

Functional Training with Phygital Elements and Artificial Intelligence Integration

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Abstract: The article explores the integration of phygital sport technologies into the system of physical education. The prospects of applying artificial intelligence, computer vision, and gamification for modernizing the training process are considered. Particular attention is given to the development of adaptive programs and the creation of digital student profiles. Modern technological solutions are analyzed, including AI-powered smart simulators, telemetry systems, and wearable sensors for activity monitoring. Gamification methods aimed at increasing user motivation are reviewed. A practical model of introducing phygital technologies into university educational programs is presented, including stages of technical equipment and teacher training. Criteria for evaluating implementation effectiveness are developed, based on the analysis of physical indicators and motivational factors. The results are relevant for specialists in physical culture and developers of sports technologies.

1 INTRODUCTION

In today's world, we are witnessing a technological revolution where artificial intelligence and digital technologies are increasingly integrated into daily life. One of the promising areas is functional training, where phygital technologies open new opportunities for personalized workouts, objective technique evaluation, and enhanced motivation. This is especially important for exercise precision, training efficiency, injury prevention, and individualized workload planning.

The aim of this article is to assess and analyze modern opportunities and future prospects of integrating artificial intelligence into functional training, with a particular focus on practical applications in higher education institutions.

The tasks include systematizing technological solutions, evaluating their potential effectiveness, and developing recommendations for optimal integration of digitalization with traditional training methods.

2 EVOLUTION OF FUNCTIONAL TRAINING THROUGH TECHNOLOGY

Functional training has evolved significantly—from simple bodyweight exercises to advanced technological training systems. Initially, these trainings were based on natural human mobility and required little equipment. With technological

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progress, new tools appeared: stopwatches, heart rate monitors, pedometers, and later—video analysis systems.

Today, smart simulators, computer vision, and sensors have become integral to the training process, enabling not only performance tracking but also real-time adjustments to improve exercise quality. Artificial intelligence now plays a central role, providing data analysis, pattern recognition, and training personalization beyond the capacity of earlier tools.

It is artificial intelligence that is becoming an integral part of innovation in the functional training industry, because previous technologies only provided data for analysis, while artificial intelligence is capable of analyzing information itself. The main advantages of artificial intelligence are: processing large volumes of data, speed, self-learning, and workout personalization. AI is capable of analyzing information from multiple sensors simultaneously and identifying patterns that might be missed during manual analysis. It can quickly react to changes in exercise technique and immediately recommend corrections. Furthermore, the algorithms continuously improve as more data is gathered and can adapt to the individual characteristics of any user.

3 HOW IT WORKS: TECHNOLOGIES FOR SMART TRAINING

Modern smart workouts are based on advanced technologies that work together to create an effective monitoring system and enhanced physical conditioning. A wide range of technological improvements make the training process more refined, productive, and safe.

3.1 Computer Vision and Neural Networks for Movement Analysis

Computer vision systems, powered by neural networks, capture and analyze movements in real time. By learning from thousands of correct and incorrect exercise examples, these systems can identify joint angles, symmetry, trajectory accuracy, and execution speed. For instance, if an athlete bends their back incorrectly or fails to raise a limb high enough, the system provides immediate feedback. Such platforms are already adopted in sports academies and endorsed by the Russian Ministry of Sports.

3.2 Sensors and Real-Time Tracking Systems

In addition to the cameras mentioned above, motion tracking can also utilize various sensors that are attached to athletes' bodies or embedded in sports equipment. Inertial sensors measure movement speed, acceleration, and spatial positioning. Placed on wrists, shins, and the lower back, they provide precise data on movement dynamics. Force platforms measure the force exerted by the athlete during exercises, collecting information on weight distribution between the right and left legs as well as dynamics of force application changes. Cardiac sensors monitor the cardiovascular system's response to exercise loads, which helps reduce the risk of dangerous movements or physical overload, while also determining the optimal level of training intensity. All these technologies create an integrated system that forms a comprehensive understanding of exercise technique and a person's physical condition.

3.3 Digital Twin

All collected data is used to create a digital twin – a virtual copy of a person that accounts for all anatomical features, current physical condition, and complete training history. This digital twin can take the form of a kinematic model of the athlete's movements, a virtual replica that mimics the person's form and actions. It enables predicting the body's response to specific movements, forecasting effectiveness, and making adjustments to the training process.

Using the digital twin, a coach can test a new exercise program to evaluate the effectiveness, risks, and benefits of such innovations. In practice, these technologies are successfully applied across various sports disciplines. Some fitness centers install smart equipment that generates personalized load schemes for each member. In team sports, they are used to analyze players' technique. Nowadays, even at home, applications are available that analyze exercise execution through a smartphone camera and provide improvement recommendations.

4 SMART TRAINING PROGRAMS

With technological advancement, monotonous workouts have transformed into engaging and diverse gaming experiences where every element sustains user interest and motivation. The system is built on various adaptive scenarios that turn exercise into a

game in real time. For example, with iFit technology, smart treadmills adjust their incline based on the route a user selects on virtual maps. Similarly, the Zwift platform automatically adjusts the resistance of a stationary bike according to the terrain of the virtual road.

Additionally, the personalization of training programs takes into account the user's psychological characteristics. Some applications foster healthy competition by comparing an individual's results with others. For solo workouts, there are dedicated games like Ring Fit Adventure, where progression through the story requires performing actual physical exercises. This integration of gameplay demonstrates high effectiveness and turns an ordinary workout into an activity users don't want to end.

Modern universities can successfully integrate gaming technologies into their physical education programs, thereby fostering sustained student motivation and enhancing the learning process. Practical implementation involves modernizing gyms by supplementing traditional equipment with smart counterparts. For instance, installing Zwift-compatible stationary bikes enables group virtual races where students compete not only in physical endurance but also in tactical thinking.

Equipping students with motion sensors and computer vision systems allows for automatic assessment of exercise technique and correctness, providing personalized feedback to each student. This facilitates the work of instructors while improving training quality. Physical education curricula can be enriched with modules incorporating gamified platforms. Practical classes can implement adaptive scenarios where exercise difficulty automatically adjusts based on students' real-time performance—particularly relevant in groups with varying fitness levels. Thus, instructors gain the ability to work with students' personal digital profiles, tracking their progress through specialized software. The academic process can also be enhanced with semester-long competitions utilizing gaming integrations, such as virtual cycling races or challenges in mobile applications.

For instructors, specialized training programs on using new technologies can be organized, with assessment conducted through term papers or projects evaluating the effectiveness of this approach. Program efficacy can be measured using metrics like class attendance rates, dynamics of physical performance, and student motivation levels. Student feedback—their opinions and satisfaction with the new system—is equally essential. According to a study conducted at Patrice Lumumba Russian University of Peoples' Friendship on gamification in Russian humanities universities, gamification yields positive results in boosting student motivation,

interest, and engagement in learning disciplines. However, it requires refinement in educators' awareness and proficiency with interactive technologies. Therefore, instructors must possess skills in using various platforms, services, and applications employed in the training process. This ensures the program's continuous improvement and adaptation to the specific educational environment

4.1 Student Training Program Using Mobile Apps and Competitive Systems

This program proposes a comprehensive approach to pilot modernizing the educational process, based on the use of accessible digital technologies and gamification. This initial implementation will provide a basis for deciding on further steps to enhance classes. The foundation is built on analog and readily available platforms in Russia that are easy to install and use, do not require significant financial investment or additional equipment, and yet are effective in transforming the learning experience. Options include utilizing the VKontakte ecosystem and its integrated applications: VK Run, VK Workouts, and VK Health for activity monitoring.

The program begins with initial testing, questionnaires, and data collection, for example using Yandex Forms, to assess the physical indicators of each student. This allows for the creation of teams of 5-7 people, taking into account their individual characteristics. Each session starts with a 15-minute warm-up using exercise complexes from the "quick workouts" section, which excellently prepares the body for subsequent loads. The main 60-minute block is then divided into two parts. The first half is dedicated to cardio exercises using a running application, which features special events such as monthly challenges to run a certain distance, for which rewards can be earned, allowing students to compete with classmates on the distance covered. The application tracks workout routes, step count, pace, active calories, and walking/running distance, enabling objective evaluation of each student's progress.

The second part is devoted to strength training, also facilitated by an application. The program offers various bodyweight workouts that require no special equipment and can be performed in a standard gym setting, along with exercises for all muscle groups with difficulty levels from easy to hard, providing students with a wide choice and allowing them to select the intensity based on their physical capabilities. Each exercise is accompanied by a detailed video instruction demonstrating correct technique, which reduces the risk of injury and ensures an appropriate

load. The final 15 minutes are allocated for flexibility and post-workout recovery exercises, which are also available in the application and ensure muscle relaxation and improved joint mobility. Throughout the entire process described above, data on the complete picture of the student's physical activity is transmitted to the "Health" application.

The competitive aspect is implemented within the applications themselves, where there is a list of each student's activity and even separate leaderboard tables comparing the activity of each user, allowing the most active student to take first place, ahead of others. There is also a system of achievements for regular attendance, for which virtual badges and awards can be earned, displayed in their profiles within the program. Thus, teachers can track the progress and effectiveness of students through such systems, and for additional motivation, they can reward the most active student, for example, with extra credit. The communication system can be implemented through closed VKontakte communities, where teachers can publish additional materials or advice, and students can ask questions and share their successes.

5 RESULTS

Following the implementation of this physical training program over a one-month period, both quantitative and qualitative indicators were obtained. The innovation involved the initial 157 students from a single faculty.

5.1 Key indicators

Attendance during the program modernization increased by 27%. Compared to standard practical classes in other groups over the same period, where students had two physical training sessions per week, those in the groups with the new training scheme started attending both sessions regularly, skipping none.

Physical performance also showed improvement. For instance, students began running a 500-meter distance 32% faster than before, and 17% more people were able to complete a 2-kilometer distance without significant fatigue compared to the standard groups.

Activity in the running app revealed that 20% of students performed cardio workouts beyond the mandatory program. The average running distance reached 1.5 kilometers, compared to 900 meters at the program's start. Additionally, 40% of participants regularly used extra strength training sessions, and the achievement system showed that by the end of the

observation period, students had earned at least 2 awards for their sports accomplishments. Data from the activity tracking program indicated that students' daily activity increased by 29%, with the average daily step count rising from 6,000 to 8,500 steps.

Academic performance in the "Physical Education" discipline improved from an average of 1.2 points per class to 1.8 points out of a maximum of 2. Furthermore, students were 30% more successful in passing the standardized tests required by the curriculum.

According to survey results, 71% of students reported increased motivation and interest in performing exercises and attending classes, attributing this to the introduction of technology and the competitive spirit fostered by the achievement system. They also noted the convenience of integrating workouts into their familiar digital environment.

5.2 Summary

Overall, this training program has demonstrated positive results and effectiveness, showing clear potential for scaling and integration into the standard curriculum. Future expansion could include enhancing the training functionality itself or incorporating personal monitoring devices, such as heart rate trackers, to further enrich the data-driven approach.

6 RISKS AND LIMITATIONS

The implementation of digital platforms for physical training carries inherent risks and limitations, which is characteristic of various innovations and technologies.

The effectiveness and accessibility of specialized applications depend on stable internet connectivity, and a session can become significantly problematic without a network connection. Furthermore, the platforms can occasionally experience data desynchronization with each other, which may require manual entry and assessment of one's results.

Research in the field of gamification shows that various game mechanics require constant updating and diversification; otherwise, user interest may not be sustained in the long term and can diminish over time. Additionally, students with lower fitness levels may struggle within a competitive system, becoming discouraged and consequently losing interest. This necessitates the refinement of adaptive competitions for different skill groups and a more personalized approach. Moreover, training for instructors on the correct use of the applications is essential, and the

level of digital literacy can vary across different age groups, complicating the digitalization process.

In addition to other factors, the process of modernizing education requires sustainable funding, and a crucial aspect will be ensuring equal access to technology for every student.

Ultimately, innovations always require adjustments, intensified effort, and detailed analysis of results, and meanwhile, they come with their own complexities. Therefore, taking these factors into account allows for the system to be refined, making it safer and more accessible.

6 CONCLUSION

Modern technology is actively transforming approaches to physical education. For students, digitalization is becoming a familiar and convenient tool that makes workouts more engaging and personalized. Through mobile applications and game mechanics, they gain the ability to track their progress, participate in competitions, and compare achievements with classmates.

The role of the instructor and coach in this system has significantly expanded. They are no longer just demonstrating exercises but also working with digital data, analyzing statistics, and helping students better understand their capabilities. However, maintaining balance is crucial – technology should complement, not replace, live interaction. Students value the opportunity to receive advice, support, and understanding from their instructor. An algorithm can never fully replace human involvement and professional intuition.

In practice, a thoughtful combination of technology and traditional training methods enables the creation of an effective and engaging physical training framework that considers the needs and interests of students.

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