

Testing of students' static balance development in physical education: ICT application

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Abstract:

The article presents a new approach to increasing the effectiveness of assessment at physical education classes among students of institutions of tertiary education, which meets the contemporary standards. The authors prove that innovative tendencies at the present stage of scientific and technological progress lead to powerful evolutionary changes in all fields of higher education. This has envisaged the launching of new ideas, application of new knowledge and the expansion of existing understanding. The article delves into the main ways of integrating information and communication technology into testing and analyses approaches to its successful implementation in the pedagogical testing system. The authors suggest the possibilities of reorganising the procedure of static balance testing by updating it through applying information and communication technology. For the first time, an innovative method of assessing the level of development of static balance, using a device that incorporates information and communication technology (devices and software), is presented. The scientific outcome is aimed at reorganising testing procedure and increasing the level of its information support. The practical value of the device presented in the article is that its application in the assessment of static balance, created using information and communication technology, unifies and intensifies the collection and processing of test results using the methods of multivariate mathematical analysis. The integration of information and communication technology, which serves as a toolkit to solve the problems of static balance testing, provides a new technological advance in the methods, didactics, organisation and practical implementation of assessment in the physical education of students.

Key words: information and communication technology; student; assessment; testing; physical education; static balance.

Introduction

The IT is an important factor for physical education development, which is based on interdisciplinary challenges of the use of information and communication technology (ICT). The relevance of the effective integration of ICT, oriented towards the effectiveness of the educational process in all fields of higher education, is conditioned by the need to solve urgent theoretical and practical problems. Therefore, the need to introduce innovations, fundamentally new approaches to the physical education of students, which would meet the current scientific requirements, is driven by the demands of innovative development, and the global advancement of ICT necessitates significant changes in all aspects of the organisation of this process. Following global innovation trends, reorganise the scientific component of physical education as a factor of ensuring their psychophysical readiness for fulfilling their professional duties.

There is a significant quantity of scientific research on the use of innovative technologies in the pedagogical practice of physical education (Anikieiev, 2015; Koryahin, et al., 2019; Kozhokar, et al., 2018). According to existing data (Koryahin, et al., 2020), the integration of ICT-related innovations in pedagogy as well as the theory and practice of physical education, is a significant contribution to the educational technologies of modern higher education institutions in order to increase their effectiveness. The researchers (Koryahin, Blavt, & Ponomaryov, 2019) emphasise the need to find ways to modernise and intensify physical education in tertiary education institutions utilising ICT.

A number of works consider the improvement of pedagogical assessment techniques as an important factor in refining the quality of physical education of students (Acar, & Eler, 2019; Di Tore, Schiavo, & D'isanto, 2016). The problems of ensuring the efficiency of physical education are constantly under scrutiny by scientists, experts and professionals (Bondarenko, et al., 2020; Kashuba, et al., 2017; Zavydivska, Zavydivska, & Khanikiants, 2019). Physical education assessment is positioned as an important component of managing this process. It has been proved that the effectiveness of this management depends on the objectivity and reliability of the assessment data, which is the basis for further planning, and therefore proves its effectiveness (Magill, &

Anderson, 2017). It is believed that management with all the assessment features such as different forms, methods, techniques and approaches, is one of those factors which provide the effectiveness of the process of physical preparation in the course of physical education of students (Zanevskyy, & Labartkava, 2020).

Experts (Kashuba, et al., 2017; Zanevskyy, & Zanevska, 2019) raise the question of the need for significant restructuring of information support for testing in physical education. The development and implementation of ICT in this process is believed to be a promising direction for improving the quality of assessment (Koryahin, Blavt, & Ponomaryov, 2019; Koryahin, et al., 2020).

A number of research articles (Anikieiev, 2015; Koryahin, et al., 2019; Nosirov, et al., 2020) justify the need for objectivity and promptness of assessment, which from a practical standpoint is determined by the importance of receiving and analysing the information about the status of the researched parameters at a certain stage of the physical education of students to increase the efficiency of physical education of students in general.

Active introduction of innovative technologies in the process of physical education corresponds to modern social development. Such a point of view makes it possible to ensure the progress of modernization in the physical education of students while studying at universities, which involves the transition to a qualitatively new level of its effectiveness (Koryahin, et al., 2020). The necessity to raise the level of scientific research in physical education by integrating them into the world practice of informatization is proved (García-Soidán, et al., 2020). As noted, the use of ICT on the basis of permanent informatization of physical education in general is a major factor in the above. It is determined that ICT in physical education is now one of the pedagogical innovations that perform the function of "supporting" the pedagogical process and open new technological opportunities as a means to achieve a high level of its effectiveness (Di Tore, Schiavo, & D'isanto, 2016). The practical significance of such developments lies in the possibility of ensuring the effectiveness and high efficiency of control procedures, the result of which is the obtaining of reliable measurement data. Their novelty lies in using the potential of modern ICT (Koryahin, Blavt, & Ponomaryov, 2019).

However, in spite of considerable interest in the researched area, today the Ukrainian theory and practice of pedagogy has a limited representation of the development of automated means for testing in physical education, the integration of which in this process will ensure its intensification. Given that the integration of ICT in the educational practice of higher education institutions is now a strategic direction in its development (Di Tore, Schiavo, & D'isanto, 2016; Koryahin, et al., 2020).and given the objective need to increase the use of ICT in assessing physical education of students in the context of higher education modernisation, *the purpose of the article is* to substantiate the implementation of ICT in assessing the ability to maintain students' static balance in the process of their physical education.

Materials and methods

Research methods. In order to achieve the purpose of the research, the need for the rapid adoption of innovations in the educational sector have been introduced, as well as conceptual provisions on the modernisation of approaches to the organisation, formation and realisation of the content of pedagogical evaluation (Mukan, Myskiv, & Kravets, 2016). The innovative idea involves the integration of interdisciplinary and complex approaches into the assessment of the physical education of students. The research strategy is focused on integrating the ICT resources to ensure assessment efficiency. The purpose has been to intensify the pedagogical assessment process, which greatly enhances its informativeness.

Organization of research. The study was implemented at the theoretical and empirical level. To achieve the objectives, the following methods were used. Specifically, the general scientific methods of theoretical level were the analysis and synthesis, and the methods used to obtaining empirical data were the pedagogical experiment, pedagogical testing mathematical methods for processing digital files, and system-functional analysis. To achieve the abovementioned goal, we have applied theoretical methods of analysis and synthesis, abstraction, formalisation, as well as applied method – scientific modelling.

Participants. The first-year students from Lviv Polytechnic National University suffering were selected for research. It is important that the number of students in the research groups was sufficient for the demonstrable evaluation of the experiment's results. The requirements for the adequacy of the information volume at the level of $p < 0.05$ were met. All procedures were conducted in accordance with approval of the Human Ethics committee of the Leon University, according to the declaration of Helsinki.

Statistical analysis. To determine the empirical authenticity of the tests, variance and correlation analysis (between the obtained test results and the correlation criterion) were used. Statistical processing of the obtained primary material was performed using IBM PC / AT "Pentium-IV" in Microsoft Windows XP Professional 2007 using the software package "Statistica 8.0."

Results

First of all, it should be noted that the implementation of ICT in the testing, which is widely used in physical education, in the context of our research has been applied on two levels. On the one hand, there have been innovative ideas, tools and methods, while on the other, the integration of ICT, which has caused a change in the elements of the pedagogical process, ensures the modernisation of the process of evaluation. Considering the above, the experimental study was aimed at eliminating a number of problematic factors (ensuring

promptness, objectivity of testing) associated with assessment using ICT (Koryahin, et al., 2020). The result of the scientific search was a developed means of testing of the ability to maintain a static equilibrium designed to intensify the pedagogical process of assessment in the physical education of students.

A summary analysis of the work done in the field of physical education theory (Badau, et al., 2021; García-Soidán, et al., 2020; Hua, et al., 2020) demonstrates that balance as a component of coordination skills has been in the focus of the specialists' attention. Coordination of the upright position of the body when standing is an indicator of the functional state of the body, correlated to the level of health. It has been proved that this is one of the best indicators of the functional state of the body, as the ability to maintain the stability of posture (balance) is vital, since performing even simple movements requires a sufficiently high level of development of organs of equilibrium (Acar, & Eler, 2019). The results of observations of the ability to maintain balance indicate a significant conditionality of these indicators by the functional state of the body, physical development and coordination abilities. Coordination abilities have been found to provide diagnostic informativeness, which is relevant for students, since the dynamics of their health is a determining factor in the course of physical education (Badau, et al., 2021).

Therefore, our research paper has been substantiated by the evidence (García-Soidán, et al., 2020) that the ability to maintain a stable body position is an important physiological factor that determines the effectiveness of students' physical fitness in their physical education. This has been evidenced by a number of fundamental studies of the vestibular analyser and its effect on maintaining equilibrium.

Upright equilibrium is a dynamic phenomenon and the result of the interaction of vestibular, visual and tactile analysers, joint and muscle proprioception and higher-order central nervous system. However, along with conditioned-reflex preconditions for the implementation of the function of body balance, constant training of organs and systems that provide stability of the body is essential. Any activity is largely determined by the ability to economically and with great efficiency to hold certain pose and rationally modify them, which generally determines its result. The ability to maintain a stable posture (equilibrium) in various positions of the body while performing movements is vital, since performing even relatively simple movements requires a sufficiently high level of development of the organs of equilibrium (Şimşek, & Şimşek, 2020).

Today, there are many ways to measure static balance – from simple testing exercises to sophisticated instruments (kefalography, basometry, statodynamography) (Magill, & Anderson, 2017). We will not dwell on the complex ways of measuring static balance, because they are time consuming and demonstrate predominantly scientific and cognitive interest, rather than practical and are therefore not used during the process of physical education of students.

Current techniques of testing equilibrium in physical education of students apply an indirect method. The Bondarevsky test is most widely used to assess static balance (MacDougall, Wenger, & Green, 2017). However, this method presumes a certain dependence of the subjective visual assessment of the expert's perception in standardisation of observance of the methodological requirements. There is a possibility of an error while timing the retention time of the required posture by the student using a stopwatch.

To assess the level of development of static balance, a portable device was developed using a built-in accelerometer (Mykytyuk, et al., 2019). This sensor is an element of the technical system and is intended to obtain information on the loss of a stable position by the subject of assessment, is connected via one of the known interfaces to the automatic log system. The device uses a mobile telecommunication system with a high-speed interface subsystem and in which the received signal is processed in real-time. The signals from the accelerometer sensor correspond to the dynamics of change in the position of the body and legs of the student, which allows to carry out reliable and effective real-time transmission of indicators of holding a stable position (static balance) (Fig. 1). The information recorded by the accelerometer is shown on the display in digital values and written to files that are stored on disk and are available for further processing.

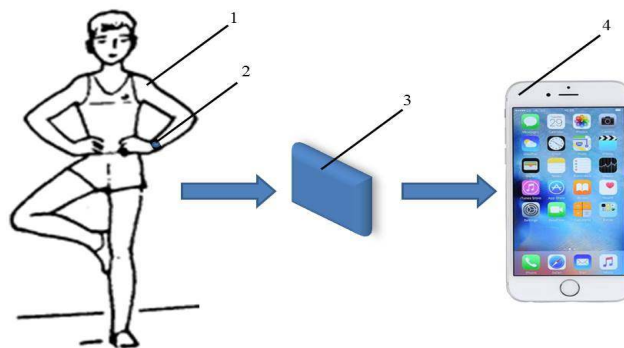


Fig. 1. Structural diagram of the method of assessing the level of development of static balance:
1 – the test subject (student), 2 – portable device with an accelerometer sensor, 3 – microcontroller,
4 – mobile telecommunication system.

Accelerometers are sensors belonging to the class of microelectromechanical systems (Wojcik, et al., 2020). The feasibility of their application in our design is that they enable compact solutions that require considerable computing resources. Accelerometers have a number of options that make them ideal for low- and ultra-low power consumption systems. These include a simple interface with the host system, low power modes, standby mode, automatic switching to active mode, multiple configurable operating modes. In addition, the feasibility of using it in a developed device is boosted by miniature size, light weight, high precision conversion rate, compatibility with wireless devices for transmitting information (Bluetooth) due to digital output. (Mykytyuk, et al., 2019).

An accelerometer-inclinometer is used to determine the spatial position change of a particular object. Its functional purpose in our device is to ensure the high accuracy and precision of the exercise causing no discomfort for the student. In addition, since the accelerometer can generate two independent signals: triggered by overcoming the threshold and triggered by changing its position, they are used in the design of the testing device. In our device, we used the integrated circuits manufactured by Analog Devices, with integrated micro electro-mechanical system (iMEMS) process (Wojcik, et al., 2020). The Bluetooth system in the device transmits information and intensifies the testing process.

Assessing static equilibrium is conducted by attaching a portable autonomous device with an accelerometer with digital output to the student's body. The developed device allows to record the moment of beginning of the test task, the dynamics of holding a stable pose (process of performance) and the time of completion. The signal received by the accelerometer sensor is processed by the microcontroller. The signals from wireless infrared communication devices are then transmitted to the mobile telecommunication system, where, using the developed software, the student's performance of the assessment is monitored and managed. The received signal is processed by the microcontroller and sent to the PC via Bluetooth. It is possible to assess multiple students individually using one PC.

Software is used to automate the process of logging assessment information and to process the final assessment data automatically. The function of this provision is to form an integrated database, which facilitates their replication, processing and interactive analysis using statistical and mathematical methods and algorithms. The interface provides a high level of ergonomic properties of the devices and the ability of professionals to work effectively with test data. Further archiving takes place in the storage and data processing centres and is accessible to each student in a personalised text file.

The maximum effect from the use of ICT is achieved through a comprehensive approach when different information systems interact with each other (Dai, et al., 2019; Koryahin, et al., 2020). This is the kind of approach that has been applied in our software infrastructure. The software verified the functioning of the developed electronic system of the device in real time, examined the basic modes of operation and selected the parameters of the circuit elements. The software implements prompt processing of the obtained assessment results using the methods of multivariate mathematical analysis. In this way, the analysis of the obtained testing results with a visual form of presentation is generated. The latter guarantees a convenient access to the results obtained, their dynamics and the account of the summary information during the physical education period, which significantly increases the informative content of the assessment.

The integrity of the abovementioned factors provides for the modernisation and intensification of the test process, long-term monitoring with constant updates of processing results. This allows to keep track of each student's testing results. Thus, the use of ICT-integrated testing devices not only assesses the required parameters, but also effectively analyses and interprets the large amounts of quantitative information received.

For the practical substantiation of the offered means of control of static balance, the pedagogical experiment on calculation by the correlation analysis of authenticity of the test of control of static balance with use of the Bondarevsky test was carried out. Determination of such a complex characteristic of the test was used to obtain information about the degree of representativeness of the research procedure. For this purpose, the test results of students I-VI were registered in the traditional way and using the developed device (Table 1).

Table 1. Authenticity of student balance control tests (n - 436)

H/B	Curriculum /Authenticity of tests (rtt)											
	I		II		III		IV		V		VI	
	M	A	M	A	M	A	M	A	M	A	M	A
H	0,759	0,977	0,638	0,752	0,645	0,730	0,652	0,884	0,823	0,910	0,676	0,830
B	0,451	0,598	0,227	0,512	0,297	0,545	0,333	0,567	0,423	0,510	0,246	0,521

Note: H - reliability of the test, B - validity of the text; M - the traditional way, A - using the developed tool

According to the calculations, the reliability coefficient of the static equilibrium test used in the study, the results of which were recorded in the traditional way, is between low and medium, which is considered acceptable. The coefficient of validity, the conformity to what is measured by this method, because it must be measured, determined by the traditional method, obtained by the traditional method is in the range of low and medium. By changing the way the results are recorded, we have achieved that the test validity has reached a high level.

In the obtained values of the degree of authenticity of the tests there is a change in the degree depending on the method of recording the results. Based on the results obtained, we can conclude that the reliability of the same test depends on the method of recording the results.

Discussion

Consequently, the conducted research expands and supplements the existing information (Anikieiev, 2015; Koryahin, et al., 2019; Mukan, Noskova, & Baibakova, 2017) on the effective physical education of students, which is recognised by scholars as historically one of the primary significant pedagogical problems and, at the same time, the focus of the innovative pedagogical movement. Our research supports scientific approaches to the landmarks (Kashuba, et al., 2017; Koryahin, et al., 2020; Kozhokar, et al., 2018) of the transition to a new educational paradigm, which imply a rethinking of the doctrine of physical education at the level of European quality, its corresponding modernisation of content and optimisation of its technological provision to raise standards.

We support the idea of the need for innovations, fundamentally new approaches to the development of assessment theory in physical education. The latter is considered as a significant mechanism of influence and management in the course of physical education (Banakh, 2019; Zavydivska, Zavydivska, & Khanikiants, 2019). The results of the study supplement the data on pedagogical assessment in physical education of students (Acar, & Eler, 2019; Di Tore, Schiavo, & D'isanto, 2016).

Our study is consistent with the information available on the relevance of ICT integration in students' physical education, which is due to a number of problematic aspects in the implementation of testing, which, accordingly, reduce the effectiveness of physical education (Koryahin, Blavt, & Ponomaryov, 2019; Zanevskyy, & Labartkava, 2020). According to the research (Koryahin, et al., 2020), the introduction of innovations in the assessment process is considered as an opportunity to improve the efficiency of physical education which is consistent with the provisions on the urgency of creating an information and educational environment in physical education to ensure the quality of higher education for student youths (Anikieiev, 2015; Di Tore, Schiavo, & D'isanto, 2016).

Conclusions

The rapid introduction of the latest technologies into the educational process of higher education is in line with modern social development and is the most important strategic priority for the sustainable development of the industry. This is considered in the context of ICT, in accordance with the requirements of time and innovative progress of science and technology.

The research is substantiated by the necessity of ensuring objectivity of the test process as an integral element of expedient construction of physical education of students and an important factor in managing its performance. The intensive development of scientific and technical process, strengthening its influence in modern science, necessitates a significant improvement in the quality of scientific research and the implementation of dramatic changes in the organisation and examination of the results of physical education. We offer a new approach to the study of assessment in this area of knowledge.

The scientific novelty of the results of this research is that for the first time the software of assessment of static balance of students in the process of their physical education, developed on the basis of ICT, is presented. The primary purpose of a representative means of assessment is to unify and intensify the process of obtaining and processing test results. Its integration into the test process provides the processing of information and structuring it in the form of a database in real time, which makes it possible to effectively solve a number of topical pedagogical tasks in the course of physical education of students of the tertiary education institutions. The latter is a testament to a new generation of ICTs that can significantly improve the quality of physical education and intensify the work of professionals.

The practical significance of the static equilibrium assessment device presented in this paper is the possibility to ensure promptness and high efficiency of the testing procedure, which results in obtaining reliable measurement data. Its novelty lies in harnessing the potential of modern ICT, which provides a mechanism for achieving prompt, rational and purposeful results. The latter is the basis for obtaining objective and versatile information for the effective management in the physical education process.

Conflict of interest

The authors state no conflict of interest.

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