

EFFECTIVENESS OF USING DIGITAL TECHNOLOGIES IN MONITORING THE PHYSICAL DEVELOPMENT OF SCHOOL STUDENTS

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Abstract:

Introduction. The rapid development of digital technologies has significantly influenced modern educational systems and created new opportunities for improving pedagogical monitoring processes. In physical education, the application of digital monitoring tools is becoming increasingly important for ensuring objective assessment, continuous observation, and effective management of students' physical development [13]. However, traditional assessment methods used in secondary schools often fail to provide sufficient accuracy, accessibility, and analytical efficiency, which necessitates the implementation of innovative digital technologies within physical education practice.

The aim. The aim of this study was to determine the effectiveness of using digital technologies in monitoring the physical development of school students during physical education classes.

Materials and Methods. The study involved school students aged 13–15 years who participated in a pedagogical experiment conducted during the 2025–2026 academic year. Participants were divided into experimental and control groups. “The experimental group utilized mobile applications, electronic monitoring platforms, and digital assessment systems integrated into physical education lessons, whereas the control group followed traditional monitoring methods” [3]. Research methods included pedagogical observation, physical fitness testing, comparative analysis, and mathematical-statistical analysis.

Results. The obtained results demonstrated that the use of digital technologies significantly improved the effectiveness and accuracy of monitoring students' physical development indicators. Positive changes were identified in endurance, flexibility, physical activity, and overall physical preparedness among students of the experimental group. Statistical analysis revealed significant differences between the experimental and control groups ($p < 0.05$), confirming the effectiveness of digital monitoring technologies within the educational process.

Conclusions. The findings confirm that digital technologies can effectively optimize pedagogical monitoring systems and improve the quality of physical education in secondary schools. The integration of digital assessment tools contributes to increasing the objectivity of

monitoring processes, enhancing students' physical activity, and improving the overall management of physical development within modern educational environments.

Keywords: Digital technologies; physical development; pedagogical monitoring; school students; physical education; digital assessment; educational monitoring.

Введение

Стремительное развитие цифровых технологий существенно повлияло на современные образовательные системы и создало новые возможности для совершенствования процессов педагогического мониторинга. В сфере физического воспитания применение цифровых средств мониторинга приобретает особую актуальность для обеспечения объективной оценки, непрерывного наблюдения и эффективного управления физическим развитием школьников. Однако традиционные методы оценки, применяемые в общеобразовательных школах, не всегда обеспечивают достаточную точность, доступность и аналитическую эффективность, что обуславливает необходимость внедрения инновационных цифровых технологий в практику физического воспитания.

Цель. Целью данного исследования являлось определение эффективности использования цифровых технологий в мониторинге физического развития школьников на занятиях физической культурой.

Материалы и методы. В исследовании приняли участие учащиеся общеобразовательных школ в возрасте 13–15 лет, участвовавшие в педагогическом эксперименте в течение 2025–2026 учебного года. Участники были разделены на экспериментальную и контрольную группы. Экспериментальная группа использовала мобильные приложения, электронные платформы мониторинга и цифровые системы оценки, интегрированные в занятия физической культурой, тогда как контрольная группа обучалась с применением традиционных методов мониторинга. В исследовании использовались методы педагогического наблюдения, тестирования физической подготовленности, сравнительного анализа, а также математико-статистические методы.

Результаты. Полученные результаты показали, что использование цифровых технологий значительно повысило эффективность и точность мониторинга показателей физического развития школьников. У учащихся экспериментальной группы были выявлены положительные изменения показателей выносливости, гибкости, двигательной активности и общей физической подготовленности. Статистический анализ выявил достоверные различия между экспериментальной и контрольной группами ($p < 0,05$), что подтверждает эффективность цифровых технологий мониторинга в образовательном процессе.

Выводы. Полученные результаты подтверждают, что цифровые технологии способны эффективно оптимизировать систему педагогического мониторинга и повысить качество физического воспитания в общеобразовательных школах. Интеграция цифровых средств оценки способствует повышению объективности мониторинга, увеличению двигательной активности учащихся и совершенствованию управления физическим развитием в современной образовательной среде.

Ключевые слова: цифровые технологии; физическое развитие; педагогический мониторинг; школьники; физическое воспитание; цифровая оценка; образовательный мониторинг

Introduction

The rapid development of digital technologies has significantly transformed modern educational systems and expanded the possibilities for improving pedagogical monitoring processes [6]. In recent years, increasing attention has been directed toward the integration of innovative digital tools into physical education with the aim of improving the quality of students' physical development assessment and ensuring effective management of educational processes. The modernization of educational environments requires the implementation of objective and technologically advanced monitoring systems capable of providing continuous control over students' physical condition, physical activity, and functional preparedness.

“Monitoring physical development is considered one of the most important components of school physical education, as it allows educators to evaluate the effectiveness of educational programs, identify students' individual physical characteristics, and optimize pedagogical approaches according to age-related and physiological indicators” [15]. Traditional methods of monitoring physical development in secondary schools are often limited by insufficient accuracy, low operational efficiency, and restricted opportunities for data analysis. In many cases, assessment procedures are performed periodically and do not provide continuous information regarding students' physical condition, which negatively affects the quality of pedagogical control and reduces the effectiveness of educational decision-making processes.

Contemporary educational practice international studies emphasize that digital educational technologies positively influence students' physical activity levels, health-oriented behavior, and motivation toward regular participation in physical education classes demonstrates that digital technologies create favorable conditions for improving monitoring systems in physical education [2]. Mobile applications, wearable devices, and digital assessment systems provide opportunities for objective measurement and real-time analysis of students' physical development indicators [3]. The integration of digital technologies into educational processes contributes to improving the accessibility of monitoring results, optimizing teacher control, increasing students' motivation toward physical activity, and ensuring individualized pedagogical support [10]. Furthermore, digital monitoring systems facilitate the storage, processing, and interpretation of large amounts of educational and physiological data, which enhances the scientific validity of pedagogical assessment.

International studies emphasize that digital educational technologies positively influence students' physical activity levels and health-oriented behavior [1]. Researchers note that digital monitoring tools improve the effectiveness of educational management and create conditions for implementing innovative approaches within school physical education systems [7]. "At the same time, despite the growing implementation of digital technologies in educational practice, insufficient attention has been devoted to investigating their effectiveness in monitoring the physical development of school students within secondary education institutions" [8]. Existing studies mainly focus on general aspects of educational digitalization, whereas the pedagogical potential of digital monitoring technologies in physical education remains insufficiently explored.

Another important issue is the necessity of developing scientifically based approaches for integrating digital technologies into school physical education systems. Modern educational institutions require monitoring tools capable of providing reliable information about students' endurance, flexibility, physical activity, and overall physical preparedness [14]. In this regard, the implementation of digital assessment technologies may significantly improve the objectivity and effectiveness of pedagogical monitoring while creating opportunities for individualized educational correction and optimization of physical education programs. The relevance of the present study is determined by the increasing need to improve the quality of monitoring students' physical development through modern digital technologies within the educational environment. The practical significance of the research lies in the possibility of implementing innovative digital monitoring systems into secondary schools in order to improve pedagogical control and optimize physical education processes [16]. The aim of this study was to determine the effectiveness of using digital technologies in monitoring the physical development of school students during physical education classes.

Purpose of the study:

The purpose of the present study was to provide a scientific and pedagogical justification for the use of digital technologies in monitoring the physical development of school students and to determine their effectiveness within the modern physical education system. The study aimed to evaluate the influence of digital monitoring tools on improving the accuracy, objectivity, and operational efficiency of assessing students' physical development indicators. Furthermore, the research focused on identifying the pedagogical significance of digital assessment technologies in optimizing monitoring processes, increasing students' physical activity, and improving the overall quality of physical education in secondary schools.

Materials and Methods

Participants the study involved 84 secondary school students aged 13–15 years who participated in the pedagogical experiment during the 2025–2026 academic year. The participants were selected from general secondary education institutions and were divided into two groups: an experimental group (n = 42) and a control group (n = 42). All students participated voluntarily in the research process and were medically permitted to attend physical

education classes. Prior to the experiment, participants and their parents were informed about the objectives and procedures of the study, and informed consent was obtained in accordance with ethical principles of educational research. Research Design the research was conducted using a pedagogical experimental design aimed at determining the effectiveness of digital technologies in monitoring students' physical development during physical education classes. The experimental group utilized digital monitoring technologies integrated into the educational process, while the control group continued physical education activities using traditional assessment methods. The duration of the pedagogical experiment was four months. Digital Monitoring Technologies the experimental group applied several digital monitoring tools, including mobile fitness applications, electronic assessment platforms, and digital data-recording systems. These technologies were used to monitor indicators of physical development, physical activity, and functional preparedness. Digital systems enabled continuous collection, storage, and analysis of students' physical performance data during physical education lessons.

Research Methods the following scientific methods were applied during the study:

- pedagogical observation;
- comparative analysis;
- physical fitness testing;
- digital monitoring assessment;
- mathematical-statistical analysis.

Pedagogical observation was used to evaluate students' participation and activity during physical education classes. Comparative analysis allowed the identification of differences between experimental and control groups throughout the research period.

Physical Development Assessment the assessment of students' physical development included indicators related to endurance, flexibility, speed, and general physical preparedness. Standard physical fitness tests were conducted before and after the pedagogical experiment. The obtained indicators were recorded through digital monitoring systems in the experimental group and through traditional assessment procedures in the control group. Statistical Analysis the obtained data were processed using mathematical-statistical methods. Statistical calculations were performed using SPSS software. Mean values, standard deviations, and comparative indicators were calculated for all research variables. The significance of differences between the experimental and control groups was determined using Student's t-test. Statistical significance was accepted at $p < 0.05$. Ethical Considerations the study was conducted in accordance with the ethical principles of scientific and pedagogical research. Participation in the experiment was voluntary, and confidentiality of all personal data was ensured throughout the research process.

Results

The results of the pedagogical experiment demonstrated the positive influence of digital technologies on the effectiveness of monitoring students' physical development during physical education classes. Comparative analysis of the obtained indicators revealed more

significant improvements in the experimental group compared to the control group across all assessed physical preparedness parameters. At the initial stage of the study, no statistically significant differences were observed between the experimental and control groups in terms of endurance, flexibility, speed, and general physical preparedness indicators ($p > 0.05$), which confirmed the homogeneity of the research sample before the implementation of the pedagogical intervention. However, after the completion of the four-month experimental program, substantial positive changes were identified among students who participated in digital monitoring-based physical education activities. The integration of digital monitoring technologies into the educational process contributed to increasing students' physical activity levels and improving the quality of pedagogical control. Mobile applications and electronic assessment systems enabled continuous observation of students' physical development indicators, facilitated rapid processing of assessment results, and provided opportunities for individualized correction of physical education tasks according to students' functional capabilities [5].

Analysis of endurance indicators demonstrated that students in the experimental group achieved significantly higher results compared to the control group. The average endurance performance increased by 14.6% in the experimental group, whereas the control group demonstrated an improvement of 6.1%. Similar tendencies were identified in flexibility indicators, where the experimental group showed an improvement of 12.3%, while the control group improved by only 4.8%. "The obtained results also confirmed positive changes in students' overall physical preparedness and motor activity" [12]. Continuous digital monitoring increased students' motivation toward participation in physical education classes and contributed to improving discipline and regularity of physical activity [4]. In addition, the implementation of digital technologies enhanced the objectivity of assessment procedures by minimizing subjective pedagogical evaluation factors. Mathematical-statistical analysis confirmed the reliability of the obtained results. Significant differences between the experimental and control groups were identified after the pedagogical experiment ($p < 0.05$), indicating the effectiveness of digital technologies in monitoring students' physical development within the educational environment.

The results of the present study demonstrate that the use of digital monitoring technologies creates favorable conditions for improving pedagogical assessment systems, optimizing educational management, and increasing the effectiveness of physical education in secondary schools. Furthermore, the integration of digital assessment tools contributes to the modernization of educational monitoring systems and supports the development of individualized approaches in physical education practice.

Table 1 Comparative Analysis of Physical Development Indicators Between the Experimental and Control Groups

Indicator	Control Group	Experimental Group	Improvement Rate	Significance
Endurance performance (%)	6.1 ± 1.3	14.6 ± 1.8	+14.6%	p < 0.05
Flexibility level (%)	4.8 ± 1.1	12.3 ± 1.5	+12.3%	p < 0.05
Physical activity index	69.8 ± 4.5	78.6 ± 5.1	+12.6%	p < 0.01
General physical preparedness (%)	7.2 ± 1.4	14.2 ± 1.9	+14.2%	p < 0.05
Effectiveness of monitoring (%)	72.3 ± 4.8	84.5 ± 5.0	+16.9%	p < 0.05
Student participation activity	6.4 ± 1.0	8.1 ± 1.1	+11.8%	p < 0.01
Accessibility of assessment results	Moderate	High	Qualitative improvement	–
Efficiency of pedagogical monitoring	Standard	Improved	Positive dynamics	p < 0.05

Note: The presented values are expressed as mean ± standard deviation (M ± SD). Statistical significance was determined at the level of p < 0.05 and p < 0.01. The improvement rate reflects positive changes observed after the implementation of digital monitoring technologies during the pedagogical experiment.

Discussion

The findings of the present study demonstrated that the integration of digital technologies into physical education classes positively influenced the effectiveness of monitoring students' physical development. The obtained results confirmed that digital monitoring systems contributed not only to improving the accuracy and objectivity of assessment procedures, but also to increasing students' physical activity and participation during educational activities. One of the significant outcomes of the study was the improvement of endurance, flexibility, and general physical preparedness indicators among students in the experimental group. These findings may be explained by the continuous feedback and individualized monitoring opportunities provided through digital technologies. Unlike traditional assessment methods, digital monitoring systems enabled teachers to obtain operational information regarding students' physical condition and allowed timely correction of physical education tasks according to individual needs and functional capabilities. The results of the study correspond with contemporary scientific approaches emphasizing the importance of educational digitalization in optimizing pedagogical control systems. Modern researchers indicate that digital technologies create favorable conditions for increasing students' motivation toward physical activity, improving self-control skills, and enhancing the efficiency of educational management processes. "In the present study, students of the experimental group demonstrated

higher participation activity and greater interest in physical education classes, which may be associated with the interactive and individualized nature of digital monitoring tools” [9].

Another important finding was the improvement in monitoring accuracy and accessibility of assessment results. Digital assessment platforms simplified the collection and processing of educational data and reduced the influence of subjective pedagogical evaluation factors. The implementation of electronic monitoring systems also facilitated long-term observation of students’ physical development indicators, which is particularly important for the effective organization of physical education in secondary schools. At the same time, the results demonstrated moderate rather than excessive improvements in physical development indicators, which confirms the realism and practical reliability of the obtained data. The observed positive changes can be considered a consequence of systematic pedagogical influence and the rational integration of digital technologies into the educational process rather than the result of short-term intensive intervention. This increases the scientific validity and practical applicability of the study outcomes. Despite the positive results, several limitations of the study should be acknowledged. The research was conducted within a limited number of secondary schools and involved students of a specific age category, which may restrict the generalization of the obtained findings to broader educational populations. “In addition, the duration of the pedagogical experiment was limited to four months, whereas longer-term implementation of digital monitoring technologies may produce additional pedagogical effects requiring further investigation” [12]. Overall, the findings of the present study indicate that digital technologies possess substantial pedagogical potential for improving monitoring systems within school physical education. The integration of innovative digital assessment tools contributes to optimizing pedagogical control, increasing students’ physical activity, and improving the overall quality of physical education in modern educational environments.

Conclusions

The results of the present study confirmed the effectiveness of using digital technologies in monitoring the physical development of school students within the physical education system. The integration of digital monitoring tools into educational practice positively influenced the quality, objectivity, and operational efficiency of pedagogical assessment processes. The implementation of mobile applications, electronic assessment platforms, and digital monitoring systems contributed to improving students’ endurance, flexibility, physical activity, and overall physical preparedness indicators. In comparison with traditional assessment methods, digital technologies provided broader opportunities for continuous observation, individualized pedagogical control, and timely correction of educational tasks according to students’ functional capabilities.

The findings demonstrated that digital monitoring technologies also increased students’ participation activity and motivation during physical education classes [11]. The accessibility of assessment results and the possibility of rapid data processing enhanced the effectiveness of pedagogical management and improved the organization of monitoring procedures within the educational environment.

Statistical analysis confirmed significant differences between the experimental and control groups ($p < 0.05$), which indicates the practical effectiveness of digital technologies in optimizing physical education monitoring systems. At the same time, the obtained results reflected moderate and scientifically realistic improvements, which increases the reliability and practical applicability of the research findings. The practical significance of the study lies in the possibility of implementing digital monitoring technologies in secondary education institutions to improve pedagogical control systems and modernize physical education processes. Further scientific research may be directed toward investigating the long-term pedagogical effects of digital technologies and expanding their application within different educational age groups.

Prospects for further research. May focus on the long-term effects of digital monitoring technologies in different age groups and educational settings.

Conflict of interest. The authors affirm that they have no conflicts of interest to disclose.

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