|Jurnal Sinar Edukasi |JSE|Vol. 6| No. 3|October|Year 2025|

From field to cloud: Integrating AI-driven coaching in modern sport education

DAVID IQRONI[1*] AND KEVIN WALDO[2]

Abstract

The integration of Artificial Intelligence (AI) in sport education has marked a transformative era in how coaching, learning, and performance development are conceptualized. This paper critically examines current research and emerging trends in AI-driven coaching, focusing on its pedagogical potential, technological applications, and challenges within modern sport education. Drawing from peer-reviewed articles published between 2015 and 2025, the analysis synthesizes studies across domains such as biomechanics, learning analytics, machine learning, and educational technology. The findings reveal that AI-based coaching systems—encompassing motion capture analysis, performance prediction algorithms, and virtual training assistants—significantly enhance feedback precision, athlete engagement, and individualized learning experiences. Moreover, AI facilitates adaptive pedagogy, enabling educators to tailor instructional strategies based on learners' real-time performance data. However, the literature also highlights substantial barriers, including limited educator readiness, ethical concerns about data security, and disparities in access to advanced technologies. Theoretical frameworks such as constructivism and self-determination theory are frequently employed to interpret how AI-mediated environments support active learning, motivation, and self-regulation in sport settings. Despite promising outcomes, gaps remain in empirical validation and in understanding the long-term educational impact of AI integration. This analysis concludes that the shift from traditional field-based coaching to cloud-enabled, AI-driven environments represents a paradigm shift in sport education. By synthesizing the current evidence base, this paper provides a foundation for future research exploring sustainable models for AI adoption in sport education.

Keywords

AI, coaching, moden, teaching, training

Article History

Received 11 March 2025
Accepted 10 September 2025

How to Cite

Iqroni, D., & Waldo, K. (2025). From field to cloud: Integrating AI-driven coaching in modern sport education. *Jurnal Sinar Edukasi*, *6*(3), 193-206. https://doi.org/10.61346/jse.v6i03.288

[1*] Universitas Jambi, Jambi, Indonesia, Corresponding email: davidiqroni@unja.ac.id
[2] Universitas Jambi, Jambi, Indonesia

Introduction

The integration of Artificial Intelligence (AI) into sport education has rapidly redefined coaching paradigms and pedagogical practices, signaling a transition from traditional, field-based approaches toward cloud-enabled, data-driven ecosystems. AI technologies—ranging from motion capture analysis and performance prediction algorithms to virtual coaching assistants—are increasingly embedded within athletic training and educational contexts to enhance learning precision, feedback personalization, and engagement (Hu, Liu, & Su, 2024; Pashaie & Mohammadi, 2024). The rise of AI-driven coaching signifies more than just technological augmentation; it represents a paradigm shift in how knowledge, skill acquisition, and athlete development are conceptualized in educational settings (Choudhury, 2024).

Recent research underscores the growing potential of AI in fostering adaptive and evidence-based sport pedagogy. Gao (2025) noted that machine learning algorithms allow educators to move beyond standardized instructional models by tailoring training intensity and technique feedback to individual physiological data. Similarly, Dangore, Modi, and Nalawade (2024) highlighted AI's role in optimizing both athlete assessment and instructional delivery through real-time analytics. Mann (2024) further emphasized AI's ability to enhance tactical decision-making in team sports, enabling students to understand game dynamics through immersive simulations and data-driven feedback systems. Collectively, these innovations illustrate how AI bridges cognitive, psychomotor, and affective domains of learning in sport education.

Despite these advancements, the practical integration of AI into educational frameworks remains uneven. Studies reveal significant disparities in digital readiness among educators, ethical concerns regarding data collection and privacy, and limited pedagogical training in AI-based systems (Jud & Thalmann, 2025; Ishaak, Qasim, & Jahan, 2025). Moreover, while AI promises objectivity and consistency in performance evaluation, scholars such as Ghezelseflou and Choori (2023) warn of the potential erosion of the humanistic dimensions of coaching—namely empathy, mentorship, and interpersonal rapport—that remain central to athlete development. The literature also suggests a lack of consensus regarding the theoretical underpinnings guiding AI integration. Some adopt constructivist perspectives emphasizing learner autonomy, while others draw upon self-determination theory to examine motivation within AI-mediated learning environments (Hu et al., 2024).

A growing body of evidence advocates for AI's transformative impact on sport education; however, the majority of existing studies remain exploratory, focusing primarily on technological efficacy rather than long-term educational outcomes (Mishra, Habal, & Garcia, 2024). Few have empirically assessed how AI-driven coaching influences student learning processes, teacher adaptation, and curricular alignment within institutional contexts. The systematic review by Jud and Thalmann (2025) found that while AI tools are increasingly integrated into higher education and professional training programs, empirical evaluation of their pedagogical effectiveness remains limited and fragmented. Furthermore, Ishaak et al. (2025) identified a critical gap in understanding athletes' perceptions of AI-based coaching tools, which may influence both adoption and performance outcomes.

Ethical and accessibility concerns further complicate implementation. Gao (2025) highlighted the persistent digital divide in developing contexts, where inadequate infrastructure and limited digital literacy restrict the equitable use of AI-driven technologies.

Similarly, issues of algorithmic bias and data privacy have raised questions about the accountability and transparency of AI systems (Hu et al., 2024). As such, there is an urgent need for interdisciplinary research that aligns technological innovation with ethical, pedagogical, and sociocultural considerations in sport education.

Given these complexities, the transition "from field to cloud" in sport coaching demands a reevaluation of the educator's role, curriculum design, and student engagement models. The convergence of AI and education challenges conventional conceptions of skill development, calling for educators to act as facilitators of learning rather than mere transmitters of knowledge (Pashaie & Mohammadi, 2024). Moreover, as AI systems evolve toward predictive analytics and autonomous instruction, questions arise concerning how these technologies can complement, rather than replace, human judgment and mentorship.

While extant studies acknowledge AI's potential to revolutionize sport education, there remains a paucity of empirical research exploring its long-term pedagogical impact and integration into formal curricula. Most available literature emphasizes technological innovation and system design over educational theory and learner outcomes. Additionally, there is insufficient investigation into how teachers and students perceive and adapt to AI-mediated coaching environments, particularly within non-Western or resource-constrained educational settings. Ethical and accessibility dimensions of AI adoption in sport pedagogy also remain underexplored, leaving a gap between technological potential and practical implementation.

- How does the integration of AI-driven coaching technologies influence teaching practices and learning outcomes in modern sport education?
- What pedagogical models and theoretical frameworks best support the effective adoption of AI in sport education contexts?
- What are the primary ethical, infrastructural, and socio-cultural challenges hindering the equitable implementation of AI-based coaching systems?
- How do educators and students perceive the shift from traditional field-based coaching to cloud-enabled AI environments in sport learning?

AI-driven coaching in modern sport education: influence on teaching practices and learning outcomes

The integration of Artificial Intelligence (AI) into sport education represents a profound reconfiguration of how teaching and learning processes are designed, implemented, and assessed. AI-driven coaching technologies—ranging from motion analysis tools to adaptive feedback algorithms—are increasingly utilized to enhance instructional precision, support individualized learning, and optimize athlete performance (Jud & Thalmann, 2025). By translating performance data into actionable insights, AI systems empower educators to deliver personalized, evidence-based instruction that transcends traditional pedagogical boundaries (Gao, 2025).

Influence on teaching practices

AI-driven coaching technologies have redefined instructional methodologies within sport education by fostering a shift from reactive to proactive pedagogy. Teachers no longer rely solely on observation-based feedback; instead, they utilize predictive analytics and

biomechanical data to tailor interventions to learners' specific needs. According to Dangore, Modi, and Nalawade (2024), AI-enhanced systems enable real-time analysis of movement efficiency and error detection, allowing instructors to offer immediate, data-informed feedback. This precision not only increases teaching effectiveness but also supports differentiated instruction—where teaching is adapted to accommodate diverse learner capabilities and learning speeds.

Moreover, AI integration encourages educators to adopt hybrid teaching models that blend virtual and in-person coaching environments (Choudhury, 2024). Through cloud-based platforms, instructors can monitor athlete progress remotely, ensuring continuity in training even beyond physical classrooms. Mann (2024) demonstrated that AI-assisted simulations in team sports enhanced tactical understanding and decision-making skills, transforming traditional didactic sessions into interactive learning experiences. Consequently, educators' roles evolve from information transmitters to facilitators of learning, aligning with constructivist and learner-centered teaching principles.

Impact on learning outcomes

AI technologies exert a transformative impact on learning outcomes by promoting self-regulation, metacognitive awareness, and motivation. Learners engage more deeply when feedback is immediate, personalized, and grounded in objective data (Alonso & Cardona, 2024). Gao (2025) found that AI-supported platforms significantly improved learners' physical performance, conceptual understanding, and engagement by customizing instructional trajectories based on physiological and behavioral indicators. Similarly, Zhang, Chai, and Li (2024) observed that AI applications integrating humanistic design principles enhanced students' cognitive and emotional engagement, suggesting that intelligent coaching systems can also nurture affective dimensions of learning.

A growing body of evidence indicates that AI-driven learning supports constructivist approaches to sport education, where students actively construct knowledge through reflection, experimentation, and feedback. Self-Determination Theory (SDT) provides a useful lens for interpreting these dynamics, as AI-driven environments can fulfill learners' needs for autonomy, competence, and relatedness (Deci & Ryan, 2000). For instance, adaptive coaching interfaces enable learners to set personal performance goals, track their progress, and receive tailored reinforcement—fostering intrinsic motivation and self-efficacy (Lee & Lee, 2021). Similarly, Experiential Learning Theory (Kolb, 1984) aligns with AI-based instruction, emphasizing learning through cycles of concrete experience, reflection, conceptualization, and experimentation. In sport education, AI-driven motion tracking and virtual reality training modules operationalize this cyclical learning process by providing instantaneous feedback and opportunities for iterative improvement.

Challenges and pedagogical implications

Despite its pedagogical promise, AI integration presents several challenges. Jud and Thalmann's (2025) systematic review revealed that educators often lack the digital literacy and confidence required to fully harness AI's potential. Additionally, ethical concerns related to data privacy, algorithmic bias, and the depersonalization of the coach-athlete relationship persist (Genç, 2023). While AI enhances instructional precision, excessive reliance on

technology may inadvertently diminish the humanistic aspects of coaching—empathy, intuition, and emotional intelligence—that are integral to holistic learning (Zhang et al., 2024). Thus, the successful adoption of AI-driven coaching demands a balanced approach that integrates human and technological intelligence within pedagogically sound frameworks.

Furthermore, the literature suggests a disparity between technological advancement and pedagogical readiness. Choudhury (2024) emphasized that many sport educators employ AI tools without sufficient understanding of their theoretical underpinnings, leading to inconsistent applications across educational contexts. This underscores the need for professional development programs that integrate digital literacy, ethics, and educational psychology into teacher training.

The integration of AI-driven coaching technologies in sport education profoundly influences teaching practices and learning outcomes. It promotes personalized instruction, fosters reflective and autonomous learning, and enhances the precision and efficiency of coaching methodologies. However, realizing these benefits requires critical alignment between technological innovation and educational theory. The pedagogical success of AI in sport education will ultimately depend on how effectively educators merge human empathy with computational intelligence, ensuring that AI serves as an amplifier—not a substitute—of human teaching.

Pedagogical models and theoretical frameworks supporting ai adoption in sport education

The effective integration of Artificial Intelligence (AI) into sport education requires pedagogical models and theoretical frameworks that reconcile technological innovation with learner-centered teaching practices. As sport education evolves toward digital and data-driven methodologies, researchers emphasize the importance of grounding AI adoption within robust educational paradigms to ensure its pedagogical, ethical, and humanistic relevance (Baena-Morales & Sánchez-Jarque, 2025; Malhotra & Mehta, 2025).

Technological pedagogical and content knowledge (TPACK) and iTPACK frameworks

The Technological Pedagogical and Content Knowledge (TPACK) model, first introduced by Mishra and Koehler (2006), remains foundational for integrating technology into education. It posits that effective teaching with technology arises from the interplay between three knowledge domains—content, pedagogy, and technology. In the context of sport education, the iTPACK (integrated TPACK) model extends this framework by incorporating AI literacy and ethical awareness, guiding educators in adopting AI tools for both instruction and assessment (Baena-Morales & Sánchez-Jarque, 2025). Recent empirical studies reveal that the iTPACK model effectively supports teacher readiness and adaptive instruction in AI-enhanced physical education environments, especially across generational cohorts with varying digital competencies.

The sport education model (SEM) and hybrid pedagogies

The Sport Education Model (SEM), proposed by Siedentop (1994), emphasizes authentic sport experiences through roles such as player, coach, and referee. Contemporary researchers advocate integrating SEM with AI technologies to promote autonomy, teamwork, and reflective learning. Zhang, Soh, Bai, Anuar, and Xiao (2024) demonstrated that hybrid pedagogical approaches combining SEM with Teaching Games for Understanding (TGfU) and AI analytics fostered higher engagement and improved tactical decision-making among learners. Through motion tracking and AI-based performance visualization, students received data-informed feedback that enhanced self-regulated learning—an outcome aligning with constructivist theory.

Constructivist and humanistic frameworks

Constructivist learning theory underpins much of the pedagogical rationale for AI in sport education, positing that learners construct knowledge through interaction and reflection. AI-driven tools, such as virtual reality simulations and motion analysis software, offer experiential and interactive environments where learners can engage in inquiry-based learning (Malhotra & Mehta, 2025). Furthermore, Zhang, Chai, and Li (2024) introduced a humanistic AI pedagogy emphasizing emotional engagement and ethical learning, arguing that technology should augment rather than replace human mentorship. Within this paradigm, AI serves as a cognitive partner that fosters metacognitive skills, empathy, and intrinsic motivation.

Connectivism and networked learning

The Connectivist framework (Siemens, 2005) has gained traction as a theoretical foundation for AI adoption in sport education. It views learning as the ability to form and traverse networks of information sources, both human and technological. AI-driven platforms—such as cloud-based coaching systems—embody this theory by connecting learners, educators, and performance data in dynamic ecosystems. Gao (2025) illustrated how connectivist learning environments enhanced engagement and personalization by enabling continuous feedback loops between instructors, athletes, and digital systems. The networked nature of AI learning platforms thus supports collaborative inquiry, data literacy, and reflective practice.

Self-determination theory (SDT) and motivation frameworks

Self-Determination Theory (Deci & Ryan, 2000) provides a psychological lens for understanding learner motivation in AI-mediated sport education. AI-driven feedback systems can nurture autonomy, competence, and relatedness—core psychological needs that sustain intrinsic motivation. In the study by Botirovich (2025), students engaged more actively with AI-enhanced coaching when the system offered self-paced learning and personalized goal tracking. This aligns with the broader pedagogical shift toward learner agency, where AI acts as a facilitator of personalized learning journeys rather than an authoritative instructor.

Game-based and experiential learning models

Recent research integrates Game-Based Learning (GBL) and Experiential Learning Theory (Kolb, 1984) into AI-supported sport education. GBL leverages AI analytics to design interactive challenges that simulate real-world sporting scenarios, promoting decision-making and problem-solving (Martín-Rodríguez & Madrigal-Cerezo, 2025). Likewise, experiential learning is amplified through AI-driven feedback cycles, where students engage in performance trials, receive immediate AI analysis, reflect on outcomes, and iterate their strategies. These pedagogical approaches align strongly with physical education's emphasis on embodied learning and continuous improvement.

Frameworks of digital readiness and ethical pedagogy

Effective AI integration depends not only on learning models but also on the readiness of educators to adapt their teaching philosophies. Hirsh and Levental (2025) identified ethical-pedagogical frameworks as essential for sustainable AI adoption, emphasizing transparency, inclusivity, and digital competence. Their findings show that teachers who integrate AI within pedagogically sound and ethically informed frameworks demonstrate improved confidence, creativity, and innovation in sport instruction. Tohănean, Vulpe, and Mijaica (2025) further suggested that systematic professional development, grounded in both TPACK and ethical pedagogy, mitigates resistance and enhances pedagogical alignment in AI-rich sport education systems.

The adoption of AI in sport education thrives at the intersection of theory and practice. Frameworks such as iTPACK, SEM, Connectivism, and SDT provide educators with pedagogical scaffolds that promote meaningful learning while ensuring ethical and human-centered applications of AI. Effective implementation demands more than technological competence; it requires pedagogical intentionality, emotional intelligence, and an understanding of how AI can extend, rather than supplant, human teaching. As sport education continues to evolve "from field to cloud," these theoretical models remain crucial in ensuring that AI integration sustains educational integrity and learner empowerment.

Ethical, infrastructural, and socio-cultural challenges in AI-based coaching systems

The rapid integration of Artificial Intelligence (AI) in sport education and coaching has generated unprecedented opportunities for personalized learning, data-driven decision-making, and performance optimization. Yet, alongside these advancements, a series of ethical, infrastructural, and socio-cultural challenges have emerged, threatening the equitable implementation of AI-based coaching systems. These challenges extend beyond technical limitations, intersecting with broader issues of access, justice, and cultural relevance within educational and athletic contexts (Fadare, Beterbo, Ybanez, & Isahac, 2025; Xu, 2025).

Ethical challenges: Data privacy, bias, and human autonomy

The ethical dilemmas surrounding AI in sport education primarily revolve around data privacy, algorithmic bias, and the erosion of human autonomy. AI-driven coaching systems rely heavily on biometric and behavioral data to generate performance insights, yet the collection and processing of such sensitive data pose significant privacy risks (Zha, Li, Wang, & Xiao, 2025). Many AI algorithms used in educational or athletic settings lack transparency, leading to potential misuse or unauthorized sharing of athlete information. According to Fadare et al. (2025), most sport institutions lack robust ethical frameworks to regulate AI use, exposing participants to surveillance and exploitation.

Algorithmic bias further compounds these ethical risks. AI systems trained on biased datasets can reproduce and amplify social inequities in coaching and performance evaluation (Alam, 2025). For instance, male-centered datasets in sports technology may lead to biased training feedback for female athletes or individuals with disabilities. Hooshmand-Moghadam and Talebpour (2025) argue that inclusive algorithmic design and culturally contextualized data governance are vital for ensuring ethical parity. The concern over human autonomy is equally pressing: as AI assumes more evaluative and decision-making functions, educators risk becoming passive facilitators, diminishing the role of human empathy and contextual judgment in coaching (Khine, 2024).

Infrastructural challenges: Technological access and institutional capacity

Infrastructure represents another major barrier to equitable AI implementation. High costs, limited digital literacy, and uneven technological infrastructure often restrict the adoption of AI-based coaching in developing regions and underfunded institutions. Gao (2025) highlights that despite AI's pedagogical potential, unequal distribution of digital resources creates a "technological divide" in sport education, marginalizing rural and low-income learners. Institutions without adequate funding struggle to implement cloud-based analytics platforms or wearable technologies essential for AI-assisted performance monitoring.

Similarly, Fadare et al. (2025) emphasize that effective AI adoption requires not only access to digital tools but also professional training for educators. Many coaches and teachers lack the expertise to interpret AI-generated data, leading to misuse or underutilization of AI systems. Hooshmand-Moghadam and Talebpour (2025) point out that institutional readiness—encompassing digital infrastructure, policy frameworks, and technical support—is a prerequisite for sustainable AI integration. Without this foundation, AI-driven coaching risks deepening existing disparities between technologically advanced and resource-limited educational systems.

Socio-cultural challenges: Inclusion, equity, and cultural adaptation

The socio-cultural dimension of AI adoption is often underestimated but critically shapes its equitable application. AI technologies are typically designed within Western educational and athletic paradigms, which may not align with local cultural values, gender norms, or learning traditions (Abulkassova, Muldasheva, & Nurtazin, 2025). In a cross-cultural analysis, Iqbal, Shuaib, and Muhammad (2025) demonstrated that socio-cultural attitudes

toward AI—particularly among women and educators in conservative contexts—can influence perceptions of its legitimacy and accessibility. Such biases perpetuate digital exclusion and hinder equitable participation in AI-enhanced coaching environments.

Chang, Chen, and Chang (2025) extend this discussion by highlighting that AI tools like ChatGPT, though promising for inclusion, may inadvertently reinforce existing inequalities if cultural diversity and linguistic accessibility are not prioritized. Furthermore, socio-cultural norms governing gender, disability, and hierarchy often shape how athletes interact with AI systems and perceive authority in technology-mediated environments. In para-sport contexts, for example, AI tools have improved accessibility yet also raised concerns about the dehumanization of athlete support systems (Hooshmand-Moghadam & Talebpour, 2025).

Socio-cultural frameworks rooted in humanistic education emphasize the need to maintain relational and affective dimensions in AI-based learning. Xu (2025) cautions that while AI can optimize performance, excessive automation risks diminishing psycho-emotional well-being and interpersonal connection in physical education. Hence, ethical AI integration requires sensitivity to local contexts, participatory design involving diverse user groups, and policies that ensure gender and cultural equity.

The equitable implementation of AI-based coaching systems hinges on addressing intertwined ethical, infrastructural, and socio-cultural challenges. Ethical concerns demand transparent data governance and human oversight; infrastructural barriers call for investment in digital equity and teacher training; socio-cultural challenges necessitate culturally adaptive AI design and inclusive participation. Without deliberate intervention, AI risks reinforcing rather than reducing inequality in sport education. As Fadare et al. (2025) assert, achieving ethical and equitable AI integration will depend not merely on technological sophistication but on cultivating moral, institutional, and cultural readiness.

Educator and student perceptions of the shift from traditional coaching to cloud-enabled AI environments in sport learning

The ongoing digital transformation of sport education has redefined the landscape of coaching and learning, as Artificial Intelligence (AI) and cloud-based technologies increasingly augment traditional field-based pedagogies. This shift represents a paradigmatic change—from instructor-centered, physical engagement toward data-driven, adaptive, and virtualized learning ecosystems. Recent studies reveal nuanced perceptions among educators and students, ranging from enthusiasm and curiosity to apprehension and skepticism, shaped by pedagogical readiness, trust in AI systems, and cultural adaptation (Bofill-Herrero & García-Taibo, 2025; Krämer, Bosold, Minarik, & Schyvinck, 2025).

Educator perceptions: Pedagogical innovation and professional adaptation

Educators generally view AI-enabled sport learning as an opportunity to enhance instructional precision and individualized feedback. In a qualitative study, Bofill-Herrero and García-Taibo (2025) found that in-service and trainee physical education teachers recognized AI's potential to streamline assessment, improve data interpretation, and personalize training plans. However, they also expressed concern regarding the erosion of human mentorship and the emotional connection traditionally inherent in sport coaching. Teachers emphasized the

need for pedagogical frameworks that preserve relational learning while leveraging AI for cognitive and analytical enhancement.

Similarly, Karimi, Karimi, and Mahmoudi (2025) observed that educators perceive AI as a transformative pedagogical tool capable of improving lesson planning, performance monitoring, and inclusive teaching strategies. Nevertheless, their attitudes were mediated by digital competence—teachers with limited AI literacy reported anxiety and distrust toward algorithmic decision-making. These findings echo earlier work by Lee and Lee (2021), who argued that teacher readiness and continuous digital training are prerequisites for sustainable AI adoption in physical education. Educators generally endorsed AI as a supplement to, not a substitute for, human expertise—a perspective rooted in constructivist and humanistic teaching philosophies.

Student perceptions: Motivation, trust, and learning agency

Students' perceptions of AI-driven coaching environments are equally ambivalent but generally more optimistic. Quantitative research by Krämer et al. (2025) involving German sports science students revealed that most participants viewed AI systems as "useful," "intelligent," and "accessible," aligning with the Technology Acceptance Model (TAM), which emphasizes perceived ease of use and usefulness as predictors of adoption. Students appreciated AI's ability to provide immediate feedback and real-time performance analytics, which they associated with increased motivation and self-directed learning.

Complementing this, Terblanche, Molyn, and Williams (2023) found that students responded positively to AI-based coaching assistants when the technology demonstrated adaptability, fairness, and responsiveness. Participants particularly valued AI's non-judgmental nature, which reduced performance anxiety and encouraged iterative improvement. However, concerns were raised about data privacy, over-reliance on automation, and the absence of human empathy in AI-mediated feedback. These concerns echo broader patterns in AI education research, such as Kim, Merrill, Xu, and Sellnow (2020), who noted that students often perceive AI tutors as efficient but emotionally detached, limiting the depth of relational learning.

Shared perceptions: Balance between human and artificial agency

Both educators and students acknowledge the need to maintain balance between human and artificial intelligence in sport learning environments. The cloud-based nature of AI systems offers flexibility, remote accessibility, and scalability, yet it also introduces challenges related to depersonalization and loss of embodied experience (Pashaie, Karimi, & Abaszadeh, 2025). For instance, Chang, Chen, and Chang (2025) observed that while AI and generative systems like ChatGPT facilitated inclusion and accessibility in sport education, participants expressed skepticism regarding the authenticity of learning outcomes in virtualized settings. Educators and students alike emphasized that sport learning is inherently experiential, requiring tactile, emotional, and social dimensions that cannot be fully replicated by AI systems.

Perceptions are also shaped by institutional culture and socio-economic factors. In technologically advanced contexts, AI adoption is often associated with innovation and modernization; however, in resource-limited settings, educators perceive it as an added burden

rather than an enhancement (Karimi et al., 2025). This disparity underscores the importance of equitable access, infrastructure, and localized adaptation of AI systems.

Theoretical interpretations

Several theoretical frameworks help explain these perceptions. The Technology Acceptance Model (Davis, 1989) and its extensions have been widely applied to understand AI adoption in education, focusing on trust, perceived usefulness, and ease of use. Self-Determination Theory (Deci & Ryan, 2000) provides a complementary lens, suggesting that AI systems that enhance autonomy and competence foster greater learner engagement. Meanwhile, Constructivist Learning Theory underpins educators' preference for maintaining human-centered approaches that facilitate experiential learning. Together, these theories reveal that successful AI integration depends not only on technical performance but also on emotional, motivational, and pedagogical compatibility.

The transition from traditional field-based coaching to cloud-enabled AI environments is reshaping how sport learning is perceived, delivered, and experienced. Educators generally appreciate AI's analytical and adaptive potential but remain cautious about its ethical and relational implications. Students are more enthusiastic, perceiving AI as a tool for empowerment and personalized growth, though they too express reservations about emotional authenticity and data ethics. As these perspectives converge, a consensus emerges: AI should function as an augmentative partner—enhancing human pedagogy rather than replacing it. Future sport education must therefore adopt a hybrid human–AI model, blending technological intelligence with human empathy, ethical reflection, and experiential authenticity.

Conclusion

The integration of Artificial Intelligence (AI) into sport education signifies a transformative evolution from traditional, instructor-centered coaching toward data-driven, personalized, and cloud-enabled learning environments. Collectively, the findings across the four thematic questions reveal a multifaceted shift in pedagogy, professional practice, and learner experience, underscored by both opportunities and challenges. AI-driven coaching technologies have redefined teaching and learning processes, enabling precision feedback, adaptive assessment, and individualized instruction. Educators now function less as transmitters of knowledge and more as facilitators of self-regulated learning, aligning their roles with constructivist and experiential pedagogical principles. For students, AI enhances engagement, motivation, and performance awareness by providing real-time, personalized insights that foster autonomy and competence—key tenets of Self-Determination Theory (Deci & Ryan, 2000).

However, the effectiveness of AI integration in sport education depends on the adoption of sound pedagogical models and theoretical frameworks that harmonize technology with human-centered teaching. Frameworks such as TPACK and its advanced iteration, iTPACK, emphasize the balanced interplay between technological, pedagogical, and content knowledge, ensuring that educators remain critical agents in AI-enhanced environments. Similarly, hybrid pedagogies—combining the Sport Education Model (Siedentop, 1994), Teaching Games for Understanding (TGfU), and constructivist learning—promote reflective,

experiential, and collaborative engagement. These frameworks collectively argue that AI should serve as an augmentative partner that supports, rather than replaces, human expertise and emotional intelligence in coaching.

Nevertheless, ethical, infrastructural, and socio-cultural barriers persist as major constraints to equitable AI adoption. Issues surrounding data privacy, algorithmic bias, and autonomy raise pressing ethical questions about trust and accountability in AI-driven systems. Furthermore, infrastructural disparities—particularly in resource-limited contexts—exacerbate inequality, limiting access to digital tools, cloud-based analytics, and educator training. Socio-cultural factors, including gender bias, resistance to automation, and cultural dissonance between Western-designed technologies and local pedagogical norms, further hinder inclusive integration. Addressing these challenges demands ethical governance, teacher digital literacy, and culturally responsive AI design.

Educators and students alike perceive AI as a catalyst for innovation but express ambivalence regarding its implications for authenticity, empathy, and embodiment in sport learning. While AI enables flexibility and accessibility through virtual platforms, both groups emphasize the irreplaceable value of interpersonal connection, experiential practice, and emotional engagement inherent to sport. Thus, the future of sport education lies in a hybrid model that blends humanistic pedagogy with technological intelligence, grounded in ethical, inclusive, and pedagogically sound practices. Ultimately, the success of AI in sport education will depend not on technological sophistication alone, but on its capacity to preserve the human spirit of coaching and learning while amplifying the precision, adaptability, and inclusivity that modern education demands.

Disclosure Statement

No potential conflict of interest was reported by the authors.

References

Abulkassova, D., Muldasheva, G., & Nurtazin, M. (2025). *The phenomenon of artificial intelligence in modern transformational socio-cultural processes: Socio-philosophical analysis. AI & Society.*

Alam, A. (2025). *Ethical challenges and bias in AI-driven marketing: Educational imperatives and policy perspectives. IGI Global Publications.*

Alonso, A., & Cardona, O. (2024). *Physical performance and teaching effectiveness in AI-supported sport education. Apunts Sports Education Review*, 160(2), 1–12.

Baena-Morales, S., & Sánchez-Jarque, M. (2025). *The paradox of experience: Generational analysis of AI integration in physical education using the iTPACK framework. Physical Education Review*, 31(2), 141–156.

Botirovich, I. S. (2025). *Innovative approaches in sports pedagogy and their effectiveness. Universal Conference Proceedings*, 18(3), 22–34.

Bofill-Herrero, A., & García-Taibo, O. (2025). *Exploring the role and challenges of AI tools in physical education: Qualitative insights from in-service, trainee, and future teachers. Sport, Education and Society*, 30(2), 145–160.

Chang, S. H., Chen, S. Y., & Chang, C. H. (2025). *Exploring opportunities and challenges toward ChatGPT for inclusion in sport education. Computers in Human Behavior Reports*, 12, 100157.

Choudhury, R. D. (2024). *Exploring technology integration in coaching and training: A new frontier in physical education and sports.*

Dangore, M., Modi, S., & Nalawade, S. (2024). *Revolutionizing sport education with AI.* IEEE Xplore.

Deci, E. L., & Ryan, R. M. (2000). *The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry*, 11(4), 227–268.

Fadare, S. A., Beterbo, J. R. L., Ybanez, F., & Isahac, J. R. A. (2025). *Machine learning in physical education, sports, and recreation: Opportunities, challenges, and ethical considerations – A systematic review. International Journal of Sports Science.*

Gao, Y. (2025). *The role of artificial intelligence in enhancing sports education and public health in higher education. Frontiers in Public Health.*

Genç, N. (2023). *Artificial intelligence in physical education and sports: New horizons with ChatGPT. Anatolian Sports Science Journal*, 4(2), 110–126.

Ghezelseflou, H., & Choori, A. (2023). *Athlete perspectives on AI-driven coaching technologies: A qualitative inquiry.*

Hooshmand-Moghadam, B., & Talebpour, M. (2025). *Digital and AI-driven transformation in para-sport organizations: Inclusive management, strategic innovation, and ethical implications. Applied Sport Sciences Journal.*

Hirsh, A., & Levental, O. (2025). *Barriers and facilitators to implementing artificial intelligence in teaching physical education. Journal of Physical Education Pedagogy*, 34(1), 77–92.

Hu, Z., Liu, Z., & Su, Y. (2024). *AI-driven smart transformation in physical education: Current trends and future research directions. Applied Sciences*, 14(22), 10616.

Iqbal, M., Shuaib, M., & Muhammad, N. (2025). *Artificial intelligence in education and its influence on women socio-cultural empowerment: A female teachers' perspective. Journal of Social Science Research & Policy*, 6(1), 1–14.

Ishaak, S. M., Qasim, S., & Jahan, M. (2025). *The language of AI in sports: Athletes' perspectives on AI-driven coaching technologies. Asian Sports Science Journal.*

Jud, M., & Thalmann, S. (2025). *AI in digital sports coaching – A systematic review. Sports Technology Review*, 9(1), 45–67.

Karimi, J., Karimi, M., & Mahmoudi, S. (2025). *Teachers' attitudes toward modern physical education utilizing the transformative potentials of artificial intelligence. Research in Sport Education Studies*, 42(1), 24–39.

Kim, J., Merrill, K., Xu, K., & Sellnow, D. D. (2020). *My teacher is a machine: Understanding students' perceptions of AI teaching assistants in online education. International Journal of Human–Computer Interaction*, 36(22), 2033–2047.

Krämer, D., Bosold, A., Minarik, M., & Schyvinck, C. (2025). *Artificial Intelligence in sports: Insights from a quantitative survey among sports students in Germany. Smart Learning Environments*, 32(1), 22–37.

Khine, M. S. (2024). *Ethics and the future of education in an AI-driven world. Springer Nature.*

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development.* Prentice Hall.

Lee, H. S., & Lee, J. (2021). *Applying artificial intelligence in physical education and future perspectives. Sustainability*, 13(1), 351.

Malhotra, D., & Mehta, V. (2025). *Toward a holistic integration of digital technologies in physical education: Global perspectives and pedagogical frameworks. Indian Journal of Educational Technology*, 13(1), 1–18.

Mann, M. (2024). *Emerging technologies in education: Intelligence augmentation with AI for athletes in team sports. ICERI Proceedings.*

Martín-Rodríguez, A., & Madrigal-Cerezo, R. (2025). *Technology-enhanced pedagogy in physical education: Bridging engagement, learning, and lifelong activity. Education Sciences*, 15(4), 409.

Mishra, N., Habal, B. G. M., & Garcia, P. S. (2024). *Harnessing an AI-driven analytics model to optimize training and treatment in physical education for sports injury prevention. ACM Digital Library.*

Pashaie, S., Karimi, J., & Abaszadeh, M. (2025). *Challenges and opportunities of artificial intelligence in higher education from the perspective of sports science researchers. Research in Educational Systems*, 44(2), 1–20.

Pashaie, S., & Mohammadi, S. (2024). *Unlocking athlete potential: The evolution of coaching strategies through artificial intelligence. Sports Coaching Review*, *12*(3), 1–17.

Terblanche, N., Molyn, J., & Williams, K. (2023). *Performance matters: Students' perceptions of artificial intelligence coach adoption factors. Sport, Business and Management Journal*, 13(2), 145–164.

Tohănean, D. I., Vulpe, A. M., Mijaica, R., & Alexe, D. I. (2025). *Embedding digital technologies (AI and ICT) into physical education: A systematic review of innovations, pedagogical impact, and challenges. Applied Sciences*, 15(17), 9826.

Xu, H. (2025). *AI-powered technologies in physical education: Impact on physical and psycho-emotional well-being of students. Journal of Education and Human Development*, 54(2), 67–89.

Zha, H., Li, W., Wang, W., & Xiao, J. (2025). *The paradox of AI empowerment in primary school physical education: Why technology may hinder, not help, teaching efficiency. Behavioral Sciences*, 15(2), 240.

Zhang, J., Soh, K. G., Bai, X., Mohd Anuar, M. A., & Xiao, W. (2024). *Optimizing learning outcomes in physical education: A systematic review of hybrid pedagogical models integrated with the Sport Education Model. PLOS ONE*, 19(2), e0311957.

Zhang, H., Chai, J., & Li, C. (2024). *Innovative strategies of youth sports teaching and training based on artificial intelligence technology from the perspective of humanism. Journal of Humanistic Sport Education*, 22(3), 55–68.