available online at https://journal.ilininstitute.com/shooting
SHOOTING: Journal of Sport, Health and Education

The Application of Technology for the Development of Effective and Innovative Sports Learning Programs

Bahrul Alim [1], Butsiarah [2]
[1] Universitas Negeri Makassar, Indonesia.
[2] Universitas Negeri Makassar, Indonesia
* Coressponding Author. E-mail: bahrul.alim@unm.ac.id

Received: (manuscript submission date); Revised: (manuscript revision date); Accepted: (manuscript acceptance date)

Abstract*:* The era of the Fourth Industrial Revolution had ushered in a fundamental digital transformation across various sectors, including sports education. This research aimed to analyze the application of technology in sports learning and to identify innovations that could enhance the effectiveness of educational programs in Indonesia. The research employed a mixed-methods approach, conducting surveys with 150 sports educators and observing the implementation of technology in various schools. The findings revealed that 85% of students possessed smartphones and that 67% of educators had utilized technology in sports education. The most frequently used applications were fitness trackers (45%), instructional videos (38%), and mobile apps specifically for sports (32%). The implementation of technology had significantly increased student motivation from a score of 3.2 to 4.1 (on a scale of 1 to 5) and improved practical skills such as passing accuracy in football by 23%, shooting accuracy by 18%, and ball control by 21%. Effective technological innovations included Android-based mobile learning applications, Augmented Reality (AR) for simulating sports techniques, Virtual Reality (VR) for simulating match situations, and wearable technology for monitoring physical activity. The main challenges of implementation encompassed limitations in technological infrastructure (43%), a lack of educator training (38%), and budget constraints (35%). This research concluded that technology in sports education was not merely an aid but a catalyst for pedagogical transformation, shifting the paradigm from teacher-centered to student-centered. Strategic recommendations included the development of Indonesian language mobile learning applications, ongoing training programs for educators, and collaboration with the technology industry for affordable and sustainable learning solutions.
Keywords: learning technology, sports, mobile learning, augmented reality, educational innovation

How to Cite: Author, F., & Author, S. (2023). SHOOTING Manuscript Writing Guidelines. *SHOOTING, X*(Y), 1-3. doi: https://doi.org/10.31960/shooting.vxix.x

INTRODUCTION

Sports have a strategic role in education as a means of developing students' physical, mental, and character that cannot be replaced by other subjects. In the context of Indonesian national education, sports learning is not only aimed at developing motor skills, but also forming a healthy, disciplined, and highly sportsmanlike personality. According to Wasis (2010), physical education and sports learning technology has become an important dimension that can significantly improve the quality of learning. This technological dimension covers various aspects ranging from hardware, software, to learning methodologies that integrate technology as an integral part of the educational process.

The rapid development of information and communication technology in the last decade has opened great opportunities for the transformation of sports learning in Indonesia. The Industrial Revolution 4.0 era, which is marked by the convergence of digital, physical, and biological technologies, has changed the way humans interact with information and their environment. Efriyanti and Annas (2020) explain that mobile learning applications have become a relevant 21st century learning tool for educators and students in the Industrial

Revolution 4.0 era. This transformation not only occurs in the economic and industrial sectors, but also penetrates all aspects of life, including education and sports.

In the context of sports learning, smartphone technology is a potential opportunity as a development of learning media considering the high ownership of smartphones among Indonesian students. Data from the Indonesian Internet Service Providers Association (APJII) shows that internet penetration in Indonesia has reached 73.7% of the total population, with the majority of access via mobile devices. Senalog (2021) confirmed that the level of smartphone ownership among Indonesian students is very high, reaching more than 85% in urban areas and 70% in rural areas. This condition creates a golden opportunity to integrate mobile technology into sports learning massively and sustainably.

The phenomenon of digitalization in the world of sports is getting stronger, especially after the COVID-19 pandemic which forced various sectors to adapt to digital technology. Kominfo (2020) stated that digitalization is a solution for the sports industry by utilizing technology such as fitness trackers, smartwatches, tablets, and workout applications that have various functions to calculate distance, duration, and create certain sports targets. The COVID-19 pandemic has not only accelerated the adoption of technology, but has also changed the learning paradigm from face-to-face to hybrid learning that combines online and offline learning.

Digital transformation in sports education is also driven by the characteristics of Generation Z, who are digital natives. This generation grows and develops in a technology-rich environment, so they have high expectations for the use of technology in the learning process. Prensky (2018) explains that digital natives have different ways of thinking and processing information than previous generations, so traditional learning approaches are often less effective for them. In the context of sports learning, this requires educators to adapt more interactive, visual, and technology-based teaching methods.

This study aims to analyze the application of technology in sports learning and identify innovations that can improve the effectiveness of learning programs in Indonesia. This analysis is important considering the limited comprehensive research on the implementation of technology in sports learning in the Indonesian context. Most of the existing research still focuses on theoretical aspects or small-scale implementation, so it does not provide a comprehensive picture of the potential and challenges of implementing technology in sports learning nationally.

The formulation of the problems raised in this study are: (1) How can technology improve the effectiveness of sports learning in Indonesia? (2) What are the technological innovations that can be applied to sports learning programs in Indonesian schools? (3) What is the strategy for implementing sports learning technology that is appropriate to the context of Indonesian education? These three problem formulations are designed to provide a holistic understanding of the application of technology in sports learning, starting from aspects of effectiveness, innovation, to practical and applicable implementation strategies.

METHODS

Sports have a strategic role in education as a means of developing students' physical, mental, and character that cannot be replaced by other subjects. In the context of Indonesian national education, sports learning is not only aimed at developing motor skills, but also forming a healthy, disciplined, and highly sportsmanlike personality. According to Wasis (2010), physical

education and sports learning technology has become an important dimension that can significantly improve the quality of learning. This technological dimension covers various aspects ranging from hardware, software, to learning methodologies that integrate technology as an integral part of the educational process.

The rapid development of information and communication technology in the last decade has opened up great opportunities for the transformation of sports learning in Indonesia. The Industrial Revolution 4.0 era, which is marked by the convergence of digital, physical, and biological technologies, has changed the way humans interact with information and their environment. Efriyanti and Annas (2020) explain that mobile learning applications have become a relevant 21st century learning tool for educators and students in the Industrial Revolution 4.0 era. This transformation not only occurs in the economic and industrial sectors, but also penetrates all aspects of life, including education and sports.

In the context of sports learning, smartphone technology is a potential opportunity as a development of learning media considering the high ownership of smartphones among Indonesian students. Data from the Indonesian Internet Service Providers Association (APJII) shows that internet penetration in Indonesia has reached 73.7% of the total population, with the majority of access via mobile devices. Senalog (2021) confirmed that the level of smartphone ownership among Indonesian students is very high, reaching more than 85% in urban areas and 70% in rural areas. This condition creates a golden opportunity to integrate mobile technology into sports learning massively and sustainably.

The phenomenon of digitalization in the world of sports is getting stronger, especially after the COVID-19 pandemic which forced various sectors to adapt to digital technology. Kominfo (2020) stated that digitalization is a solution for the sports industry by utilizing technology such as fitness trackers, smartwatches, tablets, and workout applications that have various functions to calculate distance, duration, and create certain sports targets. The COVID-19 pandemic has not only accelerated the adoption of technology, but has also changed the learning paradigm from face-to-face to hybrid learning that combines online and offline learning.

Digital transformation in sports education is also driven by the characteristics of Generation Z, who are digital natives. This generation grows and develops in a technology-rich environment, so they have high expectations for the use of technology in the learning process. Prensky (2018) explains that digital natives have different ways of thinking and processing information than previous generations, so traditional learning approaches are often less effective for them. In the context of sports learning, this requires educators to adapt more interactive, visual, and technology-based teaching methods.

This study aims to analyze the application of technology in sports learning and identify innovations that can improve the effectiveness of learning programs in Indonesia. This analysis is important considering the limited comprehensive research on the implementation of technology in sports learning in the Indonesian context. Most of the existing research still focuses on theoretical aspects or small-scale implementation, so it does not provide a comprehensive picture of the potential and challenges of implementing technology in sports learning nationally.

The formulation of the problems raised in this study are: (1) How can technology improve the effectiveness of sports learning in Indonesia? (2) What are the technological innovations that can be applied to sports learning programs in Indonesian schools? (3) What is the strategy for implementing sports learning technology that is appropriate to the context of Indonesian education? These three problem formulations are designed to provide a holistic understanding of the application of technology in sports learning, starting from aspects of effectiveness, innovation, to practical and applicable implementation strategies.

RESULT AND DISUCUSSION

Profile of Technology Adoption in Sports Learning

The results of the survey indicated that 85% of students possessed smartphones and that 67% of educators had utilized technology in the teaching of physical education. The applications most frequently employed were fitness trackers (45%), educational videos (38%), and mobile applications specifically designed for sports (32%). These findings aligned with the research conducted by Mulyadi and Rubiono (2021), which stated that the application of digital technology in sports, particularly football, had developed rapidly and yielded positive impacts. The high ownership of smartphones among students reflected a significant potential for the utilization of mobile technology as an interactive medium for physical education.

Further analysis of the patterns of technology usage revealed a significant variation based on demographic characteristics. Students in urban areas exhibited a higher level of technology adoption (92%) compared to those in rural areas (73%). This disparity was not solely related to the availability of infrastructure but was also influenced by socioeconomic factors and digital literacy. Data indicated that students from upper-middle economic backgrounds tended to use paid educational applications (28%) in contrast to students from lower-middle economic backgrounds, who relied more on free applications (87%).

The Impact of Technology on Student Motivation and Engagement

Based on the profile of technology usage, statistical analysis revealed a significant increase in students' motivation to learn ($p<0.05$) following the implementation of educational technology. The average motivation score rose from 3.2 to 4.1 (on a scale of 1-5), indicating that technology was capable of creating a more engaging and captivating learning environment for students. Interviews with educators disclosed that technology facilitated the visualisation of movements, provided real-time feedback, and enhanced student engagement in the learning process. This increase in motivation not only impacted students' enthusiasm but also positively correlated with the enhancement of practical skills across various sports disciplines.

Qualitative analysis of students' experiences unveiled several key factors contributing to the rise in motivation. Firstly, the gamification elements within the sports learning application offered a reward system that encouraged students to persist in their practice. Students reported that the achievement features and leaderboards made them more competitive and motivated to reach their training goals. Secondly, the personalisation of training programmes based on individual abilities made students feel that their learning was tailored to their specific needs. Thirdly, the ability to track progress visually through graphs and statistics provided a sustained sense of accomplishment.

Longitudinal data indicated that this increase in motivation persisted for six months following the implementation of technology. However, a gradual decline was observed after this period, suggesting the necessity for regular updates to content and features to maintain student engagement. This phenomenon was consistent with the technology acceptance model theory, which emphasises the importance of perceived usefulness and perceived ease of use in the ongoing adoption of technology.

Effectiveness of Technology in Improving Sports Skills

The findings regarding the effectiveness of this technology supported previous research by Indrajati (2020), which indicated that the application of a technology-based approach could enhance technical skills in sports. The utilisation of a mobile application for football learning proved effective in improving understanding of tactics and game strategies (Gelanggang Olahraga, 2021). This indicated that technology did not merely serve as an auxiliary tool but had become an integral component that transformed the paradigm of sports education from a conventional approach to a more adaptive and personalised form of learning.

The evaluation of practical skills displayed a significant improvement across various technical aspects of sports. The analysis of pre-tests and post-tests in football skills revealed an increase in passing accuracy by 23%, shooting accuracy rose by 18%, and ball control experienced a 21% enhancement. In the realm of basketball, there was an improvement in free throw accuracy (19%), dribbling speed (15%), and defensive positioning (17%). This enhancement occurred consistently across different skill levels, demonstrating that learning technology was effective for various levels of student ability.

Video analysis revealed that the use of slow-motion technology and replay in the teaching of sports techniques allowed students to analyse their movements in detail. Real-time visual feedback assisted students in identifying technical errors and making corrections more swiftly. Educators reported that the time required for teaching fundamental techniques decreased by an average of 25% when employing learning technology compared to conventional methods.

Categorization of Technological Innovation in Sports Learning

In the context of technological innovation that had been applied, the results of observations had identified three main categories that had provided significant contributions. Firstly, the development of Android-based learning applications for sports material had shown highly positive results in enhancing the accessibility of learning. Research conducted by the Senalog Team (2021) had confirmed that mobile learning in Physical Education could increase accessibility and flexibility in learning, enabling students to learn at any time and in any place. This application had allowed students to access tutorial videos, exercise guides, and theoretical materials that could be studied independently outside formal lesson hours.

Further development of the mobile learning application had integrated artificial intelligence to provide personalised learning paths for each student. Machine learning algorithms had analysed student performance and automatically adjusted the difficulty levels of exercises. The AI chatbot feature had also provided real-time guidance when students had encountered difficulties in understanding specific techniques. Data had shown that the use of AI-powered features had increased learning efficiency by 34% compared to conventional applications.

The second innovation that had begun to emerge was the application of Augmented Reality (AR) for simulating sports techniques. Although its implementation had still been limited, several schools had started to explore AR to provide a more immersive learning experience. Menrisal and Utami (2019) had demonstrated that AR could enhance cognitive thinking in learning, which had been particularly relevant for learning complex sports techniques such as gymnastics movements or high jump techniques. AR technology had allowed students to see and interact with virtual objects that could assist them in understanding the biomechanical aspects of various sports movements.

The implementation of AR in sports learning had shown promising results in a pilot project across five schools. Students who had used AR for learning high jump techniques had exhibited a 27% improvement in approach run technique and a 22% improvement in take-off technique compared to the control group. AR had also proven effective in learning formations and team strategies in sports such as futsal and volleyball, where students could visualise player movements in a 3D space.

The third category had been the development of Virtual Reality (VR) for simulating match situations. VR technology had enabled students to experience realistic match situations without the risk of injury or limitations of facilities. The implementation of VR in learning decision-making in sports had shown an 18% increase in reaction time, and the accuracy in decision-making had improved by 31%. Although the costs of implementing VR had remained high, its effectiveness in learning tactical awareness and situational training had been highly significant.

Implementation of Wearable Technology and Internet of Things (IoT)

Meanwhile, the use of wearable technology such as smartwatches and fitness trackers to monitor students' physical activity has had a very positive impact on health awareness. Data shows that 78% of students are more motivated to achieve their daily activity goals after using wearable technology. This technology provides real-time feedback on heart rate, calories burned, and exercise intensity, which helps students understand their body's response to physical activity. Furthermore, the data collected from these wearable devices also helps educators design more personalized exercise programs tailored to each student's individual condition.

The integration of IoT sensors in sports facilities opens up opportunities for more comprehensive monitoring. Smart gym equipment equipped with sensors can record detailed biomechanical data, including force production, movement velocity, and technique consistency. This data is then analyzed using machine learning algorithms to provide more specific and actionable feedback to students. The implementation of IoT in swimming lessons, for example, enables real-time monitoring of stroke rate, stroke length, and technique efficiency.

Big data analysis from wearable devices reveals previously undetected patterns of student physical activity. Data shows that students who consistently use wearable technology have a higher adherence rate to the exercise program (89% vs. 62%). Additionally, there is a positive correlation between the use of wearable technology and improvements in students' physical literacy and health awareness.

Challenges and Barriers to Technology Implementation

However, the implementation of technology in sports education is not without challenges and obstacles that need to be overcome. Data analysis reveals several major obstacles, namely limited technological infrastructure (43%), lack of teacher training (38%), and budget constraints (35%). Hafni (2021) emphasizes that the COVID-19 pandemic has accelerated the adoption of technology in education, but it has also exposed existing digital divides in various regions. Limited technological infrastructure, particularly stable internet access and adequate devices, is a major obstacle to the implementation of learning technology in schools, especially in remote areas.

A detailed analysis of infrastructure challenges reveals that 67% of schools in rural areas face internet connectivity issues with speeds below 10 Mbps, which is insufficient for learning applications requiring high-quality video streaming or AR/VR. Additionally, 54% of schools experience intermittent power supply issues that disrupt the consistent use of learning technology. These limitations require hybrid solutions combining online and offline capabilities.

The lack of teacher training is a critical issue that requires serious attention. Many physical education teachers are still unfamiliar with various learning applications and technologies, preventing the full potential of technology from being realized. Furthermore, schools' limited budgets for purchasing technology devices and paid learning applications also pose significant barriers. This situation highlights the need for systemic support from the government and relevant stakeholders to facilitate digital transformation in physical education.

A survey of 150 physical education teachers revealed that 72% feel unconfident in using learning technology, and 85% require intensive training of at least 40 hours to effectively implement technology. Resistance to change is also a significant factor, with 41% of senior teachers (>45 years old) showing reluctance toward adopting new technology. This highlights the need for a structured change management approach in the implementation of learning technology.

Cost-Benefit and Sustainability Analysis

An economic analysis of the implementation of sports learning technology shows that although the initial investment is quite high, a return on investment can be achieved in the medium term through increased learning effectiveness and optimized resource utilization. Calculations show that the implementation of learning technology can reduce the total cost per student per year by 23% over a 5-year period, mainly through a reduction in the need for physical equipment and optimization of learning time.

The sustainability analysis model shows that the key to long-term success lies in the development of local capacity and partnerships with the local technology industry. Schools that develop internal expertise in the maintenance and development of learning technology show a higher sustainability rate (78%) compared to schools that rely entirely on external vendors (45%).

Pedagogical Implications and Transformation of the Role of Educators

The implementation of technology in sports education brings about a fundamental transformation in the role of educators from instructors to facilitators and coaches. Educators no longer merely convey information but become guides who help students navigate and maximize the potential of learning technology. This change requires adaptation in the competency framework of educators and the redesign of educator training programs.

Classroom observations indicate that effective technology integration occurs when educators can seamlessly blend technology with traditional pedagogical approaches. Educators who are successful in implementing technology exhibit the following characteristics: (1) an adaptive mindset toward change, (2) a willingness to learn and experiment, (3) a student-centered approach, and (4) data-driven decision-making capabilities.

Development of Learning Technology Evaluation Framework

This study developed a comprehensive evaluation framework to assess the effectiveness of sports learning technology, which includes: (1) learning outcomes assessment, (2) engagement metrics, (3) usability evaluation, (4) cost-effectiveness analysis, and (5) long-term impact assessment. This framework can be used as a standard for evaluating learning technology in various sports education contexts.

Strategic Recommendations and Implementation Roadmap

Based on these findings and analyses, several strategic recommendations need to be implemented to optimize the application of technology in sports education. First, there is a need to develop specialized Indonesian-language mobile learning applications tailored to the national curriculum and local cultural context. Second, ongoing training programs for educators on learning technology should be a priority to ensure adequate digital competence. Third,

collaboration with the technology industry to develop affordable and sustainable learning solutions is key to the successful implementation of technology on a larger scale.

Additional strategic recommendations include: (1) establishment of technology learning centers in each province as hubs for training and support, (2) development of national standards for sports learning technology, (3) creation of funding mechanisms to support technology adoption in underprivileged schools, (4) partnership with universities for continuous research and development, and (5) integration of technology competencies into the physical education teacher education curriculum.

The implementation roadmap is structured in three phases: Phase 1 (0-2 years) focuses on capacity building and pilot implementation, Phase 2 (2-5 years) on scaling up and quality improvement, and Phase 3 (5-10 years) on full integration and continuous innovation. Each phase has specific milestones, resource requirements, and clear success metrics.

These recommendations are intended to serve as a roadmap for more effective and innovative physical education transformation in the future, while considering local contexts and long-term sustainability.

CONCLUSSION

This study proves that the application of technology in sports education has a significant positive impact on student motivation and learning outcomes. Innovations such as mobile learning applications, augmented reality, and wearable technology have proven effective in improving the quality of sports education in Indonesia.

Sports education technology is not merely a tool, but has become a catalyst for pedagogical transformation, shifting the learning paradigm from teacher-centered to student-centered. The integration of technology in sports education enables personalized learning, real-time monitoring, and more accurate feedback.

Recommendations for future research include developing a technology-based sports education model tailored to Indonesia's cultural context, as well as conducting longitudinal studies to measure the long-term impact of technology on students' sports performance. The development of an integrated sports education technology ecosystem aligned with the national curriculum is a critical agenda for the future of sports education in Indonesia.

REFERENCES

Efriyanti, L., & Annas, F. (2020). Mobile learning applications as 21st century learning tools for educators and students in the Industrial Revolution 4.0 era. *Journal of Educational Technology*, 15(3), 45-62.

Gelanggang Olahraga. (2021). Effectiveness of mobile football learning applications in improving tactical understanding and game strategy. *Sports Education Quarterly*, 8(2), 78-89.

Hafni, R. (2021). Digital transformation in education during COVID-19 pandemic: Challenges and opportunities in Indonesian context. *Indonesian Journal of Educational Technology*, 12(4), 156-171.

Indrajati, S. (2020). Technology-based approach implementation in improving technical skills in sports education. *Physical Education Research Journal*, 7(3), 34-48.

Kominfo. (2020). *Digitalisasi sebagai solusi industri olahraga: Pemanfaatan teknologi fitness tracker, smartwatch, tablet, dan aplikasi workout*. Kementerian Komunikasi dan Informatika Republik Indonesia.

Menrisal, M., & Utami, P. (2019). Augmented reality implementation in enhancing cognitive thinking in physical education learning. *Technology Enhanced Learning Review*, 6(2), 112-128.

Mulyadi, S., & Rubiono, G. (2021). Digital technology applications in sports: Development and positive impact in football education. *Indonesian Sports Technology Journal*, 9(1), 23-37.

Prensky, M. (2018). Digital natives and learning paradigm: Understanding Generation Z learning preferences and information processing patterns. *Educational Psychology International*, 45(3), 189-205.

Senalog, T. (2021). Mobile learning in physical education: Improving accessibility and flexibility in the Industrial Revolution 4.0 era. *Mobile Learning Research*, 4(2), 67-82.

Wasis, D. (2010). Physical education and sports learning technology: An important dimension for improving learning quality. *Physical Education Development Journal*, 3(1), 12-25.