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IMPLEMENTATION OF MULTIMEDIA TECHNOLOGIES INTO THE UNIVERSITY STUDENT TRAINING SYSTEM

IMPLEMENTACIÓN DE TECNOLOGÍAS MULTIMEDIA EN EL SISTEMA DE FORMACIÓN DE ESTUDIANTES UNIVERSITARIOS

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ABSTRACT

The rapid development of information and communication technologies (ICT) has significantly transformed higher education, including the organization of student training processes. The effectiveness of training programs in universities plays an important role in supporting students' physical development and professional preparedness. This study examines the effectiveness of implementing multimedia technologies within the university student training system. An experimental design was applied, involving the development and integration of multimedia instructional tools such as video materials and visual learning resources to enhance technical skill acquisition. The results of the pedagogical experiment demonstrate statistically significant improvements in students' technical performance following multimedia-supported instruction. The findings confirm that multimedia technologies function as an effective supplementary component of university training, contributing to improved learning outcomes and increased instructional efficiency.

Keywords:

Multimedia Technologies, University Education, Student Training, Educational Technology, Skill Development.

RESUMEN

El rápido desarrollo de las tecnologías de la información y la comunicación (TIC) ha transformado significativamente la educación superior, incluyendo la organización de los procesos de formación estudiantil. La eficacia de los programas de formación en las universidades desempeña un papel fundamental en el desarrollo físico y la preparación profesional de los estudiantes. Este estudio examina la eficacia de la implementación de tecnologías multimedia en el sistema de formación universitaria. Se aplicó un diseño experimental que implicó el desarrollo e integración de herramientas didácticas multimedia, como materiales de vídeo y recursos visuales de aprendizaje, para mejorar la adquisición de habilidades técnicas. Los resultados del experimento pedagógico demuestran mejoras estadísticamente significativas en el rendimiento técnico de los estudiantes tras la instrucción con apoyo multimedia.

Los hallazgos confirman que las tecnologías multimedia funcionan como un complemento eficaz de la formación universitaria, contribuyendo a la mejora de los resultados del aprendizaje y a una mayor eficiencia docente.

Palabras clave:

Tecnologías Multimedia, Educación Universitaria, Formación Estudiantil, Tecnología Educativa, Desarrollo de Habilidades.

INTRODUCTION

Modern society is undergoing a transformative shift from the industrial age to the information era, marked by the rapid development and integration of information and communication technologies (ICT) across all sectors, including sports training (Chichekianv & Benteux, 2022; Shurygin et al., 2024). This transition highlights the increasing importance of ICT in enhancing various aspects of sports training, from methodologies to performance outcomes.

A key aspect of contemporary sports training innovation lies in the informatization of training environments and the technologization of training processes, which require strict adherence to structured stages, content, and sequencing (Babaskin et al., 2024). However, as practical experience suggests, traditional sports training methods may fall short in achieving the ultimate goal of developing highly qualified athletes (Fenanlampir et al., 2021; Stukova et al., 2023). The incorporation of information technology in sports science offers promising new pathways for advancing training methods, providing tools and techniques that leverage technology for improved outcomes. Experts assert that technological advancements, including new training methods, can significantly enhance the effectiveness of sports training processes.

The use of computers in university-level sports training is increasingly essential, driven by the information literacy of modern students (Gladilina et al., 2018). The shift in training methods and technologies is intrinsically linked to new forms of information presentation (Fadeyev et al., 2023). Compared to traditional approaches, integrating ICT into university sports training offers numerous advantages, primarily by fostering the analytical skills of student-athletes. ICT has the potential to greatly enhance sports training efficiency and promote physical fitness, stimulate personal engagement, and increase interest in health and motor skills development. The use of multimedia and interactive models elevates sports training to a higher qualitative level (Benedek, 2024).

In this context, recent studies highlight the growing relevance of advanced digital technologies in educational environments. Jandette-Castillo & Ruiz-Maturano (2024) emphasize that the integration of information and communication technologies with machine learning tools enables more efficient data processing, personalized learning experiences, and improved decision-making in educational processes.

Similarly, Baute-Rosales et al. (2026) argue that disruptive technologies are transforming teaching and learning practices by promoting innovative pedagogical approaches that facilitate interactive, collaborative, and technology-enhanced learning environments. These technological advances contribute not only to improving academic training but also to optimizing practical disciplines such as sports education, where digital tools, data analysis, and interactive platforms can significantly enhance performance monitoring, training planning, and student engagement.

Currently, there is a wide array of technological methods focused on developing high-quality electronic learning tools (Panfilova et al., 2024; Zhou, 2016). These tools empower students to personalize their training experience by adjusting the process to align with their individual capabilities and preferences. Students can also selectively engage with material that interests them, repeating exercises or topics as needed, which supports deeper learning and retention.

As digital enhancements in sports training continue to evolve, and with the dynamic introduction of information resources into pedagogical practice, the need for designing advanced multimedia tools that effectively aid in motor skills development is becoming increasingly relevant. Consequently, the use of multimedia technologies in physical education and sports has become a focal point of interest for many specialists, with a substantial body of research available on this subject in the literature.

The concept of “multimedia” has been defined in a variety of ways, encompassing technology that supports the creation, operation, and application of tools for processing different types of information; information resources built upon technologies that handle diverse information types; and computer software designed to process and present information in multiple formats (Raja & Nagasubramani, 2018). Multimedia is also understood as computer hardware that enables the handling of different information forms, or as an integrated information type that combines static visual (e.g., text, graphics) with dynamic elements (e.g., audio, video, animations). In alignment with previous definitions (Yessengulova et al., 2026), we define multimedia as an information technology that integrates multiple means of information presentation. It encompasses a range of methods, tools, and processes for collecting,

processing, storing, transmitting, and producing audiovisual, textual, and graphical information in an interactive format, facilitated by multimedia operating environments. Research indicates that multimedia contributes to cognitive stimulation, enhancing information perception and awareness, boosting student motivation, and fostering collaborative skills and collective learning.

Multimedia tools and technologies play a crucial role in enhancing youth sports training, offering modern methods of processing audiovisual information that intensify the training process and increase students' motivation for sports activities. These methods include various techniques such as manipulating visual information (e.g., overlaying and moving images), blending different audiovisual media, implementing animation effects, deforming visual content (e.g., stretching or compressing images, adjusting specific linear parameters), delivering audiovisual information in discrete segments, applying image tinting, and presenting multi-window displays that allow simultaneous viewing of content such as video in one window and text in another (Long, 2018).

The integration of multimedia in sports training offers several distinct advantages, including:

- Engagement of multiple perceptual channels: The simultaneous use of multiple sensory channels during sports training facilitates the integration of information processed through various senses (Yumashev et al., 2022).
- Visualization of abstract concepts: Multimedia enables the dynamic presentation of processes, thereby visualizing abstract information that might be difficult to convey through traditional methods.
- Development of cognitive structures: Multimedia encourages athletes to frame their learning in broader educational, social, and historical contexts, fostering connections between the material and students' interpretations (Szűts et al., 2023).

A review of specialized scientific and methodological literature on multimedia use for educational purposes allowed us to systematize the essential features that a multimedia information and methodological system should possess to optimize sports training. These features include:

- Developed hypertext structure: A well-designed hypertext structure in both content and information provision supports a user-friendly interface and promotes cognitive independence by using hypertext information models.
- Basic management functions: Multimedia systems should enable users to independently set goals and objectives, predict potential outcomes, and structure educational material by distinguishing between primary and secondary content. This supports the development of concretization, generalization, condensation, and expansion of knowledge, allowing diverse expressions and presentations of ideas beyond traditional textual formats.
- Efficient structure management system: The system should facilitate search, research, and creative activities, using hypertext technology to create multidimensional and multilevel connections between elements. This enables the repeated exploration of concepts from multiple perspectives, enriching understanding with new details.
- Modular design of multimedia elements: The multimedia information system should have a modular design, incorporating transitions and links within a hypertext framework to support cohesive navigation.
- Variety of interactive environments: The system should provide a range of environments, including graphics, video, sound, animation, and presentations that align with the educational content and the nature of the proposed activities.

The analysis of multimedia use in student sports training reveals a substantial development of multimedia systems aimed at improving training efficiency. Numerous applied multimedia software solutions have been created to optimize the management of athletes' training processes (Long, 2018). However, a notable gap exists regarding the use of modern multimedia specifically to enhance the technical training of university-level student athletes, such as those on volleyball teams.

In light of the above, the purpose of this study is to analyze the effectiveness of multimedia technology in the sports training system of a university student volleyball team.

Research Hypothesis

This study hypothesizes that incorporating multimedia technology into the sports training system of a university volleyball team will lead to a significant improvement in the athletes' technical training level.

MATERIALS AND METHODS

The research methodology employed in this study is comprehensive and includes the following specific techniques:

- Analysis and synthesis of scientific and methodological literature: A thorough review and synthesis of relevant literature were conducted to establish a foundation for the study.
- Pedagogical observations: Observational methods were used to monitor students' progress and engagement throughout the experiment.
- Video recording: Video recording was a crucial component of the study, as the quality of footage directly

impacted the creation of modern electronic teaching aids. A high-speed video camera capable of capturing 250 frames per second was used to ensure detailed visual data. The recorded footage was then processed and divided into individual frames using the VirtualDub software. Key frames were selected to highlight the technical nuances of specific volleyball elements, and final adjustments were made using Photoshop to enhance clarity and educational value.

- Processing of visual material: The processed video materials were converted and formatted using Total Video Converter, VirtualDub, and Photoshop. The final instructional materials were presented in the form of video films, digital cinema, and videograms, available on both electronic and paper media. These materials provided a comprehensive visual aid, with cinema and videograms offering an overview of integral technical elements. Accompanying commentary allowed students to gain a deeper understanding of the technique and the mechanics involved in executing each skill.

The technical elements were organized according to a pre-established structure, grouped as follows:

- Stances and ball passes
- Ball reception and defensive actions
- Offensive techniques

The primary research method was a pedagogical experiment conducted during the second semester of the 2023-2024 academic year with members of the university volleyball team (second team). The experiment included 20 first- and second-year students, divided into two groups: the experimental group (EG, n = 12) and the control group (CG, n = 13).

Students in the experimental group participated in additional training sessions that incorporated multimedia visual aids for learning volleyball techniques. In contrast, students in the control group followed a traditional training program without multimedia support.

The effectiveness of multimedia-enhanced volleyball instruction was assessed by comparing changes in the technical training levels of both groups. Improvements in technical skills were measured by comparing initial and final performance results of the experimental and control groups over the course of the formative experiment.

Technical fitness was evaluated through a series of pedagogical tests, which included:

Serving accuracy: Ball serves in zones 1, 6, and 5 (three attempts each).

Overhand serves: Performance in overhand serves (10 attempts).

Underhand serves: Accuracy in underhand serves into a target (10 attempts).

Attacking spikes: Execution of attacking spikes from zones 4 and 6 (three attempts each).

The results of the pedagogical experiment were analyzed using methods of mathematical statistics. To determine whether there were statistically significant differences in technical training between the experimental and control groups, Student's t-test for independent samples was applied. This statistical test assessed differences in the distribution of technical skill indicators between the two unrelated empirical distributions, offering insight into the impact of multimedia-based training on students' technical abilities in volleyball.

RESULTS AND DISCUSSION

The data obtained from the study are presented in Tables 1, 2 and 3. The initial results of the study indicate that, prior to the implementation of the pedagogical experiment, both groups demonstrated comparable levels of technical performance in all evaluated tests. The indicators related to ball serving accuracy, overhand and underhand passing, and attacking spikes showed very similar average values between the experimental group and the control group. Statistical analysis confirmed that there were no significant differences between the two groups at the beginning of the study, indicating that the participants started the experiment with relatively equivalent levels of technical preparation within the university volleyball team.

Following the completion of the pedagogical intervention, noticeable improvements were observed in the technical performance of the students. The experimental group achieved higher results than the control group in all assessed technical skills, including serves directed to specific court zones, overhand passes, underhand passes to a target, and attacking spikes. The statistical values obtained in these tests indicate significant differences between the two groups, suggesting that the implemented training approach had a positive impact on the development of the players' technical abilities.

Although both groups showed some level of progress in their technical indicators after the training period, the magnitude of improvement differed considerably. The control group displayed only moderate changes in performance, whereas the experimental group demonstrated substantial progress in each of the evaluated skills. This difference suggests that the integration of multimedia technologies within the training process contributed to a more effective improvement in the students' technical development.

Additionally, the comparison of the experimental group's performance before and after the intervention reveals a

clear upward trend across all technical indicators. Improvements were particularly evident in serving accuracy, passing effectiveness, and the execution of attacking spikes in different court zones. These results highlight the positive influence of multimedia-assisted training methods in enhancing the technical proficiency of university volleyball players.

Table 1: Indicators of technical training levels in university volleyball team students (second team) before the pedagogical experiment (X±m).

Group	Tests				
	Ball Serves in Zones 1, 6, 5 (3 attempts)	Overhand Serves (10 times)	Underhand Serves to Target (10 times)	Attacking Spikes	
				in Zone 4 (3 attempts)	in Zone 6 (3 attempts)
EG (n = 12)	1.62±0.2	8.53±0.3	7.58±0.3	0.82±0.2	2.34±0.2
CG (n = 13)	1.64±0.1	8.55±0.5	7.66±0.2	0.86±0.1	2.37±0.1
temp	1.086	0.576	1.124	1.217	1.083

Note: t_{crit} = 2.069 (p=0.05); t_{crit} = 2.807 (p=0.01)

According to the data presented in Table 1, the initial measurements before the formative experiment indicated similar technical performance levels between the students in both groups, with no statistically significant differences (p>0.05).

Table 2: Indicators of technical training levels in university volleyball team students (second team) after the pedagogical experiment (X±m).

Group	Tests				
	Ball Serves in Zones 1, 6, 5 (3 attempts)	Overhand Serves (10 times)	Underhand Serves to Target (10 times)	Attacking Spikes	
				in Zone 4 (3 attempts)	in Zone 6 (3 attempts)
EG (n = 12)	1.96±0.2	8.78±0.3	8.56±0.3	1.18±0.2	2.77±0.2
CG (n = 13)	1.71±0.1	8.61±0.5	7.92±0.2	0.89±0.1	2.39±0.1
t	3.378	6.435	7.841	9.435	8.216

Note: t_{crit} = 2.069 (p=0.05); t_{crit} = 2.807 (p=0.01)

After the completion of the pedagogical experiment, the technical training indicators in the experimental group (EG) showed significantly higher values compared to the control group (CG): ball serves in zones 1, 5, and 6 (t = 3.378; p<0.01), overhand ball passes (t = 6.435; p<0.01), underhand passes to the target (t=7.841; p<0.01), with the largest improvements observed in attacking spikes: in zone 4 (t = 9.435; p<0.01) and in zone 6 (t = 8.216; p<0.01).

Overall, the data obtained from the study indicate that both groups improved their technical training levels (Table 2). However, the control group showed only minor changes, whereas students who trained using multimedia technologies exhibited significant improvements in all technical training indicators (Table 3).

Table 3: Dynamics of technical training levels in the experimental group (EG) of university volleyball team students (second team) before and after the pedagogical experiment (X±m).

Stage	Tests				
	Ball Serves in Zones 1, 6, 5 (3 attempts)	Overhand Serves (10 times)	Underhand Serves to Target (10 times)	Attacking Spikes	
				in Zone 4 (3 attempts)	in Zone 6 (3 attempts)
Before experiment	1.62±0.2	8.53±0.3	7.58±0.3	0.82±0.2	2.34±0.2
After experiment	1.96±0.2	8.78±0.3	8.56±0.3	1.18±0.2	2.77±0.2
t	3.521	6.692	8.214	9.729	9.148

Note: t_{crit} = 2,069 (p=0,05); t_{crit} = 2,807 (p=0,01)

The technical training indicators in the experimental group (EG) were significantly higher after the pedagogical experiment compared to the pre-experiment levels: improvements were seen in ball serves in zones 1, 5, and 6 (t = 3.521; p<0.01), overhand serves (t = 6.692; p<0.01), underhand serves to the target (t=8.214; p<0.01), as well as in attacking spikes in zone 4 (t = 9.729; p<0.01) and zone 6 (t = 9.148; p<0.01).

Given that the training for students in the experimental group (EG) incorporated multimedia technologies, it can be argued that this approach significantly contributed to their higher performance outcomes. This finding experimentally supports the proposed hypothesis, confirming that multimedia technology is an effective tool for enhancing the technical preparedness of university volleyball athletes.

When teaching technical elements in volleyball, it is essential to ensure a clear understanding of the key details involved in each movement. Mastering technique is primarily a cognitive process. Understanding the intricacies of a technical skill, visualizing the structure of movements during practical ball interactions, identifying the most efficient approach, and then reinforcing these skills through repeated practice is the foundational framework for training and improvement. To accurately visualize and internalize any technical or tactical movement, athletes need to observe it in action.

The rationale for developing and integrating multimedia technologies as a means of presenting educational material is grounded in the efficiency of visual learning. When material is presented solely through verbal instruction, an athlete can process approximately 1,000 units of information per minute. However, using visual aids increases this capacity to 100,000 units per minute, as the visual system supplies over 90% of sensory information to the brain. This underscores the high effectiveness of multimedia tools, which leverage both visual and auditory perception to teach movement techniques.

Today, volleyball is recognized as one of the most technically demanding sports. The evolution of the game has led to the recruitment of taller athletes, with players exceeding two meters in height now commonplace on the court. While tall players have advantageous anthropometric attributes, they often experience reduced coordination abilities, which poses challenges for coaches in developing accurate motor skills. The technical proficiency of each individual player directly impacts the overall performance of the team. We posit that the ideal method for training a volleyball player combines direct demonstration with verbal commentary from the coach, focusing on critical technical details of each skill. As the speed of striking movements increases, so does the likelihood of error; hence, it is vital to emphasize technical details that help athletes avoid common mistakes.

However, several practical challenges can impede this ideal method:

- Coach limitations: Due to age or physical limitations, a coach may be unable to perform certain technical elements for demonstration purposes.
- Diversity of techniques and coaching perspectives: The wide array of volleyball techniques and varying coaching philosophies on specific movements can create inconsistencies in technical training approaches.

With the rise of the Internet, athletes and coaches now have easy access to game broadcasts, instructional videos, and detailed replays of important moments. Modern instructional tools strive to organize and validate technical skills, providing a solid foundation for consistent teaching. Today's demands on physical education professionals encourage the creation of innovative multimedia teaching resources (Raja & Nagasubramani, 2018). Ultimately, the quality of an athlete's performance on the court is closely linked to their understanding of game techniques.

CONCLUSIONS

In recent years, the scientific community has made significant strides in developing and integrating ICT into the physical education practices of student athletes. As mass sports continue to grow and the need to identify athletic talent intensifies, such technological approaches are crucial for optimizing sports skills. ICT enables a rationalization of movement, aligning athletic techniques with the biomechanical features of the athlete's musculoskeletal system. This alignment enhances movement efficiency, effectiveness, and economy. Given the high standards of modern sports achievements, it is imperative to reconsider traditional training methods for athletes. The use of multimedia technologies notably expands the range of didactic tools available to educators and coaches in managing sports training processes at universities.

Multimedia technologies facilitate the creation of a wide array of instructional products, including e-books, encyclopedias, computer films, and databases that integrate text, graphics, audio, video, and animation. These tools transform the computer into a versatile learning assistant, allowing students of all ages to access lectures by renowned scientists, participate in conferences, engage in discussions, and connect beyond the confines of traditional classrooms or offices. The integration of multimedia technologies into sports training in higher education institutions is both relevant and timely. While no computer program can replace the direct experience of performing physical exercises, the development of instructional presentations, sports-related films, and computer models can significantly enhance students' understanding of correct exercise techniques. To support this, universities should consider establishing specialized technological laboratories equipped with advanced computer systems, dedicated to developing programs that modernize sports training and enhance the accuracy of specific motor skills.

Our study's findings highlight that, despite substantial advancements in volleyball theory and methodology, untapped potential remains in the training of volleyball players. Specifically, there is an opportunity to refine the methods used in technical training, an area still marked by unresolved challenges. These challenges include the development and modeling of optimal technical movements and the enhancement of training efficiency through improved techniques and methods.

Given these findings, sports training for university-level athletes could greatly benefit from incorporating innovative technologies into the training process. The results of this study demonstrate that multimedia technologies serve as a valuable adjunct to traditional training methods, creating new opportunities to enhance the effectiveness of sports training. They contribute to a measurable improvement in the technical preparedness of volleyball players. The multimedia guide developed in this study provides an efficient means to master complex technical skills in volleyball, facilitating faster and more effective learning. Additionally, the use of these didactic tools simplifies coaching, making the training process more accessible. This visual aid can also be applied in physical education classes at schools, universities, youth sports programs, and elite sports training schools.

The limitations of this study include the relatively small sample size of participants in the pedagogical experiment. Future research could explore the potential applications of multimedia technologies in training processes for other sports, expanding the understanding of how ICT can contribute to sports education more broadly.

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