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AI-Based Assignment Marking in African Open and Distance e-Learning Institutions: A Systematic Review

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Abstract. The rapid growth of student enrolment in African Open and Distance e-Learning (ODeL) institutions has intensified pressure on assessment systems, particularly in assignment marking, moderation, and feedback provision. Artificial Intelligence (AI) offers a promising solution for improving the scalability, consistency, and timeliness of assessment processes. However, evidence on the implementation, effectiveness, and governance of AI-assisted assessment in African ODeL institutions remains fragmented. This study synthesised literature published between 2019 and 2025 to evaluate the extent to which African ODeL institutions have utilised AI techniques in assignment marking. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, a systematic search of major academic databases identified 18 studies that met the inclusion criteria. The review examined AI techniques used, assessment types, evaluation methods, and reported challenges. Findings show that Machine Learning (ML), Natural Language Processing (NLP), and generative AI are the most frequently applied techniques, mainly in text-based assessments such as essays and short-answer responses. Although studies report gains in grading efficiency, consistency, and feedback generation, adoption remains constrained by infrastructural limitations, fairness concerns, linguistic diversity, weak governance frameworks, and limited empirical validation. Sustainable implementation requires standardised human-AI workflows, robust evaluation frameworks, and clear ethical and regulatory guidelines.

Keywords: Artificial intelligence; automated grading; assignment marking; Open and Distance e-learning; systematic review; Africa

1. INTRODUCTION

The expansion of Open and Distance electronic Learning (ODeL) has significantly changed higher education globally since the covid 19-era. This has seen an increase in student enrolment in ODeL institutions since the mode of learning offers flexibility to learn irrespective of geographical location[1], [2]. However, increased student enrolment numbers pose challenges to educators and academic institutions to provide assignment feedback timely to enhance learning and teaching [3]. Several ODeL institutions are still marking assignments manually which is sometimes time consuming, error prone and often fails to provide formative feedback to students [2]. Additionally, these challenges also place substantial workload pressure on educators leading to limited interactions with students.

Artificial intelligence (AI) has emerged as a very powerful mechanism in assignment marking through automated and semi-automated marking, generation of feedback and student performance analytics. World over, AI-based marking systems have shown great capacity to support grading of short answer responses, essays, quizzes and programming assignments utilising techniques such as rule based engines, advanced natural language processing (NLP) and machine learning (ML) models. These AI developments have stimulated several ODeL institutions in Africa to have interest in utilising AI to enhance assessment scalability while maintaining academic standards [4], [5]. Several studies in African countries mainly South Africa, Zimbabwe, Zambia, and Eswatini reported early AI-driven initiatives in automated AI-based assignment marking systems.

Despite the interest in the implementation of AI by ODeL institutions in Africa, evidence base remains under-consolidated. Studies that have been done are mostly scattered across institutional reports, experimental prototypes, and pilot implementations with inadequate synthesis in terms of effectiveness, methodological quality and ethical readiness [6], [7]. This fragmentation makes it complicated to obtain reliable conclusions with regards to applicability, effectiveness and limitations of AI bases assignment systems in African ODeL contexts.

African ODeL contexts are often characterised by uneven digital infrastructure, changing regulatory environment, linguistic diversity, and policy gaps [3].. The stated factors require

a context-sensitive evaluation rather than just adopting models that were developed in other regions. Reviews that are currently available rarely focused on African ODeL systems to provide detailed analysis of AI-based assignment marking practices. This creates a knowledge gap for stakeholders such as educators, researchers and policymakers who might seek to implement AI-based assessment solutions. These contextual complications highlight the need for a systematic, context sensitive evidence synthesis

Existing reviews on AI in education mainly focused on the application of AI in teaching and learning rather than precisely on assignment marking as an assessment function. Most literature mainly focused on application such as student support systems, adaptive learning and adaptive learning rather than AI-based assignment marking. As a result, there remains a critical knowledge gap regarding the most utilised AI techniques, the type of assessment tasks supported, the evaluation methods used to validate such systems, and the contextual challenges that affect AI-based assignment implementation in African ODeL institutions. It can remain complicated for researchers, institutions and policymakers to come up with informed decisions regarding the implementation of AI-assisted assessment systems without structured synthesis of this evidence.

To address the gap highlighted, this study synthesised empirical and peer reviewed evidence on AI based assignment marking in African ODeL institutions and addressed the following stated objectives (1) to identify the most utilised AI techniques and assessment applications, (2) examine the types of assessments and datasets utilised (3) analyse evaluation approaches and reported outcomes, and (4) investigate the ethical, technical, and institutional challenges associated with implementation. By fusing findings from several studies, this study seeks to find patterns, limitations, as well as opportunities that can provide guidance for future research and practical deployment.

The major contribution of this study is in the provision of a structured and critical synthesis of AI-based assignment marking in African ODeL contexts, distinguishing it from broader AI-in education reviews. By synthesising current findings on AI based assignment marking in African contexts, this study provides a focused, context-sensitive analysis of assignment marking within African ODeL environments. In addition, the study proposed a research-informed conceptual architecture obtained from recurrent themes

in the selected studies to guide future development of AI-based assignment marking solutions tailored to African ODeL contexts. Findings obtained are intended to inform future researchers, guide institutional adoption strategies, and support the development of responsible and scalable AI-assisted assessment frameworks in African higher education.

2. METHODS

This research study adopted a systematic review methodology (SRL) by identifying, analysing and synthesizing evidence from literature on the application of AI techniques for assignment marking by ODeL institutions in Africa. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed to ensure that the research methodology is thorough, replicable and transparent [8]. The PRISMA guidelines was selected because it provides a structured and transparent framework for literature identification, screening, eligibility assessment, and inclusion [9].

2.1 Review Design and Protocol

The study followed a structured multi-stage process comprising of (1) search strategy development, (2) study identification, (3) screening, (4) eligibility assessment, and (5) data extraction and synthesis. This approach guaranteed methodological rigor, transparency, and reproducibility of the review process [9]. The study mainly focuses on answering the following research, (1) What AI techniques have been implemented to assignment marking in African ODeL institutions? (2) What types of assessments and datasets have been used? (3) How the systems have been evaluated in terms of accuracy, reliability and effectiveness? (4) What ethical, technical and institutional challenges were report used?

2.2 Search Strategy

This study made a comprehensive search across several academic databases and scholarly engines that included Scopus, Web of Science and DOAJ to obtain peer-reviewed journal articles and conference papers that assisted in answering research questions. Thes databases were chosen because they have extensive coverage of peer-reviewed research articles in AI, education and information systems. Search focused on publications that were done from January 2019 to October 2025. Papers searched were limited to English language peer reviewed publications. The study developed a Boolean

search string to capture relevant studies as shown. ("Artificial Intelligence" OR "Machine Learning" OR "Automated Grading" OR "AI Assessment") AND ("Assignment marking" OR "Grading" OR "Assessment") AND ("Open Distance learning" OR "ODeL" OR "Distance Education" OR "Open learning") AND ("Africa"). Table 1 shows specific retrieval count per database searched.

Table 1. Search Strategy, Query Syntax, and Retrieval Summary

Name of Database	Search Fields	Implemented Search Syntax	Records Retrieved (n)
Scopus	Title, Abstract, Keywords	TITLE-ABS-KEY	25
Web of Science	Title, Abstract, Keywords	TS (Topic Search)	12
DOAJ	Full text & metadata	Full-text search	18
ACM	Full text (relevance-ranked)	Controlled query	4
Total			59

2.3 Data Inclusion and Exclusion Strategy

This review selected studies that were relevant based on predefined inclusive and exclusive criteria as summarised in Table 2.

Table 2. Inclusion and exclusion criteria

PRISMA Domain	Inclusion Criteria	Exclusion Criteria
Context or Population	Higher education ODeL institutions in Africa	Non-African or face-to-face only institutions
Intervention	AI applied to assignment marking or grading	AI used only for tutoring, proctoring, or plagiarism detection
Study Design	Empirical studies and conceptual studies informing AI marking workflows	Opinion pieces without methods; news articles

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PRISMA Domain	Inclusion Criteria	Exclusion Criteria
Outcomes	Technical performance, marking accuracy, feedback effectiveness, workload indicators	Studies not reporting marking-related outcomes
Publication Type	Peer-reviewed journal or conference papers	Theses, dissertations, reports
Language	English	Non-English
Timeframe	2019 to Oct 2025	Before 2019 or after search date

2.4 Study Selection Process

After retrieving all records, the study utilised Mendeley reference manager to identify and remove duplicate entries prior to screening. The study selection process followed the Preferred Reporting Items for Systematic Reviews (PRISMA) [9]. Four sequential stages were followed, and these are identification, screening, eligibility and inclusion . During the identification phase, records were retrieved from several academic databases relevant to educational technology and AI research. After duplications were removed studies that remained proceeded to the screening stage.

Title and abstract screening were done independently by the reviewer guided by the inclusion and exclusion criteria. Studies that did not focus on AI-based assignment marking, were not located in African ODeL or distance higher education contexts, or non-empirical and conceptual were not included. Articles that were relevant were retained for full text assessment. On the eligibility stage, all retained full-text versions of shortlisted articles were independently reviewed to consider their suitability for final inclusion. Following full-text evaluation, a total number of 18 studies were selected in the final synthesis as shown on Figure 1.

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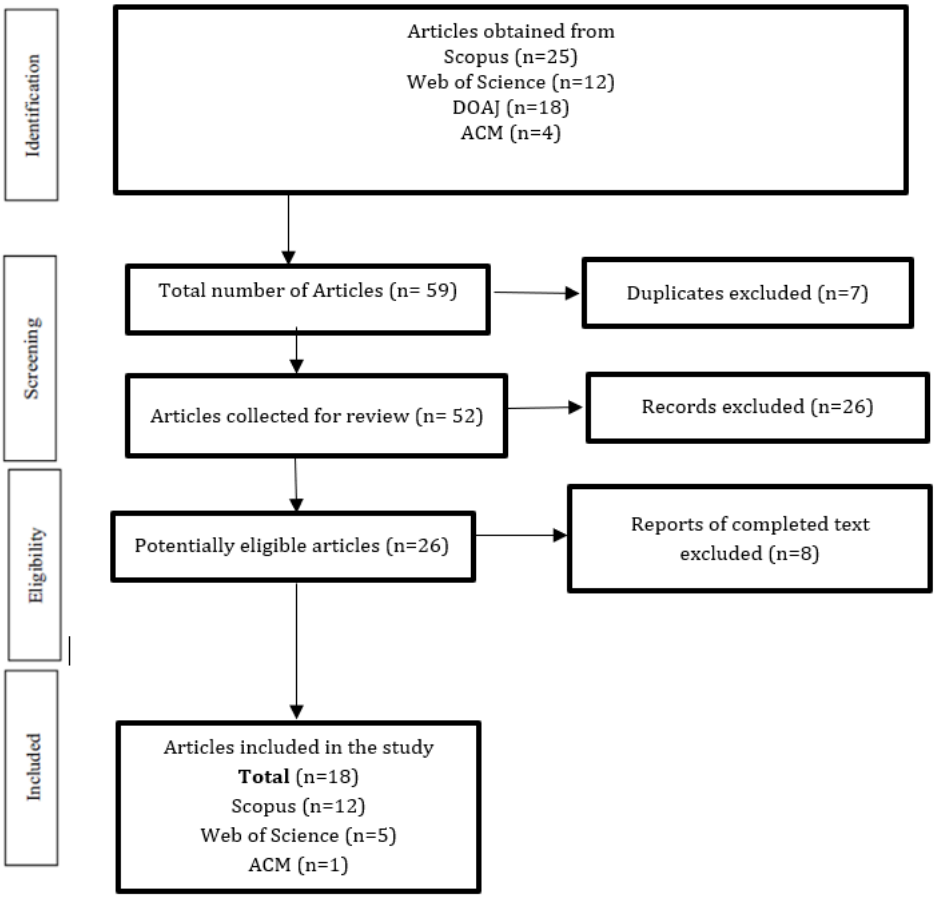

Figure 1. PRISMA Diagram

Table 3. Data Extraction Summary of Included Studies

Ref	Country or Institution	AI Technique	Assessment Type	Dataset Characteristics	Validation Methods	Reported Outcomes	Limitations
[1]	South Africa (ODeL institution)	ML (learning analytics)	Continuous online assessment	LMS-generated student data	Descriptive & comparative analysis	Improved continuous assessment monitoring	Limited AI automation focus
[2]	South Africa	AI-driven grading (ML and LLMs)	General assessment	Conceptual or secondary data	Conceptual evaluation	AI improves efficiency and consistency	Lack of empirical validation
[3]	South Africa	AI (broad)	General HE assessment	Secondary institutional data	Literature synthesis	AI enhances institutional processes	Limitations in terms of infrastructure, skills and policy
[4]	African Higher education	Generative AI (LLMs)	Reflective essays	Essay responses	Human vs AI comparison	Comparable grading performance	Bias and reliability concerns

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Ref	Country or Institution	AI Technique	Assessment Type	Dataset Characteristics	Validation Methods	Reported Outcomes	Limitations
[5]	ODeL context	AI-supported assessment	Project-based assessment	Conceptual	Pedagogical analysis	AI supports authentic assessment	Limited empirical evidence
[6]	African ODeL	AI in ODeL	General	Literature review	Systematic review	AI enhances marking in ODeL environments	Limitations in terms of infrastructure, skills and policy
[7]	Africa	AI (ML/NLP)	STEM assessments	Not specified	Conceptual/empirical mix	Improved STEM learning outcomes	Limited methodological clarity
[10]	South Africa	AI auto-marking system	General assignments	Prototype dataset	Design and system evaluation	Reduced lecturer workload	Prototype limitations
[11]	ODeL Context	AI	General assessment	Conceptual	Narrative analysis	AI enhances assessment efficiency	No empirical validation
[12]	Distance education context	Generative AI (ChatGPT)	Online assessments	Not applicable	Conceptual discussion	AI disrupts traditional assessment	Academic integrity risks
[13]	Africa (ODeL)	ML + SRL	General	Literature dataset	Systematic review	ML enhances learning & assessment	Limitations in terms of skills and infrastructure
[14]	South Africa	LLMs (Generative AI)	General assignments	Student submissions	Comparative evaluation	AI comparable to human grading	Ethical concerns
[15]	Global South	AI-enhanced pedagogies	General	Literature dataset	Systematic review	AI enhances marking	Limited African empirical data
[16]	Africa	AI (broad)	General	Literature dataset	Review	AI transforms education	Infrastructure constraints
[17]	Zimbabwe	AI	General	Conceptual	Case analysis	Opportunities for AI adoption	Infrastructure constraints
[18]	Africa	AI/learning analytics	LMS-based assessment	LMS interaction data	Statistical analysis	Enhanced student feedback retention	Limitations in terms of skills and infrastructure

All the 18 reviewed studies agree to the fact that Artificial Intelligence (AI) is swiftly transforming assessment practices in higher education, particularly in Open and Distance electronic Learning (ODeL) environments that are characterised by large enrolments, limited lecturer-student interaction and geographical dispersion. Collectively, these

studies highlight that AI offer substantial advantages in enhancing scalability, personalisation and efficiency of assessment especially through automated grading, real-time feedback systems, predictive analytics and adaptive learning technologies [6]. The AI innovations can support continuous assessment models by lightening administrative burden on lecturers, ensuring faster turnaround times, increasing marking consistency and providing more tailored feedback that promote learner development especially in high enrolment ODeL contexts such as University of South Africa [12]. Furthermore, literature also point out that AI can be essential in addressing long standing concerns over assessment reliability and discrepancies that normally arise from human subjectivity especially were multiple assessors are involved [2].

However, most the same literature underscores major risks, limitations and ethical dilemmas around fairness, validity, academic integrity and transparency. Generative AI tools such as ChatGPT can pose huge threats to assessment authenticity because they are very capable of producing very sophisticated responses that can pass high stake examinations across disciplines raising concerns about practicability of traditional online assessments [12]. Several of the studies emphasises that universities must redesign assessment so that they can be context specific, reflective as well as including oral and practical components that cannot be easily outsourced to ChatGPT or similar tools. Additionally, the literature highlights concern about algorithmic bias, poor performance of AI on creative or critical thinking tasks and the potential for AI-generated feedback to dehumanise the learning experience hence complicate the integration of AI into assessment [6], [11].

These challenges are more prominent in African ODeL systems that are characterised by infrastructural constraints, digital inequality as well as policy readiness gaps, hindering them to effectively adopt AI responsibly and equitably [3]. Furthermore, while AI technologies can be useful in ODeL assessments, successful implementation heavily depends on digital infrastructure, institutional preparedness and availability of adequately trained academic staff that can navigate emerging technological landscapes [18]. Combined, these studies highlight that future assessment in higher education ODeL environments will eventually move towards hybrid AI supported models capable of

combining the efficiency and analytical power of AI with the contextual sensitivity and ethical judgment of human assessors.

Evidence gathered from literature shows that AI will not replace human educators but will rather reshape their roles, requiring new pedagogical strategies, updated curriculum and academic integrity policies that reflect the realities of advanced AI systems. The integration of AI into ODeL assessments presents major opportunities to modernise teaching and learning and a huge responsibility that needs considerate planning, robust ethical safeguards and transformative pedagogical innovation. Ultimately, reviewed literature asserts that AI's transformative potential in ODeL contexts can be realised if institutions pursue deliberate, ethically grounded and pedagogically informed adoption pathways that balance innovation with academic integrity, fairness and student development.

3. RESULTS AND DISCUSSION

3.1. Thematic Findings

Findings from this systematic review are presented in line with the research questions that guided the study. The synthesis brought together evidence from studies examining assignment marking, AI-powered assessment practices, automated grading systems, and broader AI-supported assessment approaches, with particular attention to their relevance for African Open and Distance e-Learning (ODeL) institutions. Across the reviewed literature, six major themes emerged: AI techniques used in assignment marking, types of assessments, dataset characteristics, validation approaches, reported outcomes, and study limitations. These themes provide a structured understanding of the current state of AI-assisted assignment marking in African ODeL contexts.

As shown in Table 4, the first theme focuses on the AI techniques used in assignment marking. The reviewed studies show that Generative AI and Large Language Models (LLMs) are increasingly being applied to essay-based and text-heavy assignments, mainly because of their capacity to process natural language and generate feedback that approximates human responses. However, the evidence also suggests that these models are often assessed by comparing their outputs with those of human markers, raising important concerns about ethics, reliability, and fairness. In contrast, traditional Machine

Learning (ML) approaches appear more common in structured assessments and in systems designed for learning analytics, prediction, or prototype auto-marking tools. Table 4 also indicates that some studies adopted hybrid AI approaches or discussed AI in broad conceptual terms rather than reporting on fully implemented marking systems. This suggests that, while interest in AI is growing, much of the literature remains at an exploratory or institutional reflection stage rather than demonstrating mature, operational solutions.

Table 4. Theme 1 (AI Techniques Used in Assignment Marking)

Studies Contributing	AI Technique Theme	Key Patterns Identified
[4], [12], [14]	Generative AI or LMs	Used mostly for essay-based or text-heavy assignments; often evaluated against human graders; raises ethical concerns.
[1], [10], [18]	Machine Learning (Traditional ML)	Common for structured assessments and analytics; used for auto-marking prototypes and engagement analysis.
[6], [7], [11], [15], [16], [18]	Hybrid AI or Broad AI Techniques	Mostly systematic reviews or conceptual papers; provide high-level institutional and pedagogical insights.
[10]	AI Auto-Marking Systems (Rule-based and ML mix)	Employed in prototype or experimental systems for reducing marking workload.

The second theme, summarised in Table 5, relates to the types of assessments in which AI has been applied. The review shows that AI tools have been used most prominently in essay-based and reflective writing tasks, where LLMs and NLP-based systems can interpret narrative responses and produce grading or feedback outputs that align reasonably well with human assessors. This pattern suggests that AI is not restricted to objective or multiple-choice formats, but is increasingly being tested in more open-ended forms of assessment. At the same time, Table 5 shows that AI has also been explored in project-based assessments, STEM or quantitative assessments, and general online or LMS-based assessments. The literature indicates that AI performs better in highly

structured response environments, such as formula-driven answers or standardised digital submissions, while more subjective tasks still require substantial human oversight. In African ODeL settings, this distinction is important because many institutions use a mix of written assignments, projects, and continuous assessment tasks, meaning that the suitability of AI depends heavily on the nature of the assessment itself.

Table 5. Theme 2 (Types of assessments)

Studies Contributing	Assessment Type Theme	Insights
[4], [12], [14]	Essay-based & Reflective Writing	LLMs perform well on narrative text; good human–AI alignment but concerns about bias.
[5]	Project-based Assessments	AI increases authenticity and efficiency but may struggle with subjectivity in projects.
[7]	STEM or Quantitative Assessments	ML and NLP excel in structured or formula-driven student responses.
[1], [18]	General Online or LMS-based Assessments	More analytics-focused; not always about auto-marking.

A third theme emerging from the review concerns the dataset characteristics used in the examined studies. As presented in Table 6, many studies relied on student-generated text, such as essays and written assignments, to compare AI-generated marks with human grading. These datasets were frequently small, institution-specific, or prototype-based, which limits the extent to which findings can be generalised across ODeL institutions in Africa. Other studies used LMS engagement data or behavioural data, although these were often aimed more at learner monitoring and prediction than at direct assignment marking. Table 6 also shows that some studies were based largely on simulated datasets or secondary literature syntheses, reflecting the early stage of development in this field. This is a critical issue because the quality, diversity, and scale of datasets strongly influence the reliability of AI systems. In the African ODeL context, where linguistic diversity, varied curriculum designs, and differences in digital infrastructure are significant, limited and homogeneous datasets may fail to capture the complexity of real

educational environments. The evidence therefore points to the need for more robust, context-sensitive datasets that reflect the realities of African learners and institutions.

Table 6. Theme 3 (Dataset Characteristics)

Studies Contributing	Dataset Theme	Summary of Findings
[4]	Student-generated text (essays, assignments)	Used to compare human vs AI grading; datasets mostly small or prototype-level.
[1], [18]	LMS Engagement or Behavioural Data	Used for monitoring and prediction rather than grading.
[10]	Prototype or Simulated Data	Highlights early development stages; limits generalizability.
[15], [16], [18]	Literature-based (secondary synthesis)	Broad overviews; useful for trends

The fourth theme addresses the validation approaches used to assess AI-based assignment marking systems. As indicated in Table 7, the most rigorous validation approach identified in the review was human–AI grading comparison, in which AI-generated grades were compared with grades awarded by human markers. This method provides an important measure of reliability because it directly tests whether AI can approximate human judgement in authentic assessment contexts. Other studies used system accuracy and performance testing, especially where ML-based or rule-based systems were developed in prototype form. These studies typically reported numerical performance measures but often did not address broader educational concerns such as fairness, transparency, or the pedagogical value of machine-generated feedback. Table 7 also shows that some studies relied on descriptive or comparative analysis, particularly in learning analytics contexts, without evaluating AI as a direct marking tool. Taken together, these findings suggest that validation remains uneven across the literature. While some studies make serious attempts to establish reliability, many do not move beyond technical testing or descriptive reporting. For African ODeL institutions, stronger validation frameworks will be essential before AI can be trusted as part of high-stakes assignment marking processes.

Table 7. Theme 4 (Validation Approaches)

Studies Contributing	Validation Theme	Observations
[4], [14]	Human–AI Grading Comparison	Strongest validation method; useful for reliability checks.
[10]	System Accuracy & Performance Testing	Standard ML validation; provides quantifiable accuracy metrics.
[1], [18]	Descriptive or Comparative Analysis (Non-ML)	Mostly analytics-focused rather than grading-focused.

The fifth theme captures the reported outcomes of AI use in assignment marking and related assessment practices. Table 8 shows that one of the most consistent outcomes across the reviewed studies is improved grading efficiency and consistency. Several studies suggest that AI can reduce the time required for marking and help standardise evaluation, especially in contexts where large student numbers place heavy demands on academic staff. The table also indicates that some studies found comparable or relatively high accuracy between AI outputs and human grading, particularly in text-based assessments. Beyond grading itself, the literature points to broader benefits such as enhanced learning analytics, continuous monitoring, and pedagogical innovation. In some cases, AI was seen not only as a marking tool but as part of a wider shift toward more responsive and technology-enhanced teaching and learning. Still, these positive outcomes should be interpreted with caution. Many were reported in small-scale or experimental studies, and relatively few demonstrated long-term implementation in real institutional settings. For African ODeL systems, the potential gains are clear, but the evidence remains insufficient to claim that AI has already achieved transformative impact at scale.

Table 8. Theme 5 (Reported Outcomes)

Studies Contributing	Outcome Theme	Insights
[2], [14]	Improved grading efficiency and consistency	AI can reduce workload and time for marking.

Studies Contributing	Outcome Theme	Insights
[4]	Comparable or high accuracy	LLMs often align well with human consistency.
[1], [18]	Enhanced learning analytics or monitoring	Useful for continuous assessment rather than marking.
[5], [15]	Pedagogical innovation	Supports authentic assessment and new learning models.

The final theme concerns the limitations reported across the reviewed studies. As summarised in Table 9, one of the most significant limitations is the lack of empirical validation, since many studies remain conceptual, exploratory, or based on pilots rather than full institutional deployment. This means that much of the available evidence does not yet demonstrate how AI systems perform under real operational conditions in African ODeL environments. Table 9 also highlights concerns about bias, reliability, and fairness, especially in relation to LLMs and other generative models that may reproduce existing inequalities or fail to account for local linguistic and cultural nuances. A further challenge identified in the literature is the issue of infrastructure and scalability, with studies noting barriers such as limited bandwidth, unstable connectivity, high system costs, and uneven access to digital platforms. Prototype limitations also remain a major concern, since early-stage systems may perform well in controlled experiments but lack the robustness required for institution-wide adoption. Overall, the limitations shown in Table 9 reinforce the view that AI-assisted assignment marking in African ODeL institutions is still an emerging field. Its future success will depend not only on technical improvements, but also on stronger governance, contextual adaptation, and careful integration with human academic judgement.

Table 9. Theme 6 (Limitations)

Studies Contributing	Limitation Theme	Highlights
[14], [11]	Limited empirical validation	Many studies are conceptual. Few conduct system-level testing.

Studies Contributing	Limitation Theme	Highlights
[4], [14]	Bias, reliability & fairness concerns	LLMs may replicate or amplify bias in grading.
[6], [13], [17]	Infrastructure and scaling challenges (African context)	Connectivity, bandwidth, system cost barriers.
[10]	Prototype limitations	Early-stage systems lack robustness.

3.2. Proposed Architecture of an AI-Based Automatic Assignment Marking System in ODeL Environments.

Based on the results obtained from the synthesis table, this study a conceptual architecture for AI-based assignment marking systems tailored to ODeL environments. The architecture was developed through identified recurring system components, workflow structures, and functional requirements that consistently highlighted in existing implementations. Major elements included in the model included automated grading and feedback mechanisms, integration with learning management systems, AI models such as machine learning, natural language processing, and generative AI and robust data processing and analytics elements. Importantly, the proposed architecture inserts human-in-the-loop validation processes to guarantee oversight, accountability, and pedagogical relevance.

Table 10. Justification of proposed architecture based on literature

Evidence From Studies	Architecture Component	Theme Mapped To	Justification
Essay [4], Projects [5] , LMS data [1]	Submission & Preprocessing Layer	Assessment Types and Dataset	Architecture reflects real assessment formats and data sources used in studies
ML prototypes [10] , LMS analytics [18]	ML Scoring Engine	AI Techniques	ML repeatedly appeared for structured or numeric marking

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Evidence From Studies	Architecture Component	Theme Mapped To	Justification
NLP elements and short-text processing [4]	NLP Semantic Scoring Engine	AI Techniques	NLP required for short answer and structured text
LLM use in essays [4], [14]	LLM-Based Marking Module	AI Techniques plus Assessment Types	LLMs are dominant AI technique for text-based marking
Human vs AI grading comparisons [14]	Rubric Alignment Engine	Validation Theme	Ensures alignment between lecturer expectations and AI scoring
Human–AI comparison [4] and ethical issues [18]	Human-in-the-Loop Module	Validation Theme	Necessary to address reliability and bias concerns
Bias noted in LLM scoring [4]	Bias and Reliability Checker	Challenges Theme	Ensures fairness and transparency
African English varieties challenge [4], [10]	Linguistic Variation Module	Challenges Theme	Necessary for context-aware grading in African ODeL
Infrastructure issues [17], [18]	Low-Bandwidth Infrastructure Mode	Challenges Theme	African ODeL requires resilience to poor connectivity
Efficiency and feedback [2]	Feedback Generation Engine	Outcomes Theme	AI's major reported benefit is improved feedback speed
Workload reduction [10]	Lecturer Dashboard	Outcomes Theme	Enables lecturers to verify and adjust AI outputs
LMS-based research [1], [18]	LMS Interoperability Layer	Institutional Theme	Ensures seamless integration into actual ODeL systems

Evidence From Studies	Architecture Component	Theme Mapped To	Justification
Ethical concerns [18]	Governance and Policy Layer	Institutional or Technical Challenges	Ensures safe adoption within higher education

3.3. Proposed architecture

Based on justification table results, this study proposed an architecture that can be followed in the practical development of AI-based assessment systems. Figure 2 shows the proposed architecture that can be utilized to develop an AI based automatic assignment marking system to enhance teaching and learning in ODeL environments. The architecture comprises of four interconnected layers that all reflect patterns, AI techniques, assessment types, datasets, validation methods and implementation challenges highlighted in literature

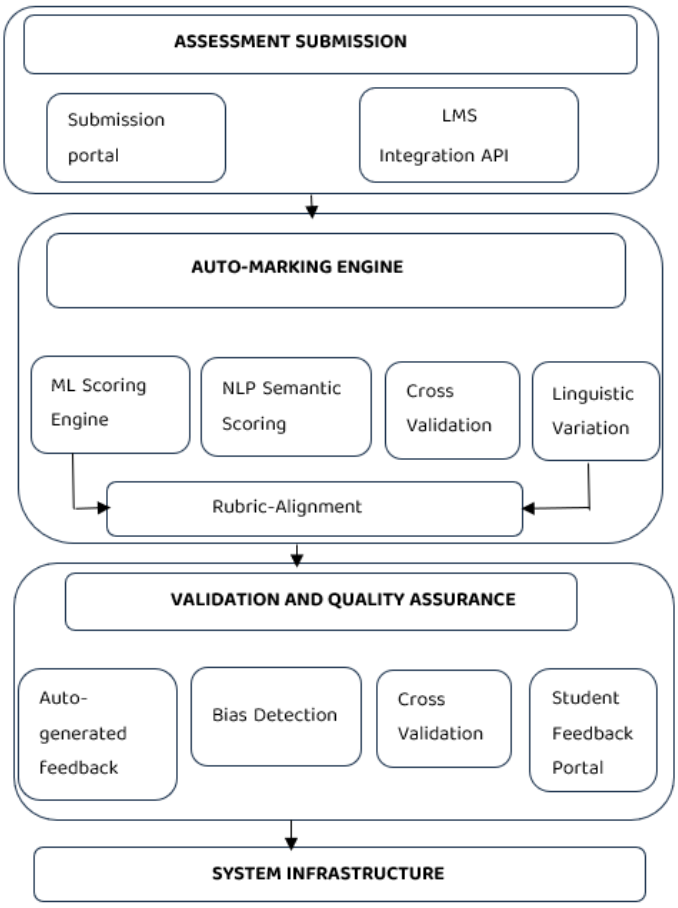

Figure 2. Proposed architecture for AI-Based Assignment Marking

As shown in Figure 2, The Assessment Submission Layer is the entry point that allows students to upload their assignments on an LMS-integrated interface. This layer supports different assessment types such as essays, projects and written tasks. The LMS Integration API component ensures that there is compatibility with existing institutional learning systems. A pre-processing module anonymises and prepares submissions for AI analysis highlighting the different dataset features identified in literature. Additionally, the Auto-Marking Engine is the main analytical layer that integrates various AI techniques identified in literature. These include ML, LLMs, and NLP. Machine learning is responsible for structured and quantitative tasks while Large Language Models for text-based submissions. Cross-validation and Linguistic variation handling modules assists in accuracy and robustness within different African languages. Finally, the rubric-alignment component assists in mapping AI output to instructor marking criteria to promote integrity.

The Validation and Quality Assurance layer covers ethical, technical and reliability issues that were highlighted in the reviewed literature. This includes issues such as human-in-the-loop mechanism, automatic bias detection and student feedback portal that provides grades and formative feedback. The last layer is the Infrastructure Layer, which is responsible for providing technological foundation for architecture deployments in African ODeL environments. Cloud and hybrid deployments supports institutions that have different infrastructural capacity, while privacy and security controls ensure conformity with data protection policies. The layers form an evidence driven architecture that aligns AI marking processes with pedagogical, institutional, and contextual realities of African ODeL systems.

3.4. Discussion

The purpose of this systematic review was to explore the state of AI-based assignment marking in African ODeL institutions with more emphasis on the Southern African region by focusing on four areas namely techniques utilised, evaluation approaches, assessment types and datasets, and encountered challenges. Findings from the reviewed literature shows that the field is promising but still characterised by fragmented evidence , and limited large-scale implementations.

1) Dominance of Text-Centric AI Techniques in African ODeL Contexts

From Across reviewed literature, AI-based assignment marking mainly utilised Machine learning (ML) and Natural Language Processing (NLP) techniques to grade text-based assignments such as essays, structured responses, reflective writing and short answer questions [4], [10] . A smaller body of work explored the use of LLMs for assignment grading showing moderate to strong alignment with human assessors especially when rubrics are given. The pattern shown point out that institutions are experimenting with AI in assessment tasks that are text based. There is limited presence of domain complex assessments that incorporate practical demonstrations, audio and videos [4]. This shows that African ODeL institutions are still at primary levels in diversifying AI-based assessments. The narrow focus reflected may be because of infrastructure constraints, limited datasets and lack of institutional capacity to implement AI architectures [6], [18].

2) Persistent Pilot-Level Implementations and Limited Empirical Rigor

Although several studies reported positive outcomes such as improved grading consistency, enhanced feedback detail and reduced turnaround time, most of these AI systems are mostly prototypes and are at a pilot stage [2], [3] . Few studies included large scale or multi-cohort deployments. These results are consistent with patters in African higher education environments characterized by experimental technology adoption rather than institutional [15], [18]. Methodologically, several studies suffer from limited dataset sizes, lack of robust performance metrics or insufficient comparison with expert graders [4], [10]. Most conceptual papers lacked empirical grounding, and tested implementations hence constrain generalizability of findings and highlight the need for context-sensitive empirical evaluations before implementing AI-marking systems on a larger scale.

3) Infrastructure, Ethics, Linguistic Diversity, and Institutional Readiness challenges

Across reviewed studies, several recurring challenges were identified. The first challenge highlighted is infrastructural limitations that includes lack of computational resources, bandwidth instability and weak data storage capacity [3], [6], [17], [18]. Furthermore, ethical issues were also highlighted and these included questions about academic integrity and plagiarism detection especially with the emergence of Generative AI. Additionally, implementing NLP-based systems that are trained with western -centric datasets is complex in African environments due to linguistic diversity [3], [6], [17], [18]. . This increases

the risk of algorithmic bias and reduced performance for multilingual students [4]. Additionally, several institutions lack in terms of AI policies, staff training programs and data governance frameworks. These highlighted challenges shows that successful implementation of AI based assignment marking in African ODeL systems also depend on ethical, infrastructural and organisational transformation rather than technical progress only [3], [6], [17], [18]. .

4) Evidence-Based Alignment with the Proposed Architecture

The synthesis of findings from literature aligned with the proposed conceptual architecture for AI-based assignment marking. Literature pointed out to the need for scalable user interfaces, robust backend orchestration, fusion of AI models such as ML, NLP, LLMs, human-in-the-loop moderation, analytics layers, LMS integration, and secure, and localised datasets [2], [3], [5], [10].. This architecture thus highlights a socio-technical vision where automation is balanced with pedagogical oversight, ethical safeguards, and institutional support structures. Findings further shows that the future of AI-based assessment in African ODeL systems will likely comprise of hybrid models, where AI automates routine tasks while human instructors take responsibility for complex judgement, contextual interpretation, and quality assurance [3], [4].. The architecture's human-in-the-loop design and analytics-driven feedback pathways support the hybrid model and assist in addressing concerns related to transparency and fairness.

4. CONCLUSION

This study systematically reviewed empirical evidence on the application of Artificial Intelligence (AI) in assignment marking within African Open and Distance e-Learning (ODeL) institutions. Findings obtained highlight that while AI techniques such as Machine Learning (ML) and Natural Language Processing (NLP) prove to have huge potential in enhancing assessment efficiency, consistency, and feedback processes, their application across African ODeL contexts remains largely at an experimental stage. Furthermore, current applications are largely focused on text-based assessments, with limited investigation of diverse assessment formats and inadequate availability of contextually appropriate datasets. Although the study noted several literature highlighting positive alignment between AI-generated and human grading, evaluation practices remain uneven and often limited to technical performance metrics with minimum emphasis on

pedagogical validity and long-term learning outcomes. Additionally, this study noted important ethical, technical, and institutional challenges and these included algorithmic bias, infrastructural limitations, absence of robust governance frameworks, and data privacy concerns. In conclusion, AI-based assignment marking in African ODeL institutions is very promising but very complex to implement. Its implementation should be approached as a socio-technical system that requires integration of technological expertise with pedagogical alignment, ethical safeguards, and institutional readiness. Future research should put priority on the development of locally appropriate datasets, standardised evaluation frameworks, and context-sensitive implementation models to support scalable and responsible adoption of AI-assisted assessment systems in African ODeL environments.

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