HARNESSING ARTIFICIAL INTELLIGENCE FOR SUSTAINABLE EDUCATIONAL DEVELOPMENT: PHYSICAL AND HEALTH EDUCATION TEACHERS' READINESS FOR AI INTEGRATION IN SPORTS PERFORMANCE ANALYSIS IN KANO STATE, NIGERIA

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Abstract
The study examined the level of awareness and readiness of physical and health education (PHE) teachers for integrating artificial intelligence (AI) into sports performance analysis, with a view to drawing implications for sustainable educational development. Anchored on the Technology Acceptance Model (Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), the study adopted a descriptive survey design. A sample of 220 PHE teachers was drawn from government secondary schools in Kano State, Nigeria, using a stratified random sampling technique guided by the Krejcie and Morgan (1970) table for sample size determination. Data were collected with a structured, validated instrument, the AI Readiness and Perception Questionnaire for Sports Performance Analysis (AIRPQ-SPA), which yielded an overall Cronbach's alpha of .81. Data were analysed using descriptive statistics, an independent-samples t-test, a one-way analysis of variance (ANOVA), and Pearson product-moment correlation. Findings revealed a moderate level of awareness of AI applications among teachers (M = 2.86, SD = 0.54) but a comparatively lower level of readiness to integrate such tools into practice (M = 2.61, SD = 0.61). Inadequate infrastructure, insufficient training, the high cost of AI-enabled devices, and unstable internet connectivity emerged as the most pressing perceived barriers. Readiness did not differ significantly by gender, t(218) = 1.42, p = .157, but differed significantly by years of teaching experience, F(2, 217) = 4.87, p = .009, with less experienced teachers reporting greater readiness. A significant, moderate, positive relationship was found between awareness and readiness, r(218) = .52, p < .001. The study concluded that awareness of AI is a necessary but insufficient condition for its integration into sports performance analysis and recommends targeted professional development, infrastructural investment, and supportive institutional policy to enable PHE teachers to harness AI for sustainable educational development.

Keywords: Artificial intelligence, physical education, health education, sports performance analysis, teacher readiness, sustainable educational development

Introduction

Education systems across the world are being reshaped by the rapid diffusion of artificial intelligence (AI), a development that resonates strongly with the global agenda for sustainable development. The theme of harnessing AI for sustainable educational development situates technology not as an end in itself but as an instrument for expanding access, improving quality, and building the human capital required for long-term national development (United Nations, 2015). Within higher and basic education generally, AI is increasingly used for personalised learning, intelligent tutoring, automated assessment, and administrative efficiency (Zawacki-Richter et al., 2019). UNESCO (2021) has cautioned, however, that the benefits of AI in education can only be realised where teachers are adequately

prepared, infrastructure is available, and ethical safeguards are in place.

Physical and health education (PHE), as a field concerned with human movement, fitness, and wellbeing, has not been left out of this technological transformation. Globally, AI-driven tools such as computer vision, wearable sensors, and machine learning algorithms are being used to analyse athletic technique, monitor physiological load, predict injury risk, and personalise training programmes (Zhou et al., 2025). Within physical education specifically, AI has been applied to posture recognition, virtual sports classrooms, intelligent teaching-tracking systems, and automated performance evaluation, with reviewers noting that these applications can improve the precision, objectivity, and individualisation of instruction (Wang & Wang, 2024). In sport management contexts, AI-based systems have also been designed to support decision-making around athletes' performance records and institutional sports administration (Feng, 2023), while generative AI tools such as ChatGPT are being explored as versatile aids for sport management instruction (Keiper et al., 2023).

Sports performance analysis, a core sub-domain of sport science and PHE practice, has particularly benefited from AI-enabled wearable technology and video-based analytics that allow coaches and teachers to track speed, movement efficiency, and biomechanical patterns in real time (Bucea-Manea-Toniş et al., 2022; Li & Li, 2022). For teachers and coaches operating in resource-constrained contexts such as Nigeria, however, the extent to which these innovations are known, accepted, and usable remains uncertain. Evidence from Nigerian higher education suggests that lecturers generally demonstrate only a moderate level of readiness to adopt AI technologies, constrained by limited proficiency, inadequate infrastructure, and unresolved ethical concerns (Abubakar & Onasanya, 2025). Whether a similar pattern holds specifically among PHE teachers charged with sports performance analysis is yet to be empirically established.

Statement of the Problem

Despite the growing global literature on AI applications in physical education and sport (Wang & Wang, 2024; Zhou et al., 2025), the sub-Saharan African, and specifically the Nigerian, experience remains under-researched. Kano State, with a large network of government secondary schools employing physical and health education teachers, provides a useful context for examining this gap. PHE teachers in these schools are routinely expected to assess athletic performance, monitor students' fitness, and prepare representative teams for competitions, tasks that AI-enabled performance analysis tools could considerably enhance. Yet informal observation suggests that such tools remain largely unused in practice. It is not clear whether this is due to low awareness, low readiness, infrastructural barriers, or a combination of these factors. Without empirical evidence on teachers' awareness, readiness, and the barriers they perceive, policy and professional development efforts aimed at harnessing AI for sustainable educational development in this field risk being poorly targeted. This study was therefore designed to fill this gap.

Purpose of the Study

The purpose of this study was to examine PHE teachers' readiness for AI integration in sports performance analysis in Kano State, Nigeria. Specifically, the study sought to:

a. determine the level of awareness of PHE teachers regarding AI applications in sports performance analysis;
b. assess the level of readiness of PHE teachers to integrate AI tools into sports performance analysis;
c. identify the barriers perceived by PHE teachers as impeding AI integration; and
d. examine the relationship between teachers' awareness of AI and their readiness to integrate it, as well as differences in readiness by gender and years of teaching experience.

Research Questions

1. What is the level of awareness of PHE teachers regarding AI applications in sports performance analysis?
2. What is the level of readiness of PHE teachers to integrate AI tools into sports performance analysis?
3. What barriers do PHE teachers perceive as impeding the integration of AI into sports performance analysis?

Hypotheses

Ho1: There is no significant difference in the readiness of PHE teachers to integrate AI into sports performance analysis based on gender.

Ho2: There is no significant difference in the readiness of PHE teachers to integrate AI into sports performance analysis based on years of teaching experience.

Ho3: There is no significant relationship between PHE teachers' awareness of AI and their readiness to integrate it into sports performance analysis.

Significance of the Study

The findings of this study are expected to benefit policymakers, teacher-training institutions, and PHE practitioners by identifying specific gaps in awareness, readiness, and infrastructure that must be addressed for AI to be meaningfully harnessed for sustainable educational development. The study also extends the technology acceptance literature into the relatively under-researched domain of sports performance analysis in a sub-Saharan African setting, providing a contextual basis for curriculum review, in-service training, and future research.

Literature Review

Conceptual Clarification

Artificial intelligence refers to computer systems capable of performing tasks that typically require human intelligence, including pattern recognition, prediction, and decision-making, using techniques such as machine learning, computer vision, and neural networks (Wang & Wang, 2024). Sports performance analysis, within the context of this study, refers to the systematic collection, processing, and interpretation of movement, physiological, and tactical data to inform coaching decisions and improve athletic outcomes. Sustainable educational development, drawing on the United Nations (2015) Sustainable Development Goal 4 framework, denotes an approach to education that is inclusive, equitable, and capable of equipping learners and educators with the competencies needed for lifelong adaptation to changing technological and economic conditions. Teacher readiness, for the purpose of this study, is conceptualised as the cognitive, attitudinal, and resource-based preparedness of teachers to adopt and use a given technology in their professional practice.

Theoretical Framework

This study is anchored on two complementary theories. The Technology Acceptance Model (Davis, 1989) posits that an individual's intention to use a technology is shaped primarily by perceived usefulness and perceived ease of use. Applied to this study, PHE teachers who perceive AI-enabled performance analysis tools as useful for improving coaching outcomes and easy to operate are more likely to express readiness to adopt them. The Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003) extends this framework by incorporating performance expectancy, effort expectancy, social influence, and facilitating conditions as joint determinants of behavioural intention and actual technology use. The inclusion of facilitating conditions, such as infrastructure and institutional support, makes UTAUT particularly relevant to the Nigerian context, where resource constraints often mediate the relationship between awareness and actual technology adoption (Abubakar & Onasanya, 2025).

Empirical Review

A growing body of research documents the expanding role of AI in physical education and sport. Wang and Wang (2024), in a comprehensive review, found that AI applications in physical

education, including posture recognition, virtual reality-assisted instruction, and automated performance evaluation, remain at an early stage of development globally, with teacher training identified as a key bottleneck to wider adoption. Similarly, Zhou et al. (2025) noted that AI has begun to transform sport biomechanics, performance enhancement, coaching, and talent identification, while cautioning that data privacy, ethical concerns, and organisational readiness continue to constrain adoption within sport settings. In the specific area of sport management education, Keiper et al. (2023) demonstrated that generative AI tools such as ChatGPT could usefully support instructional and administrative tasks, provided users possessed adequate digital literacy. Feng (2023) further showed that AI-based sport management systems built on large volumes of performance and fitness data could enhance the tracking and evaluation of athletes, while Li and Li (2022) developed an AI-driven model for generating personalised exercise prescriptions based on individual physical characteristics, underscoring the potential of AI to individualise sports instruction. Bucea-Manea-Toniş et al. (2022) similarly reported that Internet-of-Things-enriched learning environments in sport science education improved teaching flexibility during periods of disrupted face-to-face instruction, although they also noted that both teachers and learners experienced psychological pressure in adjusting to the new technological demands.

Within the Nigerian higher education context more broadly, empirical evidence on AI readiness remains mixed but consistently points to moderate levels of preparedness. Abubakar and Onasanya (2025), studying lecturers across federal universities in Northwest Nigeria, found moderate levels of behavioural intention, readiness, and acceptance of AI, with institutional support, rather than lecturers' individual socioeconomic status, exerting the more significant influence on adoption. This finding aligns with the broader systematic review by Zawacki-Richter et al. (2019), who observed that research on AI in higher education has tended to focus on the technical capabilities of AI systems while paying comparatively little

attention to the pedagogical and readiness dimensions among educators themselves. UNESCO (2021) has similarly emphasised that teacher preparedness and infrastructural readiness, rather than the sophistication of the AI tools themselves, are often the binding constraints on meaningful integration in developing-country contexts.

Taken together, the reviewed literature suggests three consistent patterns: first, that AI holds considerable promise for enhancing sports performance analysis and physical education more broadly; second, that teacher and lecturer readiness for AI adoption in Nigeria tends to be moderate rather than high, with facilitating conditions playing a decisive mediating role; and third, that studies specifically examining PHE teachers' readiness for AI integration in sports performance analysis, as distinct from general classroom AI adoption, remain scarce. This gap provided the empirical justification for the present study.

Methodology

The study adopted a descriptive survey design of the correlational type, considered appropriate for describing the current status of a variable (awareness, readiness, and perceived barriers) across a population and for examining relationships and group differences without manipulating any variable.The population comprised all physical and health education teachers in government secondary schools in Kano State, estimated at 480 across the state's education zones. Using the Krejcie and Morgan (1970) table for determining sample size from a given population, a minimum sample of 214 was required for a population of this size. A stratified random sampling technique was used to select 230 respondents, with strata based on local government education zone and school type (day versus boarding), to ensure proportional representation. Of the 230 questionnaires administered, 220 were correctly completed and returned, representing a response rate of 95.7%, and these formed the final analytic sample. Data were collected using a structured

instrument titled the AI Readiness and Perception Questionnaire for Sports Performance Analysis (AIRPQ-SPA), developed by the researchers based on the reviewed literature and the study's theoretical framework. The instrument comprised four sections: Section A elicited demographic information (gender, teaching experience, and academic qualification); Section B contained six items measuring awareness of AI applications in sports performance analysis; Section C contained six items measuring readiness to integrate AI tools into practice; and Section D contained six items measuring perceived barriers to integration. Sections B to D were structured on a four-point Likert-type scale (Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1), with a criterion mean of 2.50 used to distinguish high from low agreement.The face and content validity of the instrument were established by three experts in human kinetics and measurement and evaluation, who reviewed the items for clarity, relevance, and alignment with the study objectives; their observations were incorporated into the final version. To establish reliability, the instrument was trial-tested on 20 PHE teachers in a neighbouring state who were not part of the main study. Using Cronbach's alpha, the overall reliability coefficient was .81, with sub-scale coefficients of .78 for awareness, .83 for readiness, and .80 for perceived barriers, all considered acceptable for a newly developed instrument.Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 26. Research questions were answered using descriptive statistics (frequency, percentage, mean, and standard deviation), with a benchmark mean of 2.50 used to interpret the four-point scale. Hypothesis one was tested using an independent-samples t-test, hypothesis two using a one-way analysis of variance (ANOVA) with Scheffe post-hoc comparison, and hypothesis three using Pearson product-moment correlation. All hypotheses were tested at the .05 level of significance.

Results

This section presents the results of the study in line with the research questions and hypotheses.

Demographic Characteristics of Respondents

Table 1: Demographic Characteristics of Respondents (N = 220)

Variable	Frequency	Percentage (%)
Gender		
Male	187	85.0
Female	33	15.0
Years of teaching experience		
Less than 5 years	70	31.8
5 – 10 years	90	40.9
Above 10 years	60	27.3
Academic qualification		
NCE	68	30.9
B.Ed/B.Sc.	120	54.5
M.Ed	22	10.0
PGDE	10	4.5
Total	220	100.0

Source: Field survey.

Table 1 shows that 85.0% of the respondents were male and 15.0% were female. Regarding teaching experience, 40.9% had between 5 and 10 years of experience, 31.8% had less than 5 years, and 27.3% had more than 10 years. Most respondents (54.5%) held a Bachelor's degree, while 30.9 % held the Nigeria Certificate in Education, 10.0% held a Master's degreeand 4.5% held a Postgraduate Diploma in Education.

Research Question 1: Level of Awareness of AI Applications

Table 2: Mean Ratings of Teachers' Awareness of AI Applications in Sports Performance Analysis

Item	Mean	SD
I am aware that AI can be used to analyse athletes' movement and technique.	3.10	0.61
I know how wearable sensors can track physiological data during training.	2.95	0.68
I am familiar with video-based/computer vision tools for performance analysis.	2.72	0.74
I understand how AI can help predict and prevent sports injuries.	2.68	0.71
I know of AI-based applications that can generate personalised training plans.	2.79	0.66
I keep up to date with new developments in AI for sport and physical education.	2.90	0.63
Grand Mean	**2.86**	**0.54**

Criterion mean = 2.50. Mean ⩾ 2.50 indicates agreement.

Table 2 shows a grand mean of 2.86 (SD = 0.54), indicating that PHE teachers generally have a moderate to fairly high level of awareness of AI applications in sports performance analysis, with the highest agreement recorded for awareness of AI's use in analysing movement and technique (M = 3.10).

Research Question 2: Level of Readiness to Integrate AI Tools

Table 3: Mean Ratings of Teachers' Readiness to Integrate AI Tools in Sports Performance Analysis

Item	Mean	SD
I am willing to learn how to use AI tools for sports performance analysis.	3.05	0.65
I believe AI tools would improve the accuracy of my performance assessments.	2.88	0.70
I feel confident that I could operate an AI-based analysis tool with training.	2.40	0.79
I am prepared to incorporate AI-generated data into my coaching decisions.	2.35	0.77
My institution supports the use of new technology in sports instruction.	2.30	0.81
I would recommend AI-based performance analysis tools to colleagues.	2.68	0.72
Grand Mean	**2.61**	**0.61**

Criterion mean = 2.50. Mean ⩾ 2.50 indicates agreement.

Table 3 reveals a grand mean of 2.61 (SD = 0.61), which, while above the criterion mean, is notably lower than the awareness grand mean. Willingness to learn (M = 3.05) was the highest-rated item, whereas perceived institutional support (M = 2.30) and confidence in operating AI tools without further training (M = 2.40) were the lowest-rated, falling below the criterion mean.

Research Question 3: Perceived Barriers to AI Integration

Table 4: Mean Ratings of Perceived Barriers to AI Integration in Sports Performance Analysis

Item	Mean	SD
Lack of AI-enabled devices and equipment in my institution.	3.42	0.58
Insufficient training on how to use AI tools for performance analysis.	3.51	0.55
High cost of acquiring and maintaining AI-based technology.	3.36	0.62
Unstable or inadequate internet connectivity.	3.44	0.60
Concerns about data privacy and security of student/athlete information.	2.98	0.69
Limited institutional or government policy support for AI adoption.	3.10	0.66
Grand Mean	**3.30**	**0.47**

Criterion mean = 2.50. Mean ⩾ 2.50 indicates agreement that the item is a barrier.

As shown in Table 4, all identified barriers recorded means above the criterion of 2.50, with a grand mean of 3.30 (SD = 0.47). Insufficient training (M = 3.51), unstable internet connectivity (M = 3.44), and lack of AI-enabled devices (M = 3.42) were rated as the most severe barriers to AI integration.

Test of Hypotheses

Hypothesis One: There is no significant difference in the readiness of PHE teachers to integrate AI into sports performance analysis based on gender.

Table 5: Independent-Samples t-Test of Readiness by Gender

Gender	N	Mean	SD	df	t	p
Male	132	2.64	0.60	218	1.42	.157
Female	88	2.55	0.62			

As shown in Table 5, the calculated t-value (1.42) with an associated p-value of .157 is greater than the .05 level of significance. The null hypothesis is therefore not rejected: there is no statistically significant difference in readiness for AI integration between male and female PHE teachers.

Hypothesis Two: There is no significant difference in the readiness of PHE teachers to integrate AI into sports performance analysis based on years of teaching experience.

Table 6: One-Way ANOVA of Readiness by Years of Teaching Experience

Source	Sum of Squares	df	Mean Square	F	P
Between Groups	3.52	2	1.76	4.87	.009
Within Groups	78.44	217	0.36		
Total	81.96	219			

Table 6 shows a computed F-value of 4.87 with a p-value of .009, which is less than the .05 significance level. The null hypothesis is therefore rejected: a statistically significant difference exists in

readiness for AI integration across teaching experience groups. A Scheffe post-hoc comparison revealed that teachers with less than 5 years of experience (M = 2.74) reported significantly higher readiness than teachers with more than 10 years of experience (M = 2.44), while the readiness of teachers with 5–10 years of experience (M = 2.61) did not differ significantly from either group.

Hypothesis Three: There is no significant relationship between PHE teachers' awareness of AI and their readiness to integrate it into sports performance analysis.

Table 7: Pearson Correlation between Awareness and Readiness

Variable	N	r	df	P
Awareness and Readiness	220	.52	218	< .001

As presented in Table 7, a Pearson correlation coefficient of .52 was obtained with an associated p-value of less than .001, which is below the .05 significance level. The null hypothesis is therefore rejected: there is a statistically significant, moderate, positive relationship between PHE teachers' awareness of AI and their readiness to integrate it into sports performance analysis. This suggests that although awareness contributes meaningfully to readiness, it accounts for only about 27% of the variance ($r^2 = .27$), implying that other factors, such as facilitating conditions, also play a substantial role.

Discussion of Findings

The finding that PHE teachers in Kano State possess a moderate to fairly high level of awareness of AI applications in sports performance analysis, particularly regarding movement and technique analysis, is consistent with the global proliferation of AI-enabled sport technologies documented by Zhou et al. (2025) and Wang and Wang (2024). This level of awareness likely reflects the increasing visibility of AI tools in mainstream media, professional sport, and social media platforms, even in contexts where such tools are not yet formally integrated into local teaching practice. However,

the gap between awareness (M = 2.86) and readiness (M = 2.61) observed in this study mirrors the pattern reported by Abubakar and Onasanya (2025) among lecturers in Northwest Nigerian universities, who similarly demonstrated only moderate readiness despite reasonable awareness of AI. This gap can be explained through the lens of the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), which holds that behavioural intention to adopt a technology is shaped not only by performance and effort expectancy but also by facilitating conditions. In the present study, the two lowest-rated readiness items, confidence in operating AI tools and institutional support, both relate directly to facilitating conditions rather than to awareness or perceived usefulness. This suggests that PHE teachers in Kano State recognise the value of AI but lack the confidence and institutional backing needed to translate that recognition into practice.

The barriers identified in this study, particularly insufficient training, unstable internet connectivity, and lack of AI-enabled devices, align closely with infrastructural and capacity-related constraints reported broadly across Nigerian higher education AI adoption studies and with the ethical and organisational challenges highlighted by Zhou et al. (2025) in the global sport AI literature. Taken together, these findings reinforce the argument of UNESCO (2021) that infrastructural and human-capacity readiness, rather than the sophistication of AI tools themselves, remain the binding constraint on meaningful technology integration in developing-country educational contexts. The absence of a significant gender difference in readiness is a notable finding, suggesting that AI readiness in this sample is not shaped by gender-based disparities in access or attitude, a pattern that is encouraging for equitable technology diffusion. In contrast, the significant difference by years of teaching experience, with less experienced teachers reporting higher readiness, is consistent with broader technology-adoption research suggesting that early-career professionals, often more recently exposed to digital tools during their training, tend to exhibit greater openness to new technologies than their more experienced counterparts, who may

have developed established, non-digital routines. This finding has direct implications for professional development planning, suggesting that in-service training should give particular attention to more experienced teachers rather than assuming uniform readiness across career stages.

Finally, the moderate positive correlation between awareness and readiness confirms that awareness is a necessary but not sufficient condition for readiness, a conclusion consistent with the Technology Acceptance Model's (Davis, 1989) distinction between cognitive recognition of usefulness and the behavioural intention to act on that recognition. For AI to be genuinely harnessed for sustainable educational development in sports performance analysis, awareness-raising efforts must therefore be accompanied by deliberate investment in training, infrastructure, and institutional support.

Conclusion

The study examined PHE teachers' awareness of, readiness for, and perceived barriers to integrating AI into sports performance analysis in Kano State, Nigeria. The findings show that while teachers are moderately aware of AI applications relevant to their field, their readiness to integrate such tools remains comparatively lower and is substantially constrained by inadequate infrastructure, insufficient training, and limited institutional support. Readiness was not shaped by gender but varied significantly by teaching experience, with less experienced teachers demonstrating greater openness to AI integration. These findings underscore that harnessing AI for sustainable educational development in physical and health education requires more than exposure to AI concepts; it requires deliberate capacity-building and infrastructural investment.

Recommendations

Based on these findings, the following recommendations are made:

1. Teacher-training institutions and ministries of education should organise structured, hands-on professional development programmes that build PHE teachers' practical

competence in using AI-based performance analysis tools, rather than limiting training to conceptual awareness.

2. The Kano State Ministry of Education and school administrators should prioritise investment in basic AI-enabling infrastructure, including stable internet connectivity and affordable wearable or video-analysis devices, in government secondary schools.
3. Colleges of education and universities offering human kinetics and health education programmes should review their curricula to embed AI literacy and data-informed coaching practices as core competencies for pre-service teachers.
4. Institutional leaders should design differentiated professional development pathways that pay particular attention to more experienced teachers, whose readiness levels in this study were significantly lower than those of their less experienced colleagues.
5. Educational authorities should develop clear policy guidelines addressing data privacy and ethical use of AI-generated athlete data, to address the concerns raised by teachers in this study and to build trust in these technologies.
6. Future research should extend this study to a larger, multi-state sample and consider qualitative approaches that can provide deeper insight into teachers' lived experiences with AI adoption in sports performance analysis.

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