

PERCEPTION OF LECTURERS AND STUDENTS ON THE USE OF MACHINE LEARNING-BASED EARLY WARNING SYSTEMS FOR IDENTIFYING AT-RISK STUDENTS IN GOMBE STATE COLLEGE OF EDUCATION AND LEGAL STUDIES, NAFADA

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ABSTRACT

This study investigated the effect of an intelligent early warning system on at-risk students using machine learning techniques at Gombe State College of Education and Legal Studies, Nafada. A Research and Development (R&D) design combined with a quasi-experimental pretest–post-test control group design was adopted. The population of the study comprised all registered NCE and undergraduate students in the Departments of Mathematics/Computer Science and Legal Studies totalling 429 students. Using the Krejcie and Morgan sample size determination table, a sample of 152 participants was selected. This comprised 141 at-risk students, with 71 assigned to the experimental group and 70 to the control group and all 11 lecturers and academic advisers who were purposively selected to provide expert input and support the implementation of the intervention. The findings revealed that an intelligent early warning system can be effectively developed using machine learning techniques to identify at-risk students (grand mean = 3.64). The study further showed that the system had a positive effect on the early identification and intervention of at-risk students (grand mean = 3.69) and significantly improved students' academic performance and retention (grand mean = 3.69). The hypothesis tests indicated statistically significant effects on early identification and intervention, $t(139) = 4.86, p < .001$; academic performance, $t(139) = 5.42, p < .001$; and retention, $t(139) = 5.87, p < .001$. The study concluded that intelligent early warning systems based on machine learning techniques are effective tools for identifying academically vulnerable students and enhancing their academic performance and retention. It was recommended that Gombe State College of Education and Legal Studies, Nafada, should adopt and institutionalize the system, train relevant staff on its use, and integrate it into the college's academic monitoring and student support framework.

Keywords: Intelligent early warning system, machine learning, at-risk students, academic performance, retention, higher education.

Introduction

Student success and retention are widely recognized as important indicators of the quality and effectiveness of higher education institutions. In Nigeria, colleges of education play a critical role in preparing teachers and other professionals, yet many students encounter academic, financial, and personal challenges that increase their risk of poor academic performance and withdrawal from their programmes. At-risk students often exhibit warning signs such as poor attendance, low continuous assessment scores, repeated course failures, weak study habits, and inadequate academic preparation. When these indicators are not identified early, institutions may be unable to provide timely support, thereby increasing the likelihood of academic failure and attrition (Tinto, 2017; Ifenthaler & Yau, 2020).

Traditional methods of identifying academically vulnerable students, such as lecturers' observations, manual review of examination results, and counseling referrals, remain useful but are largely reactive. These approaches often detect academic difficulties only after substantial setbacks have occurred. In response to these limitations, higher education institutions are increasingly exploring early warning systems that analyze student data to predict academic risk and trigger timely interventions. Early warning systems are designed to identify students who may be at risk of failing courses, being placed on academic probation, or discontinuing their studies, thereby enabling institutions to provide proactive and targeted support (Howard et al., 2016; Liz-Domínguez et al., 2019).

Recent advances in Machine Learning and learning analytics have significantly enhanced the capabilities of early warning systems. Machine learning algorithms can process large and complex datasets, detect hidden patterns, and generate predictions regarding students' academic outcomes with a high degree of accuracy. Studies have shown that variables such as attendance, continuous assessment scores, cumulative grade point average, learning management system engagement, and course failure history are strong predictors of academic risk (Sarker, 2021; Chang et al., 2025).

Machine learning-based early warning systems have attracted increasing attention because of their potential to improve institutional decision-making, academic advising, and student retention. Recent empirical studies have demonstrated that these systems can accurately identify students at risk and support timely interventions that improve educational outcomes. For example, Chang et al. (2025) reported that personalized early warning systems can balance technological innovation with human-centered educational practices, while Handayani and Priyadi (2026) demonstrated strong predictive performance and favorable usability among academic advisers in higher education contexts.

Despite these promising developments, the successful adoption of machine learning-based early warning systems depends not only on technical capability but also on the perceptions and acceptance of the stakeholders who will use and benefit from them. Lecturers are expected to interpret risk reports and provide interventions, while students are the primary beneficiaries of the support generated by the system. According to the Technology Acceptance Model, users are more likely to adopt a technology when they perceive it as useful and easy to use. Positive perceptions therefore play a central role in determining whether innovative educational technologies are embraced and utilized effectively (Ifenthaler & Yau, 2020; UNESCO, 2023).

In Nigeria, the application of artificial intelligence and machine learning in higher education is still emerging. Although interest in data-driven decision-making is growing, many institutions continue to face challenges such as inadequate technological infrastructure, poor data management systems, limited technical expertise, and concerns about privacy and ethical use of student data. These constraints make it important to understand how key stakeholders perceive the potential use of machine learning-based early warning systems before large-scale implementation is considered (UNESCO, 2021; UNESCO, 2023).

At Gombe State College of Education and Legal Studies, Nafada, student monitoring is still carried out primarily through conventional approaches such as attendance records, continuous assessment results, and lecturers' observations. While these methods provide valuable information, they may not always facilitate the timely identification of students who are academically at risk. Machine learning-based early warning systems have the potential to strengthen the institution's capacity to identify vulnerable students and support more proactive academic interventions. However, successful implementation requires a clear understanding of the perceptions of lecturers and students regarding the indicators to be used, the expected effectiveness of the system, and its potential influence on academic performance and retention.

Although numerous international studies have demonstrated the usefulness of machine learning-based early warning systems, there is limited empirical evidence on lecturers' and students' perceptions of these technologies in Nigerian colleges of education, particularly in the North-East region. This gap underscores the need to investigate stakeholder perceptions and institutional readiness for adopting such systems in local contexts.

Therefore, this study examines the perceptions of lecturers and students on the use of machine learning-based early warning systems for identifying at-risk students in Gombe State College of Education and Legal Studies, Nafada. The study is expected to contribute to the growing body of knowledge on artificial intelligence in education and provide practical insights into stakeholder acceptance and institutional readiness for implementing data-driven student support systems in Nigerian tertiary institutions.

Statement of the Problem

Academic failure and student dropout remain persistent challenges in tertiary institutions and continue to undermine students' educational attainment and institutional effectiveness. In Nigeria, many students in colleges of education experience academic difficulties arising from poor attendance, low continuous assessment scores, repeated course failures, inadequate study habits, and limited academic support. When these warning signs are not recognized early, students are more likely to perform poorly, repeat courses, be placed on academic probation, or withdraw from their programmes.

At Gombe State College of Education and Legal Studies, Nafada, the identification and monitoring of academically vulnerable students are still carried out mainly through conventional approaches such as lecturers' observations, attendance records, and examination results. Although these methods are useful, they are often reactive and may not provide timely information needed to support at-risk students before significant academic problems occur. Recent advances in machine learning have created opportunities for higher education institutions to use early warning systems that analyze student data and generate predictions to guide timely interventions (Sarker, 2021; Chang et al., 2025).

Despite the growing interest in machine learning-based early warning systems, their successful adoption depends largely on the perceptions and acceptance of the key stakeholders who will interact with them, particularly lecturers and students. Lecturers are expected to interpret risk reports and provide academic support, while students are the primary beneficiaries of the interventions generated by the system. If these stakeholders do not perceive such systems as useful, effective, and relevant, implementation efforts may encounter resistance and fail to achieve the desired outcomes.

In Nigeria, and particularly in colleges of education, there is limited empirical evidence regarding how lecturers and students perceive the use of machine learning-based early warning systems for identifying at-risk students. Most existing studies focus on the technical development and predictive performance of these systems in foreign contexts, with little attention given to stakeholder perceptions and institutional readiness in developing countries. This creates a knowledge gap, especially in the North-East region of Nigeria, where technological innovations in higher education are still emerging.

Therefore, the problem of this study is the lack of empirical information on the perceptions of lecturers and students regarding the use of machine learning-based early warning systems for identifying at-risk students in Gombe State College of Education and Legal Studies, Nafada. Without such information, the institution may be unable to determine the extent to which stakeholders are willing to accept and support the implementation of data-driven technologies for improving student identification, academic support, performance, and retention.

Aim and Objectives of the study

The main objective of this study is to examine the perceptions of lecturers and students on the use of machine learning-based early warning systems for identifying at-risk students in Gombe State College of Education and Legal Studies, Nafada. The specific objectives of the study are to:

1. Determine the perceptions of lecturers and students regarding the key student indicators required for a machine learning-based early warning system to identify at-risk students.
2. Assess the perceptions of lecturers and students on the effectiveness of machine learning-based early warning systems in facilitating the early identification and timely intervention of at-risk students.
3. Examine the perceptions of lecturers and students on the potential influence of machine learning-based early warning systems on students' academic performance and retention.

Research Questions

1. What are the perceptions of lecturers and students regarding the key student indicators required for a machine learning-based early warning system to identify at-risk students?
2. What are the perceptions of lecturers and students on the effectiveness of machine learning-based early warning systems in facilitating the early identification and timely intervention of at-risk students?
3. What are the perceptions of lecturers and students on the potential influence of machine learning-based early warning systems on students' academic performance and retention?

Null Hypotheses

1. There is no significant difference between the mean ratings of lecturers and students regarding the key student indicators required for a machine learning-based early warning system to identify at-risk students.
2. There is no significant difference between the mean ratings of lecturers and students on the effectiveness of machine learning-based early warning systems in facilitating the early identification and timely intervention of at-risk students.
3. There is no significant difference between the mean ratings of lecturers and students on the potential influence of machine learning-based early warning systems on students' academic performance and retention.

Methodology

The study employed a descriptive survey research design to examine the perceptions of lecturers and students on the use of machine learning-based early warning systems for identifying at-risk students in Gombe State College of Education and Legal Studies, Nafada, Gombe State, Nigeria. The population consisted of 429 registered NCE and undergraduate students, while the accessible population comprised 240 academically at-risk students and 11 lecturers and academic advisers, making a total of 251 participants. The sample size for this study will be determined using the Krejcie and Morgan (1970) sample size determination table. 152 participants were selected, including 141 students and all 11 lecturers and academic advisers. A multistage sampling technique involving purposive, criterion, simple random, and total enumeration techniques was used in selecting the respondents for the study. Data were collected through a self-developed questionnaire titled *Machine Learning-Based Early Warning Systems Perception Questionnaire (MLEWSPQ)*, designed on a four-point Likert scale.

The instrument measured respondents' perceptions regarding the indicators, effectiveness, and influence of machine learning-based early warning systems on students' academic performance and retention. Mean and standard deviation were used to answer the research questions, while Independent Samples t-test was used to test the null hypotheses at the 0.05 level of significance using IBM SPSS Statistics.

Presentation of Results

Research Question One

What are the perceptions of lecturers and students regarding the key student indicators required for a machine learning-based early warning system to identify at-risk students in Gombe State College of Education and Legal Studies, Nafada?

Table 4.1: Mean and Standard Deviation of Respondents' Ratings on the Key Student Indicators Required for a Machine Learning-Based Early Warning System for Identifying At-Risk Students

S/N	Items	Mean	Std. Dev.	Remark
1	Student attendance records should be included as important indicators in a machine learning-based early warning system.	3.68	0.52	Agreed
2	Continuous assessment scores should be used as key indicators for identifying at-risk students.	3.74	0.46	Agreed
3	Previous semester GPA/CGPA should be considered as essential indicators in the system.	3.71	0.49	Agreed
4	Course failure history should be included in identifying students who may be academically at risk.	3.77	0.43	Agreed
5	Demographic information can enhance the effectiveness of a machine learning-based early warning system.	3.29	0.58	Agreed
6	The system should automatically generate alerts when students are identified as at risk.	3.72	0.47	Agreed
7	Lecturers and academic advisers should have access to students' risk reports generated by the system.	3.69	0.50	Agreed
8	Machine learning-based early warning systems can accurately identify students who require academic support.	3.73	0.48	Agreed
Grand Mean / Average Standard Deviation		3.67	0.49	Agreed

The descriptive statistics presented in Table 4.1 provide insight into the perceptions of lecturers and students regarding the key student indicators required for a machine learning-based early warning system for identifying at-risk students in Gombe State College of Education and Legal Studies, Nafada. Item 4 shows that respondents agree that course failure history should be included in identifying students who may be academically at risk (Mean = 3.77 ± 0.43), indicating strong acceptance of the statement. Item 5 reveals that demographic information can enhance the effectiveness of a machine learning-based early warning system (Mean = 3.29 ± 0.58), which also indicates acceptance. Item 6 shows that respondents agree that the system should automatically generate alerts when students are identified as at risk (Mean = 3.72 ± 0.47), reflecting strong agreement. Item 7 indicates that lecturers and academic advisers should have access to students' risk reports generated by the system (Mean = 3.69 ± 0.50), showing acceptance of the statement. Item 8 reveals that machine learning-based early warning systems can accurately identify students who require academic support (Mean = 3.73 ± 0.48), indicating agreement among respondents. The highest mean score among the items was recorded for Item 4, which states that course failure history should be included in identifying students who may be academically at risk (Mean = 3.77 ± 0.43), reflecting very strong agreement. The grand

mean of 3.67 with an average standard deviation of 0.49 is above the criterion mean of 2.50, showing overall agreement and a high level of consistency in respondents' perceptions.

In answering Research Question One, the findings indicate that lecturers and students perceive attendance records, continuous assessment scores, previous semester GPA/CGPA, course failure history, demographic information, automated alerts, and access to risk reports as important indicators required for a machine learning-based early warning system for identifying at-risk students in Gombe State College of Education and Legal Studies, Nafada.

Research Question Two

What are the perceptions of lecturers and students on the effectiveness of machine learning-based early warning systems in facilitating the early identification and timely intervention of at-risk students in Gombe State College of Education and Legal Studies, Nafada?

Table 4.2: Mean and Standard Deviation of Respondents' Ratings on the Perceived Effectiveness of Machine Learning-Based Early Warning Systems in Facilitating Early Identification and Timely Intervention of At-Risk Students

S/N	Items	Mean	Std. Dev.	Remark
1	Machine learning-based early warning systems can identify at-risk students before they fail their courses.	3.71	0.49	Agreed
2	The system can provide timely alerts to lecturers and academic advisers.	3.76	0.44	Agreed
3	The system can improve the speed of intervention for struggling students.	3.73	0.47	Agreed
4	Academic counseling can become more targeted when guided by the system.	3.66	0.54	Agreed
5	The system can help prioritize students who need urgent support.	3.79	0.41	Agreed
6	The system can reduce delays in identifying academic problems.	3.70	0.50	Agreed
7	The system can enhance collaboration between lecturers and academic advisers.	3.62	0.57	Agreed
8	The system can improve the overall effectiveness of intervention strategies.	3.74	0.46	Agreed
Grand Mean / Average Standard Deviation		3.71	0.49	Agreed

The descriptive statistics presented in Table 4.2 provide insight into the perceptions of lecturers and students regarding the effectiveness of machine learning-based early warning systems in facilitating the early identification and timely intervention of at-risk students in Gombe State College of Education and Legal Studies, Nafada. Item 1 shows that respondents agree that machine learning-based early warning systems can identify at-risk students before they fail their courses (Mean = 3.71 ± 0.49), indicating acceptance of the statement. Item 2 reveals that the system can provide timely alerts to lecturers and academic advisers (Mean = 3.76 ± 0.44), reflecting strong agreement. Item 3 indicates that the system can improve the speed of intervention for struggling students (Mean = 3.73 ± 0.47), showing acceptance. Item 4 shows that academic counseling can become more targeted when guided by the system (Mean = 3.66 ± 0.54), indicating agreement among respondents. Item 5 reveals that the system can help prioritize students who need urgent support (Mean = 3.79 ± 0.41), representing the highest mean score and reflecting very strong agreement. Item 6 shows that the system can reduce delays in identifying academic problems (Mean = 3.70 ± 0.50), indicating acceptance. Item 7 indicates that the system can enhance collaboration between lecturers and academic advisers (Mean = 3.62 ± 0.57), showing agreement. Item 8 reveals that the system can improve the overall effectiveness of intervention strategies (Mean = 3.74 ± 0.46), also indicating acceptance.

The grand mean of 3.71 with an average standard deviation of 0.49 is above the criterion mean of 2.50, showing overall agreement and a high level of consistency in respondents' perceptions. In answering Research Question Two, the findings show that lecturers and students perceive machine learning-based early warning systems as effective tools for facilitating the early identification and timely intervention of at-risk students in Gombe State College of Education and Legal Studies, Nafada.

Research Question Three

What are the perceptions of lecturers and students on the potential influence of machine learning-based early warning systems on students' academic performance and retention in Gombe State College of Education and Legal Studies, Nafada?

Table 4.3: Mean and Standard Deviation of Respondents' Ratings on the Potential Influence of Machine Learning-Based Early Warning Systems on Academic Performance and Retention

S/N	Items	Mean	Std. Dev.	Remark
1	Machine learning-based early warning systems can improve students' academic performance.	3.74	0.46	Agreed
2	The system can reduce the number of failed courses among at-risk students.	3.77	0.43	Agreed
3	The system can help students maintain regular class attendance.	3.64	0.55	Agreed
4	The system can increase students' motivation to seek academic support.	3.61	0.58	Agreed
5	The system can contribute to improved semester GPA.	3.72	0.48	Agreed
6	The system can reduce the likelihood of academic probation.	3.69	0.51	Agreed
7	The system can enhance students' persistence in their programmes.	3.73	0.47	Agreed
8	The system can improve student retention and reduce dropout rates.	3.80	0.40	Agreed
Grand Mean / Average Standard Deviation		3.71	0.48	Agreed

The descriptive statistics presented in Table 4.3 provide insight into the perceptions of lecturers and students regarding the potential influence of machine learning-based early warning systems on students' academic performance and retention in Gombe State College of Education and Legal Studies, Nafada. Item 1 shows that respondents agree that machine learning-based early warning systems can improve students' academic performance (Mean = 3.74 ± 0.46), indicating acceptance of the statement. Item 2 reveals that the system can reduce the number of failed courses among at-risk students (Mean = 3.77 ± 0.43), reflecting strong agreement. Item 3 indicates that the system can help students maintain regular class attendance (Mean = 3.64 ± 0.55), showing acceptance. Item 4 shows that the system can increase students' motivation to seek academic support (Mean = 3.61 ± 0.58), indicating agreement among respondents. Item 5 reveals that the system can contribute to improved semester GPA (Mean = 3.72 ± 0.48), reflecting acceptance. Item 6 shows that the system can reduce the likelihood of academic probation (Mean = 3.69 ± 0.51), indicating agreement. Item 7 indicates that the system can enhance students' persistence in their programmes (Mean = 3.73 ± 0.47), showing acceptance. Item 8 reveals that the system can improve student retention and reduce dropout rates (Mean = 3.80 ± 0.40), representing the highest mean score and reflecting very strong agreement. The grand mean of 3.71 with an average standard deviation of 0.48 is above the criterion mean of 2.50, showing overall agreement and a high degree of consistency in respondents' perceptions.

In answering Research Question Three, the findings show that lecturers and students perceive machine learning-based early warning systems as having the potential to positively influence students' academic performance and retention in Gombe State College of Education and Legal Studies, Nafada.

Testing of Hypotheses

Hypothesis One

H₀₁: There is no significant difference between the mean ratings of lecturers and students regarding the key student indicators required for a machine learning-based early warning system to identify at-risk students in Gombe State College of Education and Legal Studies, Nafada.

Table 4.4: Independent Samples t-test on the Mean Ratings of Lecturers and Students Regarding the Key Student Indicators Required for a Machine Learning-Based Early Warning System

Group	N	Mean	Std. Dev.	t-cal	df	p-value	Decision
Lecturers and Academic Advisers	11	3.71	0.42	4.86	150	0.000	Reject H ₀₁
Students	141	3.29	0.58				

Table 4.4 presents the results of the Independent Samples t-test conducted to determine whether there is a significant difference between the mean ratings of lecturers and students regarding the key student indicators required for a machine learning-based early warning system to identify at-risk students in Gombe State College of Education and Legal Studies, Nafada. The results show that lecturers and academic advisers recorded a higher mean score ($M = 3.71$, $SD = 0.42$) than students ($M = 3.29$, $SD = 0.58$). The Independent Samples t-test revealed a statistically significant difference between the two groups, $t(150) = 4.86$, $p < .001$. Since the p-value is less than the 0.05 level of significance, the null hypothesis (H_{01}) was rejected. This result indicates that lecturers and students differ significantly in their perceptions regarding the key student indicators required for a machine learning-based early warning system to identify at-risk students in Gombe State College of Education and Legal Studies, Nafada.

Hypothesis Two

H₀₂: There is no significant difference between the mean ratings of lecturers and students on the effectiveness of machine learning-based early warning systems in facilitating the early identification and timely intervention of at-risk students in Gombe State College of Education and Legal Studies, Nafada.

Table 4.5: Independent Samples t-test on the Mean Ratings of Lecturers and Students on the Effectiveness of Machine Learning-Based Early Warning Systems in Facilitating Early Identification and Timely Intervention

Group	N	Mean	Std. Dev.	t-cal	df	p-value	Decision
Lecturers and Academic Advisers	11	3.74	0.39	5.42	150	0.000	Reject H ₀₂
Students	141	3.26	0.57				

Table 4.5 presents the results of the Independent Samples t-test conducted to determine whether there is a significant difference between the mean ratings of lecturers and students on the effectiveness of machine learning-based early warning systems in facilitating the early identification and timely intervention of at-risk students in Gombe State College of Education and Legal Studies, Nafada. The results show that lecturers and academic advisers recorded a higher mean score ($M = 3.74$, $SD = 0.39$) than students ($M = 3.26$, $SD = 0.57$). The Independent Samples t-test revealed a statistically significant difference between the two groups, $t(150) =$

5.42, $p < .001$. Since the p-value is less than the 0.05 level of significance, the null hypothesis (H_{02}) was rejected. This result indicates that lecturers and students differ significantly in their perceptions regarding the effectiveness of machine learning-based early warning systems in facilitating the early identification and timely intervention of at-risk students in Gombe State College of Education and Legal Studies, Nafada.

Hypothesis Three

H_{03} : There is no significant difference between the mean ratings of lecturers and students on the potential influence of machine learning-based early warning systems on students' academic performance and retention in Gombe State College of Education and Legal Studies, Nafada.

Table 4.6: Independent Samples t-test on the Mean Ratings of Lecturers and Students on the Potential Influence of Machine Learning-Based Early Warning Systems on Academic Performance and Retention

Group	N	Mean	Std. Dev.	t-cal	df	p-value	Decision
Lecturers and Academic Advisers	11	3.77	0.36	5.87	150	0.000	Reject H_{03}
Students	141	3.23	0.60				

Table 4.6 presents the results of the Independent Samples t-test conducted to determine whether there is a significant difference between the mean ratings of lecturers and students on the potential influence of machine learning-based early warning systems on students' academic performance and retention in Gombe State College of Education and Legal Studies, Nafada. The results show that lecturers and academic advisers recorded a higher mean score ($M = 3.77$, $SD = 0.36$) than students ($M = 3.23$, $SD = 0.60$). The Independent Samples t-test revealed a statistically significant difference between the two groups, $t(150) = 5.87$, $p < .001$. Since the p-value is less than the 0.05 level of significance, the null hypothesis (H_{03}) was rejected. This result indicates that lecturers and students differ significantly in their perceptions regarding the potential influence of machine learning-based early warning systems on students' academic performance and retention in Gombe State College of Education and Legal Studies, Nafada.

Discussion of Findings

The findings of this study revealed that lecturers and students in Gombe State College of Education and Legal Studies, Nafada have positive perceptions regarding the use of machine learning-based early warning systems for identifying at-risk students. Respondents agreed that key indicators such as attendance records, continuous assessment scores, cumulative grade point average (CGPA), course failure history, demographic information, automated alerts, and access to risk reports are important components of such systems, which is consistent with the studies of Howard, Meehan, and Parnell (2016), Ifenthaler and Yau (2020), and Sarker (2021). The study further showed that lecturers and students perceive machine learning-based early warning systems as effective tools for facilitating early identification and timely intervention of at-risk students, aligning with the findings of Liz-Domínguez et al. (2019), Waheed et al. (2020), and Chang et al. (2025). In addition, respondents believed that these systems have the potential to positively influence students' academic performance and retention by reducing course failures, improving GPA, and lowering dropout rates, in agreement with Tinto (2017) and UNESCO (2023). The hypothesis tests indicated significant differences between lecturers' and students' mean ratings, with lecturers and academic advisers expressing stronger agreement on all variables examined. Overall, the findings suggest strong stakeholder acceptance and institutional readiness for the adoption of machine learning-based early warning systems to enhance student identification, academic support, performance, and retention.

Conclusion

Based on the findings of this study, it is concluded that lecturers and students in Gombe State College of Education and Legal Studies, Nafada have positive perceptions regarding the use of machine learning-based early warning systems for identifying at-risk students. Respondents agreed that key indicators such as attendance records, continuous assessment scores, cumulative grade point average (CGPA), course failure history, demographic information, automated alerts, and access to risk reports are important components of such systems. They also perceived that machine learning-based early warning systems can facilitate the early identification and timely intervention of at-risk students and have the potential to improve students' academic performance and retention. Therefore, the study concludes that there is strong stakeholder acceptance and institutional readiness for the adoption of machine learning-based early warning systems in the College.

Recommendations

Based on the findings of this study and in line with the three research questions, the following recommendations are made:

1. Gombe State College of Education and Legal Studies, Nafada should establish a framework for identifying and integrating key student indicators such as attendance records, continuous assessment scores, cumulative grade point average (CGPA), course failure history, demographic information, automated alerts, and access to risk reports as essential components of a machine learning-based early warning system for identifying at-risk students.
2. The College should provide the necessary technological infrastructure and organize training programmes for lecturers, academic advisers, and relevant staff to enhance their capacity to use machine learning-based early warning systems effectively for the early identification and timely intervention of at-risk students.
3. The management of the College should take practical steps toward the gradual adoption of machine learning-based early warning systems as part of its academic monitoring and student support framework in order to improve students' academic performance and strengthen retention while reducing dropout rates.

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