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Strategies for Integrating Technology into Physical Education Pedagogy in the 21st Century

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Abstract

Background and Aim: In the educational environment of the twenty-first century, the incorporation of technology has become a key factor in driving pedagogical innovation and improving the quality of education. This study aims to assess the implementation of technology integration in physical education identify the problems it faces, to propose strategies to enhance the integration of technology in physical education.

Materials and Methods: Firstly, the study sorted out the current situation and development trend of technology application in physical education through a literature review. Next, the study collected the views and practical experiences of experts from 7 universities in Yunnan Province, China, on the integration of technology into teaching strategies through expert interviews. The results of the expert interviews with the 7 experts were summarized and analyzed using Nvivo for textual data, and all the interview texts were coded hierarchically through the rooted theory approach. Based on the coding results, the index system of the components of technology integration into physical education pedagogy strategies was drafted, and 5 experts were selected for IOC evaluation. Then, 20 experts conducted the Delphi method, and after two rounds of Delphi analysis the experts reached a consensus, and the system of indicators of the constituent elements of technology integration into physical education pedagogy strategies was finally established. Finally, the strategies were further discussed and evaluated through focus groups with 9 experts.

Results: Through this study, a strategy for integrating technology into physical education pedagogy in the 21st century was finally established in five dimensions: teaching and learning environment, teaching and learning resources, services and management, monitoring and evaluation, and challenges and strategies.

Conclusion: The results of the study showed that experts agreed on the feasibility of the strategy of integrating technology into physical education pedagogy and the scientific and reliable nature of the proposed strategy.

Keywords: Strategies; Integrating Technology; Physical Education Pedagogy; The 21st century

Introduction

Technology integration in teaching and learning refers to the incorporation of digital technologies into educational practices to enhance the teaching and learning experience, also referred to as technology integration. This approach recognizes that technology has the potential to transform traditional teaching and learning methods by creating more engaging, interactive, and personalized learning environments. It involves the use of a variety of digital tools, resources, and platforms to support and enhance the educational process across different disciplines and subjects.

In the educational environment of the twenty-first century, the incorporation of technology has become a key factor in driving pedagogical innovation and improving the quality of education. Particularly in the field of physical education, this trend presents new challenges and opportunities. Although the development of technology has brought unprecedented possibilities to physical education pedagogy, there is no clear and systematic solution to the problems of how to efficiently and rationally integrate these technologies into physical education pedagogy; and how to effectively incorporate modern technologies while retaining the traditional essence of physical education pedagogy.

Despite the growing use of technology in education, there is still a lot of unexplored territory for the incorporation of technology in physical education. We have seen the remarkable results of digital technology in other disciplines, but the uniquely hands-on nature of physical education requires that we be more careful when incorporating technology. The goals of physical education are not only about the physical training of students, but also the development of teamwork, leadership, and self-challenge.

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How to safeguard these core values while using technology to improve the quality and efficiency of teaching and learning is an issue that needs to be explored in depth.

We must recognize that the incorporation of technology is not an end, but a means to an end that meets the educational objectives of the new era. It is a way of giving full play to the potential of technology to improve teaching and learning and enhance the teaching and learning experience without destroying the natural vigour and fun of physical education.

Technology integration in teaching means that teachers use information technology appropriately in all aspects of teaching and realize the theoretical support for the deep integration of technology and subject teaching (Zhang, et al, 2019). At present, technology integration has become one of the necessary conditions for the smooth running of education, so how to integrate technology and improve the effectiveness of education and teaching has become one of the focuses of front-line teachers and educational researchers (Meng, 2021).

Advances in technology have provided more options and possibilities for the passage of technology into physical education. Digital platforms have become an integral part of modern physical education. In recent years, visual immersion technologies represented by virtual reality, extended reality, virtual worlds, digital twins, etc., are continuously reshaping online education in terms of learning resources, teaching organization, and system platforms (Liu & Wang (2020). These tools step forward to improve the efficiency of teaching and learning, and also enhance students' engagement and interest. Bian, et al (2021) points out that wearable devices have great potential for application in the field of sports. The development of wearable technology has made the cost of devices such as fitness tracking apps and smart bracelets, watches, etc. increasingly affordable, and these devices provide great convenience for physical fitness monitoring and exercise recording so that people can get real-time feedback on exercise data at low cost.

The integration of technology not only changes the teaching method but also expands the content and scope of the physical education curriculum, as well as developing plans and feedback for the implementation of personalized learning. Liu, et al (2019) analyzed the case study of physical education teachers in developed countries who used information technology to assist physical education teaching and concluded that the application of information technology in physical education teaching can stimulate students' interest in physical education learning and promote students' participation in physical education, and pointed out that our country should change the concept of development, pay attention to the value of information technology in physical education, and focus on the development and application of new technologies.

In the face of the rapid development of technology and the need for talent training in the society of the new era, we need a strategic framework that can be updated and adapted to new changes at any time. This framework should not only consider technology and the latest trends but also have a deep understanding of the human nature of physical education and its educational purpose.

Despite the emergence of several papers and research findings on the teaching and learning of technology in recent years, there are still few strategic frameworks for technology integration in physical education. This study aims to assess the implementation of technology integration in physical education and to identify the problems it faces, propose strategies to enhance the integration of technology in physical education, meet the challenges in the field of physical education, and add to the digitalization of physical education.

In summary, the goal of this study is not only to explore the combination of technology and physical education but also to find a scientific and humanistic teaching strategy. We expect that this study will not only provide practical guidance for physical education teachers and administrators, but also create a richer, more interactive, and multi-year learning environment for students.

Objectives

Main Objective

To construct strategies for integrating technology into physical education pedagogy in the 21st century.

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Subsidiary Objectives

1. To survey the problems and challenges in technology integration in university physical education in Yunnan Province.
2. To draft and screen indicators of the components of a strategy for the integration of technology into physical education.
3. To confirm strategies for integrating technology into physical education.

Literature Review

Relevant theory

In 2009, the Director-General of UNESCO, Irina Bokova, introduced the concept of the New Humanism, in which the global and the local are harmonized. Subsequently, a UNESCO report released in 2015 reiterated the interpretation of the values of the New Humanism as "respect for life and human dignity, equality of rights, social justice, cultural diversity, international solidarity and shared responsibility for creating a sustainable future" (UNESCO, 2015). More recently, the new report, The Future of Education, suggests that education can be viewed through the lens of a social contract and includes ensuring the right to quality education throughout life as one of the fundamental principles of the new social contract (UNESCO, 2021).

The theory of physical education in China has gone through the process from the comprehensive introduction of the Soviet model of physical education to the development of an independent system and has so far developed into a situation in which a variety of teaching guiding ideologies coexist (Yu, 1997). Sun Zijian pointed out in 2001 that the reform of physical education in China has been carried out for many years, but it has not achieved the expected results, and there are still many irreconcilable contradictions, he thought that the theorization of physical education would be a feasible way. After that, many scholars have thought about and discussed the issue of physical education pedagogy theory. Promoting the reform of physical education pedagogy in China's colleges and universities is conducive to promoting the establishment of new teaching theories, updating the concepts of physical education teachers, and transmitting through quality education, cultivating the ability of students to think independently, to explore, and to innovate constantly, and to guide students to form the correct values of sports (Ma, 2014). To cater to the social demand for talent, colleges, and universities are paying more and more attention to the cultivation of students' physical quality education and lifelong learning education, as well as the development of students' overall comprehensive quality and ability and emphasizing the need to promote the exercise and cultivation of students' lifelong awareness of physical education (Huang & Huo (2011

China’s physical education theory according to the social development of different periods of the corresponding adjustment, the ultimate goal is for students' lifelong health, and for the community to cultivate all-round development and healthy talents. The integration of technology helps to cultivate students' innovative thinking and lifelong learning ability, which is crucial for education in the 21st century.

Status of technology integration

Gunnulfsen's research suggests that teachers and administrators may benefit from the knowledge of a Facebook-like website to facilitate leading instruction and managing schooling efforts. (Gunnulfsen, 2016). The researcher developed an ICT program to provide teachers with adequate knowledge and skills in global education (Etcuban, et al, 2020). Huang (2022) mentioned in his study that traditional management of resources in physical education and teaching leads to mismanagement of data and possible loss of data. However, with the development of technologies such as IoT, cloud computing, and smart edge cloud computing, the management of physical education pedagogy resources can be significantly improved. This research paper discusses the current status of teaching resources in physical education programs in colleges and universities and makes suggestions for integrating these resources into the curriculum.

Multimedia and interactive learning have been widely used to enrich the content of physical education and diversify teaching methods. Usually, multimedia is considered a modern learning tool used in the classroom, but recently they have been used in physical education and sports training, and

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the effectiveness of multimedia use is based on the theory of information visualization, which can help students store this information for subsequent recall, motivating them to learn (Kioumourtzoglou, 2022). Diosalan (2016) designed an experiment to study the effect of using the multimedia teaching method Zumba video CDs on students' physical fitness, using a random sampling method to select 60 college students, and the results of the experiment showed that there was a significant difference between the experimental group and the control group in terms of muscular strength, flexibility, body composition, and cardiovascular endurance before and after the experiment, and in addition, the multimedia teaching method greatly affected the effectiveness of the teaching process. The use of analytics and management in physical education is also increasing. By analyzing students' exercise data, teachers can more accurately assess students' physical fitness and exercise levels and provide targeted instruction (Yin, et al, 2020).

In addition, current online education suffers from the problem of boring and monotonous presentation of flat web pages, which makes it difficult to motivate learning (Violante, et al, 2015). The simplicity of human-computer interaction, incomplete learning data, and the lack of practical aspects are also more prominent (Carrillo & Flores, 2020). The results of a study showed that in distance learning students' satisfaction with the tools, assessments, and course design had the greatest impact on overall course satisfaction (Newsome, et al, 2022).

While technology provides support and enablers for teaching and learning, it also raises several related issues that somewhat constrain and limit the pace of development of technology integration into teaching and learning.

Summery

In the 21st century, with the rapid development of information technology and the acceleration of the process of global economic integration, all aspects of people's lives are undergoing profound historical changes. The integration of technology into physical education is becoming a hot topic in China and the whole process of information technology. The integration of technology has significantly changed the traditional face of physical education pedagogy, with the blended learning model being particularly prominent. Combining traditional face-to-face teaching with online teaching has increased the interactivity, flexibility, student engagement, and possibility of personalized teaching.

However, higher education plays an important role in China's education and is a hub for scientific and technological progress. Its responsibilities include training high-tech talents, researching and creating scientific and technological products, and promoting scientific and technological progress. At present, the distribution of educational resources in Chinese universities is uneven, such as backward equipment, insufficient teachers, and poor quality of courses. There are few exchanges between schools and resource sharing cannot be realized. This seriously affects the cultivation of talent in Chinese colleges and universities, restricts the development of colleges and universities, and slows down China's scientific and technological progress. The distribution of physical education pedagogy resources in traditional colleges and universities is extremely uneven, the physical education pedagogy resources of different schools cannot be shared, and the advantages of teaching resources in different regions are not the same, all of which seriously restrict the development of physical education.

However, there is still tremendous room for development in this area of research, and many issues and challenges are still in the exploratory stage; future research should further explore the deeper impacts of integrating technology into physical education and its application at different stages of education.

Given the importance of technology to human beings in the 21st century, our task was to explore the current state of technology incorporation in college physical education and to propose strategies and recommendations for applying these technologies to the teaching of physical education in Yunnan colleges and universities.

Conceptual Framework

The conceptual framework for this research is as follows:

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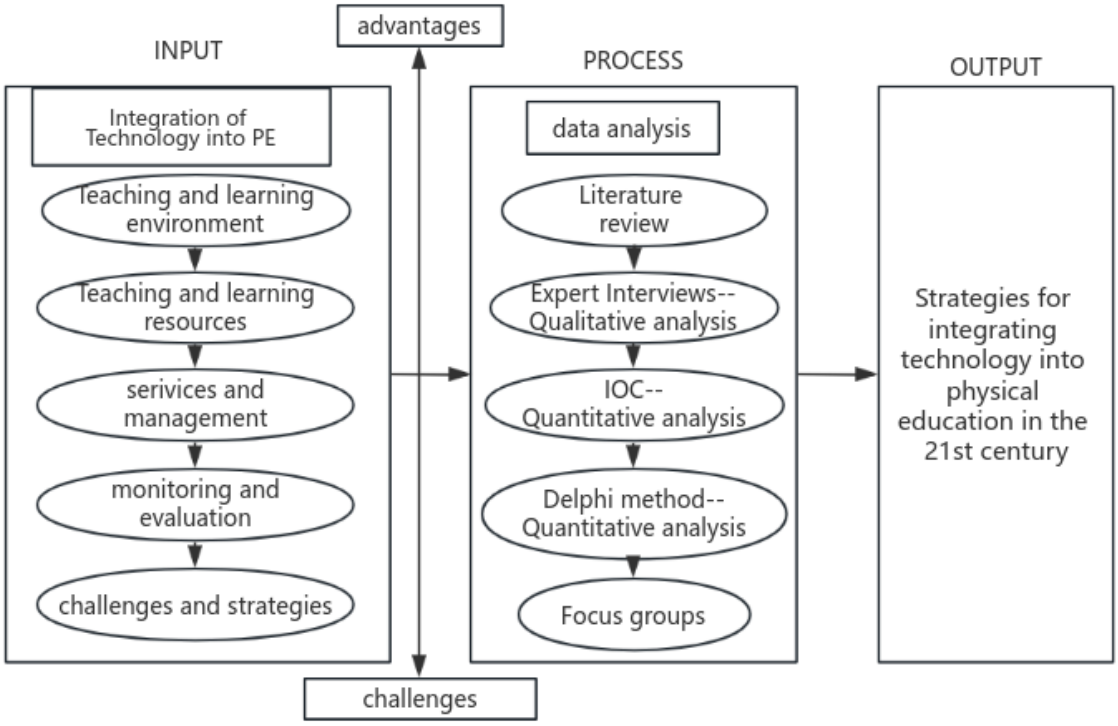

Figure 1 Conceptual framework

Methodology

1. Research Tools

The researcher designed a system of indicators for the components of the 21st-century strategy for integrating technology into physical education teaching through qualitative analyses of expert interviews, with an IOC value of 0.96 for level 1 indicators, 0.90 for level 2 indicators, and 0.86 for level 3 indicators.

2. Participants' specifications and size

Participants included experts in the fields of physical education, sports management, and information technology science.

In this study, a purposive sampling method was adopted for the selection of experts.

Experts in the discipline of Physical Education are selected from the Physical Education program and their main field of study is Physical Education or Sports Management. They have a master's degree or above, a lecturer's title or above, and five years or more work experience in physical education.

The experts for the expert interviews and IOC were selected from the university faculty. They all have a master's degree or higher, have the title of associate professor or higher, and have more than 10 years of work experience related to physical education and sport teaching, including 5-6 experts in the field of physical education and sport teaching and 1-2 experts in the field of information technology science.

Delphi Method experts are selected from among university teachers. They have a master's degree or higher, a lecturer's title or higher, and at least five years of work experience related to physical education and sports teaching. There are 14-16 of them in the field of physical education and 4-6 in the field of sports management.

Focus group experts were selected from university teachers. They had a master's degree or higher, an associate professor's title or higher, and more than 10 years of work experience related to physical education teaching. Among them, 6-8 were from the field of physical education and 1-3 from the field of sports management.

3. Data Collection and Analysis

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1. Relevant information was collected and qualitatively analyzed in conjunction with the information from the interviews with the 7 experts to identify the first draft of the indicators for the components of the strategy for integrating technology into physical education materials.

7 experts were selected to conduct expert interviews, and the textual information from the expert interviews was qualitatively analyzed using the Zagan Theory research methodology, and the text was node-divided and coded in Nvivo software. The three-stage coding of the qualitative analysis of Zagan theory was applied to identify the initial, main, and core categories.

2. 5 experts were invited to review and check the first draft of the indicators and screen the indicators of the components of technology integration into physical education pedagogy strategies.

The core categories identified by the coding were studied in depth, and an indicator system for the components of technology integration into physical education pedagogy strategies was drafted by combining the literature with the coding results, and five experts were asked to score the IOC.

3. Use the Delphi method to identify component indicators.

To improve the quality of the indicator system and the reliability of the study, the Delphi method was used to consult 20 experts, 2 rounds of questionnaires were distributed, and the data were collated and analyzed to reach a final expert consensus on the indicators.

4. Focus groups to test the appropriateness and feasibility of the strategy

9 experts were invited to form a focus group to confirm the appropriateness and feasibility of integrating technology into physical education pedagogy strategies.

Results

1. Exploring the Status and Challenges of Technology Integration in Physical Education

1.1 Interview method

7 experts were selected to conduct expert interviews, and the textual information from the expert interviews was qualitatively analyzed using the Zagan Theory research methodology, and the text was node-divided and coded in Nvivo software. The three-stage coding of the qualitative analysis of Zagan theory was applied to identify the initial, main, and core categories.

Through a sentence-by-sentence reading of the text of the interviews with the seven experts, in NVivo, all texts were node-divided and coded to help us examine the data, and the three-stage coding rooted in the qualitative analysis of the theories identified a total of 49 initial, 14 main and 5 core categories, effectively characterizing the current status and challenges of technology integration in PE teaching.

1.2 Pre-selection of Strategy Constituent Indicators（IOC）

Based on the qualitative analysis of the literature and expert interview texts, combined with coding and analysis, the indicators of the constituent elements of the response to the integration of technology into physical education were screened and adapted and a three-tiered indicator system for the integration of technology into physical education teaching strategies was constructed.

The experts' IOCs for each of the five tier-1 indicators were above 0.8, with a total score of 0.96. This indicates that the experts unanimously agreed on the components of the level 1 indicators.

The results of the IOC ratings of the experts for each of the 12 secondary indicators were above 0.8 and the total score was 0.90. This indicates a high degree of consistency of expert opinion in these items and the validity of the indicator set.

The total IOC value of the 49 Level 3 indicators is 0.86, which is a good overall agreement. However, the scores of two of them, "Technology platforms" and "Mobile device", are 0.4, which is lower than the average value. Combined with the suggestions given by the experts, due to the overlap of technology software and technology platforms, it is suggested to due to the overlap between technology software and technology platforms, it is suggested that the two terms should be combined into one and changed to "Technology software/platforms", and "Mobile device" and "Technology devices" exist. In addition, "Mobile device" is subordinate to "Technology devices", so "Technology devices" should be retained, and "Mobile device" should be deleted.

After the initial screening of the expert IOC rating scale, the first draft of the indicator system for the components of the 21st-century technology integration strategy for physical education teaching was

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finally obtained, which included five primary indicators, 12 secondary indicators, and 47 tertiary indicators.

2. Identification of indicators (Delphi method)

In this study, to ensure the scientific and generalizability of the findings, the screening criteria of the respondents were determined: firstly, the respondents should have five or more years of teaching experience; secondly, the level of education should be a master's degree or above; and thirdly, the level of title should be an intermediate title (assistant professor or lecturer) or above. Based on the above screening criteria, respondents were selected using the purposive sampling method.

The positive coefficient of 100 percent for the two rounds of expert consultation in this study indicates that the experts were highly motivated for this study.

Since the target group of experts consulted for this study remained unchanged during the two rounds of expert consultation, calculations based on the above scores and data obtained from the collection of information from expert interviews show that the degree of expert familiarity, Cs=0.84, is greater than 0.70, which suggests that the experts have a good degree of familiarity with the content of the study.

From the formula Cr = (Ca+Cs)/2, the expert authority coefficient Cr = 0.8475, which is greater than 0.70, indicating that the experts who participated in this study have high authority, which ensures the reliability of the results of this study.

Through the first round of Delphi expert consultation, experts made several suggestions on the naming of the indicators. As "database" is unclear and easily confused with "resource base", it is suggested to change it to "physical health database"; it is suggested to change "supervision" to "pedagogical supervision"; and it is suggested to change the name of the indicator to "teaching and learning supervision". It is suggested that "monitoring" be changed to "teaching supervision"; "digital monitoring" is not very directional, and it is suggested that it be changed to "exercise data monitoring"; the three tertiary indicators in the secondary indicator "evaluation" are not clear; and it is suggested that "monitoring of physical fitness" be changed to "monitoring of exercise data". The three tertiary indicators in "Evaluation" are too general and not clear enough, and it is suggested that they be changed to "Teaching Evaluation", "Training Feedback" and "Technical Quality Evaluation"; it is suggested that "Teaching and Learning", "Training Feedback" and "Technical Quality Evaluation" be changed to "Teaching and Learning". "It is suggested that the words "education system support" be replaced by "education system".

Items with a standard deviation greater than 0.8 and a coefficient of variation greater than 0.2 were deleted. Therefore, "C8 Meta-universe teaching scenarios", "C11 Information repository", "C16 Online learning", "C35 Introduction of technology", "C36 Basic settings", and "C42 Parental attitudes" were deleted. ", "C36 Basic Setting", and "C42 Parental Attitude". The experts also gave some corresponding evaluation instructions, such as the indicator of "Parental Attitude", which was pointed out to be a key indicator if the study was conducted for primary and secondary schools, while the impact of this item was relatively weaker in the study for universities, and it was suggested to be canceled. "Meta-universe pedagogical scenarios" is an innovative idea, but the costs and benefits are not yet known, so it is recommended to delete it. "Information repository" is at cross-purposes with C10 and C12 and its direction is unclear, so it is proposed to be deleted. "E-learning" is already included in C14 and is proposed for deletion, while C35 and C36 are also included in other subparagraphs and are therefore canceled.

At the end of the first round of expert consultation, taking into account the results of the experts' ratings of the importance of the indicators (standard deviation, coefficient of variation, etc.)*, the indicator items of the originally designed questionnaire were modified to form the questionnaire for the second round of expert consultation. Specific adjustments were: C8/C11/C16/C35/C36/C42 were deleted.

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Table 1 Harmonization factors for two rounds of experts

	first round			second round		
	Kendall w	$chi-squared$	p	Kendall w	$chi-squared$	p
Teaching and learning environment	0.626	100.18	0.00*	0.878	122.93	0.00*
Teaching and learning resources	0.490	68.66	0.00*	0.768	76.82	0.00*
Services and Management	0.513	51.33	0.01*	0.814	65.13	0.00*
Monitoring and Evaluation	0.645	64.54	0.00*	0.764	76.45	0.00*
Challenges and strategies	0.570	205.24	0.00*	0.820	246.10	0.00*
Overall questionnaire	0.57	526.71	0.00*	0.810	648.240	0.00*

Note: with * indicates p less than 0.05, statistically significant

Two rounds of Kendall's Coefficient of Coordination calculations were performed using SPSS and the statistics showed that:

In the indicator "Teaching and learning environment", the Kendall coordination coefficient for the first round was 0.626, (=100.18, p=0.00<0.05); for the second round, it was 0.878, (=122.93, p=0.00<0.05).

For the indicator "Teaching and learning resources", the Kendall coordination coefficient for the first round was 0.490, (=68.66, p=0.00<0.05); for the second round, the Kendall coordination coefficient was 0.768, (=76.82, p=0.00<0.05).

For the indicator "Services and management", the Kendall harmonization coefficient for the first round is 0.513, (=51.33, p=0.01<0.05); for the second round, the Kendall harmonization coefficient is 0.814, (=65.13, p=0.00<0.05).

For the indicator "monitoring and evaluation", the Kendall harmonization coefficient for the first round was 0.645, (=64.54, p=0.00<0.05); for the second round, the Kendall harmonization coefficient was 0.764, (76.54, p=0.00<0.05).

For the indicator "Challenges and strategies", the Kendall harmonization coefficient for the first round was 0.57 (=205.24, p=0.00<0.05); for the second round, the Kendall harmonization coefficient was 0.820 (246.10, p=0.00<0.05).

For the overall questionnaire, the Kendall coordination coefficient for the first round was 0.57 (=358.35, p=0.00<0.05); for the second round the Kendall coordination coefficient was 0.82, (=213.74, p=0.00<0.05).

Kendall's Coefficient of Concordance is used to measure the level of internal consistency and takes a value between 0 and 1. Generally, Kendall's Coefficient of Concordance is greater than 0.8 indicating a higher level of consistency. Therefore, the results show that the consistency of expert opinions in the second round is better compared to the first round, and the p-values are less than the test level of 0.05, which is statistically significant. It indicates that the degree of internal consistency of the questionnaire has improved and reached a strong level after the new round.

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3. Focus groups

In this study, a focus group approach was used to construct a strategy for integrating technology into physical education, and 9 experts were selected to form a focus group to explore the rationality and feasibility of the strategy.

Through expert discussions on the content of the draft strategy framework, the final result of the focus group discussions was agreement on the draft strategy for integrating technology into physical education, and they were satisfied and accepted the applicability and rationality of the model.

Conclusion

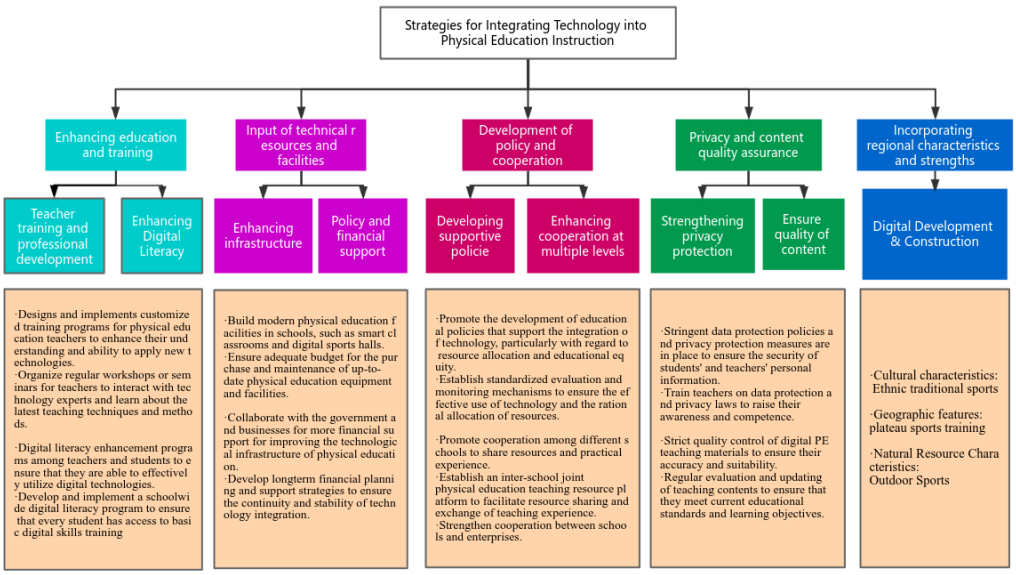

Figure 2 Strategies for integrating technology into physical education

In terms of the teaching and learning environment, includes strategies from the three dimensions of tools, facilities, and places.

Introduction and development of technology tools. Introduce and develop technology software and platforms for teaching PE, such as writing platforms, real-time feedback systems, and PE-specific apps to enhance teacher-student communication and classroom interactivity. Introduce and develop technological devices and wearables, such as sports tracking bracelets and smart fitness devices. To monitor students' performance and health and provide personalized training advice.

Upgrade technology facilities. Enhance the campus network infrastructure to improve network speed and stability to ensure the smooth operation of technological tools. Upgrade and maintain technical equipment, such as multimedia teaching equipment and motion analysis systems, to ensure their effective use in physical education. Consider the sustainability of technological facilities and the possibility of future upgrades to ensure their long-term effectiveness.

Accelerating the construction of technology venues. Build smart classrooms with advanced teaching equipment and systems, such as interactive whiteboards, and VR and AR devices, to create conditions for immersive learning experiences. Developing smart sports venues that include high-tech sports equipment, real-time data analysis tools, and the embedding of smart systems for health monitoring and exercise analysis. Establishment of smart campuses that utilize IoT, big data, and AI technologies to enable resource sharing and intelligent management within and outside the campus, such as smart course scheduling and sports activity booking.

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In terms of teaching and learning resources, this includes strategies in both the curriculum resources and teaching and learning model dimensions.

Strengthen the development and construction of teaching resources. To develop and build a sports health database to provide continuous data reference for teachers and students, and to provide data support for personalized PE teaching and exercise program development. Develop and build a resource library that contains a broad range of physical education knowledge and skills. These resources include, but are not limited to, information in the areas of sports skills, health literacy, and exercise science. To produce and integrate digital teaching materials, including e-textbooks, e-materials, online courses, video tutorials, etc., to enrich the content and means of teaching.

Developing diversified teaching modes. Blended teaching is implemented, combining online and offline teaching methods, making full use of digital resources while retaining the advantages and characteristics of traditional physical education pedagogy. Promote personalized and independent learning, provide personalized teaching content and learning pathways through intelligent platforms, encourage students to choose learning content according to their interests and needs, and combine interactive teaching software and online learning platforms to improve student participation and interactivity.

Establishing an inter-school joint physical education pedagogy resource platform. Build an inter-school joint sports teaching resources sharing platform for teachers and students from different schools to access and share teaching resources to promote the exchange of teaching experience among universities in Yunnan Province to improve the overall quality of teaching. At the same time, this platform can be used for the organization of inter-university sports activities and sports competitions to increase students' participation and competitive experience.

In terms of service and management, it includes strategies in both the instructional service and instructional management dimensions.

Combine technology integration with teaching services. Promote diversification of teaching and learning services, e.g. providing a variety of teaching and learning resources and interaction methods through online platforms to meet the learning needs and preferences of different students. Develop visualized service content, such as using interfaces in the form of graphics and images to display movement data and learning progress, to enhance students' understanding and participation. Build an information service platform to integrate teaching resources and tools and provide a one-stop teaching service experience.

Integration of technology and teaching management. Develop and improve the technical supervision system to monitor the quality and effectiveness of teaching activities and to ensure compliance with and implementation of teaching standards. Upgrading and improving the academic affairs management system, integrating the functions of course scheduling, grade management, and the setting and allocation of teaching resources, and improving management efficiency and transparency. Strengthen the cooperation between the service platform and the academic affairs system to achieve information integration and functional interoperability and simplify the process and time consumption.

In terms of monitoring and evaluation, the strategy includes both monitoring and evaluation dimensions.

Integration of technology and monitoring of teaching and learning. Implement a digital monitoring system, e.g. to monitor students' exercise performance and health indicators, to collect and monitor data, and to provide data support to optimize teaching and learning. Develop a digital reporting system that automatically generates reports on student movement and learning, providing quantitative data support to help teachers and students better understand the progress and effectiveness of learning.

Integration of technology and teaching evaluation. Strengthen the development and application of online evaluation systems to provide instant feedback, including self-evaluation, peer evaluation, and teacher evaluation, and enhance the interactivity and real-time nature of teaching. Develop intelligent evaluation tools that use artificial intelligence technology to analyze and evaluate students' motor skills and learning outcomes and provide personalized advice. Implement a quality evaluation mechanism to ensure the effectiveness and foresight of digital content and technological tools and methods. Establish a set of standardized teaching evaluation and updating mechanisms to regularly review and adapt

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teaching resources and methods to changes in educational objectives and new educational needs. To establish a standardized monitoring system to ensure effective use of technology and rational allocation of resources. Conduct regular technology and resource audits to ensure the optimization of teaching tools and methods and their consistency with teaching objectives. Establish feedback mechanisms that allow teachers, students, and other educational stakeholders to participate in teaching evaluation and monitoring and increase participation.

In terms of challenges and strategies, specific strategies are proposed in three main dimensions: institutional, conceptual, and instrumental.

Strengthening the institutional level. Promote the updating and implementation of education policies and regulations to support the use of technology in teaching and learning physical education, including the development of relevant teaching standards and assessment guidelines, application guides, etc. To formulate long-term financial planning to ensure a sufficient budget to support the procurement, construction, maintenance, and upgrading of technological tools, facilities, and venues, and to strengthen multi-channel co-operation between schools and the government, enterprises and private investment, etc., to diversify funding sources. Conduct market demand analyses to keep abreast of the latest developments in teaching and learning technologies and ensure that the technologies and objectives adopted match the market needs and trends. Tailor-made training programs to enhance teachers' and administrators' understanding of and ability to apply new technologies. Regular workshops or seminars will be held to provide opportunities for teachers to learn technology-integrated teaching techniques and methods, and to encourage them to continuously update their teaching concepts and skills. Provide training to students in the form of lectures and tutorials to enhance their digital literacy.

Enhancement of the conceptual level. Enhance the level of awareness and acceptance of new technologies among school management, teachers, and students through publicity and demonstration. Pay attention to conducting satisfaction surveys on technology integration and keep abreast of usage. Encourage and guide teachers and students to adapt to new modes of technology integration in teaching and learning and provide the necessary technical support and resources. Emphasize the importance of lifelong learning, promote an open and innovative educational culture, encourage students to explore their initiative, and focus on the development of a sense of initiative and an attitude towards learning.

To promote the development of the instrumental dimension. To keep abreast of the latest technological trends and organize seminars or teaching and research activities to assess the potential application of technological trends in physical education. Encourage and support the development of academic research related to technology integration by providing research funding guidance and advice. Regularly assess the ease of use of technology tools facilities and venues and make timely and appropriate adjustments or training based on feedback from teachers and students on actual use. Ensure that all technologies should comply with information security standards and protect the privacy of users.

In addition, after discussion, the experts believe that in the future development of the implementation process of technology integration into physical education pedagogy, the cultural characteristics, geographical characteristics and natural resources characteristics of Yunnan should be taken into account, while enhancing the level of technology integration into physical education pedagogy, digital physical education pedagogy should be combined with the local characteristics of traditional ethnic sports, plateau training, and outdoor sports, so that the development of these contents can also be included in the technology integration into physical education development planning. While expanding the content of specialty courses, the development of specialty cultures and industries should be boosted.

In summary, the strategic framework for integrating technology into physical education in the 21st century proposed in this study aims to effectively and comprehensively integrate technology into physical education through a multi-faceted and systematic approach. It addresses both real-world problems and concerns for future development.

Discussion

To effectively utilize technology, both teachers and learners must acquire several cognitive and socio-emotional competencies, often referred to as "digital literacy competencies" or "21st-century

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skills". A review of the relevant literature reveals that there is little recognition of digital learning competencies in the educational research literature, which means that educational research seems to be lagging in understanding the ever-changing digital competencies needed by teachers and learners (Silber, et al, 2019). In addition, teachers do not have adequate conceptualizations of teaching digital thinking skills, yet better information transfer and vastly improved digital thinking in schools are essential for teaching and learning in the 21st century (Meirovitz & Aran (2020).

Information overload and knowledge fragmentation is a major challenge to learning in the network era (Wang, 2023). Low levels of objective competence, unfamiliarity with frameworks such as intellectual property issues as well as technical practices of applications, and lack of understanding of virtual learning platforms can lead to resistance.

A survey shows that more than 30% of physical education teachers tend to be able to find suitable resource libraries and obtain relevant materials, but the lack of targeted physical education software greatly affects the ability of physical education teachers to obtain resources (Yang, 2021). According to Wang (2023), with the acceleration of China's education informatization process, colleges and universities have accumulated a lot of resources in teaching and research. However, due to the lack of standardization in the construction of resources and the relatively closed management style, many teaching resources are in short supply. Huang (2022) mentioned in his study that traditional resource management for physical education pedagogy leads to poor data management and may cause data loss. However, with the development of technologies such as the Internet of Things, cloud computing, and intelligent edge cloud computing, the management of physical education pedagogy resources can be significantly improved.

Existing related research, although it has been explored, validated, and applied to a certain extent in this field, still has certain limitations, especially in the new era of student-centered and lifelong education concepts of education, rapid technological development, and rapid changes in the educational environment.

Compared to most studies in the existing literature that focus on a single technology application or a specific teaching method, this study constructs a system of elemental indicators for the technology integration strategy that includes five primary indicators, 12 secondary indicators, and 41 tertiary indicators, and proposes a more comprehensive strategy framework and specific content. The strategy covers multiple dimensions related to physical education teaching and takes into account geographical characteristics and cultural contexts, providing a more comprehensive perspective for achieving deeper integration of technology and physical education teaching.

This study not only enriches the theoretical foundations of the integration of technology into the field of physical education but also provides practical guidance and specific strategies for practitioners. In addition, the findings provide important insights into understanding the role and potential of technology in modern education.

Recommendation

This study proposes development strategies for the integration of technology into physical education and sport teaching in each of the five dimensions of teaching environment, teaching resources, services and management, monitoring and evaluation, and challenges and strategies, and proposes specific development strategies in 12 dimensions, including tools, facilities, venues, curricular resources, teaching modes, teaching services, teaching management, monitoring, evaluation, institutional dimensions, conceptual dimensions, and artefactual dimensions. Among them, those that need to be promoted urgently at this stage include the following:

Policy recommendation

The development of policies and cooperation should be promoted. Promote the development of educational policies that support the integration of technology and establish standardized evaluation and monitoring mechanisms. Focus attention on the issues of resource allocation and equality in education to ensure the effective use of technology as well as the rational allocation of resources. Strengthen cooperation among schools and establish an inter-school joint physical education pedagogy resource platform to share resources and practical experience to promote co-construction and win-win

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situations. In addition, as more and more technologies are integrated into physical education pedagogy, the references to multiple platforms and systems have instead caused troubles and burdens for teachers and students, and the integration of technological platforms should be the next focus of attention, i.e., the same platform and the same account will be able to encompass the contents of multiple systems mentioned above, forming a community.

Investment in technological resources and facilities should be enhanced. Enhance the construction of modern physical education facilities such as smart classrooms and digital gymnasiums and provide funding for the purchase and maintenance of smart physical education equipment and devices. Cooperation with governments and enterprises should be strengthened to obtain more financial support for improving the technological infrastructure of physical education, and long-term financial planning should be developed to ensure the continuity and stability of technological integration.

Practice recommendation

Education and training should be strengthened. Designing and implementing technical training for physical education teachers to improve their understanding and ability to apply new technologies, and by organizing regular seminars and lectures, will help to keep physical education practitioners abreast of the latest teaching techniques and methods. This has positive implications for teacher training and professional development. In addition, in physical education, it is important to emphasize the development of digital literacy not only among teachers but also among students, as better digital literacy ensures that they can use digital technologies more effectively.

Privacy and content quality should be safeguarded. Develop a data protection policy and privacy protection measures, conduct training on data protection and privacy laws, and strengthen privacy protection. Quality control of digitized physical education materials and regular assessment and updating of content to safeguard its accuracy and suitability.

Further research recommendation

In the next step of the research, it is necessary to take into account the cultural characteristics, geographical characteristics, and natural resources of Yunnan, and combine digital sports teaching with local characteristics such as traditional ethnic sports, plateau training, and outdoor sports while improving the level of technology-integrated sports teaching method. While expanding the content of specialty courses, the development of specialty cultures and industries will be driven.

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