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The Level of AI Utilization in Teaching among Physical Education Teachers in Licheng District, Jinan City

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Abstract

Artificial intelligence (AI) has become an important driver of educational digitalization, yet its application in compulsory education physical education (PE) remains uneven and insufficiently examined. This mixed-methods study investigated the current level of AI utilization, the barriers to implementation, and practical improvement strategies among 50 PE teachers from eight public primary and junior high schools in Licheng District, Jinan City, China. Quantitative data were collected through a structured questionnaire measuring AI familiarity, training exposure, usage frequency, perceived value, perceived difficulty, self-rated competence, and school support. Descriptive statistics and cross-tabulation analysis were conducted using SPSS. Qualitative data were collected through semi-structured interviews with 25 purposively selected teachers and analyzed thematically following Braun and Clarke's six-phase framework. Results showed that AI utilization was low: 54% of teachers had never used AI tools in PE teaching, and 52% had received no AI-related training. Although teachers perceived AI as useful for assessment, personalized instruction, motivation, and teaching efficiency, they also reported high levels of difficulty related to inadequate equipment, insufficient PE-specific training, limited operational skills, privacy concerns, and lack of peer examples. A cross-tabulation showed that teachers who had received AI training were much more likely to report actual AI use than those without training, indicating that the intention-behavior gap was primarily shaped by facilitating conditions rather than teacher resistance. Interpreted through the Technology Acceptance Model and the Unified Theory of Acceptance and Use of Technology, the findings suggest that AI adoption in PE depends on environmental fit, practical training, and institutional support. The study recommends embedded professional learning in gymnasium settings, equitable PE technology investment, clear data governance, and school-based AI champion teachers.

Keywords: Artificial Intelligence, Physical Education, Teacher Technology Adoption, Mixed Methods, Technology Acceptance Model, Educational Digitalization

Introduction

The digital transformation of education has accelerated the use of artificial intelligence (AI) in teaching, assessment, learning analytics, and school management. In physical education (PE), AI-supported technologies such as motion capture systems, wearable sensors, intelligent assessment platforms, and virtual reality applications can help teachers provide more objective movement feedback, monitor student performance, and design individualized learning pathways (Hu et al., 2024; Lee & Lee, 2021; Zhou et al., 2024). These affordances are particularly relevant to PE because traditional instruction often relies heavily on teachers' visual judgment, limited class time, and subjective assessment of student performance.

In China, national education policy has emphasized the integration of digital technologies across compulsory education. The Physical Education and Health Curriculum Standards for Compulsory Education require the appropriate use of information technology in teaching, evaluation, and management, while broader education digitalization initiatives encourage schools to improve teaching quality and equity through digital tools (Ministry of Education of the People's Republic of China, 2022). However, policy expectations do not automatically lead to effective classroom implementation. PE presents distinctive implementation challenges because teaching often takes place in gymnasiums, playgrounds, and outdoor environments rather than in stable classroom settings. AI tools used in PE also require movement data, mobile devices, reliable connectivity, safety monitoring, and practical teacher competence.

Existing research on AI in PE has grown in recent years, but several gaps remain. First, much of the literature focuses on higher education, elite sports training, or technical system development, while compulsory education PE remains underrepresented (Hsia et al., 2024; Zhou et al., 2024). Second, studies often emphasize the potential functions of AI rather than the everyday conditions under which frontline PE teachers work. Third, although the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) have been widely applied to educational technology adoption, their application to PE teaching contexts remains limited. This is important because PE teachers' perceived ease of use may depend not only on software interface design but also on physical space, class size, equipment availability, school policies, and technical support.

Licheng District in Jinan City provides a useful context for examining this issue. Like many urban districts in China, schools have gradually introduced digital tools in academic subjects such as mathematics, Chinese, English, and science. However, preliminary observations suggest that PE departments often receive fewer AI-related resources and less subject-specific training. This may create an intention-behavior gap: teachers recognize the value of AI but cannot translate positive attitudes into classroom use because the necessary conditions are absent.

Statement of the Problem

The phenomenon under investigation in this study is the persistent gap between policy-driven expectations for artificial intelligence (AI) integration and the actual level of AI utilization in compulsory education physical education (PE). At the policy level, national curriculum standards and education digitalization initiatives increasingly require teachers to embed information technology and intelligent tools in instruction, assessment, and management (Ministry of Education of the People’s Republic of China, 2022). At the classroom level,

however, PE teachers continue to rely largely on visual judgment, limited class time, and subjective assessment, and many have never used AI tools in their teaching. This mismatch is the specific problem the study seeks to understand: although AI is promoted as a means of improving objectivity, personalization, and efficiency in PE, its everyday use in gymnasiums, playgrounds, and outdoor teaching environments remains low, uneven, and poorly documented.

This problem is significant for several reasons. First, PE occupies a structurally weaker position than examination-oriented subjects in most school digitalization plans, so PE departments frequently receive fewer devices, less subject-specific training, and weaker technical support. As a result, low AI use in PE cannot be assumed to reflect teacher unwillingness; it may instead reflect an unequal distribution of digital opportunities across subjects. Second, AI in PE depends on conditions that are absent from most classroom subjects, including reliable connectivity in open spaces, portable devices, safety monitoring during physical activity, and the secure handling of movement and body data. When these facilitating conditions are missing, teachers who hold positive attitudes toward AI may still be unable to translate intention into practice, producing a measurable intention–behavior gap. Third, existing research has concentrated on higher education, elite sport, and technical system development, leaving frontline compulsory-education PE teachers—and the organizational realities they face—insufficiently examined.

Taken together, these conditions define both the phenomenon and the rationale for the study. If low AI utilization in PE is driven mainly by teacher resistance, then the appropriate response is persuasion and attitude change; but if it is driven by insufficient facilitating conditions, then the appropriate response is practical support such as equipment, embedded training, clear data governance, and peer mentoring. Distinguishing between these two explanations is therefore essential for designing effective interventions, yet no study has systematically examined this question in the compulsory-education PE context of Licheng District, Jinan City. This study addresses that gap by measuring the current level of AI utilization, identifying the barriers PE teachers encounter, and interpreting these findings through the Technology Acceptance Model and the Unified Theory of Acceptance and Use of Technology in order to propose targeted, context-sensitive improvement strategies.

To address these gaps, this study examined AI utilization among PE teachers in Licheng District. It sought to answer three research questions: (1) What is the current level of AI utilization among PE teachers in Licheng District? (2) What challenges do PE teachers face in developing AI utilization competencies? (3) How can AI utilization be effectively improved in this context? By integrating questionnaire and interview data, the study contributes empirical evidence on AI adoption in compulsory education PE and provides practical recommendations for school leaders, teacher educators, and policymakers.

Literature Review

Artificial Intelligence in Physical Education

AI in physical education should not be understood only as the use of advanced machines or expensive sport science laboratories. In school PE, AI may include relatively simple applications such as automatic video feedback, movement recognition, digital fitness assessment, adaptive lesson-planning tools, learning analytics dashboards, and wearable

devices that record student activity. These tools can assist teachers in observing movement quality, identifying common technical errors, and providing more individualized feedback than is usually possible in a large class. The educational value of AI therefore lies less in replacing the PE teacher and more in extending the teacher's capacity to see, record, compare, and respond to student performance.

Compared with classroom subjects, PE requires a more embodied and situated form of technology integration. A language-learning platform can often be used on a computer screen, but an AI tool for PE must function in spaces where students are running, jumping, throwing, stretching, and interacting with equipment. The data collected in PE may include movement trajectories, body posture, heart rate, video images, and performance scores. These characteristics make PE a promising but difficult area for AI adoption. The promise is that teachers can obtain more objective information about students' physical performance. The difficulty is that such information is harder to collect safely, consistently, and ethically in active school environments.

Existing studies suggest that AI-supported feedback can strengthen reflection and assessment in PE, while systematic reviews show increasing attention to digital sports coaching and movement-based learning technologies (Hsia et al., 2024; Jud & Thalmann, 2025; Ma et al., 2025; Zhou et al., 2024). However, many of these studies are still concentrated in well-resourced or controlled settings. The school-based compulsory education context is different because teachers must handle large classes, limited equipment, short periods, outdoor weather conditions, safety concerns, and diverse student abilities. Consequently, the successful use of AI in compulsory PE depends not only on whether the technology is pedagogically valuable, but also on whether it fits the organizational and physical realities of school teaching.

Another important issue is that PE has historically occupied a weaker position in school technology planning. Digitalization projects often begin with academic subjects because their learning outcomes are easier to connect with examinations, standardized assessments, and classroom platforms. PE departments may be expected to follow the same digitalization agenda while receiving fewer devices, fewer demonstrations, and less technical support. This imbalance is important because it means that low AI use in PE should not be interpreted simply as teacher unwillingness. It may reflect the unequal distribution of digital opportunities across school subjects.

Teacher Technology Acceptance and the Intention-Behavior Gap

The Technology Acceptance Model provides a useful starting point for explaining why teachers adopt or reject new technologies. TAM argues that perceived usefulness and perceived ease of use influence intention and actual use (Davis, 1989). In PE, perceived usefulness may refer to whether teachers believe AI can improve instruction, assessment, motivation, safety, or administrative efficiency. Perceived ease of use, however, has a wider meaning than simple interface design. A tool may be technically simple but still difficult to use if there is no internet connection in the gymnasium, no device stand, no time to calibrate the camera, or no technical support when the system fails.

The UTAUT framework extends this discussion by emphasizing facilitating conditions and social influence (Venkatesh et al., 2003). These two constructs are especially relevant for PE teachers. Facilitating conditions include access to appropriate equipment, training, school policy, technical support, and time for experimentation. Social influence includes whether administrators encourage technology use, whether colleagues demonstrate successful cases, and whether the subject department values innovation. In a school environment, teachers often judge a new practice by observing whether it is feasible for colleagues who face similar class sizes, facilities, and student characteristics.

The intention-behavior gap is therefore central to this study. Teachers may express positive attitudes toward AI while still not using it in practice. This gap should not be treated as a contradiction. Rather, it indicates that intention is only one condition for adoption. When equipment is missing, training is too general, workload is heavy, and liability is unclear, positive intention may remain symbolic. This perspective is consistent with the argument that behavior is strongly shaped by situational constraints, not only by individual motivation (Saiz-González et al., 2025; Sheeran, 2002).

For PE teachers, this gap may be even wider because the first attempt to use AI carries practical risks. A teacher who tries an AI movement-analysis tool during a normal class must manage student safety, device placement, classroom discipline, data collection, and technical troubleshooting at the same time. If the attempt fails, the teacher may lose class time and confidence. Therefore, the move from intention to behavior requires a protected implementation pathway, including demonstration lessons, practice opportunities, and peer support rather than only policy slogans or one-time lectures.

Contextual Conditions in Compulsory Education PE

Compulsory education PE has features that make technology adoption different from university PE, professional coaching, or elite sport training. Classes are usually larger, student abilities are more diverse, and lesson time is limited. Teachers must also meet curriculum requirements related to fitness, skill development, health knowledge, cooperation, and safety. Under these conditions, any AI tool must be efficient enough to support teaching without consuming excessive preparation or transition time. If a tool requires long setup procedures, specialized technical knowledge, or one-to-one device access, it may not be suitable for ordinary PE classes.

School-level support is also crucial. AI integration is not simply a teacher-level decision because individual teachers usually cannot purchase devices, upgrade network coverage, design data policies, or provide technical maintenance by themselves. School leaders influence implementation through budget allocation, professional development planning, timetable design, and evaluation criteria. If PE is not represented in these decisions, AI implementation may remain concentrated in classroom subjects. As a result, PE teachers may be asked to participate in digitalization without receiving the infrastructure that makes digitalization possible.

This literature review shows that AI adoption in PE should be analyzed as an interaction between teacher perception, technological design, and institutional conditions. TAM helps explain perceived usefulness and ease of use, while UTAUT helps explain why training,

resources, and peer influence matter. The present study applies these frameworks to Licheng District to examine whether low AI use among PE teachers results from negative attitudes or from insufficient facilitating conditions. This distinction is important because different causes require different solutions: resistance requires persuasion, but structural barriers require practical support.

Methodology

Research Design

This study adopted a convergent mixed-methods design, in which quantitative and qualitative data were collected during the same phase and then integrated during interpretation (Creswell & Plano Clark, 2017). The quantitative component identified the general level and pattern of AI utilization among PE teachers, while the qualitative component explained why these patterns occurred and how teachers experienced the barriers in daily practice.

The convergent design was appropriate because the research questions required both numerical description and contextual explanation. For example, questionnaire data could show the percentage of teachers who had never used AI, but interview data were needed to clarify whether non-use resulted from resistance, lack of competence, lack of equipment, unclear policy, or workload pressure. Integrating the two data sources therefore strengthened the credibility of the findings and allowed the study to distinguish individual attitudes from systemic constraints.

A mixed-methods approach was also suitable because AI adoption in PE is a multi-layered phenomenon. It includes measurable indicators such as frequency of use, training participation, and perceived difficulty, but it also includes less visible experiences such as uncertainty, professional confidence, fear of equipment failure, and the influence of departmental culture. Relying only on a questionnaire might have produced a descriptive picture without explaining the reasons behind it. Relying only on interviews might have produced rich narratives without showing how widespread the barriers were across the sample.

The study therefore treated the questionnaire and interview as complementary rather than hierarchical sources of evidence. The quantitative results established the general pattern of low utilization and high perceived difficulty. The qualitative results explained how teachers interpreted these conditions in practice. This design was particularly useful for identifying the intention-behavior gap because positive attitude scores could be compared directly with interview accounts of why teachers still did not use AI during ordinary PE lessons.

Participants and Sampling

The target population comprised full-time PE teachers in public primary and junior high schools in Licheng District, Jinan City, China. Eight schools were selected purposively to represent different resource contexts, including schools with relatively strong digital infrastructure, schools with basic digital facilities, and schools with limited PE-related technology resources. The selected schools included four primary schools and four junior high schools.

For the quantitative phase, 50 PE teachers participated in the questionnaire survey. Within each selected school, teachers were invited through school administrators, and participation was voluntary. The sample included 32 male teachers (64%) and 18 female teachers (36%). Most participants were between 30 and 39 years old, and 88% held at least a bachelor's degree. Twenty-two teachers taught in primary schools, and 28 taught in junior high schools. For the qualitative phase, 25 teachers were selected from the questionnaire participants using maximum variation sampling. The selection considered teaching experience, school resource level, self-reported AI familiarity, and AI use experience. This strategy ensured that the interviews included complete novices, occasional users, and a small number of early adopters. The interview sample also included teachers from both primary and junior high schools, allowing the study to capture varied implementation conditions across school types.

Table 1
Demographic Characteristics of Respondents (N = 50)

Indicator	Category	Number	Percentage
Gender	Male	32	64%
	Female	18	36%
Age	20-29	12	24%
	30-39	21	42%
	40-49	13	26%
	50 and above	4	8%
Education	Junior college	6	12%
	Bachelor's degree	40	80%
	Master's degree	4	8%
School type	Primary school	22	44%
	Junior high school	28	56%

Research Instruments

Two instruments were used. The first was a structured questionnaire adapted from established educational technology adoption scales, including TAM and UTAUT-related items (Davis, 1989; Venkatesh et al., 2003). The questionnaire used a five-point Likert scale and measured eight areas: AI familiarity, AI training exposure, AI use frequency, types of AI tools used, self-rated operational proficiency, perceived usefulness, perceived difficulty, and perceived school support. Items were revised to fit PE teaching contexts, including movement analysis, student fitness assessment, skill evaluation, lesson planning, and administrative support.

Before the main survey, the questionnaire was pilot tested with eight PE teachers from a school not included in the final sample. The pilot test focused on item clarity, contextual relevance, completion time, and wording suitability for PE teachers. Minor wording changes were made after the pilot. The internal consistency of the subscales was acceptable, with Cronbach's alpha values ranging from 0.78 to 0.89.

The second instrument was a semi-structured interview protocol. Interview questions covered current AI use practices, perceived usefulness, perceived ease or difficulty of use, school support, training experiences, privacy concerns, workload issues, and suggestions for improving AI implementation in PE. The protocol provided common guiding questions while allowing follow-up questions to explore participants' specific experiences.

The questionnaire items were designed to reflect both general technology acceptance and PE-specific implementation issues. For example, items on perceived usefulness asked whether AI could assist student assessment, personalized instruction, student motivation, teaching efficiency, and new teaching methods. Items on perceived difficulty asked whether teachers experienced insufficient equipment, inadequate training, and lack of professional skills. This design made it possible to compare the value teachers attributed to AI with the obstacles they experienced when attempting to use it.

The interview protocol further explored these issues through concrete examples. Instead of asking only whether teachers supported AI, the interviews asked participants to describe a PE lesson in which AI might realistically be used, what support would be needed, what could go wrong, and who should be responsible for solving problems. These questions helped move the discussion from abstract opinions to practical classroom conditions.

Data Collection Procedure

Data were collected during the 2024-2025 academic year, from September to December 2024. Questionnaires were distributed and collected during scheduled teacher meetings or professional development sessions at participating schools. Teachers completed the questionnaire anonymously to reduce social desirability bias. Identification codes were used only to connect questionnaire and interview data for participants who volunteered for the qualitative phase.

Semi-structured interviews were conducted in Mandarin Chinese in quiet rooms within the schools. Each interview lasted approximately 30 to 45 minutes. With participants' consent, interviews were audio recorded and later transcribed for analysis. Participants were informed that the study was voluntary, that they could withdraw at any time, and that individual responses would not be shared with school administrators. All data were anonymized before analysis.

Data Analysis

Quantitative data were analyzed using SPSS. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to summarize the level of AI utilization and perceived barriers. Cross-tabulation analysis was used to examine the relationship between training exposure and actual AI use. A chi-square test of independence was conducted to determine whether the association between AI training and AI use was statistically significant.

Qualitative data were analyzed thematically following Braun and Clarke's (2006) six-phase framework: familiarization with the data, initial coding, theme searching, theme review, theme definition, and final reporting. Two researchers independently coded five transcripts, representing 20% of the interview dataset, to check coding consistency. Differences were discussed until agreement was reached. Preliminary themes were then refined by comparing them with the full interview dataset and with the questionnaire results.

Integration occurred at the interpretation stage. Quantitative findings were used to identify the overall adoption pattern, while interview themes were used to explain the meaning of

the pattern. For example, the low usage rate was interpreted alongside interview evidence about equipment shortages, workload pressure, and lack of PE-specific training.

Validity, Reliability, and Ethical Considerations

Several strategies were used to improve validity and trustworthiness. Content validity was supported through expert review by two educational technology specialists and one experienced PE teacher. Methodological triangulation between questionnaire and interview data enhanced credibility. Member checking was conducted with six participants, who reviewed the preliminary interpretation and confirmed that the themes reflected their experiences. Reliability was supported through pilot testing, acceptable Cronbach's alpha values, and independent coding of a subset of transcripts.

Ethical principles were followed throughout the study. Participants provided informed consent, and all responses were kept confidential. The study reported aggregated results and anonymized interview excerpts to protect participants' identities. The research team stored digital data on password-protected devices and used participant codes rather than names during analysis.

Findings and Discussion

Quantitative Findings

The questionnaire results showed that AI utilization among PE teachers in Licheng District remained at an early stage. Although the participants were relatively young and well educated, their familiarity, training exposure, and actual AI use were limited. This indicates that demographic readiness alone is insufficient for technology adoption when professional learning and infrastructural support are weak.

As shown in Table 2, only 20% of teachers reported being familiar or very familiar with AI, while 38% reported being unfamiliar or very unfamiliar. The largest group, 42%, selected the neutral option, suggesting partial awareness but limited operational understanding. AI-related training was also insufficient: 52% had never received any AI training, and only 18% had received training several times or many times. Actual use was even lower. Fifty-four percent of teachers had never used AI in PE teaching, and only 8% used AI often or very often. These findings show that AI had not yet become part of routine PE teaching practice in the district.

Table 2
AI Awareness, Training, and Usage Frequency (N = 50)

Indicator	Category	Number	Percentage
AI familiarity	Very unfamiliar	5	10%
	Unfamiliar	14	28%
	Neutral	21	42%
	Familiar	8	16%
	Very familiar	2	4%
AI training	Never	26	52%
	Once or twice	15	30%
	Several times	7	14%
	Many times	2	4%
AI use frequency	Never	27	54%
	Rarely (less than once per month)	12	24%
	Occasionally (1-3 times per month)	7	14%
	Often (1-3 times per week)	3	6%
	Very often (daily or nearly daily)	1	2%

Teachers nevertheless expressed positive views about the value of AI. Table 3 shows that perceived importance scores were high across all measured functions, especially assisting student assessment (M = 4.1), personalized instruction (M = 4.0), and improving teaching efficiency (M = 3.9). At the same time, perceived difficulty scores were also very high, particularly insufficient equipment and funding (M = 4.5), inadequate training (M = 4.4), and lack of professional skills (M = 4.3). This combination of high perceived value and high perceived difficulty represents the central finding of the study: PE teachers recognized the potential of AI but lacked the conditions needed to use it effectively.

Table 3
Perceived Importance and Difficulty of AI Use

Item	Mean score
Perceived importance	
Personalized instruction	4.0
Improve student motivation	3.8
Assist student assessment	4.1
Improve teaching efficiency	3.9
Provide new teaching methods	3.7
Perceived difficulty	
Lack of professional skills	4.3
Insufficient equipment and funding	4.5
Not enough practical training	4.4

A cross-tabulation was conducted to clarify the relationship between AI training and actual AI use. As shown in Table 4, teachers who had received any AI training were much more likely to report actual use than teachers who had never received training. Among teachers without training, only 19.2% reported any AI use. Among teachers with training, 75.0% reported at least some AI use. This represents a 55.8 percentage point difference. The chi-square test

indicated a statistically significant association between training exposure and AI use, X2(1, N = 50) = 13.46, p < .001, Cramer's V = .52. This result suggests that training is not merely a supplementary support but a key facilitating condition for adoption.

Table 4
Cross-tabulation of AI Training Exposure and AI Use

Training exposure	Never used AI	Used AI at least rarely	Total	Use rate
No AI training	21	5	26	19.2%
Received AI training	6	18	24	75.0%
Total	27	23	50	46.0%

Qualitative Findings

The interview data explained the quantitative pattern in greater depth. Six themes were identified: AI as distant from PE practice, recognition of value but limited implementation conditions, skill and resource gaps, data privacy and liability concerns, peer influence, and preference for AI as a teaching assistant. Table 5 summarizes these themes and their connection to the quantitative results.

Table 5
Qualitative Themes and Integrated Interpretation

Theme	Illustrative evidence	Integrated interpretation
AI perceived as distant from PE practice	Teachers described AI as belonging to classrooms or computer labs rather than gymnasiums.	Low familiarity reflected limited exposure to PE-specific AI tools.
Value recognized but implementation constrained	Teachers believed AI could support movement feedback and assessment but lacked time and conditions.	High perceived usefulness did not translate into behavior.
Skill and resource gaps	Training was often theoretical and equipment shortages were severe.	High difficulty scores were grounded in practical barriers.
Data privacy and liability concerns	Teachers were uncertain about student data storage and responsibility for AI-generated feedback.	Risk perception discouraged experimentation.
Peer influence and social learning	Teachers were more willing to try AI after seeing colleagues use it successfully.	Adoption depended on local exemplars and professional norms.
AI preferred as teaching assistant	Teachers wanted AI to assist with recording, feedback, grading, and lesson planning.	Teachers did not reject AI but wanted it to support professional judgment.

Theme 1: AI Was Perceived as Distant from PE Practice

Many teachers described AI as something far removed from daily PE teaching. Several participants noted that their departments lacked even basic PE equipment, making AI appear unrealistic. One teacher stated, "We do not even have enough balls and testing devices; AI

sounds too far away from our daily classes." This perception was not simply caused by ignorance. Rather, it reflected the mismatch between policy language about AI and the material conditions of PE classrooms, especially playgrounds and gymnasiums.

Theme 2: Teachers Recognized AI's Value but Faced Implementation Constraints
Teachers generally accepted that AI could improve movement analysis, student assessment, and feedback. However, they also emphasized heavy teaching loads, large classes, short lesson periods, and limited preparation time. A common concern was that using AI during class would require time for device setup, student organization, troubleshooting, and data interpretation. In classes with more than 40 students, teachers felt that these requirements were difficult to manage without additional support.

Theme 3: Skill and Resource Gaps Were Multifaceted
Participants repeatedly reported that training, when available, was too general. Training sessions often introduced broad AI concepts but did not demonstrate how to use AI for PE-specific tasks such as skill assessment, fitness testing, or motion correction. Teachers also lacked access to suitable devices, stable internet connections in sports spaces, and technical support staff. Therefore, the barrier was not a single lack of knowledge but a combination of inadequate tools, insufficient training, and weak support systems.

Theme 4: Data Privacy and Liability Concerns Discouraged Experimentation
Some teachers were concerned about collecting student images, movement videos, biometric data, or performance records through AI tools. They were unsure who would be responsible for data storage, parental consent, algorithmic error, or injury if AI-generated feedback was inaccurate. The absence of clear school-level data governance made teachers cautious. These concerns show that adoption requires not only equipment and training but also clear ethical and administrative guidance.

Theme 5: Peer Influence Shaped Adoption
Teachers were more willing to try AI when they could observe colleagues using it successfully in similar PE contexts. Conversely, when no teacher in the department used AI, participants tended to wait. This finding is consistent with the social influence component of UTAUT and with diffusion of innovation theory (Rogers, 2003). It suggests that school-level adoption may grow more effectively through peer demonstration and mentoring than through top-down policy slogans alone.

Theme 6: Teachers Preferred AI as a Teaching Assistant
Participants did not view AI as a replacement for PE teachers. Instead, they preferred AI tools that could function as assistants by recording movement data, generating basic feedback, supporting attendance and grading, and helping with lesson planning. Teachers emphasized that human judgment remained essential for safety, motivation, classroom relationships, and emotional support. This preference indicates that teacher acceptance may improve when AI is framed as professional support rather than technological substitution.

Integration of Quantitative and Qualitative Evidence
The integration of questionnaire and interview findings provides a clearer explanation of the overall adoption pattern. Quantitatively, the study found low familiarity, low training

exposure, and low actual use. Qualitatively, teachers explained that these outcomes were rooted in concrete school conditions rather than simple unwillingness. The two data sources therefore converged around the same interpretation: AI adoption in PE is constrained mainly by the absence of enabling conditions.

The most important integrated finding is the contrast between high perceived value and low actual behavior. Teachers rated AI as useful for assessment, personalization, motivation, and efficiency, but most had never used it. Interview evidence showed that teachers could imagine useful applications, such as recording jump technique, analyzing running posture, or generating fitness assessment feedback. However, they also reported that ordinary PE spaces lacked devices, network coverage, support personnel, and time for trial use. This explains why positive attitudes did not become routine practice.

Training emerged as a connecting factor between perception and action. In the questionnaire, teachers with training exposure were more likely to report use. In the interviews, participants clarified that training mattered only when it was practical, PE-specific, and followed by support. General lectures about AI increased awareness but did not build operational competence. This means that professional development should not be evaluated merely by whether teachers have attended a session, but by whether the session helps them perform a concrete teaching task in a real PE environment.

The integrated findings also suggest that school culture shapes teacher confidence. Teachers were reluctant to be the first person in a department to experiment with AI because failure could disrupt class order and create professional risk. When colleagues provided examples, adoption appeared less threatening. This social dimension is important because it shows that implementation can be strengthened through peer demonstration, collaborative lesson design, and small-scale pilot projects rather than relying entirely on individual initiative.

Integrated Discussion through TAM and UTAUT

The findings support and extend the Technology Acceptance Model. According to TAM, perceived usefulness and perceived ease of use influence technology adoption (Davis, 1989). In this study, perceived usefulness was relatively high: teachers believed AI could support assessment, motivation, efficiency, and individualized instruction. However, perceived ease of use was low because teachers lacked familiarity, practical skills, equipment, and technical support. This explains why positive attitudes did not produce frequent use.

The UTAUT framework provides a stronger explanation of the intention-behavior gap because it emphasizes facilitating conditions and social influence (Venkatesh et al., 2003). The cross-tabulation showed that training exposure was strongly associated with actual AI use. Interview data further showed that equipment, time, connectivity, and peer examples shaped whether teachers could act on their intentions. Therefore, the low adoption rate should not be interpreted as teacher resistance. It is better understood as a systemic implementation problem.

The findings also suggest that perceived ease of use should be reconceptualized for PE contexts. For classroom-based subjects, ease of use may refer mainly to whether a platform is simple to operate. For PE, however, ease of use also includes whether the tool works in

large classes, outdoor spaces, noisy gymnasiums, unstable internet conditions, and high-movement environments. A tool that is technically simple may still be unusable if teachers cannot set it up safely and efficiently during a short PE lesson.

The equity dimension is also important. If digitalization resources are concentrated in academic subjects while PE departments lack devices, training, and planning representation, students may receive unequal access to digital learning benefits across subjects. Because PE contributes to physical health, motor skills, social development, and lifelong exercise habits, it should not be treated as peripheral in educational technology planning. AI integration in PE requires proportional investment and PE-specific design rather than the simple transfer of classroom technologies to sports spaces.

These findings extend TAM by showing that perceived ease of use in PE is partly environmental. A teacher's perception of ease is formed not only by the interface of an AI tool but also by whether the school provides a usable setting for that tool. In other words, ease of use is socially and materially produced. A device that appears simple in a demonstration may become difficult in a crowded playground, under weak network conditions, or during a 40-minute lesson with more than 40 students.

The findings also extend UTAUT by showing that facilitating conditions may operate as a threshold factor. In some technology contexts, better facilities may gradually increase use. In this study, however, the absence of basic conditions often prevented use altogether. Teachers could not gradually increase AI use if no PE-specific tools, training, or support existed. This threshold effect explains why even teachers with positive intentions remained non-users.

From a pedagogical perspective, the results show that PE teachers value AI most when it supports formative assessment and individualized feedback. These are areas in which traditional PE instruction is often constrained by time and observation limits. A teacher may not be able to observe every student's movement in detail during a large class, but AI-supported video or sensor data could help identify common errors and provide evidence for feedback. However, such benefits will only be realized if the tools are integrated into teaching routines rather than added as extra administrative burdens.

Implications for Practice and Policy

First, professional development should be embedded in real PE teaching environments. Teachers need demonstrations in gymnasiums, playgrounds, and fitness testing areas rather than abstract lectures in conference rooms. Training should focus on specific tasks such as movement video analysis, student performance tracking, skill feedback, fitness assessment, and safe data handling.

Second, schools should allocate digital resources equitably across subjects. PE departments require devices, reliable internet coverage in sports spaces, wearable or camera-based assessment tools where appropriate, and technical support. Without such resources, policy expectations for AI integration may lead only to symbolic compliance.

Third, schools should develop clear data governance rules for AI use in PE. These rules should address student image and movement data collection, parental consent, storage, access,

deletion, algorithmic limitations, and responsibility for AI-supported feedback. Clear rules can reduce teacher anxiety and encourage responsible experimentation.

Fourth, schools can appoint AI champion teachers in PE departments. These teachers should receive deeper training and then provide peer mentoring, open lessons, and practical demonstrations. Because teachers are influenced by colleagues working in similar conditions, peer-based diffusion may be more effective than external workshops alone.

A phased implementation pathway may be more realistic than immediate full-scale adoption. In the first phase, schools can focus on awareness and needs assessment by identifying which PE tasks teachers most want AI to support. In the second phase, schools can select one or two practical tools, such as video-based movement feedback or digital fitness assessment, and test them in a small number of classes. In the third phase, successful cases can be shared within the department through open lessons, peer observation, and reflective meetings. This gradual pathway reduces risk and allows teachers to build confidence through visible results. Professional development should also be task-based. Instead of presenting AI as a broad technological trend, training should be organized around specific PE problems: how to record and analyze a standing long jump, how to give feedback on running posture, how to manage fitness-test data, or how to use AI to prepare differentiated activities. Each training session should ideally result in a usable teaching product, such as a lesson plan, assessment rubric, data template, or classroom demonstration. This approach would help teachers connect AI directly with their existing professional responsibilities.

School leaders should avoid evaluating AI implementation only by counting whether a teacher has used a tool. Such an approach may encourage superficial or performative use. A more meaningful evaluation should examine whether AI improves feedback quality, reduces unreasonable workload, supports student learning, and protects student data. For PE, quality indicators should include safety, practicality, class management, and appropriateness for movement-based activities.

For policymakers, the findings imply that subject-specific digitalization standards are needed. General school digitalization indicators may hide inequalities between subjects. A school may appear digitally advanced because it has smart classrooms while its PE spaces remain disconnected from the same infrastructure. Future policy evaluation should therefore examine whether technology resources, training opportunities, and support systems reach practical subjects such as PE, art, music, and labor education.

Conclusion

This study examined AI utilization among PE teachers in Licheng District, Jinan City. The findings showed that current AI use was low: more than half of the teachers had never used AI in PE teaching, and more than half had received no AI-related training. However, teachers generally recognized the potential value of AI for assessment, personalized instruction, student motivation, and teaching efficiency. The main problem was therefore not resistance to AI but the gap between positive intention and actual implementation.

The study contributes to theory by extending TAM and UTAUT to a compulsory education PE context. It shows that perceived ease of use in PE must include environmental fit, such as the

availability of devices, suitability for gymnasium and outdoor settings, internet stability, class size, preparation time, and technical support. It also demonstrates that facilitating conditions and peer influence are decisive in determining whether teachers can convert positive attitudes into actual practice.

Practically, the findings suggest that improving AI utilization in PE requires practical support rather than persuasion. Schools and policymakers should provide PE-specific equipment, embedded training, clear data governance, and peer mentoring mechanisms. AI should be introduced as a teaching assistant that supports teacher judgment, not as a replacement for teachers.

Several limitations should be acknowledged. The study was conducted in one urban district with a sample of 50 teachers, which limits generalizability to rural schools, other provinces, or different national contexts. The cross-sectional design identifies associations but cannot establish causality. In addition, the quantitative data relied on self-reported responses. Future research should use longitudinal and intervention designs to examine how AI use changes after training and equipment provision. Comparative studies across districts and student outcome studies are also needed to determine whether AI-supported PE improves motor skills, engagement, and physical fitness.

Future research could also include student perspectives and classroom observations. Teachers' reports are essential for understanding implementation barriers, but student experiences would help clarify whether AI-supported PE improves motivation, perceived fairness, skill learning, or engagement. Observational data would provide additional evidence about how AI tools are actually used during lessons, how much time they require, and what kinds of classroom management issues emerge.

Another direction is to compare different school contexts. Rural schools, highly resourced urban schools, private schools, and specialized sport schools may face different barriers. Comparative studies could identify which challenges are universal and which are context-specific. Such evidence would help policymakers design differentiated support rather than assuming that all schools need the same type of AI intervention.

Overall, this study provides evidence that AI adoption in PE is a systemic implementation issue. Teachers may be willing to use AI, but willingness alone is insufficient. Only when infrastructure, training, policy, and peer support are aligned can AI become a meaningful tool for improving physical education.

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