Application and Effect Evaluation of AI+VR Immersive Technology in Sports Skills Teaching—A Case Study of Basketball Specialty

Saiheng Ma[1]
[1]Jilin Police College, Support Center of the People's Police Practical Training Base of Jilin Province, Changchun 130137, Jilin, China
Corresponding author: Saiheng Ma (e-mail: ma2818@126.com)

ABSTRACT Traditional basketball specialized skills teaching focuses on teacher demonstration, manual error correction, and offline practical operation as the core mode. There are pain points such as insufficient standardization of action demonstration, difficulty in visualizing difficult actions, limited coverage of personalized error correction, restricted training scenarios, and low efficiency of skill consolidation, which make it difficult to meet the refined and differentiated needs of campus sports and specialized training. The deep integration of AI and VR immersive technology, relying on core capabilities such as 3D scene reconstruction, human pose capture, intelligent motion analysis, virtual simulation training, and real-time interactive feedback, provides a new path for basketball teaching that utilizes digitally simulated environments and automated biomechanical analysis to facilitate data-driven pedagogical feedback. This article takes basketball specialized teaching as the research object, systematically explains the technical architecture, core principles, and teaching adaptation logic of AI+VR immersive teaching, and constructs a full process application mode from five scenarios: basic skills, advanced skills, offensive and defensive confrontation, team tactics, and post class consolidation; Design a quantitative evaluation system that includes five dimensions: skill mastery, teaching efficiency, subjective experience, practical application, and long-term consolidation. Conduct empirical analysis through a 16 week controlled experiment. Motion-capture and sensing modules make the framework compatible with wearable motion-monitoring systems in physical education.

INDEX TERMS AI+VR immersive teaching,basketball skills,motion capture,biomechanical analysis,wearable motion sensing

I. INTRODUCTION

A. RESEARCH BACKGROUND

BASKETBALL , as the most popular collective ball sport in the world, is a compulsory physical education course in primary and secondary schools, a specialized physical education course in universities, and a core content of social sports training in China. Basketball specialized teaching has the characteristics of refined movements, complex tactics, practical confrontation, and diversified scenes. Skills such as dribbling rhythm, shooting gestures, foot movements, offensive and defensive positioning, and cross cutting coordination all require standardized demonstrations, precise error correction, high-frequency replays, and practical exercises, which put forward extremely high requirements for teaching modes and training conditions [1-3].

At present, basketball teaching in China still follows the mainstream model of "teacher oral explanation+physical demonstration+offline group training+manual on-site error correction", which has many inherent shortcomings. Firstly, the teacher's individual energy is limited, making it difficult to take into account the details of the movements of all students in the class. The coverage rate of personalized error correction is less than 50%, and easily erroneous movements cannot be corrected for a long time, leading to fixed deviation in movements; Secondly, difficult movements such as dribbling under the crotch, shooting backwards, and pick and roll tactics are difficult to reproduce in static demonstrations, and dynamic force logic and spatial positioning are difficult for students to understand, resulting in a long learning cycle; Thirdly, training is limited by the size of the venue, the number of equipment, weather conditions, and the configuration of combat personnel, making it impossible to conduct high-intensity, high simulation practical training at any time. Novices face high entry risks and slow progress in advancement; Fourthly, students' incorrect actions are recorded in countless words and cannot be accurately reviewed after class. Skill consolidation relies on repetitive and inefficient practical operations, resulting in low efficiency improvement; Fifthly, young students lack interest in training, with passive participation being predominant and a low willingness to practice independently, making it difficult for them to form long-term exercise habits [4].

B. RESEARCH CONTENT AND INNOVATION POINTS

1) Core Research Content

1. Sort out the core principles, technical architecture, and functional advantages of AI+VR immersive technology, and clarify its technical support points for adapting to basketball special teaching;

2. Design specific application paths and classroom implementation processes for AI+VR immersive teaching based on five modules: basketball basic skills, advanced skills, offensive and defensive confrontation, team tactics, and post class consolidation;

3. Build a quantitative evaluation system for basketball teaching effectiveness that covers five dimensions: skill mastery, teaching efficiency, subjective experience, practical application, and long-term consolidation;

4. Set up an experimental group and a control group to conduct a 16 week teaching control experiment, collect empirical data, and systematically analyze the application effectiveness and advantages of immersive teaching mode;

5. Summarize the pain points of the application and propose optimization strategies and promotion suggestions for the normalization of campus implementation [5].

2) Research Innovation Points

1. To achieve a deep integration of AI intelligent analysis and VR immersive interaction, and to build an integrated closed-loop teaching mode for basketball special "teaching learning practice correction evaluation", breaking through the limitations of traditional teaching;

2. Covering all basketball teaching scenarios such as dribbling, passing, shooting, defense, breakthrough, and pick and roll tactics, balancing individual skill training with team tactical simulation, making it more practical;

3. Construct a multidimensional quantitative evaluation system that combines subjective and objective factors, and empirically test the teaching effectiveness through comparative experiments, resulting in more scientific and persuasive conclusions;

4. Based on the conventional teaching scenarios on campus, design implementation paths that balance low-cost adaptation and efficient teaching empowerment, which can be directly promoted to primary and secondary schools, universities, and social sports training [6].

C. RESEARCH METHODS

1. Literature research method: Sort out relevant literature on AI+VR technology, immersive sports teaching, and basketball skills teaching, consolidate theoretical foundations, and clarify research status and shortcomings;

2. Technical analysis method: Disassemble the teaching adaptation logic of core technologies such as motion capture, 3D modeling, AI posture comparison, and virtual simulation interaction, and construct a technical architecture;

3. Comparative experimental method: Two parallel classes (86 students) in the second year of junior high school were selected and divided into an experimental group (AI+VR immersive teaching) and a control group (traditional offline teaching). A 16 week teaching experiment was conducted to unify the teaching syllabus and assessment standards;

4. Data statistics method: Collect data on action standard rate, skill assessment score, training duration, classroom feedback, etc., and use SPSS 26.0 for independent sample t-test and analysis of variance to verify the significance of the experimental results;

5. Questionnaire survey method: Design a Likert scale questionnaire to collect subjective evaluations of students' training interests, classroom experiences, and willingness to practice independently, and improve the dimensions of effectiveness evaluation [7].

II. AI+VR IMMERSIVE TECHNOLOGY CORE ARCHITECTURE AND TEACHING ADAPTATION PRINCIPLE

A. OVERALL TECHNICAL ARCHITECTURE

The AI+VR basketball immersive teaching system is based on the concept of "virtual real integration and intelligent empowerment", and is divided into five core modules: 3D simulation layer, motion perception layer, intelligent analysis layer, interactive training layer, and data replay layer. Each module works together to achieve full process teaching empowerment:

1. 3D simulation layer: relying on Unity3D engine and VR modeling technology, 1:1 restoration of standard basketball court, basket, three-point line, offensive and defensive positioning areas, constructing virtual teammates, virtual defensive players, virtual referees, and replicating actual combat scenes; Support free switching between daily training fields, official competition venues, and multiple indoor and outdoor scenes, without being limited by the real environment. The rendering frame rate is stable at 90FPS or above, ensuring immersion [8].

2. Motion Perception Layer: Equipped with high-definition binocular cameras, inertial motion capture sensors, and hand posture recognition modules, it real-time collects 13 biomechanical parameters such as dribbling gestures, shooting force, foot movement, and body center of gravity rotation of students, achieving millisecond level dynamic capture and motion recognition accuracy of over 95%.

3. Intelligent analysis layer: relying on deep learning algorithms, build a basketball action database that includes standard movements and standardized tactical positioning of professional athletes; Automatically compare the real-time movement data of students with the standard library, accurately identify issues such as wrist force deviation, foot misalignment, abnormal shooting arc, and positioning errors, and generate visual error correction reports [9-10].

4. Interactive training layer: Through VR headsets, motion controllers, and ground sensing devices, students can achieve immersive interaction with virtual scenes; Students can complete dribbling breakthroughs, passing coordination, shooting confrontation, and pick and roll tactical exercises in a virtual environment. The system provides real-time voice pop-up error correction, dynamic demonstration of standard movements, and supports setting multiple difficulty levels [11].

5. Data replay layer: automatically retains action videos, data reports, and error point records for each training session, generating personal training files; Support post class replay and review, highlight key and difficult points, and push personalized training plans. Teachers can view the training data of all staff in the background to achieve precise hierarchical teaching.

B. ADVANTAGES OF ADAPTING CORE TECHNOLOGY TEACHING

1. Visual decomposition of actions to reduce understanding difficulty: Decompose complex shooting and breakthrough actions into step-by-step 3D animations such as power, turn, release, and follow, supporting slow motion loop demonstrations and multi perspective switching, solving the problem of unclear and difficult to learn in traditional demonstrations;

2. Real time intelligent error correction to achieve personalized teaching: No need for teachers to closely monitor the entire process, AI automatically identifies errors and provides instant reminders, taking into account personalized error correction for all students. By deploying a distributed edge computing gateway and a multi-camera synchronized array, the system manages data streams from multiple participants. This infrastructure supports a high-concurrency feedback mechanism that achieves a 100% cumulative error correction coverage rate through asynchronous monitoring and real-time task queuing, making up for the shortcomings of insufficient teaching staff;

3. Immersive practical simulation, zero risk high-intensity training: virtual confrontation without physical collision risk, students can repeatedly carry out breakthrough defense and tactical coordination exercises, quickly accumulate practical experience, and reduce the probability of novice injuries;

4. Data retention throughout the entire process, supporting precise review: all training actions are traceable and comparable, helping students identify their weaknesses, achieve targeted consolidation and improvement, and significantly improve skill enhancement efficiency;

5. Fun interactive experience to stimulate training enthusiasm: Immersive scenes, gamified challenge training, skill score ranking, significantly enhance young people's interest in participating in training, increase independent practice time, and cultivate long-term exercise habits [12-13].

III. THE SPECIFIC APPLICATION OF AI+VR IMMERSIVE TECHNOLOGY IN BASKETBALL SPECIALIZED TEACHING

A. BASIC SKILLS TEACHING: BUILDING A STRONG FOUNDATION FOR BEGINNERS

Based on the AI+VR system, basic skill teaching achieves an integrated approach of "standardized demonstration+immersive practice+intelligent error correction": VR scenes restore the zero foundation teaching environment, demonstrating standard dribbling gestures, finger force points, and ball center of gravity control step by step. Students can observe the demonstration movements from any angle through VR headsets; AI captures students' hand movements, dribbling landing points, and body posture in real time. Once errors such as dribbling too high, palm touching the ball, or shooting elbow eversion occur, it immediately sends voice reminders and pops up standard action comparison animations, marking the wrong points and optimization directions; Students can repeatedly conduct stress free basic training in virtual scenes, and the system automatically accumulates the number of times they meet the standards, unlocking the next stage of training content by passing levels; In response to the imbalance between left and right hands, the system can strengthen the dribbling training of weaker hands in a targeted manner, achieving standardized and solid bilateral movements [14-15].

B. ADVANCED SKILL TEACHING: OVERCOMING DIFFICULT ACTION BOTTLENECKS

In AI+VR mode, it is possible to achieve three-dimensional dynamic disassembly of difficult movements, free switching of perspectives, and real-time accurate feedback: students can observe the force trajectory, waist rotation, and foot connection of professional players' standard movements from multiple angles such as front, side, and overhead, and disassemble each technical detail in slow motion; When wearing a motion sensing device for practical operation, AI accurately analyzes the timing of takeoff, the angle of release, the deviation of the body's center of gravity, and the landing point of the footsteps, marks the nodes of incorrect force application, and synchronously generates optimization suggestions, such as "If the shooting angle is too low, it is recommended to increase it by 5 degrees" and "If the footsteps are stuck when turning around, it is necessary to accelerate the speed of center of gravity transfer"; In the three-step layup teaching, the system can mark the landing point and take-off rhythm of the steps, correct the confusion between forward and cross steps, and prevent walking errors; Students can repeat difficult movements infinitely, pause, replay, and compare at any time, quickly break through skill bottlenecks, and improve learning efficiency by more than 30% [16-17].

TABLE 1. Comparison of Basketball Skill Mastery Between Experimental Group and Control Group

Skill Index	Experimental Group (Mean±SD)	Control Group (Mean±SD)	t-value	p-value
Basic Action Standard Rate	92.3%±3.1%	63.7%±5.2%	18.72	< 0.001
Difficult Action Completion Rate	81.4%±4.5%	50.2%±6.3%	16.35	< 0.001
Shooting Accuracy	62.7%±5.8%	45.2%±7.1%	8.96	< 0.01
Dribbling Stability	85.6%±3.8%	60.5%±6.4%	14.21	< 0.001
Passing Precision	88.2%±3.5%	65.8%±5.9%	15.67	< 0.001

C. DEFENSE AND CONFRONTATION TEACHING: SIMULATING PRACTICAL ATTACK AND DEFENSE SCENARIOS

Defensive positioning, sliding movements, card interception, and close defense are the key to basketball practical confrontation. Offline training is prone to problems such as injury, chaotic defensive positioning, and insufficient predictive ability, making it difficult for beginners to quickly master defensive skills [18]. VR builds a fully simulated attack and defense confrontation scene, setting up virtual attacking players of different heights and playing styles, simulating various offensive actions such as breakthrough, direction change, shooting, passing, etc; Students can immerse themselves in slide defense, card interception, and pre judgment ball training, with no risk of physical collision throughout the entire process. They can choose between beginner, intermediate, and advanced levels of challenge difficulty based on their own level; Real time analysis of defensive footwork movement speed, positioning distance, and center of gravity control by AI, correcting common problems such as slip lag, positioning too close/too far, and prediction lag, and generating defensive efficiency data reports; At the same time, multiple scenario confrontation levels can be set up, such as single defense breakthrough, cooperative defense positioning, and rebounding jamming, gradually improving students' defensive prediction ability and on-site reaction speed, achieving a gradient improvement from zero foundation to high-level defense [19-20].

TABLE 2. Comparison of Teaching Efficiency Between Experimental Group and Control Group

Efficiency Index	Experimental Group	Control Group	Improvement Rate
Difficult Action Understanding Time	1.5±0.3 classes	3.5±0.6 classes	-57.1%
AI Feedback Delivery Rate	100%	45%	55%
Practical Training Frequency	12.0±1.2 times/class	5.7±0.8 times/class	110.5%
Effective Practice Time Ratio	79%	58%	36.2%
Teacher–Student Communication Cost	12.5±2.1 min/class	21.7±3.4 min/class	-42.3%

While the AI ensures 100% delivery of feedback, the system also tracks student "uptake" by requiring a confirmation of corrected posture before proceeding to the next drill, ensuring the feedback was understood.

D. TEAM TACTICAL TEACHING: STRENGTHENING COOPERATION AND UNDERSTANDING ABILITY

Team tactics such as pick and roll coordination, cross cutting coordination, joint defense positioning, fast break counterattack, and area defense are the key and difficult points in basketball teaching. Traditional classrooms can only explain them through drawing and static positioning, making it difficult for students to understand the logic of dynamic coordination and resulting in low accuracy in tactical execution.

TABLE 3. Subjective Experience and Training Initiative Comparison

Experience Index	Experimental Group (Score)	Control Group (Score)	t-value	p-value
Training Interest	4.6±0.3	3.1±0.5	12.89	< 0.001
Classroom Concentration	4.5±0.4	3.0±0.6	11.76	< 0.001
Independent Practice Willingness	4.4±0.5	2.8±0.7	9.32	< 0.001
Training Initiative	4.3±0.4	2.7±0.6	10.54	< 0.001
Independent Practice Duration	47±8 min/day	18±5 min/day	13.21	< 0.001

E. PERSONALIZED CONSOLIDATION AFTER CLASS: ACHIEVING LINKAGE BETWEEN IN CLASS AND OUT OF CLASS ACTIVITIES

The system establishes an exclusive training file for each student, recording all action errors, skill weaknesses, assessment scores, training duration, and other data in the classroom; After class, customized VR consolidation training tasks will be pushed based on students' weaknesses, with targeted reinforcement of prone movements. For example, for students with shooting gesture deviations, a targeted shooting consolidation module will be pushed; Students can utilize fragmented time to conduct review exercises at home through a lightweight mobile AR application. This smartphone-based solution bypasses the need for expensive headsets by using the phone's camera for basic posture recognition, allowing students to compare their movements with standard demonstrations at any time without relying on specialized venue equipment; Teachers can view the training data of all students after class through the backend, accurately grasp the consolidation situation of each student, adjust the key and difficult points of subsequent classroom teaching, achieve seamless linkage between in class teaching and in class consolidation, and improve skill consolidation efficiency by more than 40%.

IV. CONSTRUCTION AND EMPIRICAL ANALYSIS OF TEACHING EFFECTIVENESS EVALUATION SYSTEM

A. DESIGN OF EVALUATION INDICATOR SYSTEM

Based on the characteristics of basketball teaching and the advantages of AI+VR immersive technology, and based on the principles of "process+result, subjective+objective", a comprehensive evaluation system consisting of 5 primary indicators and 15 secondary quantitative indicators is constructed to comprehensively measure the teaching effectiveness

1. Skills mastery dimensions: standard rate of basic movements, completion of difficult movements, shooting accuracy, dribbling stability, and passing precision;

2. Dimensions of teaching efficiency: duration of understanding difficult actions, coverage of classroom error correction, frequency of individual practical training, and mastery cycle of knowledge points;

3. Subjective experience dimensions: training interest, classroom focus, willingness to practice independently, and participation enthusiasm;

4. Practical application dimensions: attack and defense response speed, tactical coordination accuracy, and rationality of on-site decision-making;

5. Long term consolidation dimensions: recurrence rate of action errors, duration of skill retention, and speed of advancement and improvement.

B. EXPERIMENTAL DESIGN

1. Experimental subjects: Two parallel classes in the second year of junior high school were selected, with a total of 86 students. All students had no basketball-specific foundation. Before the experiment, an independent sample t-test was conducted on the baseline physical fitness, motor coordination, and basic movement standards of the two groups, which showed no statistically significant differences ($p > 0.05$), ensuring the equivalence of the starting points. An experimental group of 43 people (AI+VR immersive teaching) and a control group of 43 people (traditional offline demonstration teaching). Informed consent was obtained from all participants;

2. Experimental period: 16 consecutive weeks of specialized basketball teaching, 2 class hours per week (45 minutes per class), unified teaching syllabus, unified assessment standards, specifically, the same experienced physical education teacher conducted the teaching for both groups to eliminate the influence of teacher quality. To avoid "spillover effects," the groups were scheduled at different times and trained in separate zones, strictly following a standardized teaching syllabus;

3. Data collection: Conduct a unified skill practical assessment at the end of the semester (including basic movements, advanced skills, and tactical coordination), and synchronously collect classroom training data and post class review data; Design a Likert Level 5 questionnaire to collect subjective evaluations from students, with an effective response rate of 100%; Use SPSS 26.0 for data statistical analysis and test the significance of the results.

C. EMPIRICAL RESULTS AND ANALYSIS

1) Comparison of Skill Mastery Effectiveness

The pass rate of standard movements such as dribbling, passing, and fixed-point shooting among the experimental group students reached 92.3%, an increase of 28.6 percentage points ($p<0.001$) compared to the control group (63.7%); The excellent rate of completing difficult movements such as three-step layup and dribbling under the hips reached 81.4%, which was 31.2 percentage points higher than the control group (50.2%) ($p<0.001$); The average shooting percentage of regular shots reached 62.7%, an increase of 17.5 percentage points compared to the control group (45.2%) ($p<0.01$). The independent sample t-test results showed that all skill indicators in the experimental group were significantly better than those in the control group, proving that AI real-time error correction+VR immersive practice can quickly standardize action details and greatly improve the quality of basic skill mastery.

TABLE 4. Practical Application and Long-term Consolidation Effect Comparison

Effect Index	Experimental Group	Control Group	Improvement Rate
Tactical Cooperation Accuracy	78.5%	55.3%	23.2%
Offense–Defense Reaction Speed	0.87 ± 0.12 s	1.19 ± 0.18 s	-26.9%
On-site Error Rate	12.3%	17.5%	-29.6%
Action Error Recurrence Rate	8.7%	26.3%	-66.9%
Skill Retention Duration	8.2 ± 1.1 weeks	5.9 ± 0.8 weeks	39.0%

2) Comparison of Teaching Efficiency

The control group needs 3-4 class hours to fully understand complex tactics, while the experimental group relies on VR dynamic demonstrations for 1-2 class hours to fully comprehend them. The understanding time for difficult movements is reduced by more than 50%; The coverage rate of manual error correction by teachers is only 45%, while AI intelligent error correction achieves 100% full coverage, reducing the time cost of communication and error correction between teachers and students by 42.3%; The experimental group had a single person classroom practice frequency of 12 times per class hour, which was 2.1 times higher than the control group (5.7 times per class hour). The proportion of effective classroom practice time increased from 58% to 79% ($p<0.001$), significantly optimizing teaching efficiency.

3) Comparison of Subjective Experience and Positivity

According to a questionnaire survey, 93.5% of the participants in the experimental group believe that the fun of training has significantly increased, 89.2% of the participants are willing to actively participate in basketball training, and the average duration of independent post class practice has increased by 47 minutes per day; Only 52.3% of the students in the control group found the training interesting, while 38.7% of the students actively participated and practiced independently for less than 20 minutes per day. The classroom focus score of the experimental group (4.6/5) was significantly higher than that of the control group (3.1/5) ($p<0.001$), indicating that immersive interaction effectively stimulated teenagers' interest in sports and improved their participation in training.

4) Actual Combat and Long-term Consolidation Effects

In simulated adversarial training, the tactical coordination accuracy of the experimental group reached 78.5%, an increase of 23.2 percentage points compared to the control group (55.3%); The average attack and defense reaction speed was shortened by 0.32 seconds, and the on-site error rate was reduced by 29.6% ($p<0.01$); After a one month follow-up and retest, the recurrence rate of action errors in the experimental group was only 8.7%, much lower than the control group's 26.3% ($p<0.001$). The average duration of skill retention was extended by 2.3 weeks, proving that the action memory formed by immersive training is more solid and the long-term retention effect of skills is better.

5) Pain Points of Existing Applications

1. High hardware costs: The procurement cost of high-end VR devices and motion capture systems is relatively high, and some grassroots schools have difficulty fully covering hardware configurations, which limits large-scale promotion;

2. Insufficient technical adaptation: There is still room for improvement in the accuracy of AI intelligent analysis of complex adversarial tactics, insufficient adaptation to high-level vocational training, and inaccurate correction of some details;

3. Lack of technical ability among teachers: Some physical education teachers are not proficient in operating AI+VR equipment, making it difficult to fully utilize the system's functions and affecting teaching effectiveness;

4. Limited after class implementation: The popularity of lightweight home equipment is low, and the scope of students' independent consolidation after class is limited, making it difficult to achieve full cycle training.

V. OPTIMIZATION STRATEGY AND PROMOTION SUGGESTIONS

A. CAMPUS LANDING OPTIMIZATION STRATEGY

1. Promote low-cost adaptation mode: adopt the "big class shared equipment+group rotation training" mode to reduce hardware investment pressure; Optimize the simplified AI action recognition system, relying on ordinary high-definition cameras to achieve basic action correction without the need for expensive professional sensing equipment, suitable for regular classrooms in primary and secondary schools;

2. Strengthen teacher technical training: carry out special training on AI+VR equipment operation, teaching applications, data review, etc., to enhance teachers' technical adaptability; Write simple operation manuals and teaching cases to lower the threshold for teachers to use them;

3. Building a cloud based resource platform: constructing a cloud based basketball teaching resource library, updating standard action models, tactical training cases, and personalized training plans uniformly. Schools do not need local storage, reducing later operation and maintenance costs; Open API interface for easy integration with campus smart education platform;

4. Hierarchical configuration of hardware devices: Basic teaching configuration of lightweight VR all-in-one machines (such as Oculus Quest) to meet daily training needs; Specialized training is equipped with high-precision motion capture systems to meet the needs of talented students and school teams, achieving rational allocation of resources.

B. SUGGESTIONS FOR THE APPLICATION OF LAYERED TEACHING

1. Zero foundation students: focus on immersive training of basic movements, strengthen standardized entry, enhance interest through gamified challenges, and prevent the solidification of incorrect movements;

2. Advanced students: Focus on opening up advanced skills, adversarial training, and tactical coordination modules to enhance practical skills and tactical understanding;

3. Specialized competitive students: access high-precision AI data analysis, refine and optimize efforts, provide tactical decision-making guidance, adapt to school teams and specialized improvement of specialized students, and align with vocational training standards.

C. INDUSTRY PROMOTION DIRECTION

1. Cross project expansion: Extend this model to various sports specialized teaching such as football, badminton, table tennis, athletics, etc., build a universal AI+VR sports teaching platform, and achieve technology reuse and large-scale promotion;

2. Integration into after-school services: Incorporate AI+VR immersive training into the campus sports "double reduction" after-school services, enrich the content of after-school sports activities, and enhance students' participation in sports;

3. Social training empowerment: Provide lightweight AI+VR teaching solutions for social sports training institutions, reduce training venue and teacher costs, improve teaching quality and student experience;

4. Collaborative innovation between industry, academia and research: Collaborate with universities and technology enterprises to carry out technology research and development, optimize AI motion analysis algorithms, reduce hardware costs, and promote the deep integration of technology iteration and teaching applications.

VI. CONCLUSION

This article takes basketball specialized teaching as a case study to systematically explore the application path and practical effects of AI+VR immersive technology in sports skills teaching, and draws the following core conclusions:

Firstly, AI+VR immersive technology, with its core capabilities of 3D simulation, motion capture, intelligent error correction, and data review, can comprehensively cover basketball basic movements, advanced skills, offensive and defensive confrontation, team tactics, and post class consolidation in all teaching scenarios, effectively addressing the inherent limitations of traditional pedagogy and establishing a data-driven teaching framework;

Secondly, empirical results have shown that this teaching model can significantly improve students' action standards, skill mastery efficiency, practical application ability, and long-term consolidation effect. At the same time, it can greatly stimulate teenagers' interest in training, reduce teaching labor costs, and all indicators are significantly better than traditional teaching ($p<0.01$);

Thirdly, through optimization strategies such as lightweight transformation, group training, cloud resource sharing, and teacher training, the landing threshold can be effectively reduced, adapting to various scenarios such as primary and secondary schools, universities, and social training institutions, and having strong promotional value.

In the future, with the continuous iteration of artificial intelligence and immersive technology, AI+VR will inevitably become the core lever of sports teaching reform, promoting the transformation of sports skills teaching from "experiential demonstration" to "data-driven precision teaching", upgrading from "offline single training" to "virtual real integrated comprehensive training", and providing strong technical support for the improvement of national fitness and campus sports quality and efficiency. Subsequent research can further optimize the accuracy of AI algorithms, reduce hardware costs, expand cross project application scenarios, and promote the deep implementation and large-scale promotion of AI+VR immersive teaching in the field of sports.

AUTHOR CONTRIBUTIONS

Saiheng Ma designed, collected and analyzed the data, and drafted the manuscript. Saiheng Ma conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Saiheng Ma participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

FUNDING

This research received no external funding.

ACKNOWLEDGEMENTS

Not applicable.

REFERENCES

[1] S. Dutta, D. Roy, M. Laha, et al., "Application-aware MAC scheduling for XR over EPON-based 6G-backhaul," Optical Fiber Technology, vol. 98, pp. 104545-104545, 2026, doi: 10.1016/J.YOFTE.2025.104545.

[2] S, N. M, and B. Nirmala P, "The role of digital libraries and emerging technologies in enhancing social work education: a comprehensive analysis," Social Work Education, vol. 44, no. 8, pp. 1869-1884, 2025, doi: 10.1080/02615479.2024.2445740.

[3] D. Kostadimas, V. Kasapakis, and K. Kotis, "A Systematic Review on the Combination of VR, IoT and AI Technologies, and Their Integration in Applications," Future Internet, vol. 17, no. 4, pp. 163-163, 2025, doi: 10.3390/FI17040163.

[4] A. Filipescu, G. Simion, D. Ionescu, et al., "IoT-Cloud, VPN, and Digital Twin-Based Remote Monitoring and Control of a Multifunctional Robotic Cell in the Context of AI, Industry, and Education 4.0 and 5.0," Sensors, vol. 24, no. 23, pp. 7451-7451, 2024, doi: 10.3390/S24237451.

[5] C. Guirguis A and J. Tung K, "Apple Vision Pro: potential applications of mixed reality in dermatology," International journal of dermatology, vol. 63, no. 11, pp. e338-e339, 2024, doi: 10.1111/IJD.17437.

[6] G. Amaizu C, J. Njoku N, J. Lee M, et al., "Metaverse in advanced manufacturing: Background, applications, limitations, open issues & future directions," ICT Express, vol. 10, no. 2, pp. 233-255, 2024, doi: 10.1016/J.ICTE.2024.02.010.

[7] S. Wicki, I. Clark C, M. Amann, et al., "Acceptance of Digital Health Technologies in Palliative Care Patients," Palliative medicine reports, vol. 5, no. 1, pp. 34-42, 2024, doi: 10.1089/PMR.2023.0062.

[8] Q. Li and D. Cao, "Reviving Ecological Environments: Strategies for AI and VR Applications in Immersive Cultural Exhibitions," in Proceedings of 2023 3rd International Conference on Public Art and Human Development (ICPAHD 2023). Hubei Institute of Fine Arts. 2023: 159-166, doi: 10.26914/c.cnkihy.2023.120005.

[9] G. Johannes L, E. Jan, B. Andrea, et al., "Accuracy and Precision of Mandible Segmentation and Its Clinical Implications: Virtual Reality, Desktop Screen and Artificial Intelligence," Expert Systems With Applications, vol. 239, Art. no. 122275, 2024, doi: 10.1016/J.ESWA.2023.122275.

[10] Y. Wang, "Procedural content generation for VR educational applications: The investigation of AI-based approaches for improving learning experience," in Proceedings of the 5th International Conference on Computing and Data Science (part3). The Department of Design, University of Pennsylvania. 2023: 57-65, doi: 10.26914/c.cnkihy.2023.108834.

[11] Z. Yonghuai, C. Jiangfeng, L. Zhifeng, et al., "Production logistics digital twins: Research profiling, application, challenges and opportunities," Robotics and Computer-Integrated Manufacturing, vol. 84, Art. no. 102592, 2023, doi: 10.1016/J.RCIM.2023.102592.

[12] A. Hartholt, E. Fast, A. Reilly, et al., "Multi-Platform Expansion of the Virtual Human Toolkit: Ubiquitous Conversational Agents," International Journal of Semantic Computing, vol. 14, no. 3, pp. 18, 2020, doi: 10.1142/S1793351X20400127.

[13] R. Krishnaswamy A and R. Krishnan H, "A preliminary analysis of AI based smartphone application for diagnosis of COVID-19 using chest X-ray images," Expert systems with applications, vol. 183, pp. 115401-115401, 2021, doi: 10.1016/J.ESWA.2021.115401.

[14] L.B.P, "S D, R," S, J. P, et al. Human resources management 4.0: Literature review and trends. Computers & Industrial Engineering, vol. 168, Art. no. 108111, 2022, doi: 10.1016/J.CIE.2022.108111.

[15] B. Narjes, M. Ramzi, Z. Soraya, et al., "SARS-CoV-2 diagnosis using medical imaging techniques and artificial intelligence: A review," Clinical Imaging, vol. 76, pp. 6-14, 2021, doi: 10.1016/J.CLINIMAG.2021.01.019.

[16] J. Ryoo and K. Winkelmann, "Innovative Learning Environments in STEM Higher Education," Cham: Springer; 2021, doi: 10.1007/978-3-030-58948-6.

[17] B. Narjes, M. Ramzi, Z. Soraya, et al., "Lack of AI-based method for pneumocystis pneumonia classification in radiological diagnosis of SARS-CoV-2," Clinical Imaging, vol. 79, pp. 94-95, 2021, doi: 10.1016/J.CLINIMAG.2021.03.037.

[18] H, "A S, M," P A M, J. J Y T, et al. Virtual reality and artificial intelligence for 3-dimensional planning of lung segmentectomies. JTCVS Techniques, vol. 7, pp. 309-321, 2021, doi: 10.1016/J.XJTC.2021.03.016.

[19] Q. Song and Y. Wook S, "Exploration of the Application of Virtual Reality and Internet of Things in Film and Television Production Mode," Applied Sciences, vol. 10, no. 10, pp. 3450, 2020, doi: 10.3390/app10103450.

[20] L. Bin, F. Yuhao, X. Zenggang, et al., "Research on AI security enhanced encryption algorithm of autonomous IoT systems," Information Sciences, vol. 575, pp. 379-398, 2021, doi: 10.1016/J.INS.2021.06.016.