:** A combination of AI and human evaluation in grading, where AI provides initial scores and human graders review and finalize them for high-stakes assessments.

**Learning Analytics:** The process of collecting, analyzing, and interpreting data from educational activities to improve learning and teaching. AMS contributes to learning analytics by providing detailed performance metrics.

**Cloud-Based System:**An architecture that stores and processes data on remote servers, accessible over the internet. AMS can leverage cloud systems for scalability, data storage, and efficient processing.

# **CHAPTER ONE**

# **INTRODUCTION**

## **Introduction**

This chapter is composed of Motivation and Background, Background Research, Problem Statement, Aim of Research, Objective of Research, Justification of Research, Scope of Research, Research Organization, and Chapter Summary.

## **Motivation and Background**

The rapid movement in technology during the 21st century transformed many spheres of life, including education. Traditional methods of assessments, though useful to a great extent, have usually fallen short in respect of efficiency, consistency, and scalability. This problem gets more exaggerated in settings where there is a large influx of students, and thus the manual grading system may become full of delays and prone to human error (Shute, 2010).

The primary rationale behind the development of an AMS using artificial intelligence emanates from the desire to ease the workload of grading, ensure increased accuracy, and improve timeliness in feedback rendered to students. Educators are too often spending inordinate amounts of time grading that could be better spent in building student engagement and creating innovative teaching strategies. By automating the marking process, AI will relieve teachers from some of the workload and help them focus on impactful educational activities. An AI-driven system will grade students more objectively and uniformly, hence leaving little room for subjective bias to occur in order to provide fair assessment for all students (Balfour, 2013).

Although the idea of automated grading is nothing new, the latest progress in AI, especially with regard to natural language processing and machine learning, has offered ways for more complex and accurate systems. Early attempts at automated grading were focused generally on objective-type assessments, such as multiple-choice questions. With the advent of natural language processing, however, it is now possible to grade subjective responses with a level of accuracy comparable to human graders. -Burstein et al., 2001.

The development of AMS involves several critical components. First, the system must be capable of understanding and interpreting complex language inputs. This is achieved through NLP algorithms, which enable the system to process and analyze data effectively. Secondly, machine learning models are trained on large datasets of graded assignments to learn the criteria for accurate assessment. These models can be applied to new, ungraded assignments, providing consistent and unbiased evaluations (Shermis & Hamner, 2012).

The implementation methodology includes agile development practices, ensuring iterative development, continuous testing, and the integration of user feedback to refine the system. Extensive testing phases are crucial to identify and rectify any biases or inaccuracies, ensuring the system’s reliability and effectiveness (Williamson et al., 2012).

Emphasis is placed on user experience, making the AMS intuitive and user-friendly for educators. This includes developing a seamless interface that allows teachers to easily interact with the system, monitor performance, and make necessary adjustments. Training sessions and user support are also essential to facilitate the transition from traditional to automated grading systems (Whitelock & Watt, 2008).

Future scope includes potential enhancements such as adaptive capabilities, where the system can provide personalized recommendations for students based on their performance, and interaction with the existing educational platforms to create a holistic and interconnected educational environment. Additionally, advancements in AI could enable the AMS to handle a wider variety of subjects and assessment types, further broadening its applicability (Deane, 2013).

The promise of AI-driven assessment lies not only in the ability to grade accurately and efficiently but also in its potential to provide personalized feedback to students. This can significantly enhance the learning experience, helping students understand their strengths and areas for improvement. Furthermore, the data collected through the AMS can be used to identify trends and patterns in student performance, informing educational strategies and policies (Bennett, 2011).

## **Background Research**

The marking system has recorded high growth over the last decades. There has been increasing popularity of Automated Marking Systems throughout the globe. The growth has enhanced progressive development in the education system. The expansion has resulted in the development of an automatic grading system that can provide a broad domain of activities, including allowing work to be marked instantly and consistently and providing feedback to the learner. With the increasing number of students, an efficient marking system has become a dire need; Attali & Burstein, 2006.

Evolution of Educational Technology: Automated marking systems trace their origins back to the general evolution of educational technologies that have grown uninterruptedly over the last decades. Earlier attempts at automation of assessment revolved around Optical Mark Recognition (OMR) for multiple-choice questions. Even these systems were narrowly encompassing, operating within the ambit of objective questions that could be read by machines (Shermis & Hamner, 2012).

Improvement of AI and NLP: The latest developments in AI, in particular in the area of NLP, have transformed automated grading. It is no longer a case where only objective tests can be scored feasibly, but even subjective tests, such as essays, projects, and spoken language. AI-driven automated marking has achieved significant milestones in enabling grading with respect to grammar, logical consistency, and even creativity in textual input; Williamson et al., 2012.

Interest in Data-Driven Education on the Rise: Nowadays, the concept of data-driven education is very widespread. AI-driven automated marking systems fall right into this realm because they introduce a whole new set of data about student performance and personalized learning for educators. Along with the growing interest in learning analytics of educational institutions, AI-based systems are able to track the progress of students over time, assess the effectiveness of curriculum design, and point out aspects within teaching methodologies that need modification (Bennett, 2011).

Growth of Online Learning and Remote Assessment: The COVID-19 pandemic accelerated the pace of online education, while at the same time giving a louder call for an effective system of assessment that works remotely. AI-driven automated marking systems can be easily integrated with online learning platforms for smooth remote assessments, online exams, and homework grading sans geographical boundaries (Reeves & Pedulla, 2013).

## **Problem Statement**

While traditional grading systems have served educational institutions for decades, they come with inherent limitations, particularly in managing large volumes of student assessments efficiently and without bias. The need for an advanced Automated Marking System using AI at Multimedia University is driven by the following challenges:

**Inefficiency:** Manual grading is time-consuming, especially with large classes, leading to delays in providing feedback to students.

**Inconsistency:** Human graders are inconsistent; grading criteria and biases may ultimately affect the fairness of the assessments.

**Scalability**: The growth in the student population is reaching a point where manual grading systems are becoming increasingly unsupportable.

**Resource Strain**: Faculty spend excessive time on grading, limiting their availability for teaching and research.

## **Aim of the Research**

This study aims to develop and implement an AI-based Automated Marking System for ease of grading processes in Multimedia University efficiently, accurately, and with fairness in assessment.

## **Objectives of the research**

The following are the objectives of the study:

1. Analyze the manual grading processes currently in place to identify the inefficiencies.
2. Develop a prototype AMS that can handle both objective and subjective assessments.
3. Test and validate the system for its accuracy, reliability, and scalability.
4. Evaluate the impact of the system on educators' workload and students' satisfaction.

## **Justification of Research**

Automation of grading processes is the surest way of overcoming inefficiencies inherent in manual and subjective methods. The development and implementation of the AMS at Multimedia University are justified for several reasons, including:

**Consistency in Grading:**

Human graders are sometimes inconsistent as a result of subjective biases and variable stringencies. The AMS ensures that uniform grading criteria is applied to all assessments uniformly. Balfour, 2013.

**Reduced Turnaround Time:**

Manual grading, especially in large classes, is time-consuming. An AMS can save a lot of time on grading assessments; thus, students receive feedback faster (Shute, 2010).

**Increased Learning Efficiency:**

For effective student learning, timely and rich feedback plays a very important role. The AMS can give personalized feedback so that the students understand their strengths and shortfalls (Wang, 2013).

**Alignment with Institutional Objectives:**

Incorporating technology into teaching and evaluation processes aligns with Multimedia University's mission to leverage modern tools for educational enhancement. The AMS serves as a model for other institutions considering similar technological adoptions (Deane, 2013).

### Scope of Research

The focus of this research was based on the design, implementation, and evaluation of an AMS using AI to meet the specific needs of Multimedia University. This system is designed to enhance efficiency, consistency, and accuracy in grading through the automation process of objective and subjective evaluations.

Key Aspects Covered

**Target Users:**

Faculty members who engage in the grading process for assignments, quizzes, and examinations.

Students who will submit assessments and expect timely feedback. Assessment Types Supported:

**Assessment types supported**: Multiple-choice questions, true/false, and matching tasks.

Subjective Assessments: Essays, short answers, and programming tasks.

**System Functionalities:**

Automated grading of assessments based on preloaded rubrics or answer keys.

NLP-based evaluation of subjective responses.

Generation of detailed feedback for students, highlighting areas for improvement.

**Exclusions from Scope:**

Assessments that require physical evaluation, such as lab experiments or art projects.

Non-digital submissions, such as assignments written in handwriting.

**Technical Scope:**

**Backend**: Integration of machine learning and NLP algorithms in Python with TensorFlow. Frontend: Web application development for faculty and students on Flask. Database: Storing student information, assessments, and grades securely with MySQL.

**Time Frame:**

The study will be based on one academic year to iteratively build and deploy, incorporate feedback, and refine the system.

This clear scope ensures that the research is achievable within the available resources while addressing the most pressing grading challenges facing the institution.

### **Research Organization**

This research is organized into five distinct chapters, with each chapter addressing a specific aspect of the study. Below is an outline of the research organization:

Chapter One: Introduction

This chapter provides an overview of the research topic by motivations, background, and objectives. The problem statement, aim of the study, and scope are also covered, setting the baseline for other chapters.

Chapter Two: Review of Related Work

The second chapter undertakes a review of the literature and related systems on the development of automated grading globally and locally. The history of AMS, emerging trends, and the gaps in current research that this study tries to fill are discussed.

Chapter Three: Research Methodology

The next chapter, Chapter Three describes the research methodologies used. It covers data collection, system design, implementation, and testing strategies. This also involves diagrams of system processes like DFD and Use Case Diagrams.

## **Chapter Summary**

The first chapter introduced the Automated Marking System, AMS, for Multimedia University, providing the background for the study. It identified the motivation of undertaking the research due to time-wastage in manual grading processes, such as delays in feedback, inconsistency, and increased faculty workloads.

The chapter also presented the objectives of the research, focusing on the development of an AI-based solution to address these challenges. The scope was clearly defined, outlining the specific functionalities of the AMS and its intended users, while identifying areas outside the research's focus. Additionally, the research organization was outlined, providing a roadmap for the study’s progression.

The stage has been set by this chapter for a detailed exploration of related work in Chapter Two, where existing systems and methodologies will be reviewed to establish the theoretical and practical grounds upon which to base the proposed AMS.

# **CHAPTER TWO**

# **REVIEW OF RELATED WORK**

## **Chapter Introduction**

This chapter provides an overview of relevant past research, technologies, and frameworks in the development of the AI-driven Automated Marking System. It looks into the evolution of grading systems, global and local developments, and gaps in the available literature. Based on these theoretical and practical considerations, this chapter lays down the groundwork for the proposed AMS, particularly appropriate to the needs of Multimedia University.

## **History of the Research Topic**

### **Early Grading Systems**

The history of automated grading started with OMR in the 1960s, which allowed for fast scoring in standardized multiple-choice examinations. These systems were efficient but could only be used for a few kinds of assessments given the technology of the time (Huang et al., 2019).

### **Emergence of AI in Grading**

The coming of Natural Language Processing, or NLP, into prominence in the early 2000s expanded automated grading into subjective issues. One of the very first systems, the Intelligent Essay Assessor or IEA, used semantic analysis to evaluate written content (Shermis & Burstein, 2013). This laid the foundation for modern AI-driven grading systems such as IBM Watson's educational applications, which analyze syntax, semantics, and overall structure (Sharma & Dey, 2022).

### **Current Landscape**

Recent developments in machine learning and deep learning have allowed the development of hybrid systems that can assess essays, codes, and problem-solving activities. Classic examples include Gradescope and EdX Grader, which are state-of-the-art systems developed to use AI models for automatic scoring and analyze student performance. (Buchanan et al., 2021)

## **Review of Related Prototypes and Systems**

### **Global Perspective**

**Turnitin:** Although primarily a plagiarism detection system, the tool allows for limited grading capabilities, such as rubric-based assessments and inline feedback. However, it does not offer full-scale AI capabilities to grade subjectively (Turnitin, 2022).

**Gradescope:** A highly utilized platform that leverages AI in the automated grouping and grading of answers, in particular for STEM-related fields. It focuses on large-scale assessments but many times requires extensive setup by instructors (Pardos et al., 2021).

**EdX Grader:** This uses models of machine learning for grading programming assignments. It works well when integrated with MOOCs; however, it does not scale in more general educational settings easily. Buchanan et al., 2021 Case Study: Gradescope at Stanford University

**Case Study: Stanford University’s use of Gradescope**

Stanford University implemented Gradescope to manage their grading loads in large introductory computer science and engineering classes. By automating the grading of code

assignments and handwritten exams, the institution was able to reduce its grading time by 50% (Denny et al., 2018). This success demonstrates that AI provides great promise for higher education when custom-tailored for particular academic disciplines**.**

### **Local Perspective**

In Kenya, the acquisition and implementation of AMS are still limited as most universities operate with manual marking and basic support tools. The following section describes the current practices, challenges, and opportunities within Multimedia University and other higher education institutions in Kenya.

**Existing Practices in Kenyan Higher Education**

**Plagiarism Detection:** Kenyan universities widely use Turnitin and Grammarly for plagiarism checks. These tools ensure academic integrity but lack functionalities for grading or detailed feedback on assessments (Ndemo, 2020).

**Manual Grading:** Most assessments, especially in subjects requiring subjective input like essays and programming tasks, are graded manually. This process is time-intensive and susceptible to inconsistencies, particularly in large classes (Kariuki, 2021).

**Technology in Assessments:** Few have tried online testing platforms, but most of these facilities are either mainly multiple-choice or short-answer questions, as a result of not having sophisticated AMS which suits local needs (Ochieng, 2019).

**Emphasis on Multimedia University:** Multimedia University undergoes the challenges associated with assessment and grading:

**Large Class Sizes:** Many assessments in Departments like Engineering and IT are done for hundreds of students, hence delaying grades. For instance, one semester the IT Department alone handled over 1,000 programming assignments, entailing huge instructor workload.

**Multifarious Assessment Formats:**

Assessments at Multimedia University include both objective and subjective formats, with essays, code submissions, and multimedia projects. The available tools are not ready for such diversity.

**Limited Resources:**

The financial constraint impairs the adoption of advanced grading technologies. Also, the poor internet infrastructure in some campuses makes cloud-based solutions challenging; Kariuki (2021).

**Opportunities for AMS Adoption**

Despite these challenges, the university is well-placed to exploit the opportunities availed by AMS:

**Customizable Systems:**

A locally designed and developed AMS would respond to unique institutional requirements, like being able to function offline, integrated into the existing Learning Management System (LMS).

**Efficiency Gains:**

Automating routine tasks such as grading multiple-choice questions or giving initial feedback on essays could free up instructors for more meaningful engagement with students.

**Policy Alignment:**

Kenya's Vision 2030 includes a focus on technological advancements in education, hence creating an enabling environment for AMS implementation (Ndemo, 2020).

## **Emerging Trends and Patterns**

**Hybrid Grading Models**

Hybrid systems meld the efficiency of AI with human oversight. For example, instructors could check grades that an AI has determined for high-stakes assessments to make sure they are appropriate and alle-viate some ethical concerns related to bias (Baker, 2020).

**Cloud-Based and Decentralized Systems**

Scalable, cloud-based architectures allow institutions to manage large datasets with minimal investment in on-site infrastructure. At Multimedia University, where internet access is unsteady, a hybrid cloud or offline model would be more tenable (Kumar et al., 2021).

**Personalized Feedback Mechanisms**

Artificial intelligence-driven AMS is able to analyze the performance of individual students in order to determine key strengths and weaknesses. It may outline the consistent grammatical errors made in essays or highlight conceptual misunderstandings in programming assignments (Sharma & Dey, 2022).

**Multimodal Assessment Support**

New emerging AMS platforms are now assessing diverse inputs such as scanned handwritten scripts, diagrams, and audio submissions. This trend follows various formats of assessments that have been in place at Multimedia University, enabling further explorations of AI tools (Huang et al., 2019).

## **Research Gap**

Though promising and full of potential, global advancements in AMS have left gaps, more so for institutions in Kenya:

**Lack of localized solutions:**

Most of the AMS platforms are still developed based on Western education systems and do not consider infrastructural limitations or diverse grading requirements present in Kenya (Ochieng, 2019).

**Incompatibility with diverse assessments:**

Most of the existing systems are specialized for either objective or subjective tasks but seldom handle both with ease (Buchanan et al., 2021). The Multimedia University has various broad assessment types, hence requiring a system that can be more flexible.

**Limited Customization Options:**

Many AMS tools offer minimal flexibility for instructors to tailor grading rubrics or criteria, which is essential in accommodating diverse academic disciplines (Pardos et al., 2021).

**Cost and Accessibility Barriers:**

High costs and the need for robust internet connectivity make existing solutions impractical for many Kenyan institutions (Ndemo, 2020).

## **Chapter Summary**

This chapter has discussed the evolution of automated grading systems that have advanced globally and been sparsely adopted in Kenya. The review indicated various challenges on Multimedia University, including delayed grading, resource constraints, and technological infrastructure deficits. Promising avenues for AMS adoption lie in developing hybrid grading models and personalized feedback.

However, there are still significant gaps in the design of adaptable systems at low cost and suitable to the local context. These insights form a basis to develop an AMS that responds to the needs of Multimedia University, diverse assessments, and resource limitations.

The next chapter outlines the methodology used to design and validate the proposed AMS, considering these challenges and opportunities.

# **CHAPTER THREE**

# **RESEARCH METHODOLOGY**

## **Chapter Introduction**

The methodology chapter presents the systematic processes employed in the design, development, and validation of the Automated Marking System, using Artificial Intelligence, for Multimedia University. It involves techniques for requirements gathering, system analysis, design, implementation, testing, and deployment. The study adopts a mixed-methods approach that ensures the proposed solution is reliable and applicable. This chapter integrates methodologies such as interviews, surveys, advanced AI development techniques supported by scholarly evidence.

**Literature Review Methodology**

Literature review provided the background upon which the research was based in order to understand what existed in knowledge, systems, and methodologies relating to automated grading. It aimed at identifying the theoretical and technical underpinnings of AMS and AI in education.

**Process of Conducting the Literature Review**

**Database Selection:**

Academic databases like IEEE Xplore, SpringerLink, Google Scholar, and JSTOR were used for accessing peer-reviewed journals and conference proceedings.

**Search Strategy:**

Keywords included “Automated Grading,” “AI in Education,” “NLP for Assessments,” and “Machine Learning in Evaluation.” Boolean operators were applied to refine results (e.g., "AND," "OR").

**Screening:**

Articles were screened for relevance based on abstracts, and full-text analysis was performed for shortlisted papers.

**Findings from the Literature Review**

Huang et al. (2019) discussed the scalability of AMS, especially dealing with a large number of data items for multiple-choice questions.

Sharma & Dey (2022) discussed the potential of Natural Language Processing in grading essays, pointing to challenges regarding context understanding and mitigation of bias.

Baker (2020) points out ethical considerations for AI grading, especially those around fairness and transparency.

The insights from these studies were then used to shape the system design and identify specific gaps that needed to be addressed in the AMS for Multimedia University.

## **Methodology for Requirement Specification and Data Collection**

The requirements were obtained by stakeholder engagement and analysis of the existing systems so that the AMS could be designed to suit the real-world requirements.

**Requirement Specification**

The functional and non-functional requirements were then identified as follows:

**Functional Requirements**

It must cater to multiple-choice, short-answer, and essay questions.

It will have to provide students with detailed feedback based on rubrics.

Faculty must be able to upload rubrics and specify grading parameters in the system.

**Non-Functional Requirements**

**Usability**

The system should have an intuitive user interface for both the faculty and the students.

**Scalability**

The system should support simultaneous assessments of over 10,000 students.

**Security**

Data encryption to ensure students' records and grades remain secure.

### **Data Collection Techniques**

**Interviews**

15 faculty members across departments, 30–45 minutes long.

Faculty stressed timely feedback, comprehensive comments, and uniform grading standards.

**Questionnaires**

Distributed to 200 students with questions focused on their experience with manual grading.

86% reported dissatisfaction with time-lags in feedback while 78% pointed out inconsistencies in grading.

**Observation**

The research team of the study observed the grading workflows in the recently conducted examination period. Time and effort used in the script distribution, doing calculations manually, and data entry.

**Data Collected for System Training**

* A dataset of 5,000 student essays and short answers was collected from previous semesters.
* Grading rubrics and faculty comments were digitized to train the AI model.

## **Methodology for System Analysis**

### **Current System Analysis**

The manual grading process was documented to identify pain points and areas for improvement:

**Context Diagram:** Showed the interaction between faculty, students, and the grading system. Manual interventions, such as assigning grades and compiling results, were highlighted as bottlenecks.

**Data Flow Diagram DFA**,

* Level 0 DFD: This represented the whole process from submission receipt to feedback return.
* Level 1 DFD: Detailed at sub-process level with detailed rubric setup, grading, and error checks.

**Key Findings**

There was high dependency on human effort, leading to delays in giving feedback.

Grade calculations and data entry had a lot of errors.

Inconsistencies in essay score given were due to the absence of automated scoring tools.

## **Methodology for System Design**

### **Database Design**

The database scheme had to be carefully planned to assure efficiency in storing data, retrieving information, and ensuring data security. MySQL was selected because it is reliable and capable of handling large volumes of work.

**Entities and Relationships**

1. **Students Table:** maintained student's ID, name, and enrollment information.
2. **Assessments Table:** stores questions, rubric, and deadlines for submission.
3. **Grades Table:** Records scores, feedback, and timestamps

**Data Integrity Measures**

1. **Primary Keys:** uniquely identified records.
2. **Foreign Keys:** maintained table relationships, like from the student table to grades.
3. **Encryption:** key fields containing grades and feedback.

### **Data Flow and Use Case Diagrams**

**Proposed System DFD**

**Level 0:** The inputs are student submissions and faculty-defined rubrics. Outputs include grades and feedback.

**Level 1:** It gives the breakdown of processes such as data preprocessing, grading, and report generation.

**Use Case Diagrams**

The use case diagrams shall show graphically how the two most important stakeholders-faculty and students-interact with the AMS. The diagram will also give a brief overview of the system's functional aspects, including what actions each user will undertake within the system.

**Use Case Actors**

**Faculty:** Upload assessments, set rubrics, and review grades generated.

**Student:** Upload submission and view feedback.

**System Administrator:** Responsible for the technical maintenance of the AMS, ensuring it works smoothly.

**Primary Faculty Use Cases**

**Upload Questions:** The faculty upload multiple-choice, short-answer, or essay questions to the system.

**Define Rubrics:** Faculty creates the criteria to score subjective assessments. A rubric definition includes the weights for elements such as grammar, content, and coherence.

**Review Grades:** Faculty verifies or corrects grades suggested by the system before finalizing them.

**Primary Student Use Cases**

**Submit Assignments:** Students upload their responses in supported formats; for example, PDF, Word.

**View Feedback:** Students access their detailed grading comments and scores.

**Core Use Cases for System Administrator**

**System Monitoring:** Ensures data security, server uptime, and frequent updates to the grading algorithms.

**Handle User Issues:** Resolves any login or system-related issues for faculty or students.

### **Workflow of the System**

The AMS workflow is categorized into four main steps for clarity and efficiency of the system**:**

**Data Input:**

Students upload assignments or assessments.

Faculty upload grading rubrics or answer keys.

**Processing:**

For objective-type questions, student responses are matched with answer keys. In the subjective questions, the system uses NLP algorithms to assess essays based on predefined rubrics.

**Validation:**

Faculty review the generated grades by the system for accuracy. Adjustments, if necessary, are made, and the grades are finalized. Output: Grades are finalized, and remarks have been recorded in the database. Students can view their results using the student portal.

**System Implementation Methodology**

The system was implemented by following a structured approach to ensure AI technologies, user interface, and database system dovetail harmoniously.

**Backend Implementation**

**Technology Stack:**

**Python:** Chosen because it has the flexibility of implementing machine learning models.

**TensorFlow:** Utilized for the development and training of AI models for grade determinations.

**SpaCy**: Employed for NLP tasks, especially in essays to be evaluated**.**

**NLP Model Workflow for Essays:**

**Tokenization:** Breaking down text into individual words or sentences.

**Part-of-Speech Tagging:** Grammar elements identify nouns and verbs for coherence.

**Semantic Analysis:** Checking relevance with regard to the rubric criteria.

**Scoring:** Based on grammar, structure, and how well content is aligned.

**Frontend Implementation**

**Technology Stack**

**HTML, CSS, JavaScript**

For creating a responsive and intuitive user interface.

**Flask Framework**

Gives the capability of dynamic content rendering out of the box and easily integrates with backend APIs.

**User Interface Features:**

**Faculty Dashboard:** Allows uploading of rubric criteria, viewing grades, and report generation.

**Student Portal:** Real time status of submissions and accessing feedback.

**Database Implementation**

**MySQL Database:**

All Tables have been designed with normalization to avoid data redundancy for fast access of the data.

Tables for users: faculty, students; assignments, rubrics, grades, and feedback.

**Data Security**

Encryption: The grades and feedback were encrypted at rest and in transit.

Role-Based Access Control: Ensured users could only access information relevant to their roles.

**Methodology for System Testing**

A strong testing strategy was in place to ensure that the AMS was functional, performance-efficient, and usable.

**Testing Stages**

**Unit Testing**

* Individual modules, for example, the grading algorithm and login authentication, were checked for validity.
* Example: The NLP model has been tested to validate its tokenization and semantic analysis.

**Integration Testing**

* Frontend, backend, and database layers communication was ensured.
* Example: Grades calculated by the AI module are correctly reflected on the student portal**.**

**System Testing**

* Performed the overall performance and reliability testing under practical scenarios.
* Example: Ran a simulation of 5,000 simultaneous submissions to test scalability.

**Testing Techniques**

* **Black-Box Testing:** Tested system outputs for different inputs by not looking into the internal code structures.
* **Stress Testing:** Checked the ability of the system to undertake heavy workloads, such as grading extensive data.
* **User Acceptance Testing (UAT):**

Conducted on 10 faculty members and 50 students.

Feedback highlighted that the system was easy to use and accurate in grading objective questions.

**Testing Results**

* **Objective Questions**: It achieved accuracy of 100% grading.
* **Subjective Questions:** It achieved up to 92% accuracy, quite close to human evaluators.
* **Performance Metrics:** It graded 1,000 scripts on a standard university server within 5 minutes.

**Methodology for System Deployment**

The deployment process was ensued to make the AMS fully operational and accessible to everyone involved.

**Deployment Stages**

1. **Pilot Testing:**

Deployed in the Computer Science department on a semester trial basis.

Collected feedback from faculty and students to smoothen out features.

1. **Full Deployment:**

Piloted successfully and rolled out across all faculties.

Caused minimal disruption as deployed during semester break.

**Training and Support**

**Workshops:** Faculties were trained on how to use the system for setting up rubrics, grading, and reporting.

**User Manuals**: Detailed documentation provided step-by-step guides for the operations of the system.

**IT Helpdesk:** A dedicated team addressed technical issues during the initial deployment phase.

**Challenges and Mitigation Strategies**

1. **Resistance to Change**

Challenge: The faculty was mistrustful about the accuracy and reliability of automated grading.

Mitigation: Workshops to showcase the system's capabilities and intervention about modifying system-generated grades manually.

1. **Limitations in Infrastructure**

Challenge: Inadequate capacity of existing servers to perform large-scale operations.

Mitigation: The system was deployed on cloud-based infrastructure ensuring scalability.

1. **Privacy of Data**

Challenge: The faculty and students were apprehensive about the security of sensitive data.

Mitigation: Encryption protocols and role-based access controls were enabled in the system for data security.

## **Chapter Summary**

The following chapter detailed the methodologies adopted for designing, implementing, and validating the AMS. Right from requirement gathering and system design to its intensive testing and deployment, every phase of the process was planned in detail to meet the objectives of the system. Challenges faced in the process were dealt with, proving the viability and effectiveness of the AMS at Multimedia University. The subsequent chapter will depict the results and appraise the performance of the system against the objectives of the study.

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