Using Machine Learning Techniques to Enhance Adaptive Learning Management System in The Case of Kenyan Universities.

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ABSTRACT

Universities in Kenya have a substantial increase in the use of learning management systems (LMSs) to support e-learning. These universities have adopted LMS to ensure that students are widely reached and at the same time experience effective learning. The universities have still not adopted Adaptive LMS to help in this learning approach. Adaptive learning management systems are designed to personalize the learning experience for each individual student, taking into account their unique needs and abilities. In combination with Machine Learning techniques (ML), such technology has unprecedentedly allow students to have adaptive feedback, adaptive assessment as well as adaptive learning content.This paper proposes on how the use of machine learning techniques can enhance adaptive LMS to analyze student data and automatically adjust the learning experience accordingly. The paper recommends that Kenyan universities should adopt use of machine learning techniques to significantly improve the effectiveness of adaptive learning management systems, leading to better student outcomes and a more efficient learning.

Keywords: Adaptive Learning Management System, Machine learning technique, adaptive feedback, adaptive assessment, adaptive learning content, learning management system (LMS).

INTRODUCTION

COVID-19 had a huge impact on our educational system in the world which resulted to the suspension of academic institutions of higher learning in the country which lead to pushing for online learning. This has result to recently increase introduction of online education in various universities in sub-Saharan Africa (citation). The use of a learning management system could lead to delivery of education material paperless. According to Turnbull et al., (2021) Learning Management System is one of the best online learning platforms which not only enable the delivery of instructions and electronic resources to improve and augment student learning in a collaborative environment, but also allow instructors to focus on designing meaningful pedagogical activities. However, for learning management system to be effective it must be adaptive. Carol sinko (2023) defines Adaptive learning as personalized and dynamic approach to online education that adapts to the needs, preferences, and progress of each learner. It uses data, algorithms, and feedback to create customized learning paths and content for each individual. Adaptive learning management systems can be tailored to customize course for every student based on their level of knowledge, preferred mode of learning and continuously updates the course based on their learning speed. The adaptive learning management system can allow material to be filtered from a knowledge base that is dynamically updated using web scraping and ranked using feedback from students on the relevance and quality of each material (swetha 2021). Adaptive learning management system provides students with personalized feedback, personalized

learning content as well as personalized self-assessment tools which will ensure effective way of learning.

In Kenya, Learning Management Systems (LMS) are being used by various institutions to facilitate the delivery of high-quality professional certification programs to learners in various parts of the country, the East African region, and beyond (KIM Learning Management Systemn. d).A study on the adoption determinants of E-learning Management Systems in institutions of higher learning in Kenya found that performance expectancy, effort expectancy, social influence, and facilitating conditions influenced the acceptance of E-learning Management Systems (maina 2015). The study also found that expected performance, enabling infrastructures, institutional policies, training support, leadership, and ease of effort use influenced the adoption of E-learning Management Systems in institutions of higher learning. Overall, it appears that Learning Management Systems are being increasingly adopted by institutions of higher learning in Kenya to facilitate the delivery of educational content and improve the quality of education. Different Learning management system has been modified to meet user expectations by ensuring it is personalized in terms of having unique features, such as posting and reflection, personalized networking tools, gamified reward systems, digital badges and certificates, global classrooms, and a lifelong social e-portfolio as explained by Mohammed (Jafari ,2022).“Machine learning is a research field that formally centers on the theory, performance, and properties of learning systems and algorithms” as explained by Md Ahmed et al (2022).Machine learning techniques can be used to enhance the individual learning process in an adaptive learning management system which can help create a more student-oriented learning environment by providing personalized and adaptive feedback, assessment, and learning content as stated by **(**Gerhard Weber, n.d). Numerous studies have been done to show how learning management systems have been used in Kenyan universities, but there has been a lack of study on how adaptive Learning management systems can be employed using machine learning techniques on learners. Therefore, this study aims to examine how machine learning techniques can be deployed in adaptive learning management systems to ensure students get adaptive feedback, adaptive assessment as well as adaptive learning content.

Problem Statement

The adoption of LMSs in Kenya was really welcomed especially after the year 2020 after the Covid-19 pandemic when the on-campus learning experience was no longer an option. This allowed students and teachers to maintain interaction with their academic institutions. LMS plays a significant part in enriching and facilitating learning all around the world. This lead to many higher education’s institution to establish learning Management System in sub-Saharan Africa especially in Kenya as stated by(Mbete,2015) The different types of LMS being used include Moodle and blackboard. The use of an LMS can provide many benefits to institutions of higher learning in Kenya, especially it helps to streamline the delivery of educational content, making it easier for students to access the resources they need and for administrators to manage course materials and track learner progress. Additionally, an LMS can help to reduce training costs by eliminating the need for printed materials, venue rentals, and instructor fees associated with traditional face-to-face training. Despite the potential benefits of adaptive learning, many current learning management systems lack the ability to provide adaptive feedback, adaptive assessment, and adaptive learning content. This can limit the effectiveness of these systems in supporting personalized learning and meeting the diverse needs of learners. The purpose of this research is to investigate the development and implementation of an adaptive learning management system using machine learning techniques.

Study Objectives

To determine how machine learning techniques can be used in adaptive Learning Management system.

LITERATURE REVIEW

Learning Management System in Kenyan Universities.

This section provides an examination of how machine learning techniques can be employed in adaptive learning

management systems in Kenyan universities.

Kenya had 32 public and 33 private universities Commission for University Education (CUE) by the year 2021 (CUE, 2021). Most of these institutions are offering courses in e-learning which were mainly Learning Management System (LMS) supported by asynchronous and blended in nature as stated by (Ssekakubo et al., 2011). A study conducted by Araka (2021) stated that most learning management system in Kenyan universities doesn't provide students with individualized feedback on students' learning, lack of instructor guidance, lack of interaction with course instructors, lack of peer interaction, and lack of automation tools.

Another study by Almahaseeset al,.(2021) on Kenyan universities showed that faculty members, and students were unprepared for the immediate and massive shift to online teaching and learning and had challenges using virtual technologies for teaching and learning during the lockdown. These challenges ranged from insufficient or lack of internet bandwidth, training, increased teaching, and learning workloads to limited time for interactions . According to Kabiru et al,(2021) some of the challenges revealed include the lack of adequate e-Learning policies, inadequate Information and Communication Technology (ICT) infrastructure, the ever-evolving technologies, lack of technical and pedagogical competencies and training for e-tutors and e-learners, lack of an e-Learning theory to underpin the e-Learning practice, budgetary constraints and sustainability issues, negative perceptions towards e-Learning, quality issues, domination of e-Learning aims by technology and market forces and lack of collaboration among the e-Learning participants.

The challenges have been addressed by most learning institutions, such as training of tutors, availability of learning content, technical and pedagogical competencies as well as training of learners as found in (kabarak university, 2023).However adaptive feedback, adaptive assessment and adaptive learning content remains a challenge for most Learning management systems in Kenya. This can mainly be achieved by implementing Adaptive Learning Management System.

Adaptive Learning Management system.

An adaptive learning management system is a software that uses algorithms and artificial intelligence to personalize the learning experience for each individual student. It dynamically adjusts the level or type of course content based on the student's abilities or skill attainment, in ways that accelerate their performance with both automated and instructor interventions as explained by (Lou Pugliese,2016). The goal is to provide a customized, learner-centered, and interactive learning environment that aids and improves the learning process.

Different AI-enabled learning systems have been developed based on research on intelligent tutors, learning analytics and educational data mining techniques to enhance the advancement of the AI facilitated systems. This has helped in providing personalized feedback and help support students during their learning. It is predicted that there will be a growing number of technology-enhanced learning environment studies that will apply AI in education (Moreno-Guerrero et al., 2020).

A study by Xi Yang et, al. (2021) has shown how adaptive learning management system have been enhanced based on deep learning technology. It delves into the design and implementation of the system, including real-time personalization and personalized page ranking algorithms. The system uses students' online learning action data to construct a special learning mode for each student and provide suitable learning resources.

Another study by Sridharan, et al. (2021) discusses the development of an adaptive learning management system that creates a customized course for every student based on their level of knowledge, preferred mode of learning and continuously updates the course based on their learning speed. The material is filtered from a knowledge base that is dynamically updated using web scraping and ranked using feedback from students on the relevance and quality of each material. This research focuses on how machine learning techniques can be used to enhance

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Adaptive LMS.

Machine Learning Techniques

Machine learning can be used in education to provide a more personalized and effective learning experience for each individual student. By using machine learning techniques to analyze student behavior and performance, an adaptive learning management system can adapt the presentation of educational material to meet the specific needs of each student. This can help improve the speed, accuracy, quality, and quantity of learning for each individual student (Aleksandra Ahramovichn.d). "Machine-learning-based adaptive platforms are the most sophisticated scientific method in which to establish a truly adaptive state" (Lou Pugliese,2016). Different techniques can be used in adaptive learning management system which include classification algorithms which is a type of machine learning algorithm that assigns a label to a data input.

These algorithms use labeled data and statistical methods to produce predictions about data input classifications. The classification algorithm is used for predicting discrete responses as explained by (Badreshsetty, 2023). There are different types of classification algorithms include Logistic Regression which is used when the dependent variable is not a number but something else K-nearest neighbor algorithm classifies an object based on the majority vote of its neighbors, with the object being assigned to the class most common among its k nearest neighbors.

Decision Trees is an algorithm that creates a model that predicts the value of a target variable by learning simple decision rules inferred from the data features. Naive Bayes algorithm applies Bayes' theorem with the assumption of independence between every pair of features. Artificial Neural Networks algorithm is composed of multiple layers of interconnected nodes, where each node represents an artificial neuron that processes information using a connectionist approach to computation (monkey learnn.d).These algorithms can be used in an adaptive learning management system to predict a student's performance based on their past behavior and other relevant factors.

Gaps in Literature

The analysis of the literature indicated different types of machine learning techniques have been used in LMS, According to a study by Kulkatechol Kanokngamwitroj, et al. (2022) he uses machine learning techniques in LMS to identify the risk group and give them personal tutoring and RSU-ML-PL algorithm was designed to provide each student with a personalized and self-tutoring system where decision tree algorithm as a classification model. This algorithm model became the point of identification of risk group in the University.

Another study on how machine learning techniques can be applied on collaborative groups of learners in an LMS by (Maina, et al.2017). This study explained how instructors can group learners during an online group task based on the learners' collaboration competence level using clustering algorithms.

Md. Alimulhaque,et al(2022) conducted a study where learners using LMS can be given feedback and queries associated with technical issues and problems when they have engaged in online classes using natural processing language, in this study real time feedback was not accomplish because it cannot be done round the clock. This study aims to identify which machine learning technique can be used to enhance adaptive LMS, in relation to adaptive assessment, feedback as well as adaptive learning content.

RESEARCH METHODOLOGY

This study used a mixed-methods methodology, integrating qualitative and quantitative techniques, to increase insight on Machine learning techniques on Adaptive LMS.

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Data Collection.

Secondary Data Collection.

Secondary data was collected via a review of existing literature. To achieve this, a secondary data analysis approach was employed, using a literature review as the primary method of analysis. Secondary data sources were identified and collected through a comprehensive literature review by only reviewing articles that had "machine learning techniques used in adaptive learning management systems". The literature review focused on peer-reviewed journal articles and conference proceedings that discussed the use of machine learning techniques in adaptive learning management systems. The search was conducted using academic databases such as Google Scholar, science direct, Springer link, research gates and JSTOR.

Data Analysis

The collected data was analyzed using a narrative synthesis approach. The analysis focused on identifying common themes and patterns in the literature related to the use of machine learning techniques in adaptive learning management systems. The analysis also aimed to identify different machine learning techniques and their limitations in the existing literature.

This study is limited by the availability and quality of secondary data sources. The findings are based on the existing literature and may not reflect the most recent developments in the field. Additionally, the study is limited by the scope of the literature review, which focused on peer-reviewed sources and may not have captured all relevant information.

Different ways from the secondary data were reviewed from 15 papers on how to enhance Adaptive LMS. They included Intelligent Agents, teachers/instructors, specialized software systems, machine learning techniques as well as intelligent agents working together with machine learning techniques as shown in **figure 1** below.

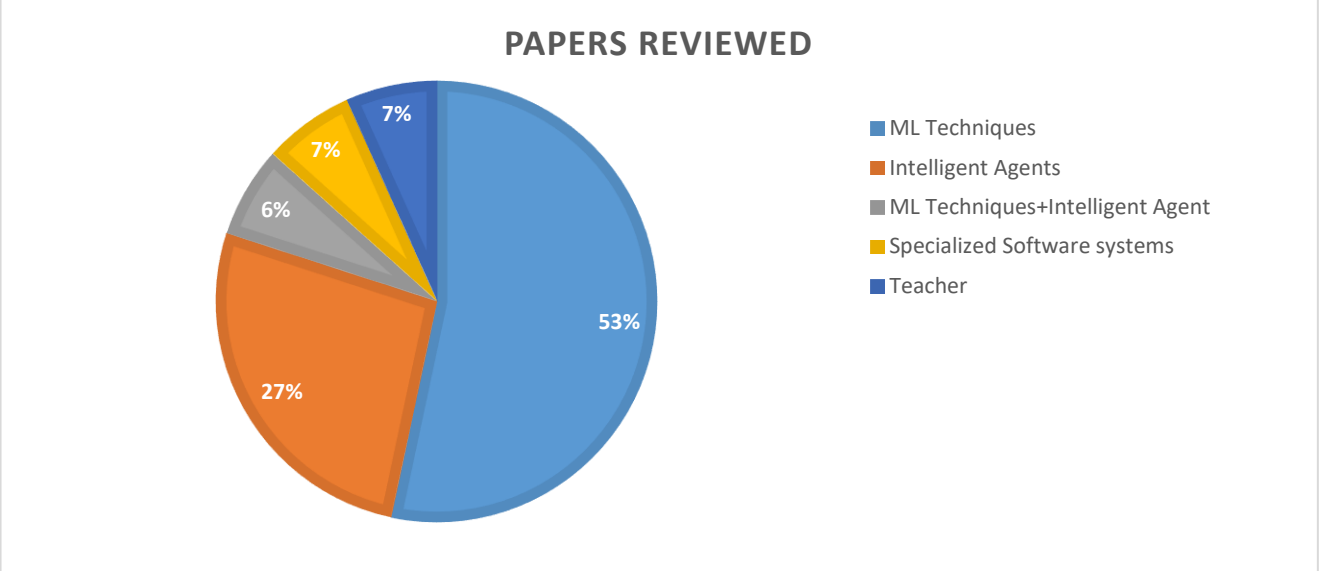

Figure 1: Different techniques used in Adaptive LMS

FUTURE RECOMMENDATION

While the developed world is increasingly embracing e-learning, the same is true of Kenya. To ensure the quality of online learning most Kenyan universities have instituted policies and guidelines to ensure that instructors spend

the required time online interacting with learners. They have also invested in technology, training of staff as well induction classes of learners before they start using different LMS (Kabarak University, 2023). In view of these events, the following proposals are made regarding Kenya's universities LMS.

The Kenyan should adopt the use of Adaptive Learning Management system to ensure personalized learning for the learners. However adaptive feedback, adaptive learning content as well as adaptive assessment on the learners can be achieved by use of machine learning techniques.

One of the future recommendations the Kenyan universities should undertake is a longitudinal study on the impact of adaptive LMS on student performance, comparative studies between different machine learning techniques, and the scalability of these systems in resource-constrained settings

Kenyan universities also have many students on their campuses that are supported by LMS which makes the instructors' role impossible, especially round the clock, hence the need for artificial intelligence (AI) such as machine learning techniques.

CONCLUSION

This research has delved into ways of integrating machine learning techniques into adaptive Learning Management systems (LMS). The main objective of this study was to determine how machine learning techniques can enhance adaptive learning management system. Through an extensive review of existing literature and empirical studies, we have gained valuable insights into the ways in which machine learning can enhance the adaptability of Adaptive LMS. These techniques have demonstrated the capability to personalize learning experience in form of adaptive feedback adaptive assessment, as well as optimize content delivery, all of which contribute to a more effective and efficient learning process.

The findings from this research have indicated that machine learning techniques hold great promise in revolutionizing the traditional LMS landscape. However, it is essential to acknowledge the challenges, such as the role of teacher/instructor, algorithm bias, and the need for continuous fine-tuning, that arise when implementing machine learning techniques in educational settings especially if Kenyan universities adopt it. As technology continues to evolve, educators, instructional designers, and technologists must collaborate in leveraging machine learning's potential. By addressing the issue of instructor support to large e-learning students, adoption of intelligent agents should be used as with machine learning techniques the future of adaptive Learning Management systems can truly be transformed through the power of machine learning.This research contributes to the ongoing dialogue in the field of education technology and highlights the need for further exploration and refinement of machine learning techniques in adaptive LMS. With the continuous advancement of artificial intelligence and data analytics, we anticipate that adaptive LMS integrated with machine learning will play an increasingly significant role in shaping the future of education sector in Kenya.

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