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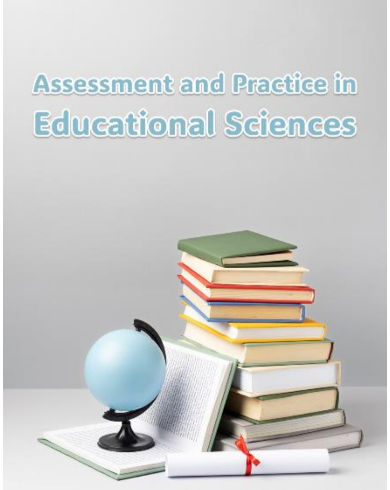

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Identifying the Drivers of Developing AI-Based Physical Education Teaching Methods in Primary Schools

ABSTRACT

The objective of this study was to identify the key drivers influencing the development and transformation of physical education teaching methods in primary schools through the integration of artificial intelligence. This qualitative exploratory study employed a fuzzy Delphi method to gather expert consensus on factors shaping AI-based instructional development in physical education. The research population consisted of specialists in artificial intelligence, educational technology, and physical education pedagogy, including university faculty members and national-level practitioners with a minimum of ten years of relevant academic or professional experience. Using purposive and snowball sampling, 15 experts were selected based on criteria of expertise, experience diversity, and willingness to participate. Data collection involved systematic document analysis using a structured extraction form, followed by semi-structured interviews guided by a protocol focused on AI trends, uncertainties, and drivers in physical education. Qualitative data were analyzed using the three-level abstraction laddering approach of Miles and Huberman (1994), moving from descriptive coding to thematic categorization and analytical interpretation. A two-round fuzzy Delphi process screened 112 initial codes, removing low-consensus items and resulting in 86 confirmed indicators that were subsequently synthesized into final driver categories. The inferential results demonstrated that AI-driven transformation in physical education relies on a multi-dimensional set of 25 key drivers spanning technological infrastructure, teacher capacity-building, institutional and policy support, pedagogical innovation, cultural readiness, and ethical considerations. Experts emphasized that modern digital infrastructure, teacher training in AI, ministry-level strategy alignment, and smart educational content are the strongest positive predictors of successful AI adoption. However, concerns were raised regarding reduced human interaction, technological dependency, and widening educational inequality, suggesting significant systemic moderation effects that influence the feasibility and sustainability of AI-based instructional change. The study concludes that achieving effective AI integration in primary school physical education requires holistic alignment across technology, pedagogy, governance, culture, and equity, highlighting the need for coordinated national strategies, targeted teacher development, and context-sensitive implementation frameworks.

Keywords: Artificial intelligence; physical education; primary schools; fuzzy Delphi; educational innovation; digital pedagogy; instructional drivers

Introduction

The rapid acceleration of artificial intelligence (AI) over the past decade has fundamentally reshaped the global educational landscape, influencing teaching models, learning processes, assessment practices, and instructional technologies across all levels of schooling. As educational systems transition from traditional teacher-centered paradigms toward technology-enhanced, data-driven models, AI has emerged as a transformative force capable of redefining how learners acquire knowledge and how teachers design, deliver, and personalize instruction. Increasingly, scholars argue that AI's impact is not peripheral but structural—deeply embedded in the architecture of modern pedagogy and essential for meeting the learning needs of new generations (1). Across various disciplines, AI is steadily shifting its role from a supplementary digital tool to an intelligent ecosystem that supports real-time decision-making, adaptive learning, and evidence-based teaching strategies (2).

International literature consistently underscores the capacity of AI to enhance both instructional quality and student engagement by enabling dynamic personalization, automating repetitive teaching tasks, and providing immediate diagnostic feedback to learners. AI-driven platforms, intelligent tutoring systems, and multimodal learning analytics have been shown to strengthen learning outcomes, particularly when applied in student-centered or competency-based educational environments (3). These developments illustrate the broader shift toward AI-integrated curricula, which promote individualized instruction, sustained learner motivation, and heightened cognitive engagement—cornerstones of advanced teaching models designed for twenty-first-century education (4). Moreover, the rise of AI operationalizes data-informed pedagogy at unprecedented levels, enabling teachers to observe learning behaviors, identify performance gaps, and design tailored interventions with greater accuracy (5). As AI expands its reach, it is increasingly viewed not simply as a technological enhancement, but as a pedagogical partner that co-creates learning experiences alongside educators.

Alongside these pedagogical transformations, scholars emphasize that AI is redefining the roles, responsibilities, and professional expectations of teachers. The integration of machine learning, learning analytics, and AI-assisted content generation requires educators to cultivate new digital competencies, understand algorithmic logic, and develop strategic capacities for interpreting data-derived insights (6). These requirements have been particularly pronounced in skill-based subjects such as physical education, where instruction traditionally relied on direct teacher–student interaction, observational feedback, and physical modeling of activities. With digital transformation affecting even highly practical subjects, educators face pressures to adopt innovative AI-based tools to enhance motor learning, track physical performance, and deliver individualized training recommendations (7). Thus, AI expands the pedagogical spectrum of physical education and introduces new mechanisms for supporting student learning in motion-intensive, skill-oriented environments.

The broader academic discourse increasingly recognizes AI as a cornerstone of future educational ecosystems. Recent reviews highlight its influence on reshaping classroom structures, instructional sequences, and cognitive–behavioral elements of learning (8). These studies show that AI's integration into educational systems is not merely a technological evolution but a systemic transformation involving curriculum policy, instructional design, governance, and equity considerations. For instance, AI-assisted learning environments leverage high-resolution learning analytics to collect and interpret vast amounts of student data, enabling highly accurate personalization strategies (9). The shift toward intelligent learning platforms also supports enhanced feedback loops, allowing students to receive guidance that is immediate, tailored, and aligned with their developmental readiness. Such platforms integrate seamlessly with classroom workflows and complement teacher expertise by offering real-time insights into students' strengths, learning preferences, and challenges (10).

Simultaneously, the global movement toward AI-assisted instruction has accelerated due to the increasing recognition of AI's capacity to bridge learning gaps, support inclusive education, and expand access to quality learning opportunities. In STEM fields, for example, AI-driven content, simulations, and intelligent models provide new pathways for interactive exploration that transcend traditional textbook-based approaches (11). AI-powered systems have significantly improved learning efficiency by enabling teachers to incorporate adaptive scaffolding, virtual experimentation, and instant remediation strategies. This computational augmentation of pedagogy is particularly beneficial in subjects characterized by complex cognitive demands or abstract conceptual structures, such as physics or mathematics, where AI tools have demonstrated considerable potential in supporting deeper conceptual understanding (12). Moreover, the integration of AI in literacy development and language learning has shown promise in supporting early learners through pronunciation modeling, individualized reading recommendations, and multimodal instructional content (13).

While AI's transformative potential is well established, researchers also highlight the need for coherent educational policies and strategic planning to ensure sustainable and equitable implementation. The successful integration of AI requires alignment between national education policies, digital infrastructure development, and teacher capacity-building initiatives (14). Without such alignment, AI risks reproducing or amplifying existing structural inequities across schools. Important considerations include not only the availability of AI technologies but also the existence of governance frameworks that regulate data privacy, ethical use, and algorithmic fairness (15). Therefore, integrating AI into schools is not solely a technical undertaking; it is a multifaceted process shaped by social, cultural, ethical, and political dimensions that require thoughtful design and implementation.

Higher education research similarly underscores the need for institutional readiness, teacher professional development, and organizational adaptation to effectively integrate AI tools into teaching and learning environments (16). Furthermore, empirical cases demonstrate that AI can improve instructional quality when combined with pedagogical innovation and teacher agency, highlighting the importance of professional expertise rather than technological determinism (17). This interplay between human pedagogical judgment and machine intelligence is echoed in studies examining AI's contributions to teacher training, where AI is portrayed as a facilitator of more reflective, data-driven instructional decision-making processes (18). Similarly, system-wide reports emphasize that AI increasingly shapes both classroom micro-dynamics and broader institutional structures, reinforcing its growing influence across entire educational ecosystems (19).

The literature further demonstrates that AI enhances learner engagement, motivation, and participation when supported by thoughtful instructional design and human-centered interface structures. Intelligent tutoring systems, for example, have been shown to significantly improve students' active involvement in learning tasks through real-time responsiveness and adaptive pathways (20). Advanced AI approaches in education also enable higher levels of personalization, facilitating student autonomy and supporting self-paced learning trajectories tailored to learners' cognitive and affective profiles (21). These capabilities are reinforced by systematic reviews confirming that AI applications in education provide new opportunities for transforming assessment, feedback cycles, and curriculum adaptation processes (22). Meanwhile, research from various regional contexts highlights AI's ability to revolutionize instructional environments through intelligent systems that support students' cognitive engagement and interactive learning experiences (23).

Collectively, these scholarly contributions reveal a strong international consensus: artificial intelligence is redefining educational practice through increased personalization, expanded digital functionality, and enhanced teacher support structures. Yet, within this global surge of AI-enabled educational innovation, relatively limited research has examined how AI can transform teaching methods in physical education—particularly in primary school contexts, where instruction is deeply intertwined with developmental, behavioral, and embodied learning processes. Physical education remains one of the least digitalized subjects in many national curricula, despite its strong potential for AI-supported motion analysis, personalized training plans, motor-skill diagnostics, and interactive simulation-based learning. Considering the increasing emphasis on holistic child development, health literacy, and lifelong physical activity habits, there is a pressing need to understand the drivers, opportunities, and challenges associated with integrating AI into primary school physical education teaching.

Given the current gap, the present study aims to identify the key drivers influencing the development of AI-based teaching methods in physical education within primary schools in Iran.

Methods and Materials

This research employed a qualitative exploratory design aimed at identifying the key drivers influencing the development of physical education teaching methods in primary schools through the integration of artificial intelligence. The qualitative orientation of the study made it essential to involve information-rich participants whose expertise could meaningfully contribute to conceptualizing these drivers. Accordingly, the statistical population consisted of experts in artificial intelligence and physical education pedagogy, particularly university faculty members, researchers, and senior practitioners who had conducted significant studies or gained considerable field experience in AI-enabled educational innovation.

To select participants, a set of rigorous criteria was applied to ensure both the quality and credibility of the expert input. These criteria included demonstrable academic or professional expertise in artificial intelligence, educational futures studies, or physical education pedagogy; a minimum of ten years of relevant teaching, research, or high-level executive experience; diversity of perspectives through the inclusion of experts from various managerial, provincial, technical, and academic backgrounds; and willingness and availability to participate in in-depth qualitative inquiry. Purposive sampling served as the primary method, with deliberate efforts to achieve maximum variation across disciplines and organizational roles. In cases where additional specialized knowledge was required, snowball sampling was used to identify further experts recommended by the initial participants. Using these strategies and guided by the principle of theoretical saturation, the research ultimately recruited fifteen experts, including administrators, AI specialists, and university faculty members, who participated in semi-structured interviews and Delphi rounds.

The data collection phase involved two primary tools designed to complement one another and generate a comprehensive understanding of the subject. The first tool was a systematic document analysis protocol implemented through a structured extraction form. This standardized form allowed the researcher to collect essential information from selected academic papers, policy documents, and technical reports by organizing the data into sections for bibliographic details—such as title, author, and publication year—as well as analytic dimensions, including key trends, primary drivers, identified challenges and opportunities, and significant quotations. This approach ensured that the document analysis process remained focused, consistent, and reliable, ultimately producing a well-documented preliminary list of variables influencing the future of AI-based physical education instruction.

To deepen the insights derived from document analysis and uncover latent dimensions within the topic, semi-structured interviews were conducted as the second major data collection tool. A carefully designed interview guide supported this process, containing open-ended questions centered on themes such as emerging global and national trends shaping the future of technology-enabled physical education, critical uncertainties related to AI adoption in primary school contexts, and the enabling and inhibiting factors affecting the development of AI-supported teaching methods. The semi-structured format allowed the interviewer to maintain alignment with the key thematic domains while retaining the flexibility necessary to pursue follow-up questions and probe more deeply into the experts' responses. This adaptive structure enhanced the richness of the qualitative data and facilitated a nuanced understanding of expert viewpoints regarding the integration of AI into physical education pedagogy.

Qualitative data were analyzed using the abstraction laddering approach proposed by Miles and Huberman (1994), which encompasses three interconnected levels of analysis. The first level, the descriptive stage, involved the systematic organization of raw data obtained through document analysis and semi-structured interviews. This step included initial coding, where meaningful segments of text were identified and labeled to represent emerging concepts. In the second level, the researcher engaged in a combinational or integrative process by grouping initial codes into broader thematic categories. These categories reflected patterns, similarities, and conceptual relationships that helped structure the underlying logic of the data. Finally, the third level represented the analytical stage, during which higher-order interpretations were developed based on the organized categories. At this level, the researcher generated inferential insights, articulated conceptual linkages, and identified the key drivers shaping the development of AI-based physical education teaching methods. This layered analytical process enabled a gradual transition from concrete observations to abstract theoretical constructs, ensuring both depth and conceptual rigor in interpreting the qualitative data.

Findings and Results

The demographic profile of the fourteen experts who participated in the study reflects a diverse and experienced panel of specialists in artificial intelligence, educational technology, and physical education pedagogy. The sample consisted of 9 men and 5 women, with ages ranging from 40 to 65 years ($M \approx 50.9$). All participants held doctoral degrees—six in physical education, four in artificial intelligence, and two in educational technology—ensuring the presence of high-level disciplinary expertise. Their professional experience was substantial, with work histories spanning from 7 to 23 years ($M \approx 13.6$), all serving as university faculty members actively involved in teaching and research. This combination of gender diversity, multidisciplinary doctoral backgrounds, and extensive academic experience provided a rich, credible, and theoretically saturated foundation for extracting expert insights relevant to identifying drivers of AI-based development in physical education teaching methods.

Table 1. Key Drivers Identified Through Thematic Analysis

Trend Code	Initial Codes (Condensed Summary)	Final Concepts (Key Drivers)
R_1	Digital infrastructure expansion, equal access to technology, smart educational platforms, reducing urban–rural tech gap, updating tools, AR/VR in PE	Access to Modern Educational Technologies
R_2	Specialized teacher training, digital/data literacy, continuous professional development, AI-based PE training design, data analysis skills	Teacher Training in AI
R_3	National educational AI policies, support institutions, inter-organizational coordination, incentives for smart schools	Ministry Support
R_4	Promoting positive attitudes toward technology, ethical tech use, student motivation, model schools, tech festivals	Technology Culture-Building
R_5	High-speed internet, smart PE facilities, equipment maintenance, tech-oriented architecture	Infrastructure Investment
R_6	Local digital PE content, personalized learning, AI progress tracking, interactive videos, smart motor-cognitive assessment	Smart and Personalized Educational Content
R_7	Data-driven evaluation, AI curriculum integration, reducing educational gaps, faster educational decisions	Interaction Between Technology and Educational System
R_8	Educational equity, tech awareness culture, family–school interaction, ethical AI use	Socio-Cultural Effects of AI
R_9	Digital literacy, creative AI-based PE training, smart feedback	Teachers' Skills and Capabilities
R_10	Innovative motor-learning methods, AI-driven improvement, virtual simulation and games	Innovation in Teaching Methods
R_11	Student motivation, interactive learning, active participation, personalized exercises, self-confidence	Student Acceptance and Participation
R_12	Macro strategies, organizational coordination, incentives, data-based management	Future-Oriented Policies
R_13	Self-learning, instant feedback, personal skill improvement, student satisfaction	Learner-Centered Education
R_14	Increased instructional accuracy, data-driven improvement, smart content, class productivity, enhanced evaluation	Improved Educational Quality
R_15	Reduced teacher–student interaction, fewer social exchanges, weakened traditional coaching, AI dependency	Reduced Human Interaction
R_16	Data analysis skills, AI-based activity guidance, tech management responsibilities, digital literacy needs	Teacher Empowerment in Smart Education
R_17	Increased reliance on AI tools, algorithm-driven decisions, reduced autonomy, infrastructure needs, system errors	Technological Dependency and Challenges
R_18	Digital access gaps, unequal facilities, inequitable expert teacher access, threats to educational equity	Increased Educational Inequality
R_19	Localized educational content, interactive design, personalized content, continuous updates	Local Digital Content Production
R_20	Joint research projects, knowledge transfer, workshops, pilot programs, continuous school–university collaboration	University–School Collaboration
R_21	Local AI platforms, data security, real-time feedback, content flexibility, technical support	Development of Local AI Platforms

R_22	Adoption of global trends, successful international experiences, global standards, online/blended learning	Alignment with Global Digital Education Standards
R_23	International standards in curriculum, cooperation with global institutions, globally competitive skills	Convergence with International Education Systems
R_24	Smart classroom management, IoT in PE, adaptive/automated learning	Expansion of Smart Schools
R_25	Automated teaching, reduced direct human interaction, teacher's changing role, increased student tech dependency	Reduced Human Role in Teaching

Analysis of the qualitative data led to the identification of 25 key drivers shaping the future development of AI-based physical education teaching methods in primary schools. These drivers emerged from a large set of initial codes that captured expert insights regarding technological, pedagogical, institutional, and socio-cultural conditions necessary for advancing smart PE instruction. The results revealed several core categories, including the expansion of access to modern educational technologies (R_1), which highlighted the need for equitable digital infrastructure and tools such as AR and VR. Another major driver was AI-focused teacher training (R_2), emphasizing professional development in data literacy, AI-based lesson design, and smart assessment. Institutional backing also appeared essential through Ministry support and policy alignment (R_3, R_12), showing the importance of governance, strategic planning, and organizational coordination. Cultural conditions, such as technology acceptance and ethical awareness (R_4, R_8), were identified as crucial for successful AI integration. Pedagogically, the findings demonstrated strong momentum toward innovative teaching methods (R_10), personalized smart content (R_6), enhanced learning outcomes (R_13, R_14), and active student engagement (R_11). At the same time, experts noted challenges such as reduced human interaction (R_15), technological dependency (R_17), and increasing educational inequality (R_18), signaling risks that must be managed in parallel with innovation. Broader systemic drivers included infrastructure investment (R_5), local AI platform development (R_21), and alignment with international educational trends (R_22, R_23). Overall, the table reflects a comprehensive and multidimensional framework, underscoring that the evolution of AI-driven PE teaching requires simultaneous progress in technology, teacher readiness, policy support, content design, and cultural adaptation.

In the first round of the fuzzy Delphi method, a total of 112 initial codes (questions) were identified and used as the primary basis for expert evaluation. Following the first round of fuzzy screening, 16 codes were removed due to low consensus levels, leaving 94 codes to be re-evaluated in the second round. In the second Delphi round, experts again reviewed the remaining items, resulting in the elimination of an additional 8 codes. Ultimately, 86 final questions were retained as the validated set of inputs for extracting the core drivers. Through the categorization of initial codes and detailed thematic analysis conducted after the second Delphi round, 25 final key drivers were identified as the major forces shaping the future development of AI-based physical education teaching methods in Iranian primary schools. These drivers formed the fundamental basis for subsequent analysis and decision-making and represent the most influential elements capable of transforming instructional practices in this domain.

Table 2. Final Key Drivers Influencing AI-Based Physical Education Teaching Methods

Key Drivers (Final Concepts)	Initial Codes
Access to Modern Educational Technologies	Equal access to technological equipment; provision of smart educational software and platforms; updating instructional tools in line with new technologies; use of AR/VR in PE teaching
Teacher Training in Artificial Intelligence	Enhancing teachers' digital and data literacy; establishing continuous professional development in educational technologies; learning practical AI applications in PE training design; developing data analysis skills
Ministry Support	Formulating macro policies for smart education; establishing support institutions for implementation; inter-organizational coordination
Technology Culture-Building	Promoting positive attitudes toward tech-based learning; teaching ethical and responsible tech use; creating model smart schools
Infrastructure Investment	Equipping sports facilities with smart technologies; ensuring equipment maintenance and updates; designing technology-oriented school architecture

Smart and Personalized Educational Content	Production of localized digital PE content; interactive videos and instant feedback; smart assessment of motor and cognitive skills
Interaction Between Technology and the Educational System	Data-driven educational evaluation; AI integration into the PE curriculum
Socio-Cultural Effects of Artificial Intelligence	Cultivating tech awareness in society; enhancing family–school interaction; promoting ethical AI values in schools
Teachers' Skills and Capabilities	Upgrading digital literacy; designing creative PE activities based on AI; using smart feedback in learning
Innovation in Teaching Methods	Creative motor-learning methods; AI-based improvement analysis; use of games and virtual simulation
Student Acceptance and Participation	Increased motivation; active engagement in smart exercises; personalized training; enhanced confidence
Future-Oriented Policies	Developing smart-education strategies; coordination among institutions; data-based managerial decision-making
Learner-Centered Education	Instant continuous feedback; improved individual skill development; increased student satisfaction
Improved Educational Quality	Higher accuracy and efficiency in teaching; data-driven instructional improvements; engaging smart content; enhanced evaluation quality
Reduced Human Interaction	Reduced direct teacher–student contact; student dependence on automated systems; need for alternative interactive activities
Teacher Empowerment in Smart Education	Data analysis–based planning; guiding smart activities; increased need for digital and technological skills
Technological Dependency and Challenges	Extensive use of smart tools; reliance on algorithms; reduced traditional teaching autonomy; infrastructure demands; potential system errors
Increased Educational Inequality	Urban–rural digital access gap; unequal school facilities; inequitable access to trained teachers; threats to educational fairness
Local Digital Content Production	Creating culturally relevant content; personalized learning materials; continuous content updates
University–School Collaboration	Knowledge transfer; practical workshops; pilot programs; continuous collaborative networks
Development of Local AI Platforms	Designing local school-friendly AI platforms; data security and privacy; real-time feedback; flexible content; continuous technical support
Alignment with Global Digital Education Standards	Adoption of global smart-education innovations; use of international benchmarks; globalized content alignment; growth of blended learning
Convergence with International Education Systems	Adoption of global curriculum standards; collaboration with international educational organizations; global skill development
Expansion of Smart Schools	Smart classroom management; use of IoT in PE activities; adaptive/automated learning
Reduced Human Role in Teaching	Automation of instructional tasks; decreased direct interaction; increased student dependency; need for alternative interactive design

Table 2 presents the final set of 25 key drivers that were validated through the fuzzy Delphi rounds and thematic analysis, reflecting the most influential forces shaping the adoption of artificial intelligence in primary school physical education instruction. These drivers encompass a wide spectrum of technological, pedagogical, institutional, and socio-cultural dimensions. Technological enablers—such as access to modern educational technologies, infrastructure investment, the development of local AI platforms, and the expansion of smart schools—emerged as foundational prerequisites for integrating AI into PE curricula. At the same time, teacher-related factors, including AI-oriented training, enhancement of digital skills, and empowerment in smart instructional environments, were identified as essential human-capital drivers. Pedagogically, innovation in teaching methods, personalized smart content, learner-centered practices, and improvements in teaching quality were highlighted as major components sustaining instructional transformation. Institutional support, particularly through Ministry policies, future-oriented planning, and university–school collaboration, plays a crucial role in ensuring coherent and sustainable implementation. Socio-cultural forces, such as technology acceptance, ethical AI culture, and student motivation, further reinforce the ecosystem required for successful change. Alongside these enablers, the framework also recognizes critical challenges, including reduced human interaction, technological dependency, and increased educational inequality—elements that must be addressed to ensure equitable and thoughtful integration of AI into physical education pedagogy. The comprehensive nature of these drivers underscores the multidimensional character of AI-based transformation in primary school PE teaching methods.

Discussion and Conclusion

The purpose of this study was to identify the key drivers shaping the development of AI-based teaching methods in physical education within primary schools. The results revealed twenty-five major drivers emerging from expert consensus through fuzzy Delphi analysis, reflecting technological, pedagogical, ethical, organizational, social, and policy-related dimensions. These findings are consistent with the broader body of international literature, which highlights that AI integration in education requires far more than the introduction of isolated technological tools; rather, it depends on systemic development across infrastructure, teacher capacity, digital culture, student engagement, and governance structures (1). The convergence between the present findings and global research underscores the fact that AI-driven transformation is a multidimensional process that must occur simultaneously across levels of the educational system.

One of the central findings of this study was the role of modern educational technology access, including digital infrastructure, smart educational platforms, and immersive tools such as augmented and virtual reality. AI-enabled transformation is impossible without robust technological foundations, a principle widely supported in international reviews emphasizing that infrastructure remains the backbone of AI-enhanced learning environments (2). Much like the experts in the present study emphasized, previous research also shows that equitable access to digital tools is foundational for creating inclusive and effective AI-supported instruction, particularly in early-grade settings where technological inequities tend to widen existing learning disparities (3). The importance of infrastructure aligns with studies that demonstrate how AR/VR environments significantly enhance engagement and interactivity in school subjects, making them a promising modality for physical education, where visualization and simulation can improve motor learning (4). Collectively, these findings confirm that technological readiness is not merely a supplementary element of AI-supported pedagogy but a prerequisite for meaningful implementation.

Another major driver identified in the study was teacher preparation and AI-related professional development. Expert consensus pointed toward the necessity of strengthening teachers' digital literacy, data competencies, and familiarity with AI-based instructional design. Research has consistently emphasized that teacher readiness is a determining factor in the success or failure of AI integration (5). Teachers must not only understand the technical functionality of AI tools but also possess pedagogical insight to implement these technologies effectively in real classrooms. The alignment between the present findings and earlier studies is notable. Scholars argue that the incorporation of AI into teaching requires teachers to shift from traditional delivery roles toward data-informed facilitation roles, which demand new forms of competence and professional identity (6). Additionally, investigations into AI-assisted learning environments reveal that teachers who have greater exposure to AI technologies are more capable of implementing personalized learning strategies that enhance student outcomes (7). These findings reinforce the conclusion that teacher capacity-building must accompany technological innovation to ensure sustainable and effective AI integration in physical education.

The study also highlighted the critical influence of governmental and institutional support, particularly in the form of national strategies, policy alignment, and organizational coordination. This aligns with global discussions emphasizing that AI integration requires governance structures capable of ensuring ethical, safe, and equitable implementation across school systems (8). Policy coherence is especially essential in physical education due to its practical nature and safety considerations, which necessitate well-regulated and pedagogically responsible use of AI tools. The literature confirms that ministries of education must play an active role in establishing guidelines, supporting digital transition, and investing in infrastructure for AI-driven transformation (9). Similarly, international scholars emphasize that large-scale implementation cannot rely solely on teacher initiative but must be supported by system-level planning and long-term investment (10). The present findings contribute to this body of knowledge by confirming that expert stakeholders in Iran perceive ministry support as essential for promoting AI-driven evolution in physical education teaching methods.

A prominent theme emerging from the study was the role of cultural and social readiness, including ethical awareness, family–school engagement, student motivation, and societal acceptance of educational technologies. This aligns with literature demonstrating that AI integration is both a technological and cultural process, influenced by values, beliefs, and community norms (11). As previous studies suggest, AI implementation must be accompanied by cultural adaptation efforts to foster trust, digital citizenship, and responsible technology use among students, teachers, and parents. These findings resonate with theoretical models showing that culturally sensitive AI implementation enhances student motivation, social participation, and learning engagement, particularly in subjects like physical education where interaction plays a vital role (12). Moreover, early-grade research emphasizes that parental support and school-wide digital culture significantly enhance the effectiveness of AI-enabled learning interventions (13). Therefore, the present study reinforces the notion that cultural alignment is an indispensable part of AI-driven educational innovation.

An important category of drivers identified in the analysis pertains to pedagogical innovation, including personalized content, smart assessment, AI-supported feedback loops, and new motor-learning methodologies. These are consistent with global findings demonstrating that AI-based content personalization significantly enhances learning outcomes, particularly in competency-based and skill-oriented subjects (14). Smart feedback systems, a key feature of AI technologies, are widely recognized for their ability to provide immediate, targeted, and continuous support for learners, thereby increasing autonomy and cognitive engagement (15). Furthermore, research shows that AI-enhanced assessment tools can analyze learner performance with high precision, enabling more accurate identification of motor skills, strengths, and challenges—an aspect especially relevant in physical education contexts (16). The present study confirms that smart assessment and personalized learning not only improve pedagogical efficiency but also transform the nature of physical education instruction, enabling tailored training plans based on individual student needs.

The study also identified innovation in teaching methods, aligning with recent research showing that AI-driven instructional models encourage creativity, interactive engagement, and deeper learning through simulation, gamification, and smart movement analysis (17). These approaches enhance students' understanding of physical movements, provide real-time corrective feedback, and allow teachers to model complex skills through digital visualization—capabilities that traditional teaching methods cannot achieve alone. Scholars similarly argue that intelligent systems allow teachers to design richer, more dynamic, and more experiential learning environments (18). Such pedagogical transformation is consistent with global research that identifies AI as a catalyst for new forms of instructional design, particularly in practice-based disciplines such as physical education.

Despite the benefits, the findings also highlighted the presence of significant challenges, including reduced human interaction, technological dependency, algorithmic errors, and potential increases in educational inequalities. These concerns are frequently raised in the international literature. For instance, researchers note that excessive reliance on AI may weaken teacher–student relationships, reduce opportunities for social interaction, and shift learning environments toward mechanized modes that neglect socio-emotional development (19). Likewise, algorithmic dependence may hinder teacher autonomy and potentially embed biases that influence learning experiences unfairly (20). Studies on advanced AI implementations warn that systems may malfunction, misinterpret student data, or provide inaccurate feedback, thereby compromising educational quality when not monitored appropriately (21). The present findings mirror these concerns, particularly in the context of physical education, where physical safety, emotional support, and real-time human judgment are critical elements of effective instruction.

Finally, the study revealed the importance of policy alignment with international standards, collaboration between universities and schools, and the development of localized AI platforms. This corresponds with global evidence showing that AI integration is most successful when supported by academic–practitioner networks that facilitate knowledge transfer and professional learning communities (22). Moreover, international collaboration frameworks are shown to assist countries in adapting global digital standards and ensuring competitiveness in the evolving educational landscape (23). The alignment between the study's findings and global evidence highlights the need for localized but globally informed AI strategies that consider national cultural context while integrating successful international models.

Overall, the results of this study reinforce the global scholarly consensus: the adoption of AI in education—particularly in motor-based subjects like physical education—requires a comprehensive, multi-layered approach that integrates technology, pedagogy, policy, ethics, capacity-building, and cultural alignment. The drivers identified in this research reflect both opportunities and challenges that must be addressed to transform physical education teaching methods in ways that are both technologically advanced and pedagogically meaningful.

This study, while rigorous in its methodology, relied on a sample of national experts whose perspectives may not fully represent all stakeholders involved in the integration of AI in primary school physical education. The qualitative nature of the Delphi method, although strong in capturing expert consensus, does not allow for the measurement of statistical relationships or predictive modeling. Additionally, the focus on Iran's educational context may limit generalizability to countries with different technological, cultural, or policy environments. Finally, because AI is a rapidly evolving field, some drivers identified in this study may change or expand as new technologies and pedagogical models emerge.

Future studies should incorporate mixed-methods approaches to combine expert perspectives with large-scale empirical data drawn from actual school environments. Research could examine the effectiveness of specific AI-based interventions in physical education through experimental or quasi-experimental designs. Comparative cross-country studies would also be valuable for identifying regional differences and successful global benchmarks. Furthermore, longitudinal research is needed to understand how AI adoption evolves over time and how it affects student learning outcomes, teacher professional identity, and digital equity.

Practitioners and policymakers should prioritize teacher training, ensuring that all physical education teachers develop competencies in AI, data interpretation, and digital instructional design. Schools should invest in equitable digital infrastructure, particularly in underserved areas, to reduce educational disparities. Ministries and educational institutions should collaborate to develop localized AI platforms tailored to cultural, linguistic, and curricular needs. Finally, schools should balance AI-based instruction with human-centered pedagogies to preserve interpersonal connection, student well-being, and holistic learning within physical education programs.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adhered in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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